

## Comparison of current Australian Standard with updated ISO standard

Current Australian Standard	AS 3778.4.7	Measurement using flow gauging structures – Rectangular, trapezoidal and U-shaped flumes
Updated ISO Standard	ISO 4359	Flow measurement structures – Rectangular, trapezoidal and U-shaped flumes

### High-level comment on differences

There are number differences between the current Australian Standards and the latest ISO, especially on the “Evaluation of Discharge” and “Uncertainty” calculations for each flume type. ISO also published (ISO 4359\_2013\_Amd\_1\_2017\_20201126\_1211) amendment with updated equations that apply to uncertainty calculations that need to be updated in the Australian Standards.

It is difficult to determine if some of the changes were due to the Australian Standards being expanded for our application or if the changes are related to the different ISO versions. There are sections in the Australian Standards that provides more information with regard to the practical application, that I think should remain in our standards. This is in contrast with ISO which normally provide generic recommendation.

The way the Australian Standards are compiled (page layout, appendixes, etc.) also makes it difficult to perform a direct comparison. I think that the ISO should be incorporated in the Australian standards in full, with either a preface or an amendment outlining the AS changes applicable to our application.

### Reviewer recommendation

I recommend that the technical committee

- accept the updated ISO in full to replace current AS (**Refer to the high-level comments**)

<i>options</i>
<ul style="list-style-type: none"> <li>• <i>accept the updated ISO in full to replace current AS (simplest option!)</i></li> </ul>
<ul style="list-style-type: none"> <li>• <i>reject the updated ISO and withdraw the current AS (in cases where the update is not appropriate for Australian practice)</i></li> </ul>
<ul style="list-style-type: none"> <li>• <i>reject the updated ISO and re-confirm the current AS without change (an alternative option in cases where the update is not appropriate for Australian practice)</i></li> </ul>
<ul style="list-style-type: none"> <li>• <i>further work required to adapt the ISO for an updated AS (non-preferred option, exceptional cases only)</i></li> </ul>



## Detailed summary of differences

The table below outlines in more detail a summary of the differences between the current Australian Standard under review and the relevant updated ISO standard and includes reviewer comment where relevant.

*Column 1: Identifies the number and name of the section in the current Australian Standard*

*Column 2: Classification of the change for that section. Classified as either:*

- **No change (green shading)** – The updated ISO is the same as the current Australian Standard.
- **Minor change (blue shading)** – Changes that have minimal impact on the outcome, including
  - minor format, style or heading changes
  - minor additions, removals or changes to a few words or clauses
  - addition or exclusion of more detailed explanation
  - very minor changes to steps or processes.
- **Significant change (orange shading)** – Changes that have a moderate to major impact on the outcome, such as
  - Changes to requirements
  - Significant changes to calculations, steps or processes.

*Column 3: More detail to describe the change, and comment from the reviewer (enough detail for the consideration of AHA and WaMSTeC members in their review).*

*Text colour is used in this column as follows:*

- **Black text** – More detailed explanation of the changes and reviewer comment. **Specific reviewer comment on the changes highlighted in yellow.**
- **Blue text** – reference to information included in the updated ISO that is not in the current Australian Standard
- **Red text** – reference to information included in the current Australian Standard that is not in the updated ISO.

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
1. Scope and field of application	Minor change	<ul style="list-style-type: none"> <li>• Minor format change and rearrangement of clauses.</li> <li>• The updated ISO provide graphical illustrations of flow conditions, typical field installations, site conditions, rectangular throated flume, trapezoidal throated flume and U-throated flume</li> <li>• The updated ISO clearly indicate the standard is not applicable to “Venturi” flumes.</li> </ul>
2. References	Minor Changes	<ul style="list-style-type: none"> <li>• The updated ISO provide statement of application of references associated with the standard.</li> <li>• The updated ISO removed reference to ISO 748 and ISO1438. The two references included in Australian Standards is not applicable to the standard.</li> </ul>
3. Definitions and symbols	Significant Changes	<ul style="list-style-type: none"> <li>• The updated ISO made a number of changes to the symbol abbreviations to align with the updated standards.</li> </ul>
4. Unit of measurement	Minor Changes	<ul style="list-style-type: none"> <li>• The Australian Standard includes as section on “Units of Measurement” that is not present in the ISO standard.</li> </ul>
5. Selection of the type of flume 5.1 5.2 5.3	Minor Changes	<ul style="list-style-type: none"> <li>• The updated ISO (5.1, 5.2 &amp; 5.3) expanded on flume principles with detailed description in conjunction with illustrations and equations. Examples of the different flume types and performance graphs of each flume type is provided in Annexure A. Sections 5.1, 5.2 and 5.3 are allocated for describing flume principles, contrast to AS.</li> </ul>
5.4	Minor Changes	<ul style="list-style-type: none"> <li>• The updated ISO (5.4) allocated section 5.4 to rectangular-throated flume, contrast to AS. The description of rectangular-throated flume was further expanded.</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>• The updated ISO (5.5) created a new section for trapezoidal-throated flumes. It also provides additional information to prevent sediment accretion</li> </ul>

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (5.6) created a new section for U-throated flumes. No changes to the content was made</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (5.7, 5.8, 5.9 &amp; 5.10) created new sections outlining simplified form of critical depth flumes theory</li> <li>Provides the basic discharge equation for critical depth flume through equation 1 – 5.</li> <li>Equations for coefficients in equation for critical depth flume is referenced further in the standard</li> </ul>
6. Installation 6.1 Selection of site 6.1.1	No change	
6.1.2	Minor Changes	<ul style="list-style-type: none"> <li>The Australian Standard includes sub-sections m) and n) describing aquatic weed and sediment. The <b>NUMBERING</b> of subsections in AS is NOT correct</li> </ul>
6.1.3	Minor Changes	<ul style="list-style-type: none"> <li>The Australian Standard provides additional criteria to reject measurement site with respect to upstream velocity distribution. The placement of all formulas, tables and figures at the end of the AS is <b>NOT</b> efficient and makes it very hard to follow the process</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (6.1.4) created a new section outlining process of measurement site selection with respect to uniform velocity distribution.</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (6.1.5) created a new section outlining process of measurement site selection with respect to non-uniform velocity distribution.</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (6.1.6) created a new section outlining the methods for determining the velocity distribution.</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (6.1.7) created a new section providing typical examples of velocity distributions in channels.</li> </ul>

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (6.1.8) created a new section highlighting the impact of flumes could have fish and other aquatic species.</li> </ul>
6.2 Installation Conditions 6.2.1 General Requirements 6.2.1.1	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (6.2.1.2) created a separate section for “Installation requirements”.</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (6.2.2) created a new section “Flume Structure”</li> <li>The updated ISO (6.2.2.1, 6.2.2.2, 6.2.2.3 &amp; 6.2.2.4) created 4 new sections outlining construction of flume structures <ul style="list-style-type: none"> <li>6.2.2.1 Construction</li> <li>6.2.2.2 Finishing</li> <li>6.2.2.3 Tolerances</li> <li>6.2.2.4 Survey</li> </ul> </li> </ul>
6.2.2 Approach Channel 6.2.2.1	Minor Changes	<ul style="list-style-type: none"> <li>Approach channel section and all subsequent sub sections were moved to new section in the updated ISO (6.2.3).</li> <li>The updated ISO (6.2.3.1) wording varies from the AS. Both standards focuses on velocity distribution, with ISO relates to channel cross section and AS relates to physical or hydraulic features impacting velocity distribution</li> </ul>
6.2.2.2 – 6.2.2.7	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (6.2.3.2 a-f) describes the general requirements related to approach channel. Contrast to the specific requirements stipulated in sections 6.2.2.2 - 6.2.2.7 in AS</li> </ul>
6.3 Flume Structure	Minor Changes	<ul style="list-style-type: none"> <li>Flume Structure section and all subsequent sub sections were moved to new section in the updated ISO (6.2.2). The <b>NUMBERING</b> of subsections in AS is NOT correct</li> </ul>

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
6.4 Downstream conditions	Minor Changes	<ul style="list-style-type: none"> <li>Downstream conditions were moved to new section in the updated ISO (6.2.4)</li> <li>The updated ISO (6.2.4.1 &amp; 6.2.4.2) created 2 sections outlining the downstream requirements</li> <li>The updated ISO (6.2.4) wording varies from the AS. Both standards focuses on downstream water level, with ISO relates to design of structure for modular flow conditions and AS relates to physical and hydraulic conditions that could impact the measurement.</li> </ul>
7. Maintenance – General requirements	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (7.1, 7.2, 7.3 &amp; 7.4) created 4 sections outlining the maintenance requirements.</li> <li>The wording between AS and ISO is similar</li> </ul>
8. Measurement of head 8.1 General requirements 8.1.1	Minor Changes	<ul style="list-style-type: none"> <li>The Australian Standard provides reference to the location of the head measurements.</li> </ul>
8.1.2	No change	
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (8.2.) created a new section “Location of head measurement”</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (8.2.1, 8.2.2, &amp; 8.2.3) created 3 new sections outlining the location of head measurement related to upstream and tail water level</li> </ul>
8.2 Gauge well 8.2.1 – 8.2.7	Minor Changes	<ul style="list-style-type: none"> <li>Gauge well section and all subsequent sub sections were moved to new section in the updated ISO (8.3).</li> <li>The updated ISO (8.3.1 – 8.3.6) describes the general gauge well requirements. Contrast to the specific requirements stipulated in sections 8.2.1 - 8.2.7 in AS. There are sections that are similar, but the AS provide much more detailed requirements.</li> </ul>

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
8.3 Zero setting 8.3.1	Minor Changes	<ul style="list-style-type: none"> <li>Zero setting section and all subsequent sub sections were <b>moved</b> to new section in the updated ISO (8.4).</li> <li>The updated ISO (8.4.1) minor word changes</li> </ul>
8.3.2	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (8.4.2, 8.4.3 &amp; 8.4.4) <b>created three new sections expanding the process of zero checks</b></li> </ul>
9. Determination of discharge 9.1 General equations for discharge 9.1.1	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (9.1.1) <b>wording varies from the AS.</b></li> <li>The updated ISO <b>provides a more in-depth explanation of the theory</b></li> </ul>
9.1.2	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (9.1.2) <b>created a separate section for Specific Energy</b></li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (9.1.3) <b>created a separate section for Continuity.</b></li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (9.1.4) <b>created a separate section for Critical Flow.</b></li> </ul>
9.1.3	Minor Changes	<ul style="list-style-type: none"> <li>Section <b>moved</b> to new section in the updated ISO (9.1.5).</li> <li>The updated ISO (9.1.5) <b>wording varies from the AS.</b></li> </ul>
9.1.4	Minor Changes	<ul style="list-style-type: none"> <li>Section <b>moved</b> to new section in the updated ISO (9.1.6).</li> <li>No word changes</li> </ul>
9.2 Calculation of discharge from observed head 9.2.1-9.2.4	Significant Changes	<ul style="list-style-type: none"> <li>The Australian Standards provides summary of theoretical process to perform the calculations</li> <li>The updated ISO (9.2.1-9.2.12) <b>provides in depth theory of discharge calculations with associated tables, illustrations and charts.</b></li> <li><b>SIGNIFICANT DIFFERENCE IN CONTENT</b></li> </ul>

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
9.3 Calculation of stage-discharge relationship 9.3.1	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (9.3.1) <b>minor word changes</b>.</li> </ul>
9.3.2	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (9.3.2) <b>minor word changes</b>.</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (9.3.3) <b>created a separate section for discussion on the conversion of effective total head to measured gauge head</b>.</li> </ul>
9.4 Approach velocity and coefficient of velocity 9.4.1	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (9.4.1) <b>minor word changes</b>.</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (9.4.2) <b>created a separate section for discussion on the default value of <math>\alpha</math></b>.</li> </ul>
9.4.2	Minor Changes	<ul style="list-style-type: none"> <li>Section <b>moved</b> to new section in the updated ISO (9.4.3).</li> <li>No word changes</li> </ul>
9.4.3	Minor Changes	<ul style="list-style-type: none"> <li>Section <b>moved</b> to new section in the updated ISO (9.4.4).</li> <li>The updated ISO (9.4.4) <b>minor word changes</b>.</li> </ul>
9.4.4	Minor Changes	<ul style="list-style-type: none"> <li>Section <b>moved</b> to new section in the updated ISO (9.4.5).</li> <li>No word changes</li> </ul>
9.4.5	Minor Changes	<ul style="list-style-type: none"> <li>Section <b>moved</b> to new section in the updated ISO (9.4.6).</li> <li>No word changes</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (9.5.) <b>created a new section “Selection of flume size and shape”</b></li> </ul>

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
10. Rectangular throated flume 10.1 Description 10.1.1	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (10.1.1) <b>minor word changes</b>.</li> </ul>
10.1.2	No Changes	
10.1.3	No Change	
10.1.4	No Change	
10.1.5	Minor Changes	<ul style="list-style-type: none"> <li>The Australian Standard <b>provides note of requirements of baffle platform</b>.</li> </ul>
10.2 Location of head measurement section	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (10.2) <b>minor word changes</b>.</li> </ul>
10.3 Provision for modular flow 10.3.1	No Change	
10.3.2	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (10.3.3) <b>created a separate section for discussion on the installation of flume in an existing channel</b>.</li> <li>No word changes</li> </ul>
10.4 Evaluation of discharge 10.4.1 – 10.4.4	Significant Changes	<ul style="list-style-type: none"> <li>The Australian Standards provides summary of theoretical process to evaluate the discharge</li> <li>The updated ISO (10.4.1 – 10.4.13) <b>provides in depth theory of discharge calculations with associated tables, illustrations and charts</b>.</li> <li>The updated ISO provides tabled layout of iterative spreadsheet calculations for determining discharge.</li> <li><b>SIGNIFICANT DIFFERENCE IN CONTENT</b></li> </ul>

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
10.5 Computation of stage-discharge relationship 10.5.1	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (10.5.1) provides a more detailed explanation.</li> </ul>
10.5.2	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (10.5.2) created a separate section for trapezoidal-throated flume stage discharge relationship.</li> </ul>
10.6 Limits of application 10.6.1	No Changes	
10.6.2	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (10.6.2) provides a more detailed explanation.</li> </ul>
10.6.3	No Changes	
10.6.4	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (10.6.4) minor word changes.</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (10.6.5.) created a new section on the maximum head</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (10.6.6.) created a new section on the overall uncertainty, referencing sections 13 and 14</li> </ul>
	Significant Changes	<ul style="list-style-type: none"> <li>The updated ISO (10.6.7.) provides an updated equation of the estimation of standard percentage uncertainty of the discharge coefficient <math>u^*(C)</math> in equation 43. This equation is now REPLACED with equation in section 10.6.7 in <b>ISO 4359:2013 / Amd.1:2017</b></li> </ul>

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
10.7 Uncertainty of measurement 10.7.1	Minor Changes	<ul style="list-style-type: none"> <li>The Australian Standard provides information on overall uncertainty of measurement dependence.</li> <li>The updated ISO does not have this section included</li> <li>The same information is provided in the updated ISO (13.1.1)</li> </ul>
10.7.2	Significant Change	<ul style="list-style-type: none"> <li>The updated ISO (10.6.7.) provides an updated equation of the estimation of standard percentage uncertainty of the discharge coefficient <math>u^*(C)</math> in equation 43. This equation is now REPLACED with equation in section 10.6.7 in ISO 4359:2013 / Amd.1:2017</li> </ul>
10.7.3	Minor Changes	<ul style="list-style-type: none"> <li>The Australian Standard provides information on combining measurement uncertainties. The same information is provided in the updated ISO (13.2)</li> </ul>
11 Trapezoidal throated flumes 11.1 Description 11.1.1	Minor Changes	<ul style="list-style-type: none"> <li>The Australian Standard provides reference in standards to design methods to approximate stage-discharge relation.</li> </ul>
11.1.2	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (10.6.4) minor word changes.</li> </ul>
11.1.3 – 11.1.6	No Changes	
11.2 Location of head measurement section	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (10.2) minor word changes.</li> </ul>
11.3 Provision for modular flow 11.3.1 – 11.3.4	No Changes	

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
11.4 Evaluation of discharge 11.4.1 – 11.4.7	Significant Change	<ul style="list-style-type: none"> <li>The Australian Standards provides summary of theoretical process to evaluate the discharge</li> <li>The updated ISO (11.4.1 – 11.4.13) provides in depth theory of discharge calculations with associated tables, illustrations and charts.</li> <li>The updated ISO provides tabled layout of iterative spreadsheet calculations for determining discharge.</li> <li><b>SIGNIFICANT DIFFERENCE IN CONTENT</b></li> </ul>
11.5 Computation of stage-discharge relationship	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (11.5.1.) created a new section providing general discussion on calculating stage-discharge relationship</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (11.5.2.) created a new section providing discussion on boundary layer treatment</li> </ul>
11.5.1	Significant Change	<ul style="list-style-type: none"> <li>Section moved to new section in the updated ISO (11.5.3).</li> <li>The updated ISO (11.5.3) provide updated process, equations and variable abbreviations.</li> </ul>
11.5.2	Significant Change	<ul style="list-style-type: none"> <li>The updated ISO (11.5.3) provide updated process, equations and variable abbreviations.</li> </ul>
11.5.3	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (11.5.4) provide a more condensed outline of the process</li> </ul>
11.5.4	Minor Change	<ul style="list-style-type: none"> <li>The updated ISO (11.5.5) minor word changes.</li> <li>The updated ISO (11.5.6) created a separate section for calculating cross sectional area of approach channel</li> </ul>
11.5.5	Minor Change	<ul style="list-style-type: none"> <li>The updated ISO (11.5.7) provide a more condensed outline of the process</li> </ul>

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
11.5.6	Minor Change	<ul style="list-style-type: none"> <li>The updated ISO (11.5.8) provide a broader discussion on the development of rating curves and the use of spreadsheet for calculations.</li> </ul>
	Significant Change	<ul style="list-style-type: none"> <li>The updated ISO (11.5.9) provide tabled layout of iterative spreadsheet calculations for determining discharge</li> </ul>
11.6 Graphical approach to design	Significant Change	<ul style="list-style-type: none"> <li>The Australian Standard provides detailed process of using graphical approach for design.</li> <li>The updated ISO does not have this section included</li> <li><b>SIGNIFICANT DIFFERENCE IN CONTENT</b></li> </ul>
11.7 Limits of Application 11.7.1	Minor Changes	<ul style="list-style-type: none"> <li>Section moved to new section in the updated ISO (11.6.1).</li> <li>No word changes</li> </ul>
11.7.2	Minor Changes	<ul style="list-style-type: none"> <li>Section moved to new section in the updated ISO (11.6.4).</li> <li>The updated ISO (11.6.4) minor word changes.</li> </ul>
11.7.3	Minor Changes	<ul style="list-style-type: none"> <li>Section moved to new section in the updated ISO (11.6.2).</li> <li>The updated ISO (11.6.2) minor word changes.</li> </ul>
11.7.4	Minor Changes	<ul style="list-style-type: none"> <li>The Australian Standard provides additional criteria for Froude number when coarse sediment deposited in approach channel</li> </ul>
11.7.5	Minor Changes	<ul style="list-style-type: none"> <li>Section moved to new section in the updated ISO (11.6.3).</li> <li>The updated ISO (11.6.3) minor word changes.</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (11.6.5.) created a new section on the maximum head</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (11.6.6.) created a new section on the overall uncertainty, referencing sections 13 and 14</li> </ul>

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
	Significant Changes	<ul style="list-style-type: none"> <li>The updated ISO (11.6.7.) provides an updated equation of the estimation of standard percentage uncertainty of the discharge coefficient <math>u^*(C)</math> in equation 58. This equation is now REPLACED with equation in section 11.6.7 in <b>ISO 4359:2013 / Amd.1:2017</b></li> </ul>
11.8 Uncertainty of measurement 11.8.1	Minor Changes	<ul style="list-style-type: none"> <li>The Australian Standard provides information on overall uncertainty of measurement dependence.</li> <li>The updated ISO does not have this section included</li> <li>The same information is provided in the updated ISO (13.1.1)</li> </ul>
11.8.2	Significant Change	<ul style="list-style-type: none"> <li>The updated ISO (11.6.7.) provides an updated equation of the estimation of standard percentage uncertainty of the discharge coefficient <math>u^*(C)</math> in equation 58. This equation is now REPLACED with equation in section 11.6.7 in <b>ISO 4359:2013 / Amd.1:2017</b></li> </ul>
11.8.3	Minor Changes	<ul style="list-style-type: none"> <li>The Australian Standard provides information on combining measurement uncertainties.</li> <li>The same information is provided in the updated ISO (13.2)</li> </ul>
12. U-throated (round-bottomed) flumes 12.1 Description 12.1.1	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (12.1.1) minor word changes.</li> </ul>
12.1.2 - 12.1.5	No Changes	
12.2 Location of head measurement section	No Changes	
12.3 Provision for modular flow 12.3.1 – 12.3.4	No Changes	

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
12.4 Evaluation of Discharge 12.4.1 – 12.4.9	Significant Changes	<ul style="list-style-type: none"> <li>The Australian Standards provides summary of theoretical process to evaluate the discharge</li> <li>The updated ISO (12.4.1 – 11.4.13) provides in depth theory of discharge calculations with associated tables, illustrations and charts.</li> <li>The updated ISO provides tabled layout of iterative spreadsheet calculations for determining discharge.</li> <li><b>SIGNIFICANT DIFFERENCE IN CONTENT</b></li> </ul>
12.5 Computation of stage-discharge relationship	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (12.5.1.) created a new section providing general discussion on calculating stage-discharge relationship</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (12.5.2.) created a new section providing discussion on boundary layer treatment</li> </ul>
12.5.1	Significant Change	<ul style="list-style-type: none"> <li>Section moved to new section in the updated ISO (12.5.3).</li> <li>The updated ISO (12.5.3) provide updated process, equations and variable abbreviations.</li> </ul>
12.5.2	Significant Change	<ul style="list-style-type: none"> <li>Section moved to new section in the updated ISO (12.5.3).</li> <li>The updated ISO (12.5.3) provide updated process, equations and variable abbreviations.</li> </ul>
12.5.3	Significant Change	<ul style="list-style-type: none"> <li>Section moved to new section in the updated ISO (12.5.3).</li> <li>The updated ISO (12.5.3) provide updated process, equations and variable abbreviations.</li> </ul>
12.5.4	Significant Change	<ul style="list-style-type: none"> <li>Section moved to new section in the updated ISO (12.5.3).</li> <li>The updated ISO (12.5.3) provide updated process, equations and variable abbreviations.</li> </ul>
12.5.5	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (12.5.4) provide a more condensed outline of the process</li> </ul>

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
12.5.6	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (12.5.5) <b>minor word changes</b>.</li> <li>The updated ISO (12.5.6) <b>created a separate section for calculating cross sectional area of approach channel</b></li> </ul>
12.5.7	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (12.5.7) <b>provide a more condensed outline of the process</b></li> </ul>
12.5.8	Minor Change	<ul style="list-style-type: none"> <li>The updated ISO (12.5.8) <b>provide a broader discussion on the development of rating curves and the use of spreadsheet for calculations.</b></li> </ul>
12.5.9	Significant Change	<ul style="list-style-type: none"> <li>The updated ISO (12.5.9) <b>provide tabled layout of iterative spreadsheet calculations for determining discharge</b></li> </ul>
12.6 Limits of Application 12.6.1	No Change	
12.6.2	Minor Changes	<ul style="list-style-type: none"> <li>Section <b>moved</b> to new section in the updated ISO (12.6.5).</li> <li>The updated ISO (12.6.5) <b>minor word changes</b>.</li> </ul>
12.6.3	Minor Changes	<ul style="list-style-type: none"> <li>Section <b>moved</b> to new section in the updated ISO (12.6.2).</li> <li>The updated ISO (12.6.2) <b>minor word changes</b>.</li> </ul>
12.6.4	Minor Changes	<ul style="list-style-type: none"> <li>Section <b>moved</b> to new section in the updated ISO (12.6.3).</li> <li>The updated ISO (12.6.3) <b>minor word changes</b>.</li> </ul>
12.6.5	Minor Changes	<ul style="list-style-type: none"> <li>Section <b>moved</b> to new section in the updated ISO (12.6.4).</li> <li>The updated ISO (12.6.4) <b>minor word changes</b>.</li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (12.6.6.) <b>created a new section on the maximum head</b></li> </ul>
	Minor Changes	<ul style="list-style-type: none"> <li>The updated ISO (12.6.7.) <b>created a new section on the overall uncertainty, referencing sections 13 and 14</b></li> </ul>

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
	Significant Changes	<ul style="list-style-type: none"> <li>The updated ISO (12.6.8.) provides an updated equation of the estimation of standard percentage uncertainty of the discharge coefficient <math>u^*(C)</math> in equation 77. This equation is now REPLACED with equation in section 12.6.8 in <b>ISO 4359:2013 / Amd.1:2017</b></li> </ul>
12.7 Uncertainty of measurement 12.7.1	Minor Changes	<ul style="list-style-type: none"> <li>The Australian Standard provides information on overall uncertainty of measurement dependence.</li> <li>The updated ISO does not have this section included</li> <li>The same information is provided in the updated ISO (13.1.1)</li> </ul>
12.7.2	Significant Change	<ul style="list-style-type: none"> <li>The updated ISO (12.6.8.) provides an updated equation of the estimation of standard percentage uncertainty of the discharge coefficient <math>u^*(C)</math> in equation 77. This equation is now REPLACED with equation in section 12.6.8 in <b>ISO 4359:2013 / Amd.1:2017</b></li> </ul>
12.7.3	Minor Changes	<ul style="list-style-type: none"> <li>The Australian Standard provides information on combining measurement uncertainties.</li> <li>The same information is provided in the updated ISO (13.2)</li> </ul>
13 Errors in flow measurements General	Significant Change	<ul style="list-style-type: none"> <li>The updated ISO (13) provides in depth theory on uncertainty of flow measurement</li> <li><b>SIGNIFICANT DIFFERENCE IN CONTENT</b></li> </ul>
	Significant Change	<ul style="list-style-type: none"> <li>The updated ISO (14) provides example of uncertainty calculations measurement</li> <li><b>SIGNIFICANT DIFFERENCE IN CONTENT</b></li> </ul>
Annexures	Significant Change	<ul style="list-style-type: none"> <li>The Australian Standards and updated ISO Annexures does not compare.</li> <li><b>SIGNIFICANT DIFFERENCE IN CONTENT</b></li> </ul>