White Paper

ISO 6789:2017 Inconsistencies, Discussion Points and Possible Amendments

May 2023

Advanced Witness Systems Ltd.

AUTHOR: RON SANGSTER, MEMBER OF BSI MTE15 AND MANAGING DIRECTOR OF ADVANCED WITNESS SYSTEMS LTD

1. Introduction

The torque standard BS EN ISO 6789:2017 has now been in limited use for the past six years and has now reached its possible revision date. Being a comparatively new, first issue standard, and following a number of years of use, a number of inconsistencies and questions have been raised within the industry. This paper attempts to highlight these inconsistencies, raise some discussion points and suggests possible amendments. The standard is a complex one and appears to be overly so, as a conformity and calibration standard, viewed by the majority of the users and even quality control departments. It has greatly increased the time required to comply to the standard and therefore the cost of calibration for what is effectively manual hand tools.

2. General Points About ISO 6789:2017

The standard in its current form comprises of two major parts, being a considerable departure from the 2003 version. It could be and seems to be required by users for it to be separated into two parts rather than parts of one standard. Manufacturers conformity and the use of the banding of 4% and 6%, though not applicable to Part 2, the calibration standard, does seem to be set in the minds of the final users, including some simple statement required after calibration of "Is it a pass or fail?". This is not a requirement of the calibration standard, though for accredited purposes, statements not within the certificate requirements can be added after the calibrator's signature. This to assist the customer. It is to be noted that with some accreditation authorities where the customer requires a pass or fail statement, **DECISION RULES** can be applied according to customer requirements. Reference to the accredited laboratories literature such as UKAS M3003 and ISO 17025 should be consulted for detail. If this standard was split into two separate standards, it would solve ambiguity by users as to which they require and reduce the not inconsiderable cost of a standard much larger than required.

The regime required for calibration does seem overly complex for use, again highlighting that these are hand tools and not instruments. Further explanation can be read below. This paper deals with the issues by part and section with each parts issue in section by section.

Note: The parts and sections listed below are to assist in locating and viewing the items and the issues, we have given reference by page number and section as listed in the ISO 6789:2017 standard itself.

3. ISO 6789:2017 Part 1

Clarity

As mentioned in our points above, the first major issue with ISO 6789:2017 Part 1 that it is not clear that it is focussed on manufacturers only as a conformity of the product. A solution would be to separate ISO 6789:2017 Part 1 from the more complex requirements of ISO 6789:2017 Part 2, to avoid confusion between them.

Taring ***(Page 4, Section 5.1.4)***

In Section 5.1.4, there is no mention of the need for taring an indicating torque tool before beginning the conformity test. For Type 1 tools (indicating), when there is no torque on the tool, the display should read zero. This should be accomplished by taring.

AUTHOR: RON SANGSTER, MEMBER OF BSI MTE15 AND MANAGING DIRECTOR OF ADVANCED WITNESS SYSTEMS LTD

Measurement Uncertainty Interval *(Page 15, Section 8)*

Clarification and definition of this term is needed and listed in the terms and standards at the beginning of the document. Though mentioned and required to be on the certificate, measurement uncertainty interval is not used mathematically in ISO 6789:2017 Part 1 and there is no mention of it in the certificate in Part 2, however it is used mathematically.

Clockwise / Counter-Clockwise Operation

The ISO 6789:2017 Part 1 standard mentions the direction of operation but doesn't state the terms clockwise / counter-clockwise until the flow chart in Annex C. It would be better that the text is normalised to use the terms clockwise and counter-clockwise.

4. ISO 6789:2017 Part 2

Clarity

Not clearly stated that ISO 6789:2017 Part 2 is used for the calibration of torque tools, and so can easily be confused with ISO 6789:2017 Part 1. As mentioned prior, a possible solution to this is to separate the two parts of the ISO 6789:2017 standard into two standalone standards to ensure clarity between the two.

Same Symbol "a" for Error and Deviation *(Part 1 – Page 3, Section 3.2. Part 2 – Page 2, Section 3.2)*

In ISO 6789:2017 Part 1, "a_d" is defined as *"Relative deviation of the torque tool from the target torque"* whereas in ISO 6789:2017 Part 2, "a_s" is defined as *"Calculated relative measurement error of the torque tool for the calibration torque"*. Since measurement error and deviation are different statistical terms, both parts of the standard should use either error or deviation. Clarification is needed.

Formulae for Part 1 is not the same as in Part 2

Part 1 – Page 12, Section 7

$$a_d = \frac{(X_o - X_t)}{X_t} \times 100$$

Where...
a_d is the calculated relative deviation of the torque tool in percent (%) for the target torque.

*X*t is for indicating tools torque tools Type I the indicated value.

*X*t is for setting torque tools Type II (Classes A, D and G), the torque value set on scale or display.

*X*t is for setting torque tools Type II (Classes B and E), the nominal torque value set.

*X*t is for setting torque tools Type II (Classes C and F), the lowest limit value or nominal torque preset value in accordance with 6.5.

*X*o is the value observed by the torque measurement device.

Part 2 – Page 5, Section 5.1

$$a_s = \frac{(X_a - X_r)}{X_r} \times 100$$

Where...
a_s is calculated relative measurement error of the torque tool for the calibration torque.

*X*a is Target indicated, set or nominal value depending on the type and class of the torque tool.

*X*r is reference value determined by the measurement device.

AUTHOR: RON SANGSTER, MEMBER OF BSI MTE15 AND MANAGING DIRECTOR OF ADVANCED WITNESS SYSTEMS LTD

In reference to our previous point, this paper recommends that the formula in Part 1 should be adopted.

Scale, Dial or Display Resolution, R ***(Page 8, Section 6.2.1)***

It should be mentioned in section 6.2.1 of ISO 6789:2017 Part 2, that for Type 2 Class B, C, E and F, the resolution should equal zero. This is due to these types of torque tools not having a scale, dial, or display.

Output Drive and Interface Measurements

Output Drive and Interface measurements combined add at least additional 80 readings into the calibration process, needing ten measurements to be taken at each position of the output drive, and a further ten measurements at each position of the drive interface. It is not clear why there needs to be this number of measurements conducted specifically, especially considering reproducibility only requires five measurements per series. Requires discussion as to industry's needs.

Reproducibility ***(Page 10, Section 6.2.2)***

The current reproducibility procedure involves four sequences of five readings, each with a disconnect in between. It's unusual for a standard to enforce four sequences for reproducibility, with most using two series of readings with a disconnect in between. This means that using four sequences introduces extra unnecessary readings, which could be removed to half the number of operations needed for the reproducibility procedure whilst not compromising the accuracy of the results. We also suggest that for Type 2 Class A, D and G tools (adjustable and graduated tools), a reset to the device should be enforced during the disconnect.

Force Loading Point ***(Page 12, Section 6.2.4)***

The torque readings obtained during operation may be affected by where the force loading point is on the torque wrench. To calculate the uncertainty this introduces into the calibration, the current ISO 6789:2017 procedure states that two sets of ten readings at the lower limit value of the measurement range should be taken from two different force loading points. The standard says these force loading points should be 10mm from either side of the centre of the marked loading point, or the centre of the hand hold position. Due to the great variation of handle lengths found in torque wrenches dependant upon the capacity and range of the wrench, 10mm can have vastly different effects on the torque readings. In would be more in keeping with the use of the torque wrench if a percentage term of the handle length was used in place of the 10mm fixed value. A percentage table dependent upon wrench size and torque value would be better. That way, the distance that the force loading point is changed to will be proportional between all sizes of torque wrenches and the manual hand holding of the tool in practice.

Distribution Functions ***(Page 14, Table 3)***

All characteristic values listed in table 3 on page 14 should by normal definitions be Type A distribution functions, not Type B, as the standard requires the collection of data (results are obtained).

Incorrect Calculation Value ***(Page 23, Table A.15)***

The relative expanded measurement uncertainty (W) at 10 N·m should be 1.166%, not 1.660% as stated in table A.15. This looks to be a typographical error requiring amendment.

Determination of the Relative Expanded Measurement Uncertainty, W

(Page 14, Section 7.2)

ISO 6789:2017 is the only standard found so far that requires proof of K Factor. K = 2 is the de facto statement in many standards and is recognised in accredited laboratories having ISO 17025 as the underlying accredited document for calibration laboratories. It is a discussion point, especially to bring it in line with other calibration standards.

5. ISO 6789:2017 Part 2 Annex C

It seems that the majority of users use a torque standard for the measuring devices such as BS 7882 or DIN 51309. Therefore, Annex C is to a large extent redundant, however the following observations are made.

W'md* Calculation** ***(Page 34, Section C.1)

In the opening remark of Annex C, the relative measurement uncertainty interval *(W'md)* is discussed. In this paragraph, it is mentioned how this value may be stated on the calibration certificate of that calibration device calibrate. We believe this paragraph should read, *"Where the torque measurement device calibrated by a laboratory meeting the requirements of ISO / IEC 17025, the maximum relative measurement uncertainty interval W'md might not be stated on the calibration certificate of that calibration device but can be calculated."*

Hysteresis Error ***(Page 38, Section C.6.2.2)***

ISO 6789:2017 Part 2 Annex C includes the measurement of hysteresis error of the zero signal. This paper suggests is kept consistent with BS 7882 and ISO 376, which do not include hysteresis error. In BS 7882, relative residual deflection (R0) is based from the largest zero deviation, whereas ISO 6789:2017 is based off the difference between the zero deviations.

Corrections Made for Error

There is currently no accommodation for situations where corrections are made for the error of the measuring device.

Determination of the Relative Expanded Measurement Uncertainty, W'md

(Page 40, Section C.7.2)

ISO 6789:2017 is the only standard found so far that requires proof of K Factor. K = 2 is the de facto statement in many standards and is recognised in accredited laboratories having ISO 17025 as the underlying accredited document for calibration laboratories. It is a discussion point, especially to bring it in line with other calibration standards.

6. New Possible Work

Since the concept of this standard, technology and products have moved on such as torque turn and torque angle requirements with other technologies should now be considered.

7. Conclusion

We hope that the points raised following comments from many users and knowledgeable standards individuals will enable those involved in the revision of the standard to have sight of the issues and be able to address them.

Advanced Witness Systems in the UK have the instruments, calibration machines and software able to meet the requirements of ISO 6789:2003, 2017 or in-house standards. View our website or contact us via sales@awstorque.co.uk, or on 01295 266939.

Advanced Witness Systems Ltd.

Unit 8 Beaumont Business Centre,
Beaumont Close,
Banbury.
OX16 1TN
Tel: +44 (0) 1295 266939
Email: sales@awstorque.co.uk
www.awstorque.co.uk

Registered in England Company Number: 2565074

Disclaimer: The information in this white paper is believed to be fair and accurate but represents the view of the staff of AWS Ltd. and should not be used for any specific purpose other than that intended, which is to encourage further questions, understanding and debate of the new standard.