Comparison of current Australian Standard with updated ISO standard

Current Australian Standard	AS 3778.4.5-1991	Measurement of water flow in open channels- Part 4: Measurement using flow gauging structures- Method 4.5; Triangular Profile weirs
Updated ISO Standard	ISO 4360: 2020	Hydrometry- Open channel flow measurement using triangular profile weirs

High-level comment on differences

There is a 36 year gap between the old AS (which was based on ISO 4360- 1984), and the new ISO. In that long period, language and terminology changes have occurred, starting with the use of the word "Hydrometry" in the title, and including the use of the more precise terms modular and non-modular flow (for free and drowned flow), as well as a significant change in philosophy and method of discharge uncertainty calculation.

The new standard also includes more explanatory diagrams. These diagrams appear next to the text which refers to them, rather than appearing at the end of the standard, such as in the old AS. Also of note is the fact that the use of internet references and softcopy files (such as Excel files) has now become commonplace, in technical documents, and also in new standards. In the new ISO, there are also links given to both a discharge calculation spreadsheet and a measurement uncertainty calculation spreadsheet, as well as links to terminology databases.

In summary the new ISO is a timely improvement, and a necessary update for the hydrometric industry.

Some other "very general" or specific comments from the review, for your consideration are:-

The original 1991 committee had a broader range of committee members- can we do anything about this?

The members of the original 1991 Australian Standards committee who reviewed and approved the formulation of AS3778.4.5 (1991) from ISO 4360 (1984), was more broad than our current committee. The old committee, as well as representing hydrographic interests, also included representatives from :- The association of consulting engineers; The Australian water and wastewater association; Institute of instrumentation and control; University of NSW, and; University of Queensland.

My reason for raising this is noting from colleagues dealing with consulting engineers, who specify where and what monitoring works they want for a site, without knowing that there are standards covering these, which tell them up front what site characteristics to avoid, and what measurement uncertainty they are likely to be able to achieve. There are several recent examples where this would have saved substantial relocation and rework and angst. So…I

don't know how or what we would need to do to educate the university processes that taught these environmental engineers, and also if there is still a consulting engineer body which could be contacted to disseminate the availability of the standards.

For your information (no action required)- There was an additional intermediate ISO update from ISO 4360 1984 to the new 2020

The additional ISO update of ISO4360 was published in 2008. One point top note here is that there are at least 2 sets of changes updated from the original ISO 4360 (1984) that AS3778.4.5(1991) is based upon. This explains why there is less commonality in section headings with the present comparison.

The new ISO includes links to access an Excel sheets for calculating discharge and measurement uncertainty, as well as terminological databases

This is worth noting because it is a new aspect that the 1991 committee would not have had to deal with. The new ISO allows the purchaser to click on a link within the standard to download the discharge calculalation spreadsheet, as well as a uncertainty calculation spreadsheet. Will the AS (updated), enable access to this separate document in the same way? Also noting that the ISO has two clickable links to enable access to terminological databases for ISO and IEC. Are there other AS's with similar such links? Will Standards Australia need to work some IT magic to make this happen after conversion to AS's?

Reviewer recommendation

I recommend that the technical committee

- *accept the updated ISO in full to replace the current AS.*

(This recommendation was reached following further discussion with Working Group members)

In future ISO review processes, as the opportunity arises, make the following typographical and format corrections:-

1. Correct the typographical errors at the end of the Symbols table, as explained in the detailed comments for reviewing section 3 in the table below;
2. The new section 8.3- break this up into subsections 8.3.1 and 8.3.2, and rename the headings- as explained in the comment for sections 7 and 8- to improve clarity, and avoid confusion;
3. Correct the small typographical error identified at the end of section 11 comments

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
Title	Minor Change	Format and language change- title is shorter and more succinct, and uses the new term hydrometry
Preface	Significant difference	The AS contains a Preface, common to all AS's, which lists all of the interrelated Australian Standards. This is something our new committee will need to consider rewriting as a new preface to cover all the proposed updates, in all AS3778's.
Foreword	Significant difference	The ISO contains a Foreword explaining the ISO update process in general, and then names the particular subcommittee that made the update. It also states that the 2020 version corrects a calculation error in the 2008 version, as well as now providing an Excel worksheet to better enable calculation of measurement uncertainty…provided as part of the new ISO, accessible by clicking on a link in the ISO. Will this link work in the same way in the updated AS?
1. Scope and field of application	Minor Change	The wording is exactly the same except for the new ISO referring to the "drowned" condition, as being more correctly the "non-modular" flow condition
2. References	Significant change	The AS refers to four other related ISO's:- 748 (velocity area methods); 772 (vocabulary and symbols); 4373 (water level sensors), and; 5168 (measurement uncertainty calculation). The new ISO uses the section title "Normative References" and refers only to the vocabulary and symbols ISO 772.
Terms and Definitions (see below)	Minor Change	In addition to referring the reader to ISO 772, the new ISO contains two clickable link references to both the ISO and IEC terminological databases.

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
3. Definitions and Symbols	Significant change	The new ISO places the table of symbols in the main text of the standard, whereas the old AS places it in Annexe C. The majority of the symbols used in discharge calculations are the same (such as A for Area, and B for weir width etc). The new ISO does however have two new and additional symbols for Coriolis coefficient, as well as for combined coefficient of velocity for non-modular flow. It also does not specifically list downstream level as having a "h_2" symbol, but explains the use of the "2" subscript separately, along with other subscripts used. The more significant change is the change in the symbols used for uncertainty calculations, consistent with the philosophical changes made to the updated version of ISO5168:- The older AS approach refers to systematic and random uncertainties using "X" symbols, whereas the new ISO uses "u" for standard uncertainty and "U" for expanded uncertainty. I note that there are a couple of typographical errors in the wording for the uncertainty symbols in the new ISO "symbols" table:- • u( ):- units of measurement currently is "as parameter", whereas more explicit would be "in parameter units"; • u*( ):- quantity description currently is "percentage uncertainty in parameter specified in parentheses", should more precisely be:- "standard uncertainty in parameter specified in parentheses"; • U:- should be U*( ); and description currently is expanded percentage uncertainty, but should be:- "expanded uncertainty in parameter specified in parentheses";
4. Units of Measurement	Minor change	The AS has this section, whereas the ISO does not
Principle	Minor change	The new ISO has this section, whereas the old AS does not. It is basically a re-statement of the Scope
5. Installation	Minor change	The new ISO begins with the same wording as the old AS, but gives it the explicit subheading of "General"

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
5.1 Installation- Site Selection	Minor change	The new ISO is the same as the old AS for most of it's content, except for at the end:- on the subtopic of velocity distribution in the channel the ISO mentions that ADCPs can be used (as well as current meters) for assessing this, and also gives three sketches of satisfactory velocity distributions in three channels of different shapes
5.2 Installation- Installation conditions	Minor change	This subsection has four sub-sub sections:- General; Approach channel; Measuring structure, and ; Downstream channel. The new ISO changes the order of these sub-sub headings, placing Measuring structure before Approach channel. The new ISO gives an expanded version of the Measuring structure subsection, including a detailed Figure in a 3 dimensional view, setting out and explaining its key features. Another additional paragraph is at the end of the Downstream channel subheading, on the subject of including consideration of fish passage. One small language change is the use of the words "gauge well" for level sensing, instead of "stilling well".
6. Maintenance	Minor change	The new ISO uses mostly the same content as the old AS, but changing "stilling well" to "gauge well" and referring to other types of level measurement device maintenance. In addition it points out the need to keep flow straighteners clean (if present), and also to check the accuracy of the head measurement device, periodically

7. Measurement of Head **8. Specification for the standard weir**	Significant change	The new ISO covers the old AS sections 7 and 8 under the one heading "8. Measurement of head(s)". The re-arrangements and changes noted are:- • The old "7.1 General" content is included in the new "8.1 General" subsection content, but the new ISO is broader in content, in the range of spot measurements and continuous type measurement options referred to. • The old 7.2 (Stilling wells and float wells) is now covered in the first half of the new 8.3 (Gauge wells) • The old 7.3 (Zero setting) is now covered in the new section 8.4 of the same name. The content of the new section is based on the old, but is more precise in explaining how to use benchmarks to check for structure settlement, and on how many spot levels to take to confirm the crest level. • The old 8.1 (Description) is now covered in the new section 6.3.2 (Measuring structure), earlier in the new ISO. The new ISO also gives the structure diagram in the text itself rather than at the end of the main text (as the old AS does). The diagram itself is more detailed in the new ISO. • The old 8.2 (Location of head measurement section) is now covered in the new 8.2 (Location of head measurement(s)), and breaks up the content into two new subheadings:- Modular (free) flow, and; Non-modular (drowned) flow. Other differences noted were:- the location of head measurement now has the range [redacted] to [redacted] h_{max}, rather than explicitly [redacted]h_{max}.; more precise definition on what constitutes drowned flow conditions, using either an additional tailwater level or a crest tapping. • The old 8.3 (Condition for modular flow) has now been included in the new sections 8.2.1 (Modular (free) flow), and 8.2.2 (Non-modular (drowned) flow). • The old 8.4 (Location of crest Tapping), no longer has a specific heading in the new ISO. Instead the new ISO has included its content in the second half of its new Section 8.3 (Gauge wells). The content has been expanded, and now includes a detailed figure explaining more precisily how to design and construct the crest tapping. I would have found it helpful if the new ISO section 8.3 had have been called "Gauge wells and Crest Tappings", and broken its content up under the two subheadings:- 8.3.1 Gauge wells, and; 8.3.2 Crest Tappings…for better clarity

Section (AS section number)	Classification of change AS to ISO	More detail and comment on changes in the updated ISO
		• The new section 8.5 (Dimensions) is not in the old AS. It is a good practical addition in pointing out the need to check the as-built dimensions
9. Discharge characteristics	Minor Change	The content and calculation formulae presented are largely the same. The differences noted are:- • Name change for section 9.1- was "Equations", now "Formulae for discharge; • The new ISO has a link embedded in its text, for the user to download an excel spreadsheet designed to calculate both free flow and drowned flow; • Expanded description of free flow and drowned flow formulae in the new ISO section 9.1; • The new ISO offers an alternative to the Cd and Cv formula, in giving a formula that uses only Cd; • The "Limitations" in section 9.3 show a larger applicability in the new ISO, with minimum width being reduced to [redacted]m (instead of [redacted]m), and the height of the crest above the bed, as a ratio with hmax, allowing for a reduced value of "p" (by the ratio limit changing from [redacted] to [redacted]); • The old AS section 9.4 (Accuracy) has disappeared completely, as the new approach to uncertainty does not include the old accuracy/error conceptual approach.

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10. Uncertainties in flow measurement	Significant change	This section shows a significant change in philosophy, content, and terminology. The change follows the significant change in approach caused by the ISO's publication in 1995 of the "GUM" Guide to the expression of Uncertainty in measurement, which subsequently lead to its application and updating of water industry uncertainty approaches via ISO 5168 (2005), and ISO/TS 25377 (2007). The new ISO text for this section is considerably shorter, as the following aspects have been shifted or made available as Annexes:- Introduction to measurement uncertainty; Sample measurement performance for use in hydrometric worked examples; Spreadsheet for use with this document. The uncertainty calculation method now follows that in GUM and ISO 5168, in using standard uncertainty (u(x) for absolute units, or u*(x) for relative % uncertainty), and expanded uncertainty terminology (U(x) for absolute units, or U*(x) for relative % uncertainty). It also tabulates uncertainty sources using the "uncertainty budget" approach incorporating sensitivity coefficients for each source. The discharge uncertainty calculation spreadsheet designed for download via a link in this section of text, conforms with this new calculation method and terminology.
11. Examples	Significant change	The old AS presents 2 examples using it's calculation methodology, one for free flow conditions and the other for drowned condition…both using a 10m wide weir. The new ISO presents only one example using a small weir (only 0.6m wide), and only for free flow conditions. Discharge and uncertainty calculations conform with the new ISO sections 9 and 10 methods. One typographical error is noted in the formula used in section 11.6.1:- [redacted]