6

Torque Tools are Measurement Equipment

6-1. Torque Tools are Measurement Equipment

(1) Control of torque tools —— 76

(2) Calibration of torque tools —— 76

6-2. Traceability

(1) Traceability system —— 77

(2) Diagram of torque traceability and National standard —— 78

(3) ISO 9000-related documents —— 80

6-3. Engagement with JCSS and development of services

(1) JCSS outline —— 81

(2) JCSS calibration service —— 82

(3) Flow of JCSS calibration —— 84

6-4. Accuracy and Uncertainty

(1) Accuracy —— 85

(2) Uncertainty —— 86

(3) Analysis procedure for uncertainty in measurements —— 88

(4) Example of uncertainty —— 89

(5) Accuracy of torque tools —— 91

(6) Durable accuracy of torque tools (Tohnichi standards) —— 92

6-5. Tool control

(1) Tool Control —— 93

(2) Select testers —— 93

(3) Testers for torque tools —— 94

(4) Standards of Tohnichi, ISO, JIS (ISO 6789, JIS B 4652) —— 94

(5) Naming of hand torque tools —— 95

(6) Cautions for calibration of hand torque tools 95

Torque Tools as Measuring Equipment

Main measuring equipment

Dial indicating torque wrench

Digital torque screwdriver

Caliper※

Digital micro meter※

Dial gauge ※

* Provided from Mitutoyo

Measurement Control in ISO 9001: 2008 (Extract)

Human resource

6.2.2 ▶ Competence, awareness and training

a) Determine the necessary competence for personnel performing work affecting product quality.
b) Provide training or take other actions to satisfy these needs.
c) Evaluate the effectiveness of the action taken.
d) Ensures that its personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of the quality objectives.
e) Maintain appropriate records of education, training, skills, and experience.

Measuring equipment

7.6 ▶ Control of monitoring and measuring devices.

Where necessary to ensure valid results, measuring equipment shall

a) be calibrated or verified at specified intervals, or prior to use, against measurement standards traceable to international or national measurement standards.
b) Provide training or take other actions to satisfy these needs.
c) be identified to enable the calibration status to be determined.
d) be safeguarded from adjustments that would invalidate the measurement result.
e) be protected from damage and deterioration during handling, maintenance and storage.

In addition, the organization shall assess and record the validity of the previous measuring results when the equipment is found not to conform to requirements.

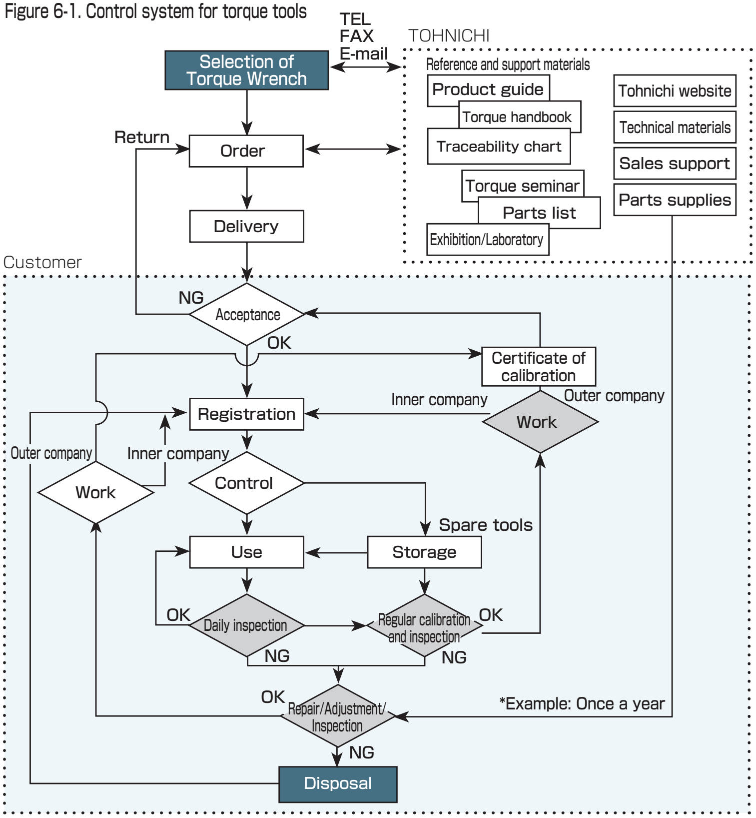
6-1 Torque Tools are Measurement Equipment

(1) Control of torque tools

The process for controlling torque tools (Figure 6-1) involves ascertaining the accuracy by adequately checking the measurement of the tools upon reception at the facility and on a daily basis. The decision of how to set up the process for the control should assess the following factors: importance, usage frequency, and usage torque capacity of the measuring instruments, by referring to the ISO standards (ISO 6789), JIS standards (JIS B 4652), and the manufacturer's nominal accuracies. The periodic calibration cycle depends on the same factors, but normally this is set between 3 months and a year. If possible this cycle should be readjusted as the tool ages to allow more effective control.

Due to torque tools are precision measurement equipment contrast to standard hand tools, take care for storage and management to maintain accuracy and durability.

Figure 6-1. Control system for torque tools



(2) Calibration of torque tools

Because torque is expressed as Torque = Force x Length, it is required that the reference standard used in the calibration should use weights for the force and a scale or calipers for the length. The reference standard being used as the standard for testing other torque tools should be three times more accurate than the item being tested. Therefore, to calibrate a torque tool with a 1% accuracy rating, a better than ±0.3% rated reference standard must be used. The reference standard must then be periodically calibrated by an official organization to maintain their accuracy and traceability.

6-2 Traceability

(1) Traceability system

Generally, measurement equipment will be calibrated with more precise standard equipment and the standard equipment also calibrated by a higher level of standard devices. Eventually, it chains to National standard and when it certified, it can be described as traceable for National standard. Torque can be resolved into length by the force. As the units of length and force are approved by official calibration laboratory respectively these units, or in part of country, torque itself chains directory to official calibration laboratory.

Tohnichi is producing a wide variety of torque tools based on the traceability system (Figure 6-2). Services, such as calibration and repair, are very important and necessary factors in the control process. All of these services required for internal company controls of torque tools, such as inspection sheets, calibration certificates, and traceability charts (Figure 6-3), are available upon request. Use the Traceability Issue Request forms from Tohnichi agents and included with the general product information for such traceability requests.

Figure 6-2. Traceability of Tohnichi products

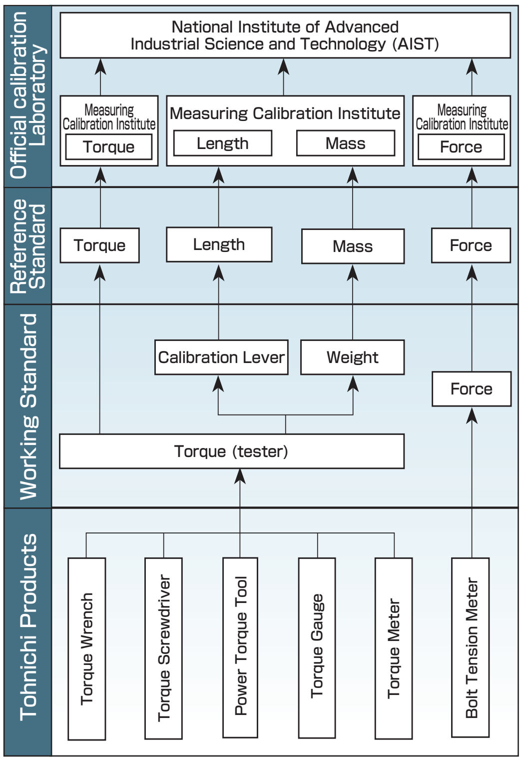
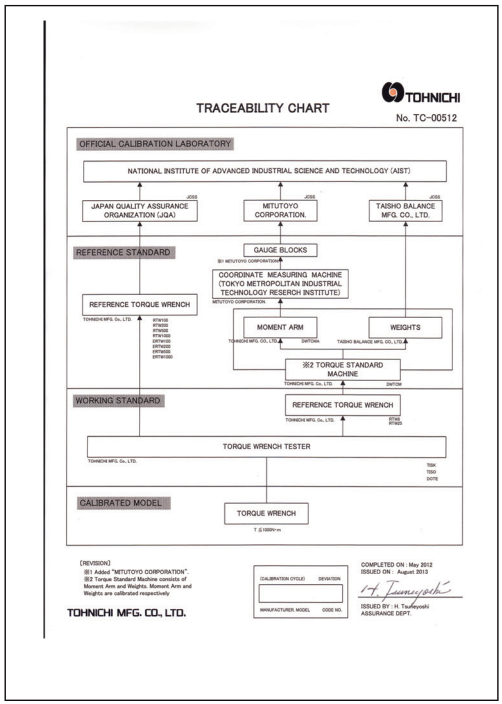


Figure 6-3. Traceability chart

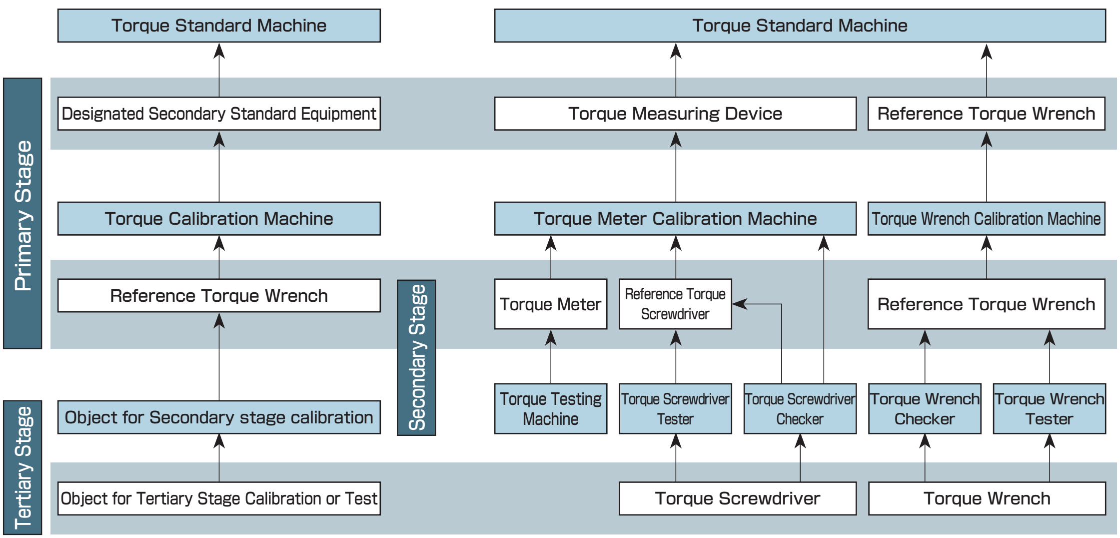


6-2 Traceability

(2) Diagram of torque traceability and National standard

In order to secure traceability system using torque SI units, the establishment of calibration methods using national torque standards is quickening worldwide. In Japan, a supply system using national torque standards has been prepared, in which "torque meters" that measure pure torsion are already being supplied in a range of 5 N·m to 20 kN·m, and "reference torque wrenches" that occupy the top standard of torque wrench testers are being provided in a range of 5 N·m to 5 kN·m. Items from the technical requirement application principles to the torque level structure for torque meters and reference torque wrenches disclosed by National Institute of Technology and Evaluation (NITE) shows in the figure 6-4. The layer composed of torque wrench and torque screwdriver and chains to torque tester and checker is "Tertiary Stage", the layer chains to reference torque wrench and reference torque screwdriver is "Secondary stage", and the layer chains from torque calibration machine to designated secondary standard equipment is "Primary stage".

Figure 6-4. Traceability System Diagram



Apply the word "Calibration" to primaly stage and secondary stage, label "Test" for tertiary stage. "Test" is ineligible for JCSS.

■Designated standard equipment… (Torque standard Machine)	Equipment designated as the national standard that realizes the torque units.
■Designated secondary … standard equipment (Reference torque wrench)	Reference torque wrench calibrated using the designated standard equipment. In addition to realizing the reference standards relating to the calibration company' s torque, this is used for maintenance and control of calibration equipment.
■Working standard … (Torque wrench calibration Machine)	This is an actual loading type, load cell type, or build-up type torque wrench standard tool used for direct comparison calibration of the reference torque wrench, the calibration equipment, by the primary stage calibration company.
■Regular reference standard … (Reference torque wrench)	Among the torque measurement equipment, this indicates a tool with a torque wrench shaped sensor part (torque converter) provided with a lever that certainly conveys the torque together with the side force and bending moment.
■Torque wrench tester	This is a tool for calibrating (or testing) torque wrenches, and is equipment that realizes torque using a torque loading device. It is used for calibrating by reference torque wrenches to chain higher standards.

Using these, through the establishing of a torque supply system by JCSS (refer to 6-3.), a traceability system for torque will be established similar to that for other units.
However, outside the torque ranges provided, local calibration will be required using [Force x Length = Torque] (Assembly unit) as before. In addition, because the level provided by JCSS is only up to the secondary level, it will basically only cover up to torque wrench testers and torque screwdriver testers.
It is expected that torque wrenches and torque screwdrivers will be transferred and have their calibration based on the JIS B 4652 standard as described below.

Establishment of Hand Torque Tools - Requirements and Test Methods (JIS B 4652) Standard

Following the progress in establishing the torque supply system described above, it was required to prepare standards for manual torque tools because the contents of the previously used JIS B 4650 standard for manual torque wrenches mainly gave stipulations regarding torque wrench product specifications, resulting in the following problems:

1) The standard only covered torque wrenches, with no stipulations for torque screwdrivers.
2) There were many specifications relating to manufacturing according to models and materials, and the method of calibration was unclear.
3) The standards had not been agreed to conform with international standards.

Here, the international standard ISO 6789: 2003 (Assembly tools for screws and nuts. Hand torque tools. Requirements and test methods for design conformance testing, quality conformance testing and recalibration procedure) was translated and submitted by the Japan Measuring Instruments Federation as the Japanese industrial standards, and this was established as JIS B 4652 on April 20, 2008.

6-2 Traceability

(3) ISO 9000-related documents

Torque equipment is also required to be controlled, calibrated and have traceability with national standards as a measurement instrument according to ISO 9000. Tohnichi provides certificate of calibration shown in Figure 6-5. Alternatively, upon the customer's request, we also issue an inspection certificate, traceability chart shown in Figure 6-6. Tohnichi stores the histories of these issued documents for a certain period and it helps maintain your torque management system base on ISO 9000.

Figure 6-5. Certificate of calibration supplied with torque wrenches

TOHNICHI

Certificate of Calibration
校 正 証 明 書

Date of First Used: / /

Name:	TORQUE WRENCH	Serial No.:	302453D
Model:	DB280N-1/2-S	Accuracy ±(%):	3
Max.Capacity:	280	Temperature (℃):	24
Units:	N·m	Inspector:	K.FUJIHARA
Date of Calibration: (Day/Month/Year)	19/02/2013		

Set Torque	Lower	Upper		Actual Readings				
30	29.2	30.9	CW	30.8	30.7	30.7	30.7	30.6
			CCW	30.7	30.7	30.7	30.5	30.7
50	48.6	51.5	CW	50.8	50.7	50.9	50.9	50.8
			CCW	50.3	50.3	50.4	50.5	50.4
150	145.7	154.6	CW	150.5	150.4	150.7	150.7	150.6
			CCW	150.0	149.9	150.0	149.9	149.8
280	271.9	288.6	CW	281.1	281.0	280.7	280.9	280.8
			CCW	279.4	279.2	279.1	279.1	279.3

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We certify that product identified above was calibrated using reference standard
That is traceable to the national standards specifications and according to TOHNICHI STANDARDS.
We have verified that these test results comply with product specifications.
Measured values are within tolerance according to ISO6789.
The uncertainty of measurement of the reference standard use is ±1%.

標準器 Standard Equipment	Model	Serial No.
ﾄﾙｸﾚﾝﾁﾃｽﾀ TORQUE WRENCH TESTER	TISK1000N-1	705342W

参照標準 Reference Standard	公的機関 Official Facility	製造番号 Serial No.
参照用ﾄﾙｸﾚﾝﾁ RTW1000 REFERENCE TORQUE WRENCH	(財)日本品質保証機構 JAPAN QUALITY ASSURANCE ORGANIZATION	701572Y
参照用ﾄﾙｸﾚﾝﾁ RTW200 REFERENCE TORQUE WRENCH	(財)日本品質保証機構 JAPAN QUALITY ASSURANCE ORGANIZATION	701570Y

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TEL:03-3762-2452 FAX:03-3761-3852
00512

TOHNICHI MFG. CO., LTD.
Head of Calibration
H. Tsuneyoshi

Figure 6-6. ISO Related document

1. Calibration Certificate
(Combined with inspection certificate)

2. Inspection Certificate

3. Traceability Chart

6-3 Engagement wit JCSS and development of services

As of November 2011, Tohnichi Accredited Room registered as an authorized calibration service provider of JCSS Secondary stage.

(1) JCSS outline

Japan Calibration Service System (JCSS) consists of the National standards provision system and the Calibration laboratory accreditation system introduced by the amended Measurement Law enforced in November, 1993.
Under the JCSS of calibration laboratory accreditation system, calibration laboratories are assessed and accredited as Accredited Calibration Laboratories to meet the requirements of the Measurement Law, relevant regulations and ISO/IEC 17025. International Accreditation Japan (IAJapan), NITE, plays as the accreditation body of JCSS and conducts accreditation process with the system conforming to ISO/IEC 17011 and relevant international criteria.

JCSS, Accredited Calibration Laboratories meet the requirements laid down in the Measurement Law as well as those of ISO/IEC 17025.
Calibration certificates with the above JCSS symbol issued by Accredited Calibration Laboratories assure the traceability to National Measurement Standards as well as a laboratory's technical and operational competence and are acceptable in the world through the ILAC and APLAC MRA.
(Reference Material Producers meets the requirements of ISO Guide 34:2009 and ISO/IEC 17025:2005)

Extract from National Institute of Technology and Evaluation (NITE)

Figure 6-7. JCSS symbol

Figure 6-8. JCSS symbol with MRA compliant

6-3 Engagement with JCSS and development of services

(2) JCSS calibration service

The following diagram figure 6-9. is traceability chart to National standard from a perspective of torque wrench. Secondary stage torque category that Tohnichi has been registered applied the torque range from 10N·m to 1000 N·m of torque wrench tester shown in figure 6-10., is calibrated by a reference torque wrench on the JCSS system. The calibration certificate that issued by accredited calibration laboratories under the JCSS system has JCSS symbol and MRA compliant symbol on the certificate and certify the torque to be traced directly to National standard shown in figure 6-11.

Figure 6-9 Traceability chart from the view point of calibration service

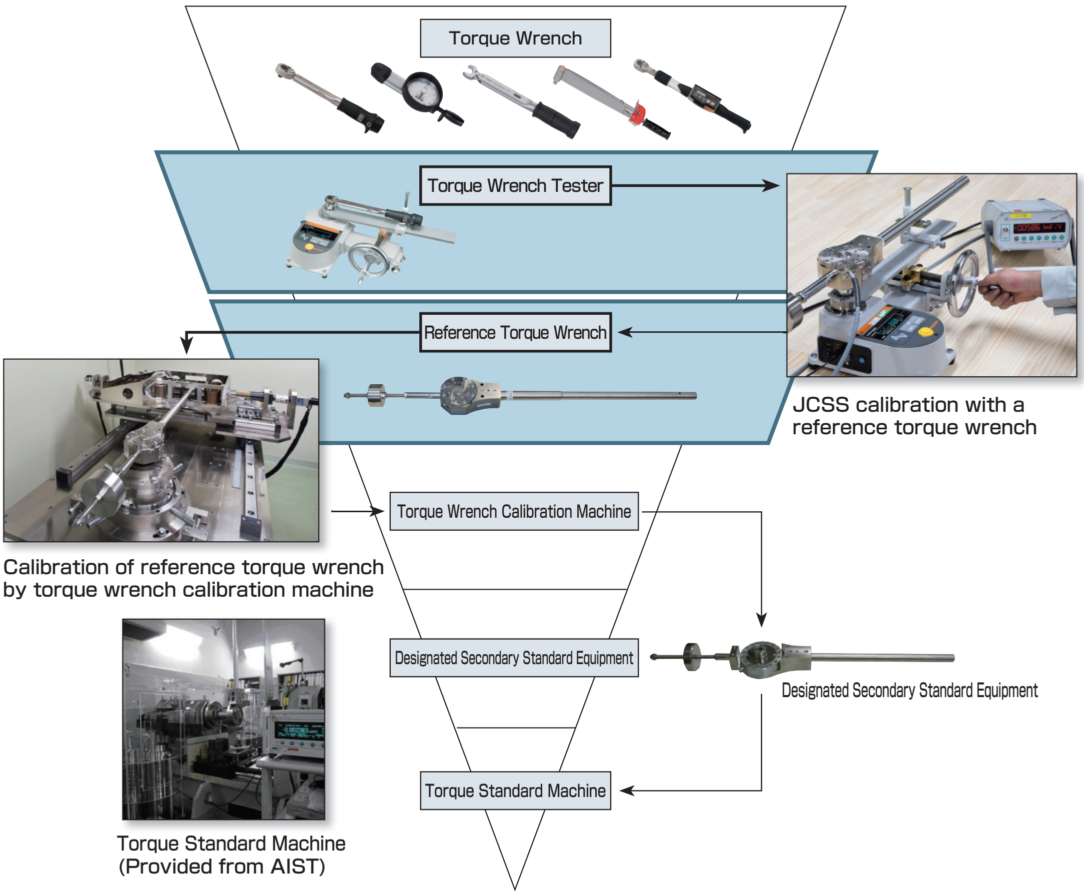
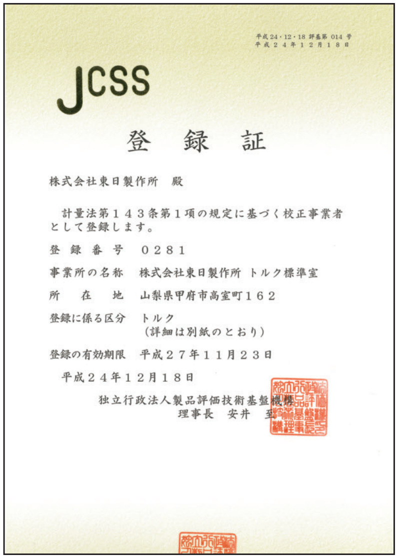


Figure 6-10 JCSS certification of registry and MRA attestation certification
(Registration the torque range from 10 N·m to 1000 N·m)


平成24・12・18 評基第 014 号
平成２４年１２月１８日

JCSS

登　録　証

株式会社東日製作所　殿

計量法第１４３条第１項の規定に基づく校正事業者として登録します。

登　録　番　号　０２８１

事業所の名称　株式会社東日製作所 トルク標準室

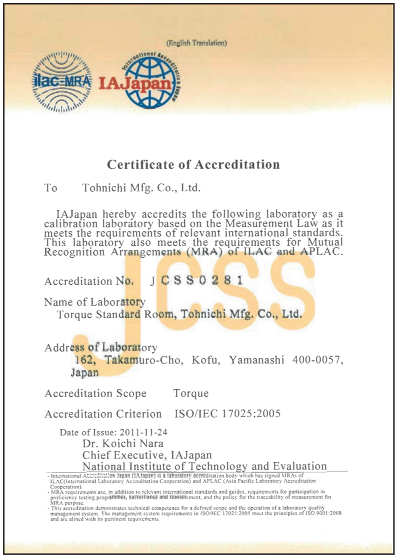
所　在　地　山梨県甲府市高室町１６２

登録に係る区分　トルク
（詳細は別紙のとおり）

登録の有効期限　平成２７年１１月２３日

平成２４年１２月１８日

独立行政法人製品評価技術基盤機構
理事長　安井　至


(English Translation)

ilac-MRA IAJapan

Certificate of Accreditation

To　Tohnichi Mfg. Co., Ltd.

IAJapan hereby accredits the following laboratory as a calibration laboratory based on the Measurement Law as it meets the requirements of relevant international standards. This laboratory also meets the requirements for Mutual Recognition Arrangements (MRA) of ILAC and APLAC.

Accreditation No.　J C S S 0 2 8 1

Name of Laboratory
Torque Standard Room, Tohnichi Mfg. Co., Ltd.

Address of Laboratory
162, Takamuro-Cho, Kofu, Yamanashi 400-0057, Japan

Accreditation Scope　Torque

Accreditation Criterion　ISO/IEC 17025:2005

Date of Issue: 2011-11-24
Dr. Koichi Nara
Chief Executive, IAJapan
National Institute of Technology and Evaluation

- International Accreditation Japan (IAJapan) is a laboratory accreditation body which has signed MRAs of ILAC(International Laboratory Accreditation Cooperation) and APLAC (Asia Pacific Laboratory Accreditation Cooperation).
- MRA requirements are, in addition to relevant international standards and guides, requirements for participation in proficiency testing programmes, surveillance and reassessment, and the policy for the traceability of measurement for MRA purpose.
- This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system. The management system requirements in ISO/IEC 17025:2005 meet the principles of ISO 9001:2008 and are alined with its pertinent requirements.

Figure 6-11. Example of JCSS calibration certificate (Initial page only)


ilac-MRA IAJapan JCSS
JCSS 0281

総数5頁の1頁
121004-7227W0DU

121004-7227W0DU
JCSS 0281
MRA/IAJapan
12−10

校正証明書

依頼者名	株式会社 東日製作所 トルクセンター大阪
依頼者住所	大阪市北区本庄東2-12-1
校正実施場所	株式会社 東日製作所 トルク標準室
計量器名	トルクレンチテスタ（指示計器一体型）
製造者名	株式会社 東日製作所
型式及び容量	DOTE100N3　100 N·m
器物番号	707227W
校正方法	JMIF019(TTSG-T202/W202)によるが、一部の方法は、東日トルク標準室「不確かさ評価に関する規定（TBS-8106）」による
校正実施条件	2頁のとおり
校正結果	3~5頁のとおり
受付年月日	2012年7月2日
校正年月日	2012年10月4日

校正結果は以上のとおりであることを証明する

発行日　2012年8月8日

校正事業者住所　山梨県甲府市高室町162番
株式会社 東日製作所 トルク標準室長

発行責任者名　相川 省三　印

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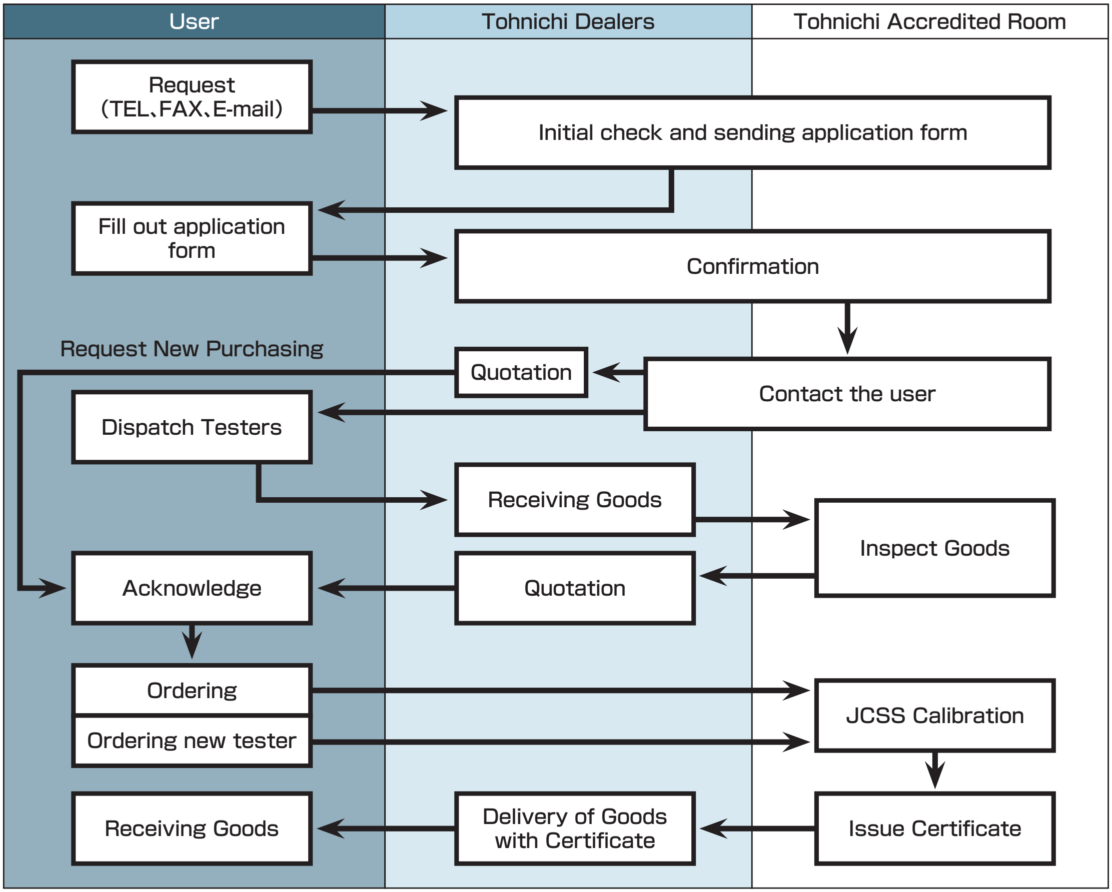
6-3 Engagement with JCSS and development of services

(3) Flow of JCSS calibration

Figure 6-12 shows a flowchart of JCSS calibration system. Application form is sent in advance to confirm requirements. "Tohnichi Accredited Room" performs calibration.

Under JCSS calibration system, not only newly purchasing Tohnichi torque wrench testers, also being used tester can be calibrated. Contact Tohnichi for further information.

Figure 6-12 Flow of JCSS calibration



6-4 Accuracy and Uncertainty

(1) Accuracy

Accuracy is the overall favorable condition including the correctness and precision of values shown by measuring equipment or measurement results. Further, correctness is the condition where there is little deviation, while precision is the condition where there is little dispersion.

Accuracy = Deviation + Dispersion

Deviation: In graduated torque measuring devices, this is the difference between the graduated values and the measured values. In torque measuring devices without graduation (preset type), this is the difference between the set torque value and the measured torque value.

Dispersion: The standard for the dispersion is taken as 2σ or 3σ.

Figure 6-13. Relation between deviation and dispersion

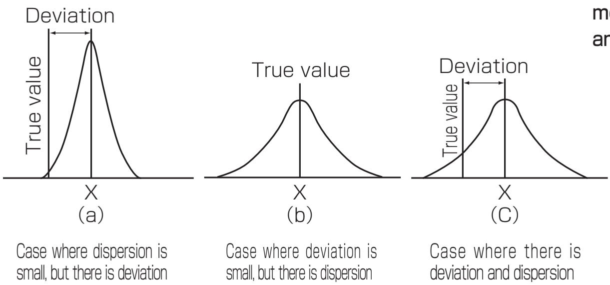


Figure 6-14. Relation of measured value and true value

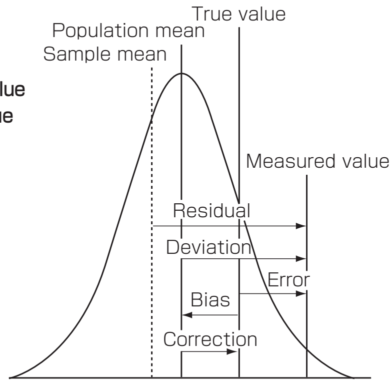


Table 6-1. Glossary of terms used in measurement(Extracted from JIS Z 8103, Glossary of terms used in measurement)

Term	Definition
True value	Value consistent with the definition of a given particular quantity. (refer to Figure 6-14) Remarks: Excluding particular cases, this is an ideal value it is unattainable practically.
Measured value	That value which has been obtained by a measurement. (refer to Figure 6-14)
Error	That value subtracted by the true value from a measured value. (refer to Figure 6-14) Remarks: The ratio of an error to the true value is called the relative error. However, in the case where it is not liable to be confused, it may also be called simply an error.
Bias	A subtracted value of population mean of measured value by a true value. (refer to Figure 6-14)
Deviation	A subtracted value by population mean from a measured value. (refer to Figure 6-14)
Residual	A subtracted value by sample mean from a measured value. (refer to Figure 6-14)
Correction	Value added algebraically to the uncorrected result of a measurement to compensate for systematic error. (refer to Figure 6-14) Remarks: 1. The correction is equal to the negative of the estimated systematic error. 2. The ratio of the correction to the read out value or calculated value is called the correction rate, and the value of correction rate expressed in percentage is called the percentage correction. 3. For the purpose of compensating the presumable systematic error, the factor to be multiplied to the measured result before correction is called the correction factor.
Dispersion	Unevenness of the magnitudes of measured values. Otherwise, the degree of irregularity. Remarks: In order to express the magnitude of dispersion, for example a term of “standard deviation” is used.

6-4 Accuracy and Uncertainty

(2) Uncertainty

Without assuming the conventional concept of the true value (which is generally unknown), the uncertainty is obtained from the data dispersion (already known) in the data range, using the measured results themselves. (Figure 6-13) The methods of evaluating uncertainty are classified under the following two types:

① Evaluation method by statistical analysis from a series of measured values. (Uncertainty type A)

② Evaluation method by a means other than statistical analysis from a series of measured values. (Uncertainty type B)

Further, for both of type A and type B, the standard uncertainties and the standard deviations (or similar values) are estimated from the normal distribution, rectangular distribution and trapezoid distribution. Finally, these are combined by the propagation rule of errors. (The combined standard uncertainty) Under these procedures, the overall uncertainty is indicated as the Extended Uncertainty.

Table 6-15. Factors for uncertainty in general measurements

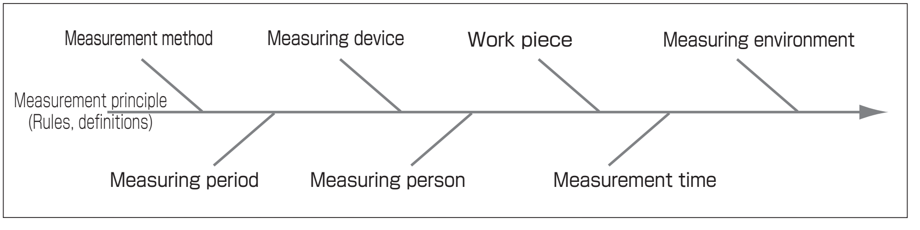
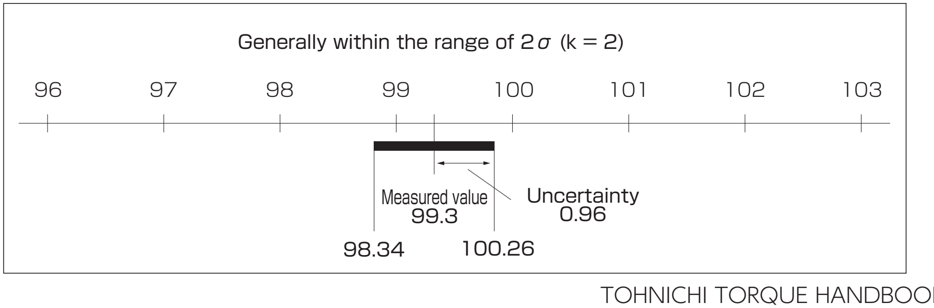
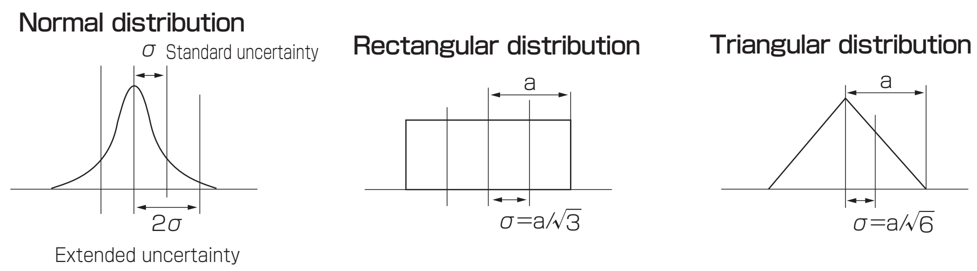


Table 6-9. Uncertainty



In normal distribution, σ (standard error) equals the standard uncertainty and generally, 2σ equals the extended uncertainty. In rectangular distribution, dividing the half width of distribution (a) by $\sqrt{3}$ equals the extended uncertainty ($a/\sqrt{3}$). In triangular distribution, dividing the half width of distribution by $\sqrt{6}$ equals the standard uncertainty ($a/\sqrt{6}$).

Table 6-17. How to estimate the uncertainty



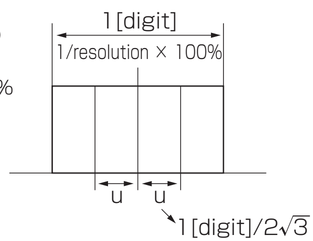
To obtain the resolution of a digital display for the uncertainty of 1 [digit], dividing 0.5 [digit] (half the width of 1 [digit]) by $\sqrt{3}$ equals the standard uncertainty (1 [digit]/$2\sqrt{3}$). For example, if the resolution (Nmin) using the minimum torque capacity (Tmin) is taken as 100, 1 [digit] equals 1% and the uncertainty of its resolution (Udigit) equals 0.29%.

Table 6-18. Example of estimating the uncertainty from the rectangular distribution

Resolution of digital display

Uncertainty for 1 [digit] (Udigit)
Resolution Nmin at Tmin
$\text{Udigit} = 1/(\text{Nmin} \times 2\sqrt{3}) \times 100\%$
1/resolution × 100%

Nmin	Udigit
100	0.29%
200	0.14%
400	0.07%



6-4 Accuracy and Uncertainty

(3) Analysis procedure for uncertainty in measurements

① Setting the method of measurement and calibration. (Describe the procedure concisely.)
Describe the principles and measuring methods, measuring devices and instruments concisely.

② Construction of the mathematical model (Write the formulas or state the principal factors.)
a) Describe the formulas if they can express the uncertainty.
b) If the uncertainty cannot be expressed by numerical formulas, indicate the factors of the uncertainties and combine them by adding.
c) Execute the test of significance through experiments based upon the design of experiments and factor analysis. Then estimate the uncertainties of each factor.

③ Correction of values (Describe the correction items and the methods, if any.) If corrections are made, the estimation of uncertainties should be carried out after the data correction.

④ Analysis and estimation of uncertainty elements (Including type A and type B classification) point out and classify the uncertainty elements, and estimate the standard deviation (or similar values) per element as follows:
a) Uncertainty of standard. (Described as the standard uncertainty.)
b) The uncertainty compared to the standard. Uncertainty resulting from factors such as the calibration equipment, calibration environment, calibration period, work piece, etc. (Described in the standard uncertainty; show the basis of the method of determination).

⑤ Calculation of combined standard uncertainty (Square root of sum of squares)

$$uc = \left(\sum_{i=1}^{n} ui^2\right)^{1/2} = \sqrt{u1^2+u2^2+\cdots un^2}$$

(The apparent differences between type A and type B will disappear.)

⑥ Calculation of extended uncertainty

$$u = k \cdot uc$$

k: Coverage factor
(Generally, k = 2 is taken. If not, describe the reason for this.)

(4) Example of uncertainty

① Theoretical formula

Torque [N·m] = Mass of dead weight [kg] x Gravitational acceleration [m/s²] x Effective length of calibration lever L [mm]

② Hypothetical models

·Torque calibration kit	DOTCL100N
·Torque wrench tester	DOTE100N3

③ Uncertainty of calibration of torque wrench tester

Extended uncertainty of torque calibration kit: UIA
Extended uncertainty of torque calibration work: UIB
Extended uncertainty of measured torque: UIT ($UIT^2 = UIA^2 + UIB^2$)
Extended uncertainty of torque wrench tester: UC
Extended uncertainty of calibration of torque wrench tester: UT ($UT^2 = UIT^2 + UC^2$)

④ Uncertainty of torque calibration kit

Factors	Standard uncertainty
·Mass (standard dead weight)	0.0004%
·Mass for measurement	0.01%
·Gravitational acceleration	0.005%
✻(Refer to P. 23, "Acceleration of gravity")	
·Corrections of specific gravity	0.015%
·Vertical/horizontal conversion	0.014%

Combined standard uncertainty for force

$$uf = \sqrt{0.0004^2+0.01^2+0.005^2+0.015^2+0.014^2} = 0.023\%$$

Factors	Standard uncertainty
·Scale (calibration)	0.006%
·Length of lever (process tolerance)	0.02%
·Diameter of wire	0.02%
·Elongation of lever	0.014%

Combined standard uncertainty of length of lever

$$ul = \sqrt{0.006^2+0.02^2+0.02^2+0.014^2} = 0.032\%$$

Combined standard uncertainty of torque calibration kit

$$ua = \sqrt{uf^2+ul^2} = \sqrt{0.023^2+0.032^2} = 0.04\%$$

Extended standard uncertainty of torque calibration kit (k = 2)

$$UIA = 2 \times ua = 0.08\%$$

6-4 Accuracy and Uncertainty

⑤ Uncertainty of torque calibration

Factors	Standard uncertainty
・Horizontality of wire	0.06%
・Inclination of lever (horizontality)	0.06%
・Length of lever (angle of drive)	0.03%
・Newton conversion	0.03%
・Repeated uncertainty	0.1%

Combined standard uncertainty of torque calibration work:

$$ub = \sqrt{0.06^2+0.06^2+0.03^2+0.03^2+0.1^2} = 0.14\%$$

Extended uncertainty of torque calibration work:

$$UIB = 2\times ub = 0.28\%$$

Extended uncertainty of calibration torque:

$$UIT = \sqrt{UIA^2+UIB^2} = 0.29\%$$

⑥ Uncertainty of calibration of torque wrench tester

Factors	Standard uncertainty
・Resolution of torque wrench tester (zero point)	0.06%
・Resolution of torque wrench tester (display)	0.06%
・Friction of axis bearing area	0.005%
・Uncertainty of gauge	0.14%
・Uncertainty of display	0.14%

Combined standard uncertainty of torque wrench tester:

$$uc = \sqrt{0.06^2+0.06^2+0.005^2+0.14^2+0.14^2} = 0.22\%$$

Extended uncertainty of torque wrench tester:

$$UC = 2\times uc = 0.44\%$$

Extended uncertainty of calibration of torque wrench tester:

$$UT = \sqrt{UIT^2+UC^2} = 0.52\%$$

⑦ Traceability of torque tools

The extended uncertainty of the torque wrench tester is required to be below ±1% (k = 2). The extended uncertainty of the torque of the torque calibration kit should be below ±0.3% (k = 2). Therefore, the standard uncertainty of the calibration kit is expected to be below 0.15%. Each standard uncertainty of inferior characteristics that is below 0.015% can be ignored.

(5) Accuracy of Torque Tools

Situation where calibration of a torque wrench or torque screwdriver is being carried out using a measuring instrument. Match the indicated value on the index of the graduated scale of the measuring instrument being calibrated with the measuring point, and read the numbers on the measuring instrument.

$$As(\%) = \frac{(\chi_a - \chi_r)}{\chi_r} \times 100$$

As(%) : Calculated deviation of the torque tool
Xa : Indicated Value of torque tool
Xr : Reference Value (Calibration Equipment)

$$\text{Calculated value from torque tool deviation} = \frac{\text{Indicating Value of torque tool} - \text{Measuring Value of Calibration Equipment}}{\text{Measuring Value of Calibration Equipment}} \times 100$$

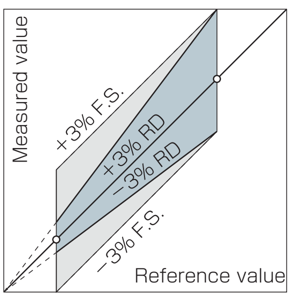
Indicated Value of torque tool

Reference Value (Calibration Equipment)

Calculation example As(%) $\chi a = 50$ $\chi r = 52$

$$As = \frac{(50-52)\times 100}{52} = -3.85\%$$

Figure 6-19. Difference in accuracy between RD and FS



Idea of Tohnichi product accuracy is reading each values that differences between indicating value and measuring value. Figure 6-19 shows that concept of each Reading (RD) and Full Scale Values (F.S.).
In case of F.S. 3% accuracy, 3% difference of high value point is covered all measuring points. In contrast, reading 3% means against each measuring points.

6-4 Accuracy and Uncertainty

Table 6-2. List of Torque Equipment Accuracy

Description	Model Name	Accuracy
Digital Torque Wrench Tester	TF、TCC、DOTE	± 1% + digit
Digital Torque Meter	TME	
Digital Torque Screwdriver Tester	TDT	
Digital Torque Wrench Checker	LC	
Digital Rotary Torque Checker	ST	
Digital Torque Screwdriver	STC	± 1%
Digital Torque Wrench	CEM、CTA、CTB	
Digital Torque Gauge	ATGE、BTGE	± 2% +1digit
Torque Meter	TM	± 2%
Torque Gauge	ATG、BTG	
Torque Wrench Tester	DOT	
Digital Torque Wrench	CPT	± 3%
Torque Screwdriver	RTD、LTD、NTD、FTD、MTD、RNTD、A/BMRD、A/BMLD etc.	
Torque Wrench	QL (E)、CL (E)、DQL (E)、TW、SP、QSP、PQL、MPQL etc.	
Semi-automatic Torque Wrench	A、AC、DAC	
Torque Wrench	QSPCA12N ~ 70N	± 4%
Power Torque Tool	U、UR、AUR、AP、DAP、ME、MC、DCME、HAT etc.	± 5%
Torque Wrench	QSPCA6N	± 6%

(6) Durability Accuracy of Tohnichi Standard

■Manual Torque Tools

Guaranteed 100,000 cycle operations at maximum torque value or one year from the first use under proper operation. With proper calibration, adjustment and parts replacement if required, on every 100,000 cycles, torque wrenches up to 420N·m models can be used 1,000,000 times, up to 1000N·m models 500,000 times, and more than 1000N·m models 250,000 times.

■Power Torque Tools

Guaranteed 500,000 cycle operations or one year from the first use under proper operation. Required periodical calibration and overhauling.

6-5 Tool Control

(1) Tool Control

Any torque equipments break down and cause malfunction as they are used for a long time. To prevent it, periodical check and calibration are required.
Daily Check : To prevent a large number of defect product
Periodic Calibration : To control accuracy of each torque equipments

Table 6-3. Daily Check and Periodic Calibration

		Self-Management	Central-Management
Inspection of Accuracy		Daily check by operators	Regular Inspection at Repair/Accredited Room
Torque Degradation		Early detection leads to prevent a big defects production.	Detection of defects on periodic time.
Malfunction		Possible to prevention	Using until they break down.
Applicable Type		Click Torque Wrench and Power Torque Tool	Indicating Torque Wrench
Tester		Torque Wrench Checker	Torque Wrench Testers, DOT/DOTE/TCC/TF
Correspondence	Worker	Accuracy Check and Replacement	Replacement
	Tool room	Check Torque Wrench Testers, Adjustment and Repairing	Inspection all tools, Adjustment and Repairing

(2) Select Testers

Checker for Daily Check ··· Not using loading device, operated by hand, there is possibilities to be affected by loading position, speed and direction.

Tester for Calibration ··· Operated on loading device, calibration values are stable.

Table 6-4. Select Testers

Type / Article	Checker		Tester			
	LC	ST	TDT	DOT	DOTE	TF, TCC
Object	Torque Wrench	Power Tool, Torque Wrench	Torque Screwdriver	Torque Wrench	Torque Wrench	Torque Wrench
Accuracy	± 1%+1digit	± 1%+1digit	± 1%+1digit	± 2%	± 1%+1digit	± 1%+1digit
Torque Range	Small-Medium-Large	Small-Medium-Large	Small	Small-Medium	Small-Medium-Large	Small-Medium-Large
Analog	×	×	×	○	×	×
Digital	○	○	○	×	○	○
Manual	○	○	○	○	○	○ (TCC)
Power	×	×	×	○ (DOT-MD)	○ (DOTE-MD)	○ (TF)
Direction	Right	Right/Left	Right/Left	Right	Right/Left	Right/Left

6-5 Tool Control

(3) Testers for torque tools

Table 6-5. Example of Torque tools and Testers/Checkers

Torque tools	Representative Model	Tester / Checker
Pneumatic screwdriver	U、UR、AUR	TCF＋TP＋Display
Semi-automatic airtork	A、AC、DAC	DOT・DOTE・LC・TF・TCC Torque wrench tester
Fully automatic airtork	HAT、AP、DAP	TCF＋TP＋Display、ST
Multiple unit	ME、MC、MG、DCME	TCF＋TP＋Display、ST
Manual torque screwdriver	RTD、LTD、AMRD、BMRD	TDT、ATGE、TCF＋Display
Manual torque wrench	QL、SP、QSP、TW、QSPCA	DOT・DOTE・LC・TF・TCC Torque wrench tester
Tester, Checker, Torque meter	DOTE、LC、TF、TDT、TME	Calibration kit (weight + calibration lever/pulley)

(4) Standards of Tohnichi, ISO, JIS (ISO 6789, JIS B 4652)

Table 6-6. Permissible deviation of torque value

A. Dial indicating type	Tohnichi standard	Wrench、Screwdriver	± 3%	
	ISO、JIS standard	Wrench	Below 10 N·m ± 6%	Above 10 N·m ± 4%
		Screwdriver	± 6%	
B. Adjustable type	Tohnichi standard	Wrench、Screwdriver	± 3%	
	ISO、JIS standard	Wrench	Below 10 N·m ± 6%	Above 10 N·m ± 4%
		Screwdriver	± 6%	
C. Preset type	Tohnichi standard	Wrench、Screwdriver	± 3%※	
	ISO、JIS standard	Wrench	Below 10 N·m ± 6%	Above 10 N·m ± 4%
		Screwdriver	± 6%	

Permissible deviation of JIS, ISO sectionalize by the maximum torque range of torque tools. ※QSPCA is based on ISO and JIS standard

Table 6-7. Measurement procedure

A. Dial indicating type	1. Tohnichi standard	Preliminary loading at maximum capacity → Release loading → Zero adjustment → Measure 5 times at each measuring point
	2. ISO standard	
	3. JIS standard	
B. Adjustable type	1. Tohnichi standard	5 times preliminary loading at maximum capacity → Measure 5 times at each measuring point
	2. ISO standard	
	3. JIS standard	
C. Preset type	1. Tohnichi standard	5 times preliminary loading at torque set value → Measure 5 times
	2. ISO standard	
	3. JIS standard	

Table 6-8. Measurement point

A. Dial indicating type	Tohnichi standard	20% 60% 100% ※ of maximum torque value
	ISO、JIS standard	
B. Adjustable type	Tohnichi standard	
	ISO、JIS standard	
C. Preset type	Tohnichi standard	Torque set value
	ISO、JIS standard	

※In case of lower limit of the measurement range is less than 20% of the maximum torque of torque tool, Tohninichi standard also measures at that point.

(5) Naming of hand torque tools

Table 6-9. Naming of torque tools

Type I Indicating type torque tool (ISO, JIS)		Tohnichi equivalent model
Class A	Twisting or deflection beam type wrench	F、CF
Class B	High rigidity housing type wrench with scale, dial, or display unit	DB、CDB、T
Class C	High rigidity housing type wrench with electronic indicator	CEM
Class D	Screwdriver with scale, dial, or display unit	FTD
Class E	Screwdriver with electronic indicator	STC

Type II Adjustable type torque tool (ISO, JIS)		Tohnichi equivalent model
Class A	Variable torque type wrench with graduations or display unit	QL、CL、PQL
Class B	Fixed torque type wrench	QSP、CSP、QSPCA
Class C	Variable torque type wrench with no graduations	–
Class D	Variable torque type screwdriver with graduations or display unit	LTD、RTD
Class E	Fixed torque type screwdriver	NTD、RNTD
Class F	Variable torque type screwdriver with no graduations	–
Class G	Deflection beam / variable torque type wrench with graduations	–

(6) Cautions for calibration of hand torque tools

Common items	Calibration Device	The maximum permissible uncertainty of the calibration equipment: measurement should be ±1% of the indicated value. (including coefficient k = 2)
	Calibration Temperature	Should be in the range of 18 to 28°C and should have a temperature variation of less than ±1°C. (The maximum relative humidity should be 90%)
Type I Indicating type torque tools	Installation	Within ±3%, applied force within ±10°, screwdriver gradient within ±5°.
	Preliminary Loading	Carry out preliminary loading one time up to the maximum value in the working direction, and set to zero after releasing the load.
	Loading Method	Load gradually with increasing force until the indicated torque value is reached.
Type II Adjustable type torque tools	Installation	Tilt within ±3%, applied force within ±10°, screwdriver gradient within ±5°.
	Preliminary Loading	Carry out loading five times to the maximum capacity (torque tool nominal capacity) in the working direction, and carry out averaging.
	Loading Method	After loading gradually with increasing force up to 80% of the target torque value, slowly apply a final loading evenly over 0.5 to 4 seconds to reach the target torque value.