To Relevant Government Agencies, Statutory Boards, Professional Engineers, Licensed Plumbers, M&E Consultants, Associations and Organisations

Dear Sir/Madam

(A) WATER SAMPLING REQUIREMENTS FOR NEW DEVELOPMENTS
(B) INDICATION OF PIPE JOINING METHODS

This circular is to inform water service workers (i.e. Professional Engineers/Licensed Water Service Plumbers) of the following new requirements to be complied with in carrying out water service work.

(A) WATER SAMPLING REQUIREMENTS FOR NEW DEVELOPMENTS

2 Currently, upon disinfection of the water service installation, water service workers are required to carry out water sampling from water storage tanks and water service pipes for bacteriological and chemical testing by a SAC-SINGLAS accredited testing laboratories.

3 For Notification of Water Service Work for new developments submitted to PUB from 1 Dec 2016, in addition to the existing bacteriological and chemical tests conducted for water storage tanks, water service workers are required to carry out additional water sampling tests for leaching of heavy metals. A 1-litre water sample is to be taken as a first drawn sample (i.e without flushing) from the water service installation after the water has been left stagnant in the water service installation for at least 24 hours. The heavy metals to be tested and their maximum allowable concentration are indicated below:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Max. allowable concentration (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony</td>
<td>0.02</td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.01</td>
</tr>
<tr>
<td>Barium</td>
<td>0.7</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.003</td>
</tr>
<tr>
<td>Chromium</td>
<td>0.05</td>
</tr>
<tr>
<td>Lead</td>
<td>0.01</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.006</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.07</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.01</td>
</tr>
<tr>
<td>Silver</td>
<td>0.01</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.4</td>
</tr>
<tr>
<td>Copper</td>
<td>2</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0.07</td>
</tr>
</tbody>
</table>
4 Water samples for leaching of heavy metals tests shall be taken from the following sampling points:

<table>
<thead>
<tr>
<th>Type of Development</th>
<th>Water Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) New development with</td>
<td>Taken from at least one potable water tank and one terminal fitting (eg. tap/mixer) per development</td>
</tr>
<tr>
<td>potable water tanks</td>
<td></td>
</tr>
<tr>
<td>b) New Development without</td>
<td>Taken from at least one terminal fitting (eg. tap/mixer) per development</td>
</tr>
<tr>
<td>potable water tanks</td>
<td></td>
</tr>
</tbody>
</table>

5 The water sample(s) shall be collected by water service workers and tested by a SAC-SINGLAS accredited laboratory prior to the application of the Temporary Occupation Permit (TOP) for the development. The water service worker shall check and ensure that the results of the water sampling tests are satisfactory before the water service installation is put into use. These satisfactory test results shall be kept by the water service worker and shall be produced for verification purposes as and when requested by PUB.

(B) INDICATION OF PIPE JOINING METHODS

6 For Notification of Water Service Work for new developments submitted to PUB from 1 Dec 2016, water service workers are required to indicate clearly in their submission drawings the joining methods (eg. brazed joints, press fit joints, compression joint, mechanical joint, etc.) used in the water service installation. Water service workers are reminded to ensure that no lead soldering alloys are used in these joints.

7 For any further clarification, please contact the following officers:

<table>
<thead>
<tr>
<th>Name of Officer</th>
<th>Contact No</th>
<th>Email address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee Cai Jie</td>
<td>67313250</td>
<td><a href="mailto:lee_cai_jie@pub.gov.sg">lee_cai_jie@pub.gov.sg</a></td>
</tr>
<tr>
<td>Tham Tuck Kuan</td>
<td>67313622</td>
<td><a href="mailto:tham_tuck_kuan@pub.gov.sg">tham_tuck_kuan@pub.gov.sg</a></td>
</tr>
<tr>
<td>Olivia Teo (Ms)</td>
<td>67313967</td>
<td><a href="mailto:olivia_teo@pub.gov.sg">olivia_teo@pub.gov.sg</a></td>
</tr>
<tr>
<td>Ow Zhao Hui</td>
<td>67313934</td>
<td><a href="mailto:ow_zhao_hui@pub.gov.sg">ow_zhao_hui@pub.gov.sg</a></td>
</tr>
</tbody>
</table>

Yours faithfully

MICHAEL TOH
DIRECTOR
WATER SUPPLY (NETWORK) DEPARTMENT
Stipulation of Standards & Requirements for Water Fittings for Use in Potable Water Service Installations
## Contents

<table>
<thead>
<tr>
<th>Items</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Introduction</td>
<td>4</td>
</tr>
<tr>
<td>2  Compliance and non-compliance of water fittings</td>
<td>5</td>
</tr>
<tr>
<td>3  Review of Standards and Requirements</td>
<td>6</td>
</tr>
<tr>
<td>4  General Conditions that Apply to All Fittings</td>
<td>8</td>
</tr>
<tr>
<td>Stipulated Standards and Requirements</td>
<td></td>
</tr>
<tr>
<td>5  Water Storage Tanks</td>
<td></td>
</tr>
<tr>
<td>5.1 Fiberglass Integral Water Storage Tank</td>
<td>9</td>
</tr>
<tr>
<td>5.2 FRP / GRP Sectional Water Storage Tank (Minimum Grade 316)</td>
<td>10</td>
</tr>
<tr>
<td>6  Water Pipes and Pipe Fittings</td>
<td></td>
</tr>
<tr>
<td>6.1 Acrylonitrile Butadiene Styrene (ABS) Pipes and Fittings</td>
<td>10</td>
</tr>
<tr>
<td>6.2 Cement Lined Ductile Iron Pipes and Fittings</td>
<td>10</td>
</tr>
<tr>
<td>6.3 Chlorinated Polyvinyl Chloride (PVC-C) Pipes and Fittings</td>
<td>11</td>
</tr>
<tr>
<td>6.4 Compression and Capillary Pipe Fittings</td>
<td>12</td>
</tr>
<tr>
<td>6.5 Copper Tubes</td>
<td>12</td>
</tr>
<tr>
<td>6.6 Copper/Copper Alloy or Stainless Steel Mechanical Jointing End</td>
<td>13</td>
</tr>
<tr>
<td>Connectors</td>
<td></td>
</tr>
<tr>
<td>6.7 Crosslinked Polyethylene (PE-X) Pipes and Fittings</td>
<td>13</td>
</tr>
<tr>
<td>6.8 Galvanised Iron / Malleable Iron Pipe Fittings with Plastic Core</td>
<td>14</td>
</tr>
<tr>
<td>6.9 Glass Reinforced Plastics (GRP) Pipes and Fittings</td>
<td>14</td>
</tr>
<tr>
<td>6.10 Light Gauge Stainless Steel Tubes (Minimum Grade 304)</td>
<td>16</td>
</tr>
<tr>
<td>6.11 Malleable Cast Iron Pipe Fittings with Plastic Core</td>
<td>16</td>
</tr>
<tr>
<td>6.12 Multilayer Pipes of Polybutylene (PB), Polyethylene of Raised</td>
<td>17</td>
</tr>
<tr>
<td>Temperature (PE-RT), Crosslinked Polyethylene (PE-X), Polypropylene</td>
<td></td>
</tr>
<tr>
<td>(PP) and Chlorinated Poly(Vinyl Chloride) (PVC-C) and Their Associated</td>
<td></td>
</tr>
<tr>
<td>Fittings</td>
<td></td>
</tr>
<tr>
<td>6.13 Polybutylene (PB) Pipes and Fittings</td>
<td>18</td>
</tr>
<tr>
<td>6.14 Polyethylene (PE) Pipes and Fittings</td>
<td>18</td>
</tr>
<tr>
<td>6.15 Polypropylene (PP) Pipes and Fittings</td>
<td>20</td>
</tr>
<tr>
<td>6.16 Stainless Steel Pipes and Tubes (Minimum Grade 304)</td>
<td>20</td>
</tr>
<tr>
<td>6.17 UPVC Lined Steel Pipes</td>
<td>21</td>
</tr>
<tr>
<td>6.18 UPVC Pipe Fittings</td>
<td>21</td>
</tr>
<tr>
<td>6.19 UPVC Pipes</td>
<td>21</td>
</tr>
</tbody>
</table>
### Valves

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Anti-vacuum Valves</td>
<td>22</td>
</tr>
<tr>
<td>7.2</td>
<td>Copper Alloy / Ductile Iron Float Operated Valves (Diaphragm type)</td>
<td>22</td>
</tr>
<tr>
<td>7.3</td>
<td>Copper Alloy / Ductile Iron Float Operated Valves (Piston type)</td>
<td>23</td>
</tr>
<tr>
<td>7.4</td>
<td>Copper Alloy / Ductile Iron Water Pressure Reducing Valves</td>
<td>23</td>
</tr>
<tr>
<td>7.5</td>
<td>Copper Alloy And Stainless Steel Ball Valves (DN 8 to DN 100)</td>
<td>23</td>
</tr>
<tr>
<td>7.6</td>
<td>Copper Alloy Gate, Globe and Check Valves</td>
<td>24</td>
</tr>
<tr>
<td>7.7</td>
<td>Copper Alloy Solenoid Valves</td>
<td>24</td>
</tr>
<tr>
<td>7.8</td>
<td>Draw-off Taps and Stopvalves (Screw-down pattern)</td>
<td>24</td>
</tr>
<tr>
<td>7.9</td>
<td>Ductile Iron Butterfly Valves</td>
<td>25</td>
</tr>
<tr>
<td>7.10</td>
<td>Ductile Iron Check Valves (10 mm - 1000 mm)</td>
<td>25</td>
</tr>
<tr>
<td>7.11</td>
<td>Ductile Iron Gate Valves</td>
<td>25</td>
</tr>
<tr>
<td>7.12</td>
<td>Ductile Iron Globe and Check Valves (10 mm - 450 mm)</td>
<td>26</td>
</tr>
<tr>
<td>7.13</td>
<td>Ductile Iron Solenoid Valves</td>
<td>26</td>
</tr>
</tbody>
</table>

### Taps and Mixers

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>Single Taps and Combination Taps</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Mechanical Mixers</td>
<td>28</td>
</tr>
<tr>
<td>8.2</td>
<td>Thermostatic Mixing Valves (up to 50mm)</td>
<td>29</td>
</tr>
<tr>
<td>8.3</td>
<td>Thermostatic Mixers (15mm &amp; 22 mm)</td>
<td>30</td>
</tr>
</tbody>
</table>

### Others

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>Constant Flow Regulators</td>
<td>31</td>
</tr>
<tr>
<td>9.2</td>
<td>Copper Alloy / Ductile Iron Y-Pattern Strainer</td>
<td>31</td>
</tr>
<tr>
<td>9.3</td>
<td>Dual Flush Water Closets Flushing Cisterns</td>
<td>32</td>
</tr>
<tr>
<td>9.4</td>
<td>Ductile Iron Flange Adaptor (with / without rubber expansion joints)</td>
<td>33</td>
</tr>
<tr>
<td>9.5</td>
<td>Metallic and Non-Metallic Flexible Connecting Tubes (For hot and cold water)</td>
<td>33</td>
</tr>
<tr>
<td>9.6</td>
<td>Requirements for Urinal Flush Valves under Water Efficiency Labelling Scheme (WELS)</td>
<td>34</td>
</tr>
<tr>
<td>9.7</td>
<td>Requirements for WC flush valves</td>
<td>42</td>
</tr>
<tr>
<td>9.8</td>
<td>Steel Flange Adaptor (with / without rubber expansion joints)</td>
<td>54</td>
</tr>
<tr>
<td>9.9</td>
<td>Toilet Seat With Bidet</td>
<td>54</td>
</tr>
<tr>
<td>9.10</td>
<td>Water heaters</td>
<td>55</td>
</tr>
</tbody>
</table>
1 Introduction

This document is to provide for suppliers, retailers and installers of water fittings such as:

- pipes
- pipe fittings
- valves
- taps/mixers
- urinal flush valves
- flush valves for water closets (WCs)
- dual-flush low capacity flushing cisterns (LCFCs)
- coating/lining materials in contact with potable water
- water storage tanks

The guidance on the standards and requirements stipulated by PUB for such water fittings to comply with before they can be offered for sale, displayed or advertised for use in potable water service installations.

All water fittings such as pipes, pipe fittings, valves, taps/mixers, urinal flush valves, flush valves for WCs, dual-flush low capacity flushing cisterns, materials, etc. for use in potable water service installations in Singapore shall comply with the standards and requirements stipulated by PUB.

Prior PUB approval for the water fittings is not required but suppliers, retailers and installers shall ensure that the water fittings comply with the standards and requirements stipulated by PUB and that their installation and use in potable water service installations conform to the Public Utilities (Water Supply) Regulations and Singapore Standard CP48 : Code of Practice for Water Services.

For flush valves and flushing cisterns, suppliers, retailers and installers of such fittings shall ensure compliance with the requirements on backflow prevention and wastage of water as stipulated in the Public Utilities (Water Supply) Regulations and the Singapore Standard CP48: Code of Practice for Water Services.

For enquiries
Inspectorate Branch
Water Supply (Network) Department
PUB
40 Scotts Rd #10-01
Environment Building
Singapore 228231

Telephone: 65172925 / 65172928 / 65172932 / 65172934 / 68852521 / 68852972
Fax: 68852442
E-mail: pub_waterfittings@pub.gov.sg
2 What is deemed as a compliant water fitting?

A water fitting shall be deemed to comply with the stipulated standards if it is certified or tested as complying with such standards by a conformity assessment body (product certification body/testing laboratory) accredited by the Singapore Accreditation Council (SAC) or its Mutual Recognition Arrangement (MRA) partners. Separate approval from PUB for the water fitting is not required. However, fittings must be supported with valid, complete and full test reports and certificates. Test reports and certificates issued by a product certification body/testing laboratory accredited by the SAC or its MRA partners must bear the SAC-SINGLAS logo or the logo of the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement (ILAC-MRA) respectively.

Suppliers, retailers and installers shall ensure that these test reports and certificates of all the water fittings which they offer for sale, advertise, display, sell or supply are properly kept and must be produced for verification upon request by PUB.

Please note that PUB will not accept any test report or certificate issued by a product certification body/testing laboratory (notwithstanding that the certification body/testing laboratory is accredited by the SAC or its MRA partners) if the test report or certificate does not bear the SAC-SINGLAS logo or the logo of the ILAC-MRA partner. PUB continues to conduct checks and will take action against non-compliance.

Non-Compliance of Water Fittings

It is an offence under the Public Utilities (Water Supply) Regulations to offer for sale, advertise, display, sell or supply or install non-compliant water fittings.

All water fittings which are installed by the Licensed Plumbers must comply with PUB’s stipulated requirements and Standards and its use in water service installations conform to the Public Utilities (Water Supply) Regulations and Singapore Standard CP 48 : Code of Practice for Water Services.

PUB will conduct surveillance inspections and will not hesitate to take action against non-compliance. The penalty for the offence is a fine not exceeding $10,000 or imprisonment for a term not exceeding 12 months or to both.
3 Review of Standards and Requirements

PUB reviews the standards and requirements stipulated for water fittings from time to time to allow for innovation and changes in technology and to ensure relevance.

The testing requirements stipulated by PUB address 3 Main Concerns below:

1. Water Wastage
2. Water Contamination
3. Reliability/Integrity/Durability

Water fittings that fail or break down during the tests in accordance with the relevant Standards and requirements that PUB stipulates means that they fail to address the concerns above.

If standards and requirements for a water fitting are not stipulated in this document, the supplier or retailer shall approach PUB to stipulate the necessary standards and requirements for compliance.

The water fitting / coating materials / lining materials in contact with potable water will be assessed based on, not limited to, its installation and use, its working principles, its materials, its working principles, etc. PUB has the rights to disallow its use or stipulate the standards and requirements as it deems fit for such water fittings to comply with, before it can be offered for sale, advertised, displayed, sold or supply.

Please note that when the standards and requirements have been stipulated for the water fitting you are enquiring for, it does not constitute as approval or clearance on the use of the water fitting for potable water service installations. Suppliers, retailers and installers shall ensure that the water fitting are tested for compliance with the standards and requirements stipulated by PUB before it can be offered for sale, advertised, displayed, sold or supply.

The following documents are to be provided to Water Fittings Section for assessment and evaluation:

- Type of product (e.g. pipes, pipe fittings, valves, coating/lining materials, etc.), brand, model, size (if any);
- Describe the working principle/specific use of the product with complete drawings/photos showing the internal parts of the mechanisms, materials, etc.;
- The manufacturer and country of origin of the product;
- For pipes/pipe fittings, provide full details of the materials, jointing method, etc.;
- For coating / lining materials in contact with potable water, please provide the materials
- International Standards (e.g. BS, BS EN, ISO, AS/NZS, etc.) that the product has been fully tested for compliance with. Full details of the test carried out on the product are also required.
- Any other information as and when requested by PUB.

If necessary, a sample of the product is to be furnished to Water Fittings Section for examination. Please note that all of the above documents/information shall be in English language.
Requests for stipulation of standards and requirements can be submitted to:

Water Fittings Section
Inspectorate Branch
Water Supply (Network) Department
PUB
40 Scotts Rd #10-01
Environment Building
Singapore 228231
Telephone: 65172925 / 65172928 / 65172932 / 65172934 / 68852521 / 68852972
Fax: 68852442
E-mail: pub_waterfittings@pub.gov.sg
4  IMPORTANT : GENERAL CONDITIONS THAT APPLY TO ALL FITTINGS

Stipulated Standards and Requirements that Apply to All Water Fittings, whichever applicable:

1. All water fittings shall be legibly marked with the following information where applicable:
   a) Manufacturer’s identification mark, brand name or logo either on body or plate
   b) Marking of the Standard eg. BS EN 545 : 2010. (if the Standard so requires)
   c) Nominal size and direction of flow
   d) Colour code for hot and cold water supply

2. All non-metallic material in contact with water shall comply with SS 375 : 2001 or BS 6920 : 2000 and clause 8 of SS 375 : Part 1 : 2001. For non-metallic materials intended for use in hot water applications, the temperature used for the High Temperature Tests shall be the maximum temperature for which the non-metallic materials are designed for and declared/specified by the manufacturer. In the absence of any documented declaration of this maximum temperature by the manufacturer, the temperature used for the High Temperature Tests shall be the highest specified by the SS 375 : 2001 or BS 6920:2000. The non-metallic materials shall only be used in a potable water reticulation system with maximum water temperature not exceeding the temperature at which the non-metallic materials were tested and found complying with in the High Temperature Tests. Non-metallic seat washers shall also comply with BS 3457 : 1973.

3. All metallic material in contact with water shall comply with the test on 'Extraction of Metals - App H' of AS/NZS 4020 : 2005. The maximum allowable concentrations of metals listed in Table 2 of AS/NZS 4020:2005 shall not exceed the limits specified by the World Health Organisation (WHO) Guidelines for Drinking Water Quality.

4. All copper alloy water fittings except for exposed terminal fittings shall be of gunmetal, bronze or DZR brass materials only. For gunmetal or bronze fittings, they shall comply with BS EN 1982 : 2008^4. Those which are of Dezincification resistant type (DZR) shall comply with the tests on 'Composition' and 'Resistance to dezincification' of BS EN 12163 : 1998 or BS EN 12165 : 1998 or BS EN 12420 : 1999. Such fittings shall have an additional marking of ‘DZR’ or ‘CR’. CW602N is the material composition designation for copper alloy with dezincification resistance in accordance with BS EN 12163 : 1998 or BS EN 12165 : 1998 or BS EN 12420 : 1999.

5. All elastomeric seals for joints in pipework, pipelines, water fittings and valve seats for the flushing mechanism of the WC flushing cisterns shall comply with SS 270 : 1996.

6. All other water fittings incorporated in the water fitting shall comply with the relevant Standards stipulated by PUB.

7. All water fittings shall comply with the Standards stipulated by PUB and its use in water service installations shall conform to the Public Utilities (Water Supply) Regulations and Singapore Standard : CP 48.

8. All water fittings shall also comply with all other relevant statutory requirements.

Note 1 : For items 2 to 5 above, the materials shall be supported with a complete, full and valid test report showing compliance with the stipulated standards. Partial/combined test reports are not acceptable.
STIPULATED STANDARDS AND REQUIREMENTS

5 Water Storage Tanks – Fibreglass Integral Water Storage Tank

<table>
<thead>
<tr>
<th>5.1</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SS 245 : 1995</td>
<td>Full compliance</td>
</tr>
</tbody>
</table>

The water storage tank shall be certified by a Professional Engineer to be structurally sound with regard to hydrostatic, deflection and leakage.

In addition, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

Water Storage Tanks – FRP / GRP Sectional Water Storage Tank

<table>
<thead>
<tr>
<th>5.2</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SS 245 : 1995</td>
<td>Full compliance:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Construction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Dimensions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Visual Defects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Physical properties of GRP panels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Hydrostatic test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Leakage test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Deflection test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Luminous transmittance test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Marking</td>
</tr>
</tbody>
</table>

In addition, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.
### Stainless Steel Sectional Water Storage Tank (Minimum Grade 316)

5.3 **Standards* to comply with** | **Tests**
---|---
BS EN 10088 Part 2 : 1995 | Chemical composition for Nitrogen is not required.  
The water storage tank shall be certified by a Professional Engineer to be structurally sound with regard to hydrostatic, deflection and leakage.  
All associated fittings of a stainless steel tank of grade 316 in contact with potable water shall be similarly stainless steel of grade 316.  
In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable

### Water Pipes and Pipe Fittings

#### Acrylonitrile Butadiene Styrene (ABS) Pipes and Fittings

6.1 **Standards* to comply with** | **Tests**
---|---
-Cheemical composition for Nitrogen is not required  
In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable

#### Cement Lined Ductile Iron Pipes and Fittings

6.2 **Standards* to comply with** | **Tests**
---|---
BS EN 545:2010 | - Pipe Dimensions  
- Straightness of Pipes  
- Tensile Test  
- Brinell Hardness Test  
- Zinc Mass  
- Thickness of Paint Coatings  
- Thickness & Surface Condition of Cement Mortar Lining  
- Compressive Strength of Cement Mortar Lining  
- Works Leak Tightness for Pipes & Fittings  
- Leak Tightness of Flexible Joints to Positive Internal Hydrostatic Pressure
6.2 Standards* to comply with  | Tests |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Leak Tightness of Flexible Joints to Negative Internal Pressure</td>
<td></td>
</tr>
<tr>
<td>- Cyclic Internal Hydraulic Pressure</td>
<td></td>
</tr>
<tr>
<td>- Leak Tightness and Mechanical Resistance of Flanged Joints</td>
<td></td>
</tr>
<tr>
<td>- Leak Tightness and Mechanical Resistance of Pipe Saddles to Positive Internal Pressure</td>
<td></td>
</tr>
<tr>
<td>- Leak Tightness and Mechanical Resistance of Pipe Saddles to Negative Internal Pressure</td>
<td></td>
</tr>
<tr>
<td>- Microstructure</td>
<td></td>
</tr>
<tr>
<td>BS EN 598:2007**</td>
<td>- Diametral Stiffness of Pipe test</td>
</tr>
<tr>
<td></td>
<td>- Abrasion Resistance test</td>
</tr>
</tbody>
</table>

**With effect from 1 Sep 2015, cement lining of ductile iron pipes and fittings complying with BS EN 545:2010 for the supply of potable water shall also comply with Diametral Stiffness of Pipe test and Abrasion Resistance test under BS EN 598:2007.

With effect from 1 Sep 2015, only the following pipe sizes and Classes of cement lined DI pipes and fittings as listed in Table below shall be allowed for display, advertisement, sale, supply and installation in potable water service installations in Singapore.

<table>
<thead>
<tr>
<th>Nominal Diameter (DN)</th>
<th>Pipe Classes under BS EN 545:2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤150mm</td>
<td>C100</td>
</tr>
<tr>
<td>200 to 250mm</td>
<td>C64 or C100</td>
</tr>
<tr>
<td>300mm</td>
<td>C50 or C64 or C100</td>
</tr>
</tbody>
</table>

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable

**Chlorinated Polyvinyl Chloride (PVC-C) Pipes and Fittings**

6.3 Standards* to comply with  | Tests |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BS 7291 Part 1 : 1990</td>
<td></td>
</tr>
<tr>
<td>BS 7291 Part 4 : 1990</td>
<td>Full compliance</td>
</tr>
</tbody>
</table>

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable
### Compression and Capillary Pipe Fittings

<table>
<thead>
<tr>
<th>6.4</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
|     | BS EN 1254-1:1998 (Fittings with ends for capillary soldering or capillary brazing) | - Leaktightness under internal hydrostatic pressure  
- Stress corrosion resistance test  
- Carbon content test  
- Carbon film test |
|     | BS EN 1254-2:1998 (Fittings with compression ends) | - Leaktightness under internal hydrostatic pressure (Type A & B)  
- Resistance to pullout (Type A & B)  
- Leaktightness under internal hydrostatic pressure whilst subjected to bending (Type A only)  
- Stress corrosion resistance test |

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

### Copper Tubes

<table>
<thead>
<tr>
<th>6.5</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
|     | BS EN 1057 : 2006 | Full compliance:  
- Dimensions And Tolerances  
- Composition Analysis  
- Tensile Test  
- Vicker's Hardness Test  
- Carbon Content Test  
- Carbon Film Test  
- Bending Test  
- Drift Expanding Test  
- Flanging Test  
- Freedom From Defects Test  
- Hydrostatic Test |

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.
Copper/Copper Alloy or Stainless Steel Mechanical Jointing End Connectors

<table>
<thead>
<tr>
<th>6.6</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
|     | BS EN 1254-2:1998          | - Leaktightness under internal hydrostatic pressure  
|     | AS 3688 : 2006            | - Resistance to pullout   
|     |                            | - Leaktightness under internal hydrostatic pressure whilst subjected to bending  
|     |                            | - Stress corrosion resistance test  
|     |                            | - Determination of mean depth of dezincification |
|     |                            | - Strength of Joint Assembly (Pressure Cycling Test)  
|     |                            | - Resistance To Pull-Out Of Assembled Joints  
|     |                            | - Method Of Determining Compatibility Of Fittings With Pipe |

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

Crosslinked Polyethylene (PE-X) Pipes and Fittings

<table>
<thead>
<tr>
<th>6.7</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
|     | BS 7291 : Part 1 : 2010    | - Long-term hydrostatic strength of pipes  
|     |                            | - Hydrostatic pressure resistance of assembled pipes and fittings  
|     |                            | - Resistance to thermal cycling of assembled pipes and fittings  
|     |                            | - Resistance to cyclic pressure shock of assembled pipes and fittings  
|     |                            | - Opacity  
|     |                            | - Oxygen permeability |
|     | BS 7291 : Part 3 : 2010    | - Dimensions  
|     |                            | - Degree of cross-linking  
|     |                            | - Elongation  
|     |                            | - Short-term hydrostatic  
|     |                            | - Pressure resistance of pipe at 95°C  
|     |                            | - Short-term hydrostatic pressure resistance at 20°C of assembled fittings & pipes  
|     |                            | - Resistance to pull-out of assembled joint  
|     |                            | - Resistance to vacuum |

PE-X pipes and joint fittings to be laid concealed and any leaks along such pipes and joint fittings shall be detectable using commonly available devices. The supplier of such pipes and fittings shall ensure after sales service in terms of provision of equipment and trained personnel for pipe location and leak detection.
<table>
<thead>
<tr>
<th>6.7</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>

Galvanised Iron / Malleable Iron Pipe Fittings with Plastic Core

<table>
<thead>
<tr>
<th>6.8</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BS 143 &amp; 1256 : 2000</td>
<td>Full compliance</td>
</tr>
</tbody>
</table>

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable

Glass Reinforced Plastics (GRP) Pipes and Fittings

<table>
<thead>
<tr>
<th>6.9</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BS EN 1796:2006+A1:2008</td>
<td>For GRP pipes:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Dimensions &amp; tolerances</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Initial specific ring stiffness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Long-term specific ring stiffness under wet condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Initial resistance to failure in a deflected condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Ultimate long-term resistance to failure in a deflected condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Initial specific longitudinal tensile strength</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Initial failure and design pressures for pressure pipes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Long term failure pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For GRP fittings and joints:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Dimensions &amp; tolerances</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Non-end-load-bearing flexible joints with elastomeric sealing rings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Initial leakage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Leak-tightness when subject to internal pressure following assembly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Leak-tightness when subject to negative pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Leak-tightness test when simultaneously subject to misalignment &amp; draw</td>
</tr>
</tbody>
</table>
### 6.9 Standards* to comply with Tests

<table>
<thead>
<tr>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
|                           | - Leak-tightness test when subject to positive cyclic pressure  
|                           | - Leak-tightness test when simultaneously subject to angular deflection & draw  
|                           | End-load-bearing flexible joints with elastomeric sealing rings  
|                           | - Initial leakage  
|                           | - Resistance to pressure including the end thrust - External pressure differential  
|                           | - Resistance to pressure including the end thrust - Misalignment with internal pressure  
|                           | - Resistance to pressure including the end thrust - Short duration resistance  
|                           | - Resistance to pressure including the end thrust - Resistance to bending for pipes  
|                           | **Wrapped or cemented joints**  
|                           | - Initial leakage  
|                           | - Resistance to pressure excluding the end thrust  
|                           | - Resistance to the joint to bending and pressure including end thrust (if applicable)  
|                           | **Bolted flange joints**  
|                           | - Initial leakage  
|                           | - Resistance to pressure excluding the end thrust  
|                           | - Resistance to pressure including the end thrust  
|                           | - Resistance of the joint to bending and pressure including end thrust  
|                           | - Torque resistance |


In addition, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.
### Light Gauge Stainless Steel Tubes (Minimum Grade 304)

<table>
<thead>
<tr>
<th>6.10</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BS EN 10312 : 2002</td>
<td>Visual Examination</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dimensional Inspection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Material Identification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drift Expanding Test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flattening Test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leak Tightness Test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tensile Test</td>
</tr>
</tbody>
</table>

All light gauge stainless steel tubes tested after 1 Jun 10 shall comply with BS EN 10312:2002. Light gauge stainless steel tubes tested before 1 Jun 10 may comply with either BS 4127:1994 or BS EN 10312:2002

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable

### Malleable Cast Iron Pipe Fittings with Plastic Core

<table>
<thead>
<tr>
<th>6.11</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SS 368 : 1994</td>
<td>The following tests/specifications are not required:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Erichsen test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Abrasion resistance test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Accelerated weathering resistance test</td>
</tr>
</tbody>
</table>

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable
Multilayer Pipes of Polybutylene (PB), Polyethylene of Raised Temperature (PE-RT), Crosslinked Polyethylene (PE-X), Polypropylene (PP) and Chlorinated Poly(Vinyl Chloride) (PVC-C) and Their Associated Fittings

6.12 Standards* to comply with Tests

<table>
<thead>
<tr>
<th>Standards to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
| BS EN ISO 21003-2:2008 + A1:2011 For pipes (with plastic inner layers) | - Appearance  
- Opacity  
- Pipe dimensions  
- Pressure strength test  
- Thermal durability test  
- Strength of weld line  
- Delamination test  
- Oxygen permeability test  
- Physical and chemical properties  
- Marking |
| BS EN ISO 21003-3:2008 For fittings | - Material properties  
- Thermal stability  
- Opacity  
- Appearance  
- Dimensions  
- Sealing element test  
- Visual inspection on the marking |
| BS EN ISO 21003-5:2008 For joints | - Internal Pressure Test  
- Bending test  
- Pull out test  
- Thermal cyclic test  
- Pressure cyclic test  
- Leak tightness under vacuum |

Plastic pipes and joint fittings to be laid concealed and any leaks along such pipes and joint fittings shall be detectable using commonly available devices. The supplier of such pipes and fittings shall ensure after sales service in terms of provision of equipment and trained personnel for pipe location and leak detection.

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.
### Polybutylene (PB) Pipes and Fittings

<table>
<thead>
<tr>
<th>6.13 Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
- Hydrostatic pressure resistance of assembled pipes and fittings  
- Resistance to thermal cycling of assembled pipes and fittings  
- Resistance to cyclic pressure shock of assembled pipes and fittings  
- Opacity  
- Oxygen permeability |
| **BS 7291 : Part 2 : 2010** | - Dimensions  
- Resistance to thermal ageing  
- Pigmentation  
- Elongation  
- Short-term hydrostatic pressure resistance of pipe at 95°C  
- Short-term hydrostatic pressure resistance at 20°C of assembled fittings & pipes  
- Resistance to pull-out of assembled joint  
- Resistance to vacuum |

PB pipes and joint fittings to be laid concealed and any leaks along such pipes and joint fittings shall be detectable using commonly available devices. The supplier of such pipes and fittings shall ensure after sales service in terms of provision of equipment and trained personnel for pipe location and leak detection.

In addition, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

### Polyethylene (PE) Pipes and Fittings

<table>
<thead>
<tr>
<th>6.14 Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
| **BS EN 12201-1 : 2003 (General)** | - Materials  
- Tensile strength for butt fusion (in the form of pipe)  
- Slow crack growth (in the form of pipe) |
| **BS EN 12201-2 : 2003 (Pipes)** | - Visual examination  
- Dimensions  
- Hydrostatic strength at 20°C  
- Hydrostatic strength at 80°C (165 hours)  
- Hydrostatic strength at 80°C (1000 hours)  
- Elongation at break  
- Melt mass-flow rate  
- Oxidation induction time  
- Markings |
### 6.14 Standards* to comply with

<table>
<thead>
<tr>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
| **BS EN 12201-3 : 2003** (Fittings) | - Visual examination  
- Dimensions  
- Hydrostatic strength at 20°C  
- Hydrostatic strength at 80°C (165 hours)  
- Hydrostatic strength at 80°C (1000 hours)  
- Melt mass-flow rate  
- Oxidation induction time  
- Cohesive resistance for electrofusion fittings  
- Tensile strength for butt fusion - spigoted fittings  
- Impact resistance of tapping tees  
- Markings |
| **BS EN 12201-4 : 2003** (Valves) and | - Visual examination  
- Dimensions  
- Hydrostatic strength at 20°C  
- Hydrostatic strength at 80°C (165 hours)  
- Hydrostatic strength at 80°C (1000 hours)  
- Leak tightness of seat and packing  
- Operating torque  
- Stop resistance  
- Resistance to bending between supports  
- Leak tightness under tensile load  
- Leak tightness under and after bending applied to the operating mechanism  
- Impact loading  
- Multiple test  
- Oxidation induction time  
- Melt mass-flow rate  
- Markings |
| **BS 7291:Part1:2010** | - Opacity |

PE pipes and joint fittings to be laid concealed and any leaks along such pipes and joint fittings shall be detectable using commonly available devices. The supplier of such pipes and fittings shall ensure after sales service in terms of provision of equipment and trained personnel for pipe location and leak detection.

+ All polyethylene (PE) pipes, fittings and valves tested after 1 Jan 2012 shall comply with BS EN 12201:2003. PE pipes and fittings tested before 1 Jan 2012 may comply with either BS EN 12201:2003 or BS 7291:2010 (from 1 Sep 2011) or BS 7291:2006 (before 1 Sep 2011).

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.
### Polypropylene (PP) Pipes and Fittings

<table>
<thead>
<tr>
<th>6.15</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DIN8077 : July 1999</td>
<td>Full compliance</td>
</tr>
<tr>
<td></td>
<td>DIN8078 : April 1996</td>
<td>- Surface finish</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Creep strength</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Impact strength</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Heat reversion</td>
</tr>
<tr>
<td></td>
<td>ISO 15874-2</td>
<td>- Opacity</td>
</tr>
<tr>
<td></td>
<td>DIN 16962 Part 1 to 13</td>
<td>- Form supplied</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Surface finish</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Long term hydrostatic pressure resistance</td>
</tr>
<tr>
<td></td>
<td>ISO 15874-3</td>
<td>- Opacity</td>
</tr>
</tbody>
</table>

PP pipes and joint fittings to be laid concealed and any leaks along such pipes and joint fittings shall be detectable using commonly available devices. The supplier of such pipes and fittings shall ensure after-sales service in terms of provision of equipment and trained personnel for pipe location and leak detection.

+ All polypropylene pipes and fittings tested after 31 Aug 11 shall also be tested to comply with the Opacity in accordance with ISO 15874.

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

### Stainless Steel Pipes and Tubes (Minimum Grade 304)

<table>
<thead>
<tr>
<th>6.16</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BS 3605 Part 1 : 1991 or BS 3605 Part 2 : 1992</td>
<td>- Mechanical properties at room temperature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Chemical composition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Flattening test properties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Bend test properties / weld bend test properties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Leak tightness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Intergranular corrosion test</td>
</tr>
</tbody>
</table>

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.
### UPVC Lined Steel Pipes

<table>
<thead>
<tr>
<th>6.17</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SS 367 : 1994</td>
<td>- Internal lining Tensile test Hydraulic test Flattening test Softening point test Bending test</td>
</tr>
</tbody>
</table>

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

### UPVC Pipe Fittings

<table>
<thead>
<tr>
<th>6.18</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SS 174 : 1977</td>
<td>Full compliance</td>
</tr>
</tbody>
</table>

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

### UPVC Pipes

<table>
<thead>
<tr>
<th>6.19</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SS 141 : 1976</td>
<td>Full compliance</td>
</tr>
</tbody>
</table>

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.
## 7 Valves

### Anti-vacuum Valves

<table>
<thead>
<tr>
<th>7.1</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
|     | BS EN 14451:2005         | In accordance with the test sequence specified in BS EN 14451:2005:  
- Stage 1 Visual verification  
- Stage 2 Tightness  
- Stage 3 Flow rate/pressure loss  
- Stage 4 Bending moment, mechanical strength of body and leak tightness  
- Stage 5 Tightness  
- Stage 6 Endurance  
- Stage 7 Vacuum  
- Stage 8 Tightness |

*With effect from 1 Oct 12, only anti-vacuum valves that have been tested to comply with BS EN 14451:2005 shall be allowed for display, advertisement, sale, supply and installation in potable water supply systems in Singapore. Anti-vacuum valves tested to comply with BS 6282:Part 2:1982 prior to 1 Oct 12 will continue to be allowed for display, advertisement, sale, supply and installation until 1 Oct 13.

After 1 Oct 13, only anti-vacuum valves that have been tested to comply with BS EN 14451:2005 shall be allowed for display, advertisement, sale, supply and installation in potable water supply systems in Singapore.

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

### Copper Alloy / Ductile Iron Float Operated Valves (Diaphragm type)

<table>
<thead>
<tr>
<th>7.2</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
|     | BS 1212 Part 2 : 1990     | Only the following tests/specifications are required:  
- Constructions and Dimensions  
- Performance (Only tests for hydraulic pressure and shutoff, backnut distortion and backflow prevention) |
|     | BS 1968 : 1953            | Full compliance |
|     | BS EN 1092 Part 2 : 1997  | Only the following tests/specifications are required:  
- Mating dimensions  
- Flange thickness |
|     | BS EN 545 : 2010          | Microstructural examination ( for DI material ) |


In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.
## Copper Alloy / Ductile Iron Float Operated Valves (Piston type)

**7.3 Standards* to comply with**

| Tests | BS 1212 Part 1 : 1990 | - Construction and Dimensions  
|       |                   | - Performance  
| BS 1968 : 1953 | Full compliance  
| BS EN 1092 Part 2 : 1997 | - Mating dimensions  
|                   | - Flange thickness  
| BS EN 545 : 2010 | - Microstructural examination ( for DI material )  


In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

## Copper Alloy / Ductile Iron Water Pressure Reducing Valves

**7.4 Standards* to comply with**

| Tests | BS EN 1567 : 2000 | - Pressure strength and tightness of body  
|       |                   | - Tightness between inlet and outlet chamber  
|       |                   | - Set point range for adjustable/non-adjustable valves  
| BS EN 545 : 2010 | - Microstructural examination ( for DI material )  


In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

## Copper Alloy And Stainless Steel Ball Valves (DN 8 to DN 100)

**7.5 Standards* to comply with**

| Tests | BS EN 13828:2003 | - Operating Torque Test  
|       |                   | - Torque & Bending Test  
|       | Stops & Spindle  
|       | - Mechanical Resistance Test  
|       | Hydraulic Tests  
|       | - Leak Tightness Test  

PUB – Stipulation of Standards for Water Fittings  
Updated as at 31 Aug 2016
### 7.5 Standards* to comply with Tests

- Hydraulic Strength
- Endurance Test

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable

### Copper Alloy Gate, Globe and Check Valves

#### 7.6 Standards* to comply with Tests

| BS 5154 : 1991 | - Dimensions and tolerances of body ends  
|               | - Pressure testing |

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable

### Copper Alloy Solenoid Valves

#### 7.7 Standards* to comply with Tests

| BS 5154 : 1991 | - Pressure testing |

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable

### Draw-off Taps and Stopvalves (Screw-down pattern)

#### 7.8 Standards* to comply with Tests

| SS 75 Part 2 : 1978 | - Design & construction  
|                     | - Hydraulic test |

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable
### Ductile Iron Butterfly Valves

<table>
<thead>
<tr>
<th>7.9</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BS EN 593 : 2004</td>
<td>- Dimensions and tolerances  &lt;br&gt; - Pressure test</td>
</tr>
<tr>
<td></td>
<td>BS EN 545 : 2010</td>
<td>- Microstructural examination (for DI material )</td>
</tr>
</tbody>
</table>

The valves shall be coated with an appropriate non-corrodible or corrosion-resistant material complying with SS 375 : 2001 or BS 6920 : 2000 and clause 8 of SS 375 : Part 1 : 2001. Only fusion bonded coating is allowed.

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

### Ductile Iron Check Valves (10 mm - 1000 mm)

<table>
<thead>
<tr>
<th>7.10</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BS 5153 : 1974</td>
<td>- Body ends  &lt;br&gt; - Design and manufacture  &lt;br&gt; - Pressure testing</td>
</tr>
<tr>
<td></td>
<td>BS EN 545 : 2010</td>
<td>- Microstructural examination (for DI material )</td>
</tr>
</tbody>
</table>

The valves shall be coated with an appropriate non-corrodible or corrosion-resistant material complying with SS 375 : 2001 or BS 6920 : 2000 and clause 8 of SS 375 : Part 1 : 2001. Only fusion bonded coating is allowed.

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

### Ductile Iron Gate Valves

<table>
<thead>
<tr>
<th>7.11</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BS 5163-1:2004</td>
<td>- Dimensions and tolerances</td>
</tr>
<tr>
<td></td>
<td>BS 5163-2:2004</td>
<td>- Stem caps materials &amp; dimensions  &lt;br&gt; - Stem caps : Resistance to operating loads</td>
</tr>
<tr>
<td></td>
<td>BS EN 1074-1 &amp; 2:2000</td>
<td>- Resistance to internal pressure of the shell &amp; all pressure containing components  &lt;br&gt; - Resistance of the obturator to differential pressure  &lt;br&gt; - Leaktightness to internal pressure  &lt;br&gt; - Leaktightness to external pressure</td>
</tr>
</tbody>
</table>
7.11 Standards* to comply with | Tests
---|---
- Leaktightness of gearbox to external pressure
- Seat tightness at high differential pressure
- Seat tightness at low differential pressure
- Max Operating Torque for operation & leak tightness
- Hydraulic characteristics (Not applicable to full bore gate valves or clear way valves)
- Resistance of valves to bending
- Resistance of valves to operating loads
- Endurance Test

BS EN 545:2010 | - Microstructural Examination (for DI material)

The valves shall be coated with an appropriate non-corrodible or corrosion-resistant material complying with SS 375 : 2001 or BS 6920 : 2000 and clause 8 of SS 375 : Part 1 : 2001. Only fusion bonded coating is allowed.

In addition, the product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable

Ductile Iron Globe and Check Valves (10 mm - 450 mm)

7.12 Standards* to comply with | Tests
---|---
BS 5152 : 1974 | - Body ends
- Design and manufacture
- Pressure testing

BS EN 545 : 2006 | - Microstructural examination (for DI material)

The valves shall be coated with an appropriate non-corrodible or corrosion-resistant material complying with SS 375 : 2001 or BS 6920 : 2000 and clause 8 of SS 375 : Part 1 : 2001. Only fusion bonded coating is allowed.

In addition, the product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable

Ductile Iron Solenoid Valves

7.13 Standards* to comply with | Tests
---|---
BS 5163 : 1986 | - Pressure testing

BS EN 545 : 2010 | - Microstructural examination (for DI material)
7.13 Standards* to comply with

<table>
<thead>
<tr>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>The valves shall be coated with an appropriate non-corrodible or corrosion-resistant material complying with SS 375 : 2001 or BS 6920 : 2000 and clause 8 of SS 375 : Part 1 : 2001. Only fusion bonded coating is allowed. In additional, product shall also comply with the stipulation standards and requirements in pages 8 &amp; 9, where applicable</td>
</tr>
</tbody>
</table>

Taps and Mixers

Single Taps and Combination Taps

8.1 Standards* to comply with

<table>
<thead>
<tr>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS EN 200 : 2008</td>
</tr>
<tr>
<td>Leak-tightness Characteristics</td>
</tr>
<tr>
<td>Pressure Resistance Characteristics - Mechanical Performance Under Pressure</td>
</tr>
<tr>
<td>Mechanical Strength Characteristics - Torsion Test for Operating Mechanism</td>
</tr>
<tr>
<td>Mechanical Endurance Characteristics</td>
</tr>
<tr>
<td>Hydraulic Operating Characteristics –</td>
</tr>
<tr>
<td>a. Only required for taps intended to be registered with 1-tick or above under the Mandatory Water Efficiency Labelling Scheme (MWELS). The test criteria for the flow rates shall be in accordance with the criteria set for the respective MWELS products.</td>
</tr>
<tr>
<td>b. Flow Rate Duration Test (clause 8.2) specified in SS 448 for Class F &amp; G Taps (The maximum flow rates in Table 3 shall be 6 litres/min for basin taps and 9 litres/min for shower taps) is required.</td>
</tr>
<tr>
<td>c. For sensor operated taps, the test for closure of device during power failure is required.</td>
</tr>
<tr>
<td>BS EN 14506 or SS 448 : Part 1 to 4 : 1998</td>
</tr>
<tr>
<td>Vacuum Tests</td>
</tr>
<tr>
<td>Water Tightness Characteristics</td>
</tr>
<tr>
<td>Pressure Resistance Characteristics</td>
</tr>
</tbody>
</table>
| Hydraulic Characteristics:
### 8.1 Standards* to comply with Tests

- Only required for taps intended to be labelled with at least 1-tick and above rating under the MWELS. The methodology of the Flow Rate Test (clause 8.1) will be served as a base for the testing of MWELS products (with criteria set for the respective MWELS products).

- Only the Flow Rate Duration Test (clause 8.2) For Class F & G Taps (The maximum flow rates in Table 3 shall be 6 litres/min for basin taps and 9 litres/min for shower taps) is required.

- For sensor operated taps, the test for closure of device during power failure is required.

**Mechanical Tests**

**Mechanical Endurance Characteristics**

**Backflow Prevention Test**

AND

**BS EN 248 : 2002**

- Corrosion Resistance Test – Test With Neutral Saline Spray
- Test for Coating Adherence – Test For Resistance To Thermal Shock

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable

---

### Mechanical Mixers

<table>
<thead>
<tr>
<th>8.1 Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS EN 817 : 2008</td>
<td>Leaktightness Characteristics</td>
</tr>
</tbody>
</table>

**Hydraulic Characteristics:**

- Determination of sensitivity
- Determination of flow rate
- Only required for taps intended to be labeled with at least 1-tick and above rating under the MWELS. The methodology of the Verification of Hydraulic Characteristics (10.6) will be served as a base for the testing of MWELS products (with criteria set for the respective MWELS products).

**Mechanical Strength Characteristics**
### 8.1 Standards* to comply with

<table>
<thead>
<tr>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Resistance Characteristics</td>
</tr>
<tr>
<td>Mechanical Endurance Characteristics</td>
</tr>
<tr>
<td>Backflow Prevention Test (To be carried out in accordance with either BS 5412:1996 or SS 448:1998)</td>
</tr>
<tr>
<td><strong>AND</strong></td>
</tr>
<tr>
<td>BS EN 248 : 2002</td>
</tr>
<tr>
<td>Corrosion Resistance Test – Test With Neutral Saline Spray</td>
</tr>
<tr>
<td>Test for Coating Adherence – Test For Resistance To Thermal Shock</td>
</tr>
</tbody>
</table>

+ All mechanical mixers tested after 1 Sep 09 shall comply with BS EN 817:2008. Mechanical mixers tested before 1 Sep 09 may comply with either BS EN 817:1998 or BS EN 817:2008.

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

---

### Thermostatic Mixing Valves (up to 50mm)

#### 8.2 Standards* to comply with

<table>
<thead>
<tr>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>For sizes up to 22 mm</td>
</tr>
<tr>
<td>1.) Leakage tightness</td>
</tr>
<tr>
<td>2.) Hydraulic operating characteristics</td>
</tr>
<tr>
<td>a. Flow rate (using hot and cold water)</td>
</tr>
<tr>
<td>b. The sensitivity (using hot and cold water)</td>
</tr>
<tr>
<td>c. Safety with cold water failure</td>
</tr>
<tr>
<td>d. Temperature stability:</td>
</tr>
<tr>
<td>i. with changing inlet pressure</td>
</tr>
<tr>
<td>ii. with changing inlet temperature</td>
</tr>
<tr>
<td>3.) Mechanical performance under pressure</td>
</tr>
<tr>
<td>4.) Endurance characteristics</td>
</tr>
<tr>
<td>5.) Torsional resistance</td>
</tr>
<tr>
<td>Or</td>
</tr>
<tr>
<td>6.) Electronic valves – power failure (if applicable)</td>
</tr>
<tr>
<td>AS 4032.1:2005</td>
</tr>
<tr>
<td>Or</td>
</tr>
<tr>
<td>1.) Torque test</td>
</tr>
<tr>
<td>2.) Watertightness at ambient temperature</td>
</tr>
<tr>
<td>3.) Thermal shut-off</td>
</tr>
<tr>
<td>8.2</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AS 4032.1:2005</th>
<th>For sizes &gt; 22m to 50mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.) Torque test</td>
<td></td>
</tr>
<tr>
<td>2.) Watertightness at ambient temperature</td>
<td></td>
</tr>
<tr>
<td>3.) Thermal shut-off</td>
<td></td>
</tr>
<tr>
<td>4.) Sensitivity of temperature adjustment</td>
<td></td>
</tr>
<tr>
<td>5.) Mixed water temperature overshoot on starting from ambient</td>
<td></td>
</tr>
<tr>
<td>6.) Temperature stability of mixed water</td>
<td></td>
</tr>
<tr>
<td>7.) Watertightness at operating temperature</td>
<td></td>
</tr>
<tr>
<td>8.) Endurance</td>
<td></td>
</tr>
<tr>
<td>9.) Electronic valves – Power Failure (if applicable)</td>
<td></td>
</tr>
</tbody>
</table>

*With effect from 1 Oct 2016, all thermostatic mixing valve (TMVs) shall be tested to comply with either BS EN 1111:1999 or AS 4032.1:2005 where applicable as stated above, before they can be display, advertised, sold, supplied and installed in potable water service installations in Singapore.

TMVs which have been tested to comply with AS 4032:1998 can continue to be displayed. Advertised, sold, supply and installed in potable water service installations in Singapore till further notice.

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable

### Thermostatic Mixers (15mm & 22mm)

<table>
<thead>
<tr>
<th>8.3</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BS EN 1287 : 1999</td>
<td>The following test/specification is not required : - Flow rate test</td>
</tr>
<tr>
<td></td>
<td>BS EN 248: 2002</td>
<td>Full compliance</td>
</tr>
</tbody>
</table>

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable
## 9 Others

### Constant Flow Regulators

<table>
<thead>
<tr>
<th>9.1</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>The flow rate shall be tested at a pressure of 50 kPa to 550 kPa at intervals of 50 kPa. Within the pressure range of 150 kPa and 550 kPa, the flow rate shall remain within ±10% of the specific rating of the CFR.</td>
<td></td>
</tr>
</tbody>
</table>

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable

### Copper Alloy / Ductile Iron Y-Pattern Strainer

<table>
<thead>
<tr>
<th>9.2</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
| BS EN 1092 Part 2 : 1997 | Only the following tests/specifications are required:  
- Mating dimensions  
- Flange thickness  
- Pressure / temperature rating |
| BS EN 545 : 2010 | Only the following test/specification is required:  
- Microstructural examination (for DI material) |


In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable
### Dual Flush Water Closets Flushing Cisterns

#### 9.3 Standards* to comply with

<table>
<thead>
<tr>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
                        | - Marking  
                        | - Front Thrust Test (except conceal cistern)  
                        | - Colour Fastness Test (For plastic cistern except conceal cistern)  
                        | - Distortion Test  
                        | - Impact Test (For plastic cistern except conceal cistern)  
                        | - Leakage Test  
                        | - Torque Test  
                        | - Volume Of Discharge per Flush (for full & reduced flush)  
                        | - Water Line  
                        | - Water Inlet Valve  
                        | - Hydraulic Test  
                        | - Endurance Test (for full & reduced flush)  
                        | - Flushing Tests  
                        | - Load Test On Operating Mechanism (for full & reduced flush)  
                        | - Flush Button Design  
                        | - WC Drainline Transportation Test (For cisterns with full flush volume of less than 3.5 litres/flush)  
| And                       |       |
| BS 1212 : Part 4, Section 3 and Section 4 (except Clauses 18, 19 and 20.1) |       |

| Pans                      |       |
| SS 574:Part 2:2012        | - Flushing Test  
                        | - Load Test For Wall Hung Pan  
                        | - Trap Seal Depth Determination and Restoration Test  
| For Vitreous China WC Flushing Cisterns/Pans |       |
| BS 3402:1969              | - Visual Examination  
                        | - Resistance To Burning/Staining  
                        | - Warpage  
                        | - Crazing Test  
                        | - Quality Of Glazing  
                        | - Water Absorption  
                        | - Chemical Resistance  

For independent WC flushing cistern and pan, the height set-up between the cistern outlet and the centreline of the discharge into the pan for testing purpose shall not exceed 80mm. This maximum set-up distance is not applicable for flushing cistern with permanently integrated flush pipe of predetermined fixed length that does not allow any adjustment or change. However, the set-up distance for testing purpose shall be clearly reflected in the test reports and the product manual such that the installer is aware of the limitation. Under no circumstances shall this set-up testing distance be reduced when the cistern is installed for use.
### 9.3 Standards* to comply with Tests

With effect from 1 May 2015, only dual flush low capacity flushing cisterns tested to comply with SS 574:Part 1 & Part 2:2012 will be accepted for submission for WELS labelling.

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

### Ductile Iron Flange Adaptor (with / without rubber expansion joints)

<table>
<thead>
<tr>
<th>9.4 Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS EN 1092 Part 2 : 1997</td>
<td>Only the following tests/specifications are required :</td>
</tr>
<tr>
<td></td>
<td>- Mating dimensions</td>
</tr>
<tr>
<td></td>
<td>- Flange thickness</td>
</tr>
<tr>
<td></td>
<td>- Pressure / temperature rating</td>
</tr>
<tr>
<td>BS EN 545 : 2010</td>
<td>Only the following test/specification is required :</td>
</tr>
<tr>
<td></td>
<td>- Microstructural examination (for DI material)</td>
</tr>
</tbody>
</table>

The adaptors shall be coated with an appropriate non-corrodible or corrosion-resistant material complying with SS 375 : 2001 or BS 6920 : 2000 and clause 8 of SS 375 : Part 1 : 2001. Only fusion bonded coating is allowed.

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.

### Metallic and Non-Metallic Flexible Connecting Tubes (For hot and cold water)

<table>
<thead>
<tr>
<th>9.5 Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS/NZS 3499 : 1997</td>
<td>Full compliance</td>
</tr>
</tbody>
</table>

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.
9.6 Standards* to comply with - Requirements for Urinal Flush Valves

For flush valves, suppliers, retailers and installers shall have to ensure compliance with the requirements on backflow prevention and conservation of water as stipulated in the Public Utilities (Water supply) Regulations and the Singapore Standard CP 48: Code of Practice for Water Services.

Every flush valve serving a urinal shall be such a design and be and remain so arranged as to give a single flush of not less than 0.5* litres and not more than 1.5 litres (notwithstanding that the operating member continues to be held actuated).

There shall be no pre-flush, flushing at fixed time intervals or multiple flushing features.

Urinals in public toilets shall be fitted with automatic flushing devices. The automatic flushing devices shall be activated by sensors and equipped with manual over-ride feature. The manual over-ride feature shall comply with the following requirements:

a. The manual over-ride feature shall allow manual activation of flushing in the event of malfunction or breakdown of the sensor or sensing unit. In the event of a power supply failure, the sensor and the manual over-ride may not function.

b. When manual over-ride is activated, the flushing shall take place immediately and the sensor flushing shall be overridden to prevent double flushing i.e. the over-ride shall over-ride all sensor operation even when the sensor has been activated and the sensor shall not activate another flush after the user leaves the sensing area.

c. The manual over-ride button shall not be placed in a conspicuous position such that it would encourage unnecessary activation by users.

d. The volume of water discharged per flush by manual over-ride shall continue to be 0.5* - 1.5 litres for urinals (notwithstanding that the operating member continues to be held actuated).

Every flush valve shall be fitted with an adequate device or so constructed to prevent the backflow of water and shall be of such a design so as not to cause wastage of water.

Flush valve shall be incorporated with check valves that comply with BS 5154 and vacuum breakers that comply with American Society of Sanitary Engineering Standard No.1001. Alternatively, flush valves shall derive water from separate storage tank which is not connected in any way with all other fittings supplying basins, sinks, heater, etc.

All water fittings incorporated in the flush valve shall comply with the relevant Standards stipulated by PUB.

Flush valves shall not be used in residential dwelling units.
For sensor operated flush valves, the sensor shall comply with the requirements given in Appendix A.

The flush valve shall be tested to meet the requirements of the relevant tests given in Appendices B to C and shall be supported with test reports from a testing laboratory:

Please note that PUB does not enquire into the effective performance of the flush valve. Compliance with the requirements and Standards stipulated by PUB does not constitute an endorsement or recommendation of the flush valve for its proposed use. The onus is on the manufacturer/supplier to ensure that flush valve performs according to specifications and effectively for its proposed use.

For the tests and supply of waterless urinals, suppliers shall contact the Water Reclamation (Network) Department at 67313256 or 67313245 for further assistance.

*Urinal flush valve with flush volume below 0.5 litre may be used if its Manufacturer ensures that it is designed to perform effectively with such flush volume. In addition, such urinals shall be tested to comply with the Dye Test specified in Clause 10.5 of the ASME A112.19.2-2003.

APPENDIX A

REQUIREMENTS FOR SENSORS OF FLUSHING DEVICES

1) Each sensor unit shall only operate one flushing device for a sanitary appliance. The sensor unit when installed shall not be affected by the operation of adjacent sensor unit.

2) The sensor unit's stable sensing area shall be adjusted for an activating distance

Of 600mm for a urinal.

3) The sensor units shall be designed to being operation only after a person approaches the unit and remain within the sensing zone for a duration exceeding 5 sec.

4) The sensor units shall be designed to flush after each usage with minimal time delay (eg. immediate for urinal flush valve) and without multiple flushing or any flushing at fixed time intervals. There shall also be no pre-flush.

5) Sensor shall only activated flushing devices after usage and such flushing devices shall be capable of delivering the stipulated volume per 0.5* - 1.5 litres for each bowl urinal) required for flushing (solenoid valve shall be provide with flow regulator for adjustment of volume of discharge).

6) Urinal sensor flush valves installed in public toilets shall be provided with manual over-ride feature to allow manual activation of flushing in the event of malfunction or breakdown of the sensor or sensing unit. In the event of a power supply failure, the sensor and the manual over-ride may not function. The manual over-ride shall
9.6 **Standards* to comply with - Requirements for Urinal Flush Valves**

not be placed in a conspicuous position such that it would encourage unnecessary activation by users. When manual over-ride flushing is activated, the flushing shall take place immediately and the sensor flushing shall be overridden to prevent double flushing i.e. the over-ride feature shall override all sensor operation even when the sensor has been activated and the sensor shall not activated another flush after the user leaves the sensing area. The volume of water discharge per flush by manual over-ride shall continue to be 0.5* - 1.5 litres for urinals, notwithstanding that the operating member continues to be held actuated.

7) The sensor units shall be designed to permit easy adjustment of volumes and flow rates on the flushing devices.

8) All sensor devices shall be firmly installed on the wall fronting the appliance. Sensor devices may be installed at ceiling levels if the above requirements and the limitation on sensing distance can be complied with.

9) Agents are required to ensure proper adjustment of sensor-operated flush valves, in particular, the sensing distance and timing for activation of sensor and flushing prior to delivery to site.

10) Agents shall also ensure proper installation and adjustment of the sensor-operated flush valves at site to prevent multiple flushing.

Note:
*Urinal flush valve with flush volume below 0.5 litre may be used if its Manufacturer ensures that it is designed to perform effectively with such flush volume. In addition, such urinals shall be tested to comply with the Dye Test specified in Clause 10.5 of the ASME A112.19.2-2003.

**APPENDIX B**

**TESTING OF SENSOR DEVICE FOR URINAL FLUSH VALVE**

**PART I - TESTING OF SENSOR DEVICE FOR URINAL FLUSH VALVE**

(1) **ENDURANCE TEST FOR SENSOR DEVICE FOR URINAL FLUSH VALVE**

1. This test shall be the first test to carried out on the sensor operated flush valve
2. The sensor operated flush valve shall be initially set to give a volume of discharge of 1.0 ± 0.5 litres at flow dynamic pressure of 3.0 ± 0.5 bars. The sensor operated flush valve is then subjected to 75,000 cycles of test.
3. The sensing distance, time delay before activation of sensor, time delay for activation of flush, average volume of discharge and average discharge time for three consecutive flushes shall be recorded at the start of the test and after each 25,000 cycles.
4. After each 25,000 cycles, the change in volume of discharge shall not exceed 10% of the volume of discharge at the start of the test and any reduction in the volume of discharge shall not result in a volume of discharge falling below 0.5 litres.
9.6 Standards* to comply with - Requirements for Urinal Flush Valves

5 The sensor operated flush valve shall be capable of continuous operation without sticking, chattering or leaking and shall have no change in the following viz:

(a) Sensing distance
   Requirement: 600±100mm

(b) Time delay before activation of sensor
   Requirement: The sensor device shall be design operation only after a person approaches the unit within sensing distance of 600±100mm and remains within the sensing area for a duration exceeding 5 seconds.

(c) Time delay for activation of flush
   Requirement: The sensor device shall be designed to flush only immediately or less than 5 seconds after the person leave the sensing area.

(2) DETERMINATION OF SENSING DISTANCE AND TIME DELAYS

(a) Sensing distance
   Requirement: 600±100mm

   Condition: 150mm x 150mm white paper shall be used for determination of sensing distance.

(b) Time delay before activation of sensor
   Requirement: The sensor device shall be design operation only after a person approaches the unit within sensing distance of 600±100mm and remains within the sensing area for a duration exceeding 5 seconds.

(c) Time delay for activation of flush
   Requirement: The sensor device shall be designed to flush only immediately or less than 5 seconds after the person leave the sensing area.

(3) PRE-FLUSH/FLUSHING AT FIXED TIME INTERVAL/MULTIPLE FLUSHING FOR FLUSH VALVE

The sensor device for flush valve shall have no pre-flush, flushing at fixed time intervals or multiple flushing features.

(4) MANUAL OVER-RIDE FEATURE FOR URINAL FLUSH VALVE (WHERE APPLICABLE)

   If the sensor device for a urinal flush valve is equipped with a manual over-ride feature, it shall comply with the following:

(a) When manual over-ride flushing is activated, the flushing shall take place immediately and the sensor flushing shall be overridden to prevent double flushing i.e. the over-ride feature shall over-ride all sensor operation even when the sensor has been activated and the sensor shall not activate another flush after the user leaves the sensing area.

(b) The manual over-ride button shall not be placed in a conspicuous position such that it would encourage unnecessary activation by users.
9.6 Standards* to comply with -
Requirements for Urinal Flush Valves

(c) When the manual over-ride feature is activated, the urinal flush valve shall
delivery a volume of discharge of not more than 1.5 litres and not less than 0.5* litres per flush at each of the following dynamic pressures: 0.7, 1.0, 1.5, 2.0 and 3.0 bars with the operating member continued to be held activated.

APPENDIX B

TESTING OF SENSOR DEVICE FOR URINAL FLUSH VALVE
PART II - TESTING OF URINAL FLUSH VALVE

(1) ENDURANCE TEST

This shall be the first test to be carried out on the flush valve.
The flush valve shall be initially set to give a volume of discharge of 1.0 ±0.5 litres at flow dynamic pressure of 3.0 ±0.5 bars. The flush valve is then subjected to 75,000 cycles of test.

The average volume of discharge for three consecutive flushes shall be recorded at the start of the test and after 25,000 cycles.

After each 25,000 cycles, the change in volume of discharge shall not exceed 10% of the volume of discharge at the start of the test and any reduction in the volume of discharge shall not result in a volume of discharge falling below 0.5* litres.

The flush valve shall be capable of continuous operation without sticking, chattering or leaking.

(2) HYDRAULIC TEST

Test A:
Hydraulic test on flush valve body
With the outlet of the flush valve plugged, a hydraulic pressure of 20 bars is applied through the inlet for 60 seconds. There shall be no sign of leakage or permanent distortion of any component of the flush valve.

Test B:
Hydraulic test on stop valve (for flush valve with built-in stop valve only)
The inlet of the stop valve is connected to a hydraulic pressure system with the seat of the stop valve in closed position. A hydraulic pressure of 20 bar is applied for 60 seconds. The stop valve is inspected for leakage and other defects.

Test C:
Hydraulic test on check valve (for flush valve with built-in check valve only)
Hydrostatic pressure test on check valve body and seat shall be carried out in accordance with BS 5154:1991 specifications. There shall be no visible leakage or permanent distortion of any component of the check valve during tests.

(3) EFFECTIVENESS OF VACUUM BREAKER TEST
(for flush valve with built-on vacuum breaker only)
## 9.6 Standards* to comply with - Requirements for Urinal Flush Valves

The flush valve is installed as in the volume of discharge test and the lower end of the flush is submerged in water such that the distance from the bottom of the vacuum breaker to the water level is 150mm.

With the valve seat slightly opened (by inserting a 2mm diameter wire) and actuating member held in operating position, the flush valve inlet (without a check valve/stop valve fixed) is connected to a vacuum line and the test is conducted in following order:

(a) A constant vacuum of 635mm mercury is applied for a period of 30 seconds.  
(b) Intermittent vacuum of 50, 125, 380, 635 mm of mercury are applied. Each application is for 5 seconds on and 5 seconds shut.  
(c) First a slowly increasing vacuum is applied at a uniform rate from 50 mm to 635 mm mercury. Next, a slowly decreasing vacuum is applied at a uniform rate from 635mm to 0 mm mercury. 

In tests (a) to (c), if the water rise in the flush pipe exceeds 76mm, the vacuum breaker is deemed to have failed the test.

### (4) VOLUME OF DISCHARGE TEST

(a) A flush pipe of 300 mm length is to be secured to the outlet of flush valve. The internal diameter of the flush pipe shall be at least 13mm.  
(b) With the flush valve connected to a water supply system, a pressure gauge and a control valve are fitted at the inlet of the flush valve.  
(c) The flow regulator is to be set at maximum. Before commencing the actual test, the flush valve is subjected to a series of trial runs and the dynamic pressure is adjusted to 0.7 bars.  
(d) The operating member is actuated and the water discharge from the flush pipe is collected until the flow of water ceases (for manual over-ride, the operating member shall continue to be held actuated until the flow of water ceases). Record the volume of water collected.  
(e) With the flow regulator adjusted to the maximum setting, repeat the above procedure at each of the following dynamic pressure: 1.0, 1.5, 2.0 and 3.0 bars. 
(f) When tested in accordance with the procedure above, the discharge volume per flush shall not be more than 1.5 litres and less than 0.5* litres. 

Note:  
Supplier, retailers and installers of flush valves shall have to ensure compliance with the requirements on backflow prevention and wastage of water as stipulated in Public Utilities (Water Supply) Regulations and Singapore Standard CP48: Code of Practice for Water Services.
### 9.6 Standards* to comply with - Requirements for Urinal Flush Valves

PUB does not enquire into the effective performance of the flush valve and compliance with the above testing requirements does not attest to the effective performance of the flush valve. The responsibility of ensuring the effective performance of flush valve lies with the manufacturer and supplier of the flush valve.

*Urinal flush valve with flush volume below 0.5 litre may be used if its Manufacturer ensures that it is designed to perform effectively with such flush volume. In addition, such urinals shall be tested to comply with the Dye Test specified in Clause 10.5 of the ASME A112.19.2-2003.

---

### APPENDIX C

#### TESTING OF MANUAL OPERATED URINAL FLUSH VALVE

**Endurance Test**

1. This test shall be the first test to be carried out on the flush valve.

2. The flush valve shall be initially set to give a volume of discharge of 1.0 ± 0.5 litres at flow dynamic of 3.0 ± 0.5 bars. The flush valve is then subjected to 75,000 cycles of test.

3. The average volume of discharge for three consecutive flushes shall be recorded at the start of the test and after each 25,000 cycles.

4. After each 25,000 cycles, the change in volume of discharge shall not exceed 10% of the volume of discharge at the start of the test and any reduction in volume of discharge shall not result in a volume of discharge falling below 0.5* litres.

5. The flush valve shall be capable of continuous operation without sticking, chattering or leaking.

**Hydraulic Test**

**Test A:**

Hydraulic test on flush valve body

With the outlet of flush valve plugged, a hydraulic pressure of 20 bars is applied through the inlet for 60 seconds. There shall be no sign of leakage or permanent distortion of any component of the flush valve.

**Test B:**

Hydraulic test on stop valve (for flush valve with built-in stop valve only)

The inlet of the stop valve is connected to hydraulic pressure system with the seat of the stop valve in closed position. A hydraulic pressure of 20 bars is applied for 60 seconds. The stop valve is inspected for leakage and other defects.

**Test C:**

Hydraulic test on check valve (for flush valve with built-in check valve only)
9.6 Standards* to comply with - Requirements for Urinal Flush Valves

Hydrostatic pressure test on check valve body and seat shall be carried out in accordance with BS 5154:1991 specifications. There shall be no visible leakage or permanent distortion of any component of the check valve during the tests.

(3) EFFECTIVENESS OF VACUUM BREAKER TEST
(For flush valve with built-on vacuum breaker only)

1 The flush valve is installed as in volume of discharge test and the lower end of the flush pipe is submerged in water such that the distance from the bottom of the vacuum breaker to the water level is 150 mm.

2 With the valve seat slightly opened (by inserting a 2 mm diameter wire) and the actuating member held in operating position, the flush valve inlet (without a check valve/stop valve fixed) is connected to a vacuum line and the test is conducted in the following order:

   (a) A constant vacuum of 635 mm mercury is applied for a period of 30 seconds.
(b) Intermittent vacuum of 50, 125, 255, 380, 635 mm of mercury are applied. Each application is for 5 seconds on and 5 seconds shut.
(c) First a slowly increasing vacuum is applied at a uniform rate 50m to 635 mm mercury. Next, a slowly decreasing vacuum is applied at a uniform rate from 635 mm to 0 mm mercury.

In tests (a) to (c), if the water rises in the flush pipe exceeds 76 mm, vacuum breaker is deemed to have failed the test.

(4) VOLUME OF DISCHARGE TEST

1 A flush pipe of 300 mm length to be secured to the outlet of the valve. The internal diameter of the flush pipe shall be at least 13mm.

2 With the flush valve connected to a water supply system, a pressure gauge and a control valve are fitted at the inlet of the flush valve.

3 The flow regulator is to be set at maximum. Before commencing the actual test, the flush valve is subjected to a series of trail runs and the dynamic pressure is adjusted to 0.7 bars.

4 The operating member is actuated and held actuated and the water discharge from the flush pipe is collected until the flow of water ceases (the operating member shall continue to be held actuated until the flow of water ceases). Record the volume of water collected.

5 With the flow regulator adjusted to the maximum setting, repeat the above procedure at each of the following dynamic pressures: 1.0, 1.5, 2.0 and 3.0 bars.
### Requirements for Urinal Flush Valves

6. When tested in accordance with the procedure described above, the discharge volume per flush shall not be more than 1.5 litres and less than 0.5* litres.

Note:
Supplier, retailers and installers of flush valves shall have to ensure compliance with the requirements on backflow prevention and wastage of water as stipulated in Public Utilities (Water Supply) Regulations and Singapore Standard CP48: Code of Practice for Water Services.

PUB does not enquire into the effective performance of the flush valve and compliance with the above testing requirements does not attest to the effective performance of the flush valve. The responsibility of ensuring the effective performance of flush valve lies with the manufacturer and supplier of the flush valve.

*Urinal flush valve with flush volume below 0.5 litre may be used if its Manufacturer ensures that it is designed to perform effectively with such flush volume. In addition, such urinals shall be tested to comply with the Dye Test specified in Clause 10.5 of the ASME A112.19.2-2003.

### Requirements for flush valves for WC

Please note that PUB does not enquire into the effective performance of the flush valve and compliance with the above testing requirements does not attest to the effective performance of the flush valve. The responsibility of ensuring the effective performance of flush valve lies with the manufacturer and supplier of the flush valves.

### Standards* to comply with - Requirements WC flush for valves

For flush valves, suppliers, retailers and installers shall have to ensure compliance with the requirements on backflow prevention and conservation of water as stipulated in the Public Utilities (Water supply) Regulations and the Singapore Standard CP 48: Code of Practice for Water Services.

Every flush valve serving a water-closet pan shall be such a design and be and remain so arranged as to give a single flush of not more than 4.5 litres (notwithstanding that the operating member continues to be held actuated). The water closet pan to be used with flush valves shall be of a design suitable for use with the flush valve of up to 4.5 litres maximum capacity and shall conform to the functional requirements and tests in Singapore Standard 574 : Part 2 : 2012.

There shall be no pre-flush, flushing at fixed time intervals or multiple flushing features.

Water closets in public toilets shall be fitted with automatic flushing devices. The automatic flushing devices shall be activated by sensors and equipped with manual over-ride cum by-pass features. The manual over-ride cum by-pass feature shall comply with the following requirements:
### Standards* to comply with - Requirements WC flush for valves

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>The manual over-ride cum by-pass feature shall allow manual activation of flushing in the event of malfunction/breakdown of the sensor or sensing unit or failure of power supply. In the event of a power supply failure, the sensor and the manual over-ride may not function, however the manual by-pass shall continue to be functional.</td>
</tr>
<tr>
<td>b</td>
<td>When manual over-ride or by-pass flushing is activated, the flushing shall take place immediately and the sensor flushing shall be overridden to prevent double flushing i.e. the over-ride and by-pass feature shall over-ride all sensor operation even when the sensor has been activated and the sensor shall not activate another flush after the user leaves the sensing area.</td>
</tr>
<tr>
<td>c</td>
<td>The manual over-ride / by-pass button/s shall not be placed in a conspicuous position such that it would encourage unnecessary activation by users</td>
</tr>
<tr>
<td>d</td>
<td>The volumes of water discharged per flush by manual over-ride and by-pass shall continue to be not more than 4.5 litres for water closets (notwithstanding that the operating member remains held actuated).</td>
</tr>
</tbody>
</table>

Every flush valve shall be fitted with an adequate device or so constructed to prevent the backflow of water and shall be of such a design so as not to cause wastage of water.

Flush valve shall be incorporated with check valves that comply with BS 5154 and vacuum breakers that comply with American Society of Sanitary Engineering Standard No.1001. Alternatively, flush valves shall derive water from separate storage tank which is not connected in any way with all other fittings supplying basins, sinks, heater, etc.

All water fittings incorporated in the flush valve shall comply with the relevant Standards stipulated by PUB.

Flush valves shall not be used in residential dwelling units.

For replacement of existing water closet flush valves of flushing cisterns, it must be ensured that the existing water closet pans used are compatible with the reduced flush (where applicable) from the newly installed flush valves so as not to affect the flushing efficiency. If not compatible, the existing water closet pans shall be replaced with compatible ones.

For sensor operated flush valves, the sensor shall comply with the requirements given in Appendix A.

The WC flush valve shall be tested to meet the requirements of the relevant tests given in Appendices B to E and shall be supported with test reports from a testing laboratory:

Please note that PUB does not enquire into the effective performance of the flush valve. Compliance with the requirements and Standards stipulated by PUB does not constitute an endorsement or recommendation of the flush valve for its proposed use. The onus is on the manufacturer/supplier to ensure that...
9.7 Standards* to comply with - Requirements WC flush for valves

flush valve performs according to specifications and effectively for its proposed use.

APPENDIX A

REQUIREMENTS FOR SENSORS OF FLUSHING DEVICES

1) Each sensor unit shall only operate one flushing device for a sanitary appliance. The sensor unit when installed shall not be affected by the operation of adjacent sensor unit.

2) The sensor unit's stable sensing area shall be adjusted for an activating distance as follows:
   a) 900mm for water closet

3) The sensor units shall be designed to being operation only after a person approaches the unit and remain within the sensing zone for a duration exceeding 5 sec.

4) The sensor units shall be designed to flush after each usage with minimal time delay (eg. min 5 sec for WC flush valve and immediate for urinal flush valve) and without multiple flushing or any flushing at fixed time intervals. There shall also be no pre-flush.

5) Sensor shall only activated flushing devices after usage and such flushing devices shall be capable of delivering the stipulated volume per flush (not more than 4.5 litres for WC) required for flushing (solenoid valve shall be provide with flow regulator for adjustment of volume of discharge).

6) WC sensor flush valves installed in public toilets shall be provided with manual over-ride cum by-pass feature to allow manual activation of the flushing in the event of malfunction/breakdown of the sensor or sensing unit or failure of power supply. In the event of a power supply failure, the sensor and the manual over-ride may not function, however the manual by-pass shall continue to be functional. The manual over-ride/ by-pass button/s shall not be placed in a conspicuous position such that it would encourage unnecessary activation by users. When manual over-ride or by-pass flushing is activated, the flushing shall take place immediately and the sensor flushing shall be overridden to prevent double flushing i.e. the over-ride and by-pass feature shall over-ride all sensor operation even when the sensor has been activated and the sensor shall not activate another flush after the user leaves the sensing area. The volumes of water discharge per flush by manual over-ride and by by-pass shall continue to be not more than 4.5 litres for water closets, notwithstanding that the operating member continues to be held actuated.

7) The sensor units shall be designed to permit easy adjustment of volumes and flow rates on the flushing devices.

8) All sensor devices shall be firmly installed on the wall fronting the appliance. Sensor devices may be installed at ceiling levels if the above requirements and the limitation on sensing distance can be complied with.
9.7 Standards* to comply with - Requirements WC flush for valves

9) Agents are required to ensure proper adjustment of sensor-operated flush valves, in particular, the sensing distance and timing for activation of sensor and flushing prior to delivery to site.

10) Agents shall also ensure proper installation and adjustment of the sensor-operated flush valves at site to prevent multiple flushing.

APPENDIX B

TESTING OF SENSOR OPERATED 4.5 LITRES WATER CLOSET FLUSH VALVE

PART I - TESTING OF SENSOR DEVICE FOR WATER CLOSET VALVE

1. ENDURANCE TEST FOR SENSOR DEVICE FOR WATER CLOSET FLUSH VALVE

i. This test shall be the first test to be carried out on the sensor operated flush valve.

ii. The sensor operated flush valve shall be initially set to give a volume of discharge of not more than 4.5 litres and less 3.5 litres at flow dynamic pressure of 3.0 ± 0.5 bars. The sensor operated flush valve is then subjected to 75,000 cycles of test.

iii. The sensing distance, time delay before activation of sensor, time delay for activation of flush, average volume of discharge and average discharge time for three consecutive flushes shall be recorded at start of test and after each 25,000 cycles.

iv. After each 25,000 cycles, the change in volume of discharge shall not exceed 10% of the volume of discharge at start of the test and any reduction in the volume of discharge shall not result in a volume of discharge falling below 3.5 litres.

v. The sensor operated flush valve shall be capable of continuous operation without sticking, chattering or leaking and shall have no change in the following viz:

(a) Sensing distance

   Require 800 to 900 mm

(b) Time delay before activation of sensor
<table>
<thead>
<tr>
<th>9.7 Standards* to comply with - Requirements WC flush for valves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requiremment: The sensor device shall be designed to begin operation only after a person approaches the unit within the sensing distance of 800 to 900 mm and remains within the sensing area for a duration exceeding 5 seconds.</td>
</tr>
<tr>
<td>(c) Time delay for activation of flush</td>
</tr>
<tr>
<td>Requiremment: The sensor device shall be designed to flush only after 5 to 10 seconds after the person leaves the sensing area.</td>
</tr>
</tbody>
</table>

**APPENDIX C**

1. **DETERMINATION OF SENSING DISTANCE AND TIME DELAYS**

   (a) **Sensing distance**

   - Requiremment: 800 to 900 mm
   - Condition: 150 mm x 150 mm white paper shall be used for determination of sensing distance.

   (b) **Time delay before activation of sensor**

   - Requiremment: The sensor device shall be designed to being operation only after a person approaches the unit within the sensing distance of 800 to 900 mm and remain within the sensing area for a duration exceeding 5 seconds.

   (c) **Time delay for activation of flush**

   - Requiremment: The sensor device shall be designed to flush only after 5 to 10 seconds after the person leaves the sensing area.

2. **PRE-FLUSH/FLUSHING AT FIXED TIME INTERVALS/MULTIPLE FLUSHING FOR WATER CLOSET FLUSH VALVE**

   The sensor device for flush valve shall have no pre-flush, flushing at fixed time intervals or multiple flushing features.
### 3. MANUAL OVER-RIDE OR BY-PASS FEATURE FOR WATER CLOSET FLUSH VALVE (WHERE APPLICABLE)

If the sensor device for the WC flush valve is equipped with a manual over-ride or by-pass feature, it shall comply with the following:

(a) When manual over-ride or by-pass flushing is activated, the flushing shall take place immediately and sensor flushing shall be overridden to prevent double flushing i.e. the over-ride or by-pass feature shall over-ride all sensor operation even when the sensor has been activated and the sensor shall not activate another flush after the user leaves the sensing area.

(b) The manual over-ride or by-pass button shall not be placed in a conspicuous position such that it would encourage unnecessary activation by users.

(c) When the manual over-ride or by-pass feature is activated, the WC flush valve shall deliver a volume of discharge of not more than 4.5 litres and not less than 3.5 litres per flush at each of the following dynamic pressure: 1.0, 1.5, 2.0 and 3.0 bars with the operating member continue to be held actuated.

### APPENDIX D

**TESTING OF SENSOR OPERATED 4.5 LITRE WATER CLOSET FLUSH VALVE**

#### PART II - TESTING OF WATER CLOSET FLUSH VALVE

1. **ENDURANCE TEST**

   This test shall be the first test to be carried out on the flush valve. The flush valve shall be initially set to give a volume of discharge of not more than 4.5 litres and not less than 3.5 litres at flow dynamic pressure of 3.0 ± 0.5 bars. The flush valve is then subjected to 100,000 cycles of test.

   The average volume of discharge and average discharge time for three consecutive flushes shall be recorded at the start of the test and after each 25,000 cycles. After each 25,000 cycle, the change in volume of discharge shall not exceed 10% of the volume of discharge at the start of the test and any reduction in the volume of discharge shall not result in a volume of discharge falling below 3.5 litres.

   The flush valve shall be capable of continuous operation without sticking, chattering or leaking.

2. **HYDRAULIC TEST**

   Test A: Hydraulic test on flush valve body
### APPENDIX D

#### 1. EFFECTIVENESS OF VACUUM BREAKER TEST

(For flush valve with built-on vacuum breaker only)

The flush valve is installed as in the volume of discharge test and the lower end of the flush pipe is submerged in water such that the distance from the bottom of the vacuum breaker to water level is 150mm. With the valve seat slightly opened (by inserting a 2mm diameter wire) and the actuating member held in operating position, the flush valve inlet (without a check valve/stop valve fixed) is connected to a vacuum line and the test is conducted in the following order:

i. A constant vacuum of 635 mm mercury is applied for a period of 30 seconds.

ii. Intermittent vacuum of 50, 125, 255, 380, 635 mm of mercury are applied. Each application is for 5 seconds on and 5 seconds shut.

iii. First a slowly increasing vacuum is applied at a uniform rate from 50mm to 635mm mercury. Next, a slowly decreasing vacuum is applied at a uniform rate from 635mm to 0 mm mercury.

In test i to iii, if the water rise in the flush pipe exceeds 76mm, the vacuum breaker is deemed to have failed the test.

#### 2. VOLUME OF DISCHARGE TEST

A flush pipe of 300mm length is to be secured to the outlet of the flush valve. The internal diameter of the flush pipe shall be at least 25mm. With the flush valve connected to water supply system, a pressure gauge and a control valve are fitted at the inlet of the flush valve. The flow regulator is to be set at maximum. Before commencing the actual test, the flush valve is subjected to a series of trail runs and the dynamic pressure is adjusted to 1.0 bar.
9.7 Standards* to comply with - Requirements WC flush for valves

<table>
<thead>
<tr>
<th>Type of Test</th>
<th>Method</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper test</td>
<td>12 separate sheets of loosely crumpled soft tissue (twin-ply, sheet area between 14,000 mm²)</td>
<td>The trap shall be cleared completely four time out of five in each test.</td>
</tr>
</tbody>
</table>

The operating member is actuated and the water discharged from the flush pipe is collected until the flow of water cease (for manual over-ride and by-pass, the operating member shall continue to be held actuated until the flow of water ceases). A stop watch is started as soon as water emerges from the flush pipe and stopped when the flow of water ceases. Record the volume of water collected and discharge time.

With the flow regulator adjusted to the maximum setting, repeat the above procedure at each of the following dynamic pressures: 1.5, 2.0 and 3.0 bars.

When tested in accordance with the procedure described above, the discharge volume per flush shall not be more than 4.5 litres and less than 3.5 litres and the rate of discharge shall not be less than 1.2 litres per second.

When tested in accordance with the procedure described above, the flush valve shall discharge at a rate not less than 1.2 litres per second or shall be capable of discharging at some slower rate provide that a satisfactory flush can be delivery to the WC pan. The flush valve shall be deemed to be capable of delivering satisfactory flush only when it complies with the flushing test requirement as given in (5).

Notwithstanding the rate of discharge from the flush valve, the flush valve must still be tested to comply with the flushing test requirements in (5).

3. FLUSHING TEST

The flush valve is to be tested for flushing efficiency.

The flush valve to be tested complete with all its fittings shall be connected in accordance with the manufacturer’s instructions to a WC pan with a minimum 25 mm internal diameter flush pipe. The height of the flush pipe measuring from the bottom of the vacuum breaker to the rim of the WC pan shall be 700 mm for oriental WC pan and 300 mm for other pedestal WC pan. The complete suit shall then be placed on a firm flat horizontal surface with the pan outlet discharge freely into air with no obstruction within a distance of 150 mm of the pan outlet measured in the direction of the axis of the outlet.

With the flush valve connected to a water supply system, a pressure gauge and a control valve are fitted at inlet of flush valve for adjusting the water supply pressure.

APPENDIX E

Before carrying out the flushing test, the flush valve shall be adjusted to give a discharge of 4.5 ±0.0, -1.0 litres.

Flushing tests as prescribed in Annex G of SS 574 : Part 1 : 2012 shall be carried out for each of the appliances. The type of tests are as follows:

<table>
<thead>
<tr>
<th>Type of Test</th>
<th>Method</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper test</td>
<td>12 separate sheets of loosely crumpled soft tissue (twin-ply, sheet area between 14,000 mm²)</td>
<td>The trap shall be cleared completely four time out of five in each test.</td>
</tr>
</tbody>
</table>
9.7 Standards* to comply with - Requirements WC flush for valves

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Towel test</td>
<td>A piece of towel (360 x 340 mm) and flush within 20 secs</td>
</tr>
<tr>
<td>Ball test</td>
<td>A ball of non-absorbent material, relative density = 1.075 to 1.080, dia=43 ±0.5mm</td>
</tr>
<tr>
<td>Sawdust test</td>
<td>Sprinkle 20g of fine dry sawdust on the inside of the pan between normal water level and the flushing rim</td>
</tr>
</tbody>
</table>

The unflushed area between the water surface and the underside of the rim shall not exceed 5,000 mm².

The flushing test shall be carried out for each of the following dynamic water supply pressure 1.0, 1.5 and 3.0 bars.

Note:
Supplier, retailers and installers of flush valves shall have to ensure compliance with the requirements on backflow prevention and wastage of water as stipulated in Public Utilities (Water Supply) Regulations and Singapore Standard CP48: Code of Practice for Water Services.
The sensor operated 4.5 litres water closet flush valve shall be used in conjunction with a water closet pan complying with SS 574 : Part 2 : 2012.
PUB does not enquire into the effective performance of the flush valve and compliance with the above testing requirements does not attest to the effective performance of the flush valve. The responsibility of ensuring the effective performance of flush valve lies with the manufacturer and supplier of the flush valve.

APPENDIX E

TESTING OF MANUAL OPERATED 4.5-LITRE WATER CLOSET FLUSH VALVE

1. ENDURANCE TEST

This test shall be first test to be carried out on the flush valve.
The flush valve shall be initially set to give a volume of discharge of not more than 4.5 litres and not less than 3.5 litres at flow dynamic pressure of 3.0 ± 0.5 bars. The flush valve is then subjected to 100,000 cycles of test.
The average volume of discharge and average discharge time for three consecutive flushes shall be recorded at the start of the test and after each 25,000 cycles.
After each 25,000 cycle, the change in volume of discharge shall not exceed 10% of the volume of discharge at the start of the test and any reduction in the volume of discharge shall not result in a volume of discharge falling below 3.5 litres.
The flush valve shall be capable of continuous operation sticking, chattering or leaking.
2. **HYDRAULIC TEST**

   **Test A:** Hydraulic test on flush valve body
   With the outlet of the flush valve plugged, a hydraulic pressure of 20 bars is applied through the inlet for 60 seconds. There shall be no sign leakage or permanent distortion of any component of the flush valve.

   **Test B:** Hydraulic test on stop valve (for flush valve with built-in stop valve only)
   The inlet of the stop valve is connected to a hydraulic pressure system with the seat of the stop valve in closed position. A hydraulic pressure of 20 bars is applied for 60 seconds. The stop valve is inspected for leakage and other defects.

   **Test C:** Hydraulic test on check valve (for flush valve with built-in check valve only)
   Hydrostatic pressure test on check valve body and seat shall be carried out in accordance with BS 5154: 1991 specifications. There shall be no visible leakage or permanent distortion of any component of the check valve during the tests.

3. **EFFECTIVENESS OF VACUUM BREAKER TEST**
   (for flush valve with built-on vacuum breaker only)
   The flush valve is installed as in the volume of discharge test and the lower end of the flush pipe is submerged in water such that the distance from the bottom of the vacuum breaker to water level is 150mm. With the valve seat slightly opened (by inserting a 2 mm diameter wire) and the actuating member held in operating position, the flush valve inlet (without a check valve/stop valve fixed) is connected to a vacuum line and the test is conducted in the following order:

   i. A constant vacuum of 635 mm mercury is applied for a period of 30 seconds.
   
   ii. Intermittent vacuum of 50, 125, 255, 380, 635 mm of mercury are applied. Each application is for 5 seconds on and 5 seconds shut.
   
   iii. First a slowly increasing vacuum is applied at a uniform rate from 50mm to 635mm mercury. Next, a slowly decreasing vacuum is applied at a uniform rate from 635mm to 0 mm mercury.

   In test i to iii, if the water rise in the flush pipe exceeds 76mm, the vacuum breaker is deemed to have failed the test.

4. **VOLUME OF DISCHARGE TEST**
   A flush pipe of 300mm length is to be secured to the outlet of the flush valve. The internal diameter of the flush pipe shall be at least 25mm.

   With the flush valve connected to water supply system, a pressure gauge and a control valve are fitted at the inlet of the flush valve.

   The flow regulator is to be set at maximum. Before commencing the actual test, the flush valve is subjected to a series of trail runs and the dynamic pressure is adjusted to 1.0 bar.
### 9.7 Standards* to comply with - Requirements WC flush for valves

<table>
<thead>
<tr>
<th>Type of Test</th>
<th>Method</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper test</td>
<td>12 separate sheets of loosely crumpled soft tissue</td>
<td>The trap shall be cleared completely four times</td>
</tr>
</tbody>
</table>

The operating member is actuated and held actuated and the water discharge from the flush pipe is collected until the flow of water ceases (the operating member shall continue to be held actuated until the flow of water ceases). A stop watch is started as soon as water emerges from the flush pipe and stopped when the flow of water ceases. Records the volume of water collected and discharge time.

With the flow regulator adjusted to the maximum setting, repeat the above procedure at each of the following dynamic pressures: 1.5, 2.0 and 3.0 bars.

When tested in accordance with the procedure described above, the discharge volume per flush shall not be more than 4.5 litres and less than 3.5 litres and the rate of discharge shall not be less than 1.2 litres per second.

When tested in accordance with the procedure described above, the flush valve shall discharge at a rate not less than 1.2 litres per second or shall be capable of discharging at some slower rate provide that a satisfactory flush can be delivery to the WC pan. The flush valve shall be deemed to be capable of delivering satisfactory flush only when it complies with the flushing test requirement as given in (5). Notwithstanding the rate of discharge from the flush valve, the flush valve must still be tested to comply with the flushing test requirements in (5).

#### 5. FLUSHING TEST

The flush valve is to be tested for flushing efficiency.

The flush valve to be tested complete with all its fittings shall be connected in accordance with the manufacturer's instructions to a WC pan with a minimum 25 mm internal diameter flush pipe. The height of the flush pipe measuring from the bottom of the vacuum breaker to the rim of the WC pan shall be 700mm for oriental WC pan and 300mm for other pedestal WC pan. The complete suit shall then be placed on a firm flat horizontal surface with the WC pan outlet discharge freely into air with no obstruction within a distance of 150mm of the pan outlet measured in the direction of the axis of the outlet.

With the flush valve connected to a water supply system, a pressure gauge and a control valve are fitted at the inlet of the flush valve for adjusting the water supply pressure.

Before carrying out the flushing test, the flush valve shall be adjusted to give a discharge of $4.5 \pm 0.0, -0.1$ litres.

Flushing tests as prescribed in Annex G of SS 574 : Part 1 : 2012 shall be carried out for each of the appliances. The type of tests are as follows:

- **Paper test**: 12 separate sheets of loosely crumpled soft tissue
  - The trap shall be cleared completely four times
### 9.7 Standards* to comply with - Requirements WC flush for valves

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
<th>Time out of five in each test.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Towel test</td>
<td>A piece of towel (360 x 340 mm) and flush within 20 secs</td>
<td></td>
</tr>
<tr>
<td>Ball test</td>
<td>A ball of non-absorbent material, relative density = 1.075 to 1.080, dia= 43 ±0.5mm</td>
<td></td>
</tr>
<tr>
<td>Sawdust test</td>
<td>Sprinkle 20g of fine dry sawdust on the inside of the pan between normal water level and the flushing rim</td>
<td>The unflushed area between the water surface and the underside of the rim shall not exceed 5,000 mm².</td>
</tr>
</tbody>
</table>

The flushing test shall be carried out for each of the following dynamic water supply pressure 1.0, 1.5 and 3.0 bars.

**Note:**
Supplier, retailers and installers of flush valves shall have to ensure compliance with the requirements on backflow prevention and wastage of water as stipulated in Public Utilities (Water Supply) Regulations and Singapore Standard CP48: Code of Practice for Water Services.

The sensor operated 4.5 litres water closet flush valve shall be used in conjunction with a water closet pan complying with SS 574 : Part 2 : 2012.

PUB does not enquire into the effective performance of the flush valve and compliance with the above testing requirements does not attest to the effective performance of the flush valve. The responsibility of ensuring the effective performance of flush valve lies with the manufacturer and supplier of the flush valve.

All the WC flush valves submitted for test after 1 August 2008 shall be subjected to the requirement of 100,000 cycles in the Endurance Tests.

WC flush valves with flush volumes of lower than 3.5 litres (i.e. <3.5 litres) per flush shall be subjected to additional tests prescribed by PUB. Suppliers shall request separate clearance from PUB for sale, supply or use of such WC flush valves in Singapore.

In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable.
Steel Flange Adaptor (with / without rubber expansion joints)

<table>
<thead>
<tr>
<th>9.8</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
|     | BS 4504 Part 3 : Sect 3.1 : 1989 | Only the following tests/specifications are required :  
- Mating dimensions  
- Flange thickness  
- Materials  
- Pressure / temperature rating  
In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable  |

Toilet Seat With Bidet

<table>
<thead>
<tr>
<th>9.9</th>
<th>Standards* to comply with</th>
<th>Tests</th>
</tr>
</thead>
</table>
|     | JIS A4422 : 1986 | Full compliance  
1) Washing temperature  
2) Washing water quantity  
3) Rear washing force  
4) Warm wind performance  
5) Insulation Performance Test  
6) Hydraulic-proof performance test  
7) Water impact preventive performance  
8) Counterflow preventive performance  
9) Negative pressure activation performance  
10) Mechanical Strength Test  
11) Durability  
12) Construction  |
| Or | JIS A4422 : 2011 | Full compliance:  
1) Washing water temperature  
2) Washing water quantity  
3) Rear washing force  
4) Warm air temperature  
5) Warm air volume  
6) Heated seat temperature  
7) Pressure withstand  
8) Water hammer  
9) Backflow prevention and vacuum breakers  
10) Mechanical strength – seats, bowl covers, installation  
11) Endurance – operations, seats, seats and bowl covers  
12) Construction  
13) Water system  
14) Electrical system  |
|     | In additional, product shall also comply with the stipulation standards and requirements in pages 8 & 9, where applicable. |   |
### Water heaters

#### 9.10 Tests for water heaters

**Requirements for water heaters**

All water fittings (including pipes and hot water storage tanks) used shall be of non-corrodible or corrosion-resistant materials. Coated or lined corrodible or non-corrosion resistant materials are not allowed.

The heater shall be legibly marked with the following:
- Manufacturer's identification mark (trademark, brand name, etc)
- Colour code for hot and cold water supply


All metallic material in contact with water shall comply with the test on 'Extraction of Metals - App H' of AS/NZS 4020 : 2005. The maximum allowable concentrations of metals listed in Table 2 of AS/NZS 4020:2005 shall not exceed the limits specified by the World Health Organisation (WHO) Guidelines for Drinking Water Quality.

All copper alloy water fittings except for exposed terminal fittings shall be of gunmetal, bronze or DZR brass materials only. For gunmetal or bronze fittings, they shall comply with BS EN 1982 : 2008. Those which are of Dezinification Resistant type (DZR) shall comply with the tests on 'Composition' and 'Resistance to dezincification' of BS EN 12163 : 1998 or BS EN 12165 : 1998 or BS EN 12420 : 1999. Such fittings shall have an additional marking of 'DZR' or 'CR'. CW602N is the material composition designation for copper alloy with dezincification resistance in accordance with BS EN 12163 : 1998 or BS EN 12165 : 1998 or BS EN 12420 : 1999.

All elastomeric seals for joints in pipework, pipelines, water fittings and valve seats for the flushing mechanism of the WC flushing cisterns shall comply with SS 270 : 1996.

All water fittings incorporated in the water heater shall comply with the relevant Standards stipulated by PUB.


The water heater shall also comply with all other relevant statutory requirements such as those on electricity from the Energy Market Authority (EMA), safety from SPRING Singapore, etc.

======

---

PUB – Stipulation of Standards for Water Fittings
Updated as at 31 Aug 2016

Page 55 of 55
Owners, Developers, Architects, Engineers, Contractors, and Builders

Dear Sir/Madam,

WATER/AIR TIGHTNESS TESTS FOR SANITARY PLUMBING/DRAINAGE SYSTEM

PUB has previously (WRN/17.2 dated 29 Apr 16) reminded QPs and sanitary plumbers to submit water/air tightness tests results for sanitary plumbing system with the QP’s completion form (PUB-BPU-COMPOFWORK).

2. There has been some queries on how the tests should be conducted. We have worked with the Singapore Plumbing Society (SPS) to standardise the air tightness test procedures. The procedure and forms for reporting of test results are shown in Annex A, B1 & B2.

3. In the standardised testing, high pressure air test is first carried out on the sanitary piping including the main building stack before enclosing the pipes in service duct/shafts or above ceiling boards. Any leaks detected can still be rectified if found. This needs to be coordinated with the construction sequence floor by floor. Subsequently, after all the sanitary appliance and fittings have been installed, a low pressure air test or water test shall be carried out to check air tightness of the sanitary appliance installations.

4. The above standard dual stage air test will need to be carried out for all high rise development given PUB approval from 1 Apr 2017. In the interim period, low pressure air test or water test of the sanitary plumbing system shall continue to be carried out for all projects in advanced construction stage where sanitary pipes are already enclosed in ducts/shafts and sanitary appliances are already installed.

5. Single owner landed residential development and A&A works are exempted from the high pressure air test and shall continue with the current water or low pressure air test to ensure water/air tightness of the sanitary plumbing system.

6. PUB will be conducting pre-TOP site check to audit the water/air tightness test of the sanitary plumbing system during construction stage. QPs will be informed in advance for projects selected for the site audit. If you have any queries concerning this circular, please email us at PUB_BPU@pub.gov.sg

Yours faithfully

[Signature]

TAN CHEE HOON
for DIRECTOR,
WATER RECLAMATION (NETWORK) DEPARTMENT, PUB
Annex A

WATER/AIR TIGHTNESS TESTS FOR SANITARY PLUMBING/DRAINAGE SYSTEM

The water/air tightness test shall be done in accordance with the following procedures to ensure that the completed sanitary plumbing/drainage system is free of leaks.

1. Dual Stage Air Tightness Test of Sanitary Plumbing System

   Air tightness test shall be carried out in two stages during development:

   a) Stage 1- A high pressure air test to confirm that all pipes and joints are air tight before they are covered up behind conduits/shafts. This test shall be carried out in sections of the completed pipework for every 2 to 4 floors of high rise development as the work progresses. This will allow any leaks to be easily detected and repaired before the pipes are concealed.

   b) Stage 2- After installation of sanitary appliances to wall and floor outlets, the appliance connections shall be tested for air tightness through a low pressure air test.

1.1 High Pressure Air Test

   This test should be conducted when all sanitary appliances are not yet installed and all water traps are dry.

   i. Plug all open ends of the pipes with PVC pipe caps or inflatable rubber plugs.

   ii. Install at one end of the discharge stack under test, a modified pipe-end cap with a pressure gauge and an air inlet valve connected to an air pump.

   iii. Pump air into the pipes till an air pressure of 34kPa (or 5 PSI). Close the air inlet valve and check that the pressure in the pipe can be sustained for 15 minutes after shutting off the air pump.
1.2 Low Pressure Air Test

This test should be conducted after all sanitary appliances are installed

i. Fill all the floor and WC traps (water seals) with water. Plug any remaining open ends of the pipes with PVC pipe caps or inflatable rubber plugs.

ii. Insert a flexible hose pass a water seal and pump in air until air pressure of 38mm water is obtained, measured by a water gauge manometer.

iii. Close the air inlet valve and check that pressure in the pipe is sustained for at least 3 minutes after shutting off the air pump.

1.3 Water Test

In place of the low pressure air test, a water test may be conducted on the section of the pipes/stacks for each floor with the whole sanitary system filled with water up to the overflow level of the lowest sanitary appliance connected to it. No water leak shall be detected.

2. Water Tightness Test of Sanitary Drainage System

For sanitary drainage system laid below ground, water tightness test in accordance with BS EN 1610 shall be done before covering up the pipes. Fill pipe with water up to the ground level (overflow level) of the upstream manhole, within a maximum pressure of 5.0 m head of water and a minimum pressure of 1.0m head of water measured at the top of the pipe. For inspection chambers, fill with at least 5.0m head of water or up to 10cm below the chamber’s cover slab for shallower chambers.

Maintain pressure within 1 kPa of the test pressure by topping up with water. To pass the water tightness test, the amount of make-up water added should not exceed 0.15 lit/m2 of pipes wetted surface and 0.40 lit/m2 for inspection chambers wetted surface during the 30 min.
Annex B1

Result of Leak Tests on Sanitary Plumbing System

Project Reference:

Project Title:

Test Method:
  *High pressure air test / Low pressure air test/Water test

<table>
<thead>
<tr>
<th>Block No:</th>
<th>Storey Level: (eg. 1st Floor, 2nd Floor)</th>
<th>Unit No: (eg. #02-01, 03-01, etc)</th>
<th>Date of 1st test of sanitary discharge pipes/stacks, ventilating pipes/stacks, WCs, Floor traps, etc at the unit</th>
<th>1st test Result (Leak / No Leak)</th>
<th>(To specify the point of leak detected)</th>
<th>(if found leak at 1st test) Date of final retest which shows no Leak in the sanitary discharge pipes/stacks, ventilating pipes/stacks, WCs, Floor traps, etc at the unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1:</td>
<td></td>
<td>Common area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>102</td>
<td>1st floor</td>
<td>Common area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2nd floor</td>
<td>#02-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>#02-02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>#02-03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd floor</td>
<td>#03-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Example 2:</td>
<td>(for typical unit layout, eg HDB flat)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>103</td>
<td>2nd to 15th floor</td>
<td>#02-01 to #15-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>#02-02 to #15-02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>#02-03 to #15-03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>--ditto--</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tested/Checked by: (Name of plumbing contractor in charge of test) | Signature: | Company & Designation: | Date: |
Witnessed by: (Name of QP's authorised representative) | Signature: | Company & Designation: | Date: |
Annex B2

Result of Water (Hydrostatic) Tests on Sanitary Drainlines, Inspection Chambers, Sewer, Manholes

Project Reference:

Project Title:


<table>
<thead>
<tr>
<th>Section of drainlines/sewers (eg. IC1-IC2, IC-MH); Inspection chamber/manhole</th>
<th>Diameter (mm)</th>
<th>Length of Pipe (m)</th>
<th>Date of test</th>
<th>Water Loss [Pipe: litres per m length; Manhole/chamber: litres per m²]</th>
<th>Result [Pass/Fail]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tested/Checked by: (Name of plumbing contractor in charge of test)

Signature:  
Company & Designation:  
Date:  

Witnessed by: (Name of QP’s authorised representative)

Signature:  
Company & Designation:  
Date:  

Certified by: (Name of QP and QP’s stamp)

Signature:  
Date:  


Notes:

1. Sewer/Sanitary Drainline:

<table>
<thead>
<tr>
<th>BS EN 1610 Allowable water loss Calculation</th>
<th>150mm dia pipe</th>
<th>200mm dia pipe</th>
</tr>
</thead>
</table>
| Not greater than 0.15 l/m² during 30 min for pipelines | Wetted internal area = D * 3.142  
= 0.15 * 3.142  
= 0.4713 m² per m length  
Allowable water loss ≤ 0.15x 0.4713  
≤ 0.0706 litres per m length | Wetted internal area = D * 3.142  
= 0.2 * 3.142  
= 0.6284 m² per m length  
Allowable water loss ≤ 0.15x 0.6284  
≤ 0.0942 litres per m length |
| m²- wetted internal surface | D- Diameter | L- Length |

| Allowable water loss ≤ D * 3.142 * L * 0.15 |

2. Manhole/Inspection Chamber:

The test requirement is satisfied if the amount of water added is not greater than 0.4 l/m² during 30 minutes for manhole / chambers
DISTRIBUTION (via e-mail):

The President
Singapore Institute of Architects (SIA)
Eunos Technolink
Blk 3, Kaki Bukit Road 1, #02-01
Singapore 415935

The President
Singapore Plumbing Society
117B Jalan Besar Lvl 3
Singapore 208837

All CORENET e-Info subscribers

The President
Association of Consulting Engineers, Singapore (ACES)
Thomson Road Post Office
PO Box 034
Singapore 915702

The President
Institution of Engineers, Singapore (IES)
70 Bukit Tinggi road
Singapore 289758

The President
Real Estate Developers’ Association of Singapore (REDA-S)
190 Clemenceau Avenue #07-01
Singapore Shopping Centre
Singapore 239924

The President
Singapore Contractors Association Limited (SCAL)
Construction House
1 Bukit Merah Lane 2
Singapore 159760

The President
Board of Architects Singapore (BOA)
5 Maxwell Road
#01-03 Tower Block
MND Complex
Singapore 069110

The President
Professional Engineers Board, Singapore (PEB)
5 Maxwell Road,
#01-02 Tower Block
MND Complex
Singapore 069110