QA Workshop
Traceability Exercise

To run this exercise you will need the following:

- Rulers with differing scales (see Appendix 1 for rulers which can be printed onto card). Each student needs a ruler.
- Sufficient identical cards for the students to measure (5 x 3 inch unlined index cards are ideal)
- Certified reference standard (see Appendix 2 for a reference standard which can be printed onto card).

The exercise

Stage 1: Product analysis

The cards represent a 'product' which is being tested for quality control purposes.

Give each student a ruler and a card. Make sure that there are a range of different rulers within the group.

Ask each student to find the midpoint of the short side of the card and then to measure the distance from this point to the opposite corner, as shown in Figure 1:

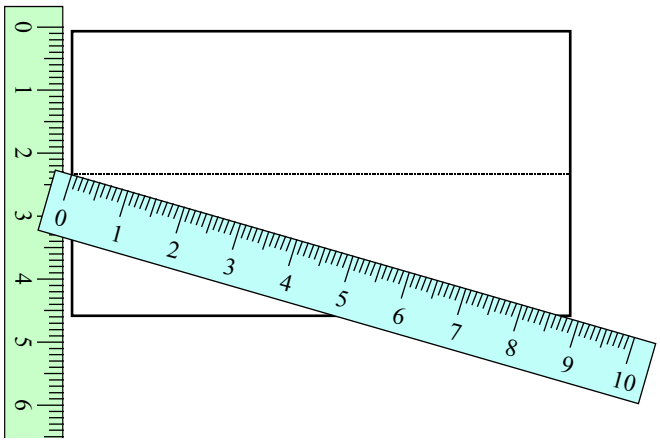

Figure 1: Dimension to be measured

Ask the students to work independently and not to compare their measurement procedure or result with each other.

Ask each student to report their result and record it on a flip chart.

Stage 2: Intercomparison

The initial round of product analysis will show a large spread of results. At this stage of the exercise the students don't know whether there is a problem with the cards, the rulers or the way they made the measurement.

Get the students to swap cards with a neighbour and repeat the measurement.

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Ask each student to report their result from the second measurement and record it against their original result.

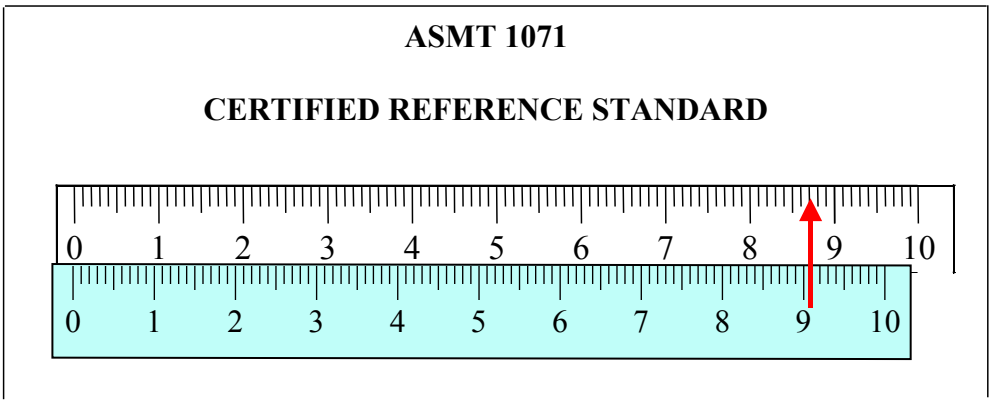
Each student should get the same result as they got in the first round. This tells the students that it cannot be a problem with the cards. Their measurements on two different cards will be in agreement, but there will be a significant spread of results across the group.

Ask the students if they know what the problem is and what they could do about it.

Hopefully the students will realise that the rulers they have been using have different scales. They have all been making measurements of length, but not on the same scale. The solution is to calibrate the rulers using a common reference standard.

Step 3: Calibration

Give each student a 'Certified Reference Standard' card. Ask them to calibrate their ruler by lining it up with the reference ruler and reading off the appropriate value, as shown below. In this example, the student's initial reading was 9.1. The calibrated reading is 8.7.



Record each student's result after calibration.

The results will now show much better agreement. Establishing the traceability of the individual rulers to a common reference standard has improved the comparability of the measurements.

As an additional exercise, the students can be asked to calculate the cost of rejecting all the cards that, prior to calibration of the rulers, would have been considered out of specification. Set an acceptable range (e.g. expected value ±0.1) and give the cards a value (e.g. £2000). This illustrates the fact that measurements that are not fit for purpose could potentially cost a manufacturing company large amounts of money through needlessly rejecting product.

Step 4: Thought experiment

Ask the students to think about a new method of producing cards of a standard size:

The cards are produced by measuring a 4x4 square using a ruler and then cutting out the square.

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The resulting squares are weighed on a traceable balance (i.e. a balance that has been properly calibrated using traceable weights).

Does the ruler still need calibrating? Why?

Although the final measurement in the process uses a traceable balance, the ruler will also affect the result as it will determine the size of the card. The ruler therefore needs calibrating as well.

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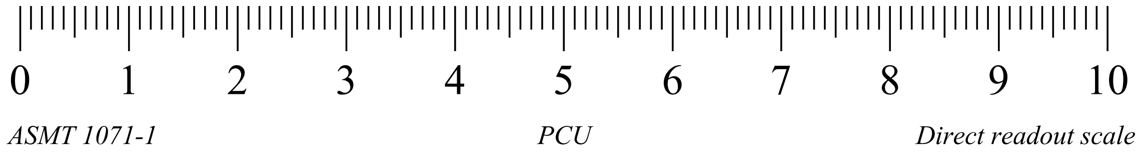
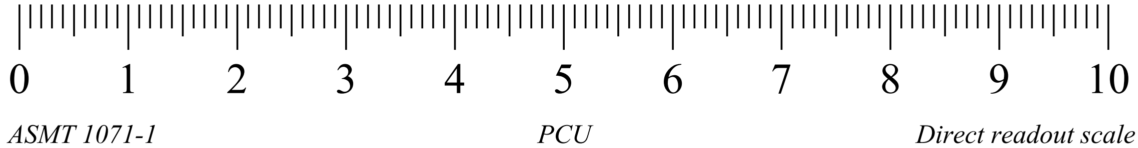
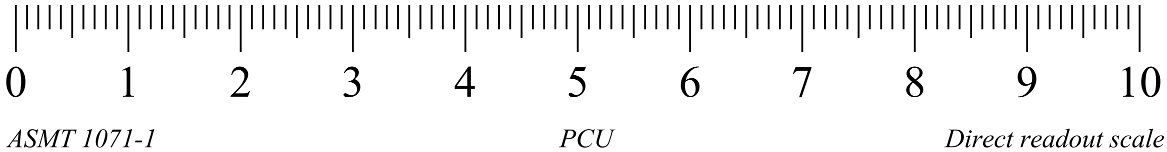
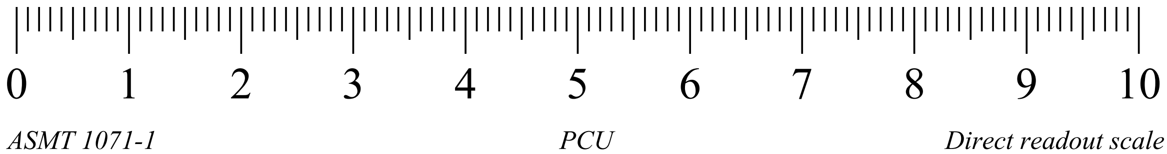
Appendix 1: Rulers

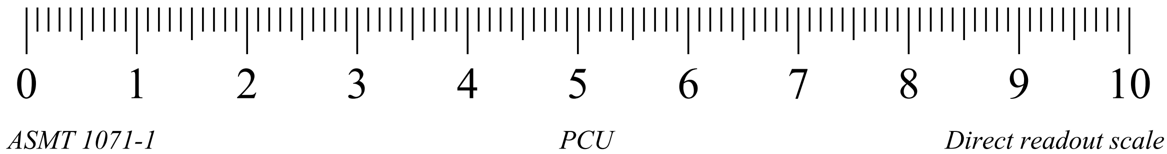
Group 1 Nominal-1 +-1

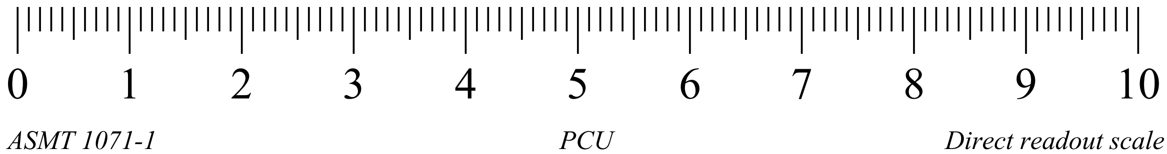


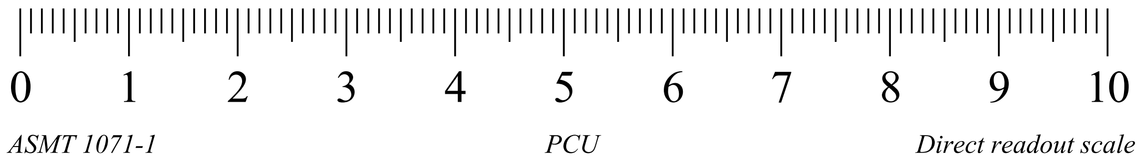












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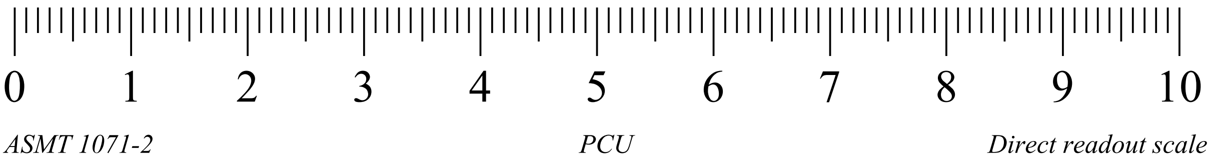
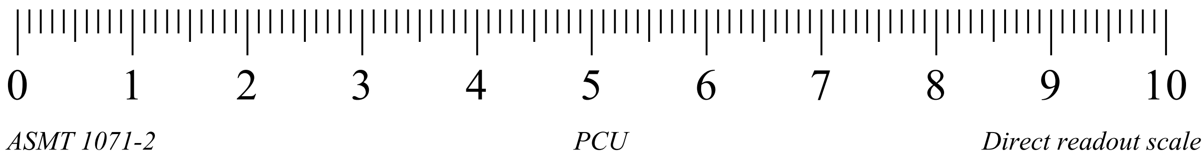
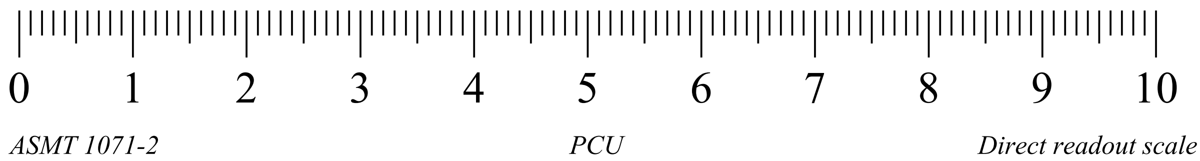
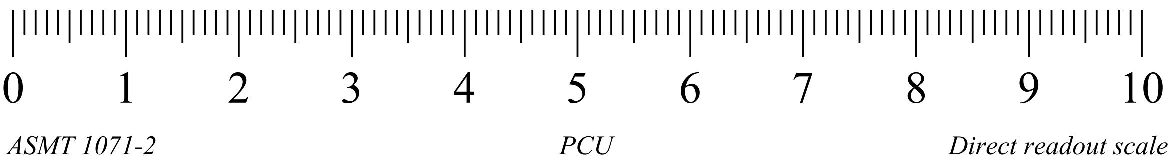
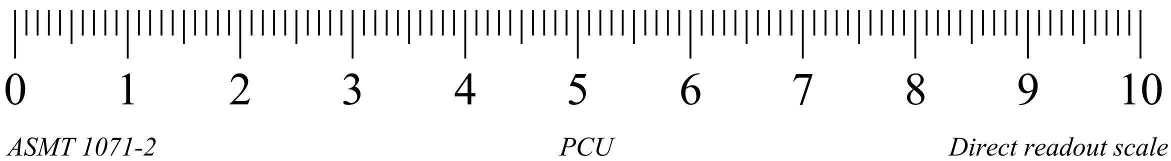
Group 2 Nominal +-3

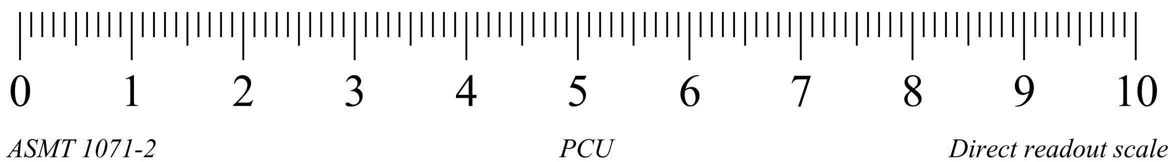


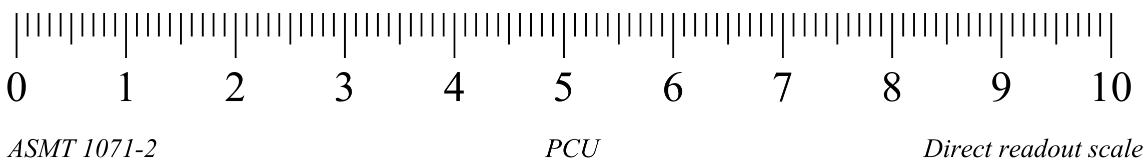












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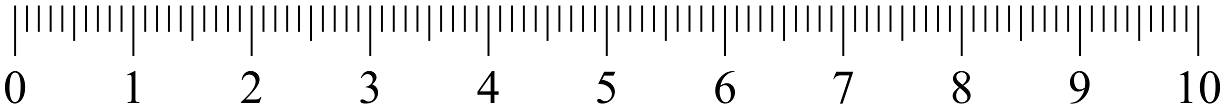
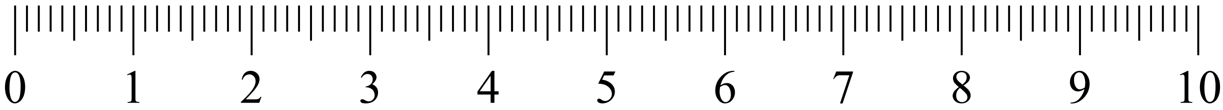
Group 3: Nominal +3



ASMT 1071-2 *PCU* *Direct readout scale*



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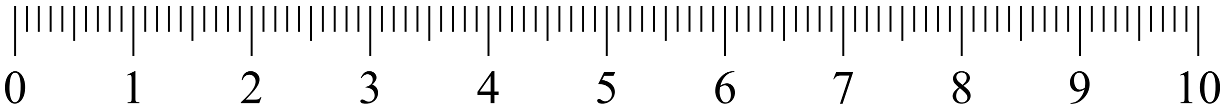

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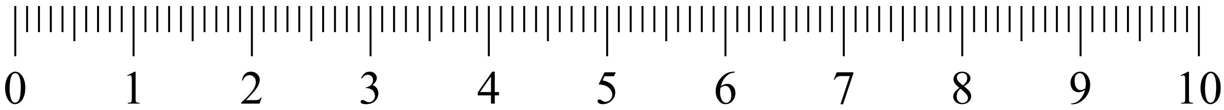

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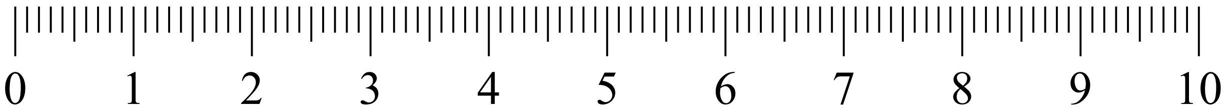

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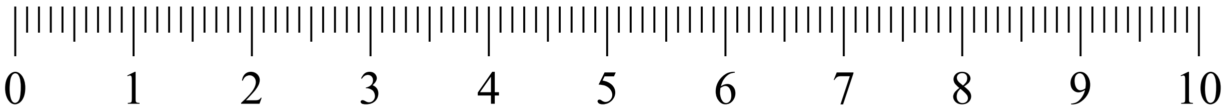

ASMT 1071-2 *PCU* *Direct readout scale*

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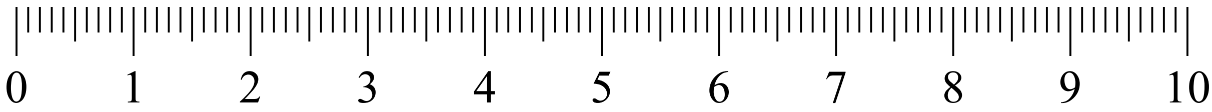
Group 4 Nominal+1,+2,+3



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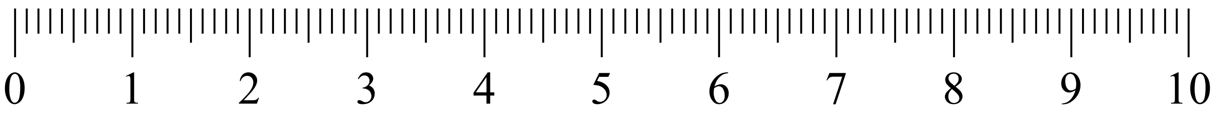

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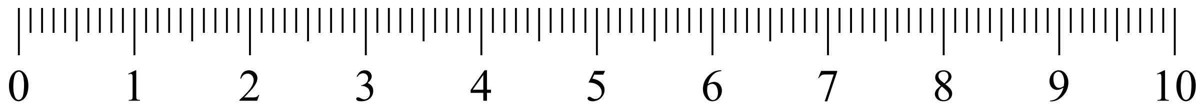

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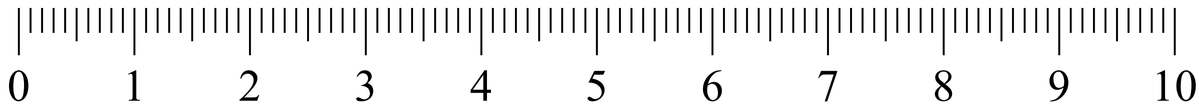

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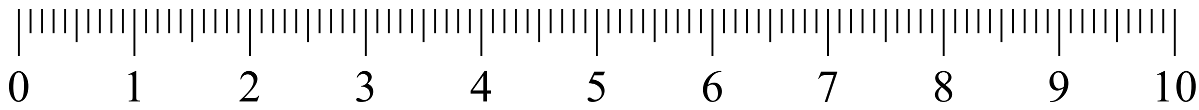

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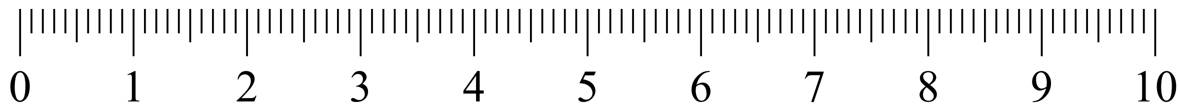

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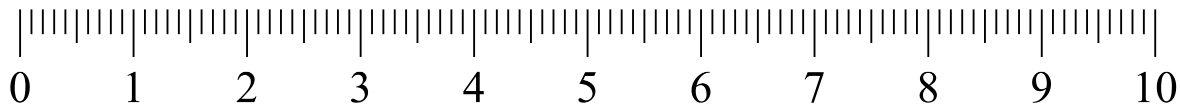

ASMT 1071 *PCU* *Direct readout scale*

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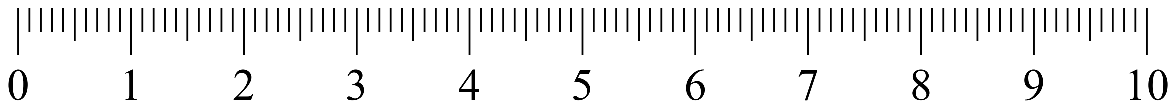
Group 5 -2+-2



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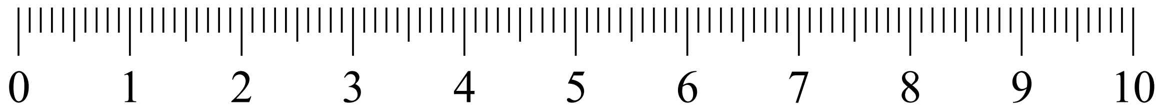

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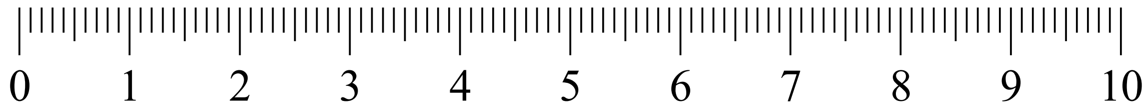

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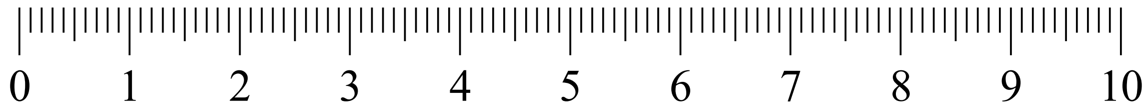

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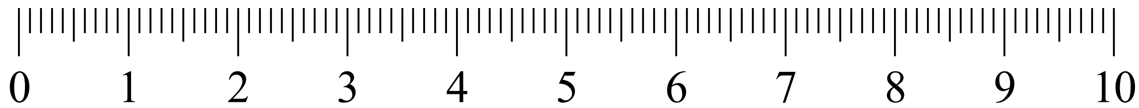

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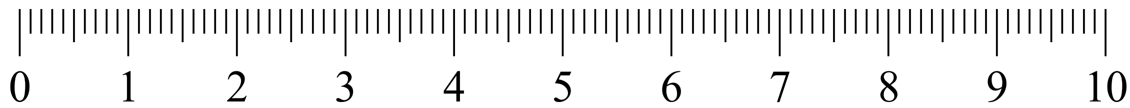

ASMT 1071-5 *PCU* *Direct readout scale*

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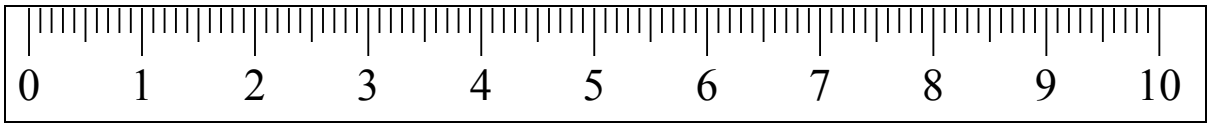
Appendix 2: Certified reference standard

ASMT 1071

CERTIFIED REFERENCE STANDARD



PCU

The above scale is certified for comparator use following test method ASMT 1071.

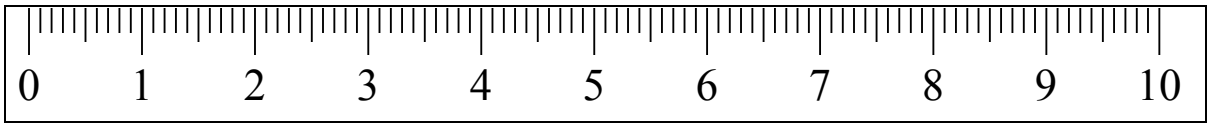
Scale readings are certified as follows:

Nominal	Observed	Uncertainty
2.00	2.001	0.03
5.00	4.98	0.04
8.00	8.03	0.04
10.00	10.01	0.05

Uncertainties are quoted as combined standard uncertainty calculated from standard uncertainties using a coverage factor k=2.

ASMT 1071

CERTIFIED REFERENCE STANDARD



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