

4. Tightening Reliability

4-4 Tightening Control

It is necessary to decide accuracy of tightening control to respond to the importance of tightening position, to choose and to control necessary torque tools for tightening torque.

Table 4-3 Bolt tightening control

Class	Control	Tightening tolerance	Application	Application example	Application tightening equipment	Tightening equipment control	Torque assurance system
A	Standard	±30%	Threaded joint to use fixing parts. (No external force except gravity)	Bolts tightened to static parts such as cover. (Non air-tightness)	Selection by model capacity. (No torque control)	Periodical maximum performance measurement.	Periodical inspection by retightening method. ($\alpha = 1.05$)
B	Individual	±20%	Threaded joint with high margin on factor of safety. (Fixing, air tightness, transferability against external force)	Bolts tightened to dynamic parts. (Strength classification no specified) Bolts for low pressure sealing.	Torque controlled tightening device. (Indirect control device)	Periodical tightening torque measurement.	Daily inspection by retightening method. (α : measured values)
C	Individual	±10%	Threaded joint with low margin on factor of safety. (Fixing, air tightness, transferability against external force)	Bolts tightened to dynamic parts. (Strength classification specified) Bolts for high pressure sealing.	Torque controlled tightening device. (Direct control Type)	Periodical tightening torque measurement. Daily tightening torque check.	Daily inspection by retightening method. Daily check of tightening device.
D	Individual	±5% (Angle method)	Threaded joint by limiting design. (Fixing, air tightness, transferability against external force)	Main bolt connecting rod of engine. High pressure hydraulic equipment.	Nutrunner with torque control. (with angle monitoring)	Periodical tightening torque measurement. Daily tightening torque check.	Monitoring. Daily check of tightening device.

5. Selection of Tightening Tools

5-1 Selection of Tightening Tools

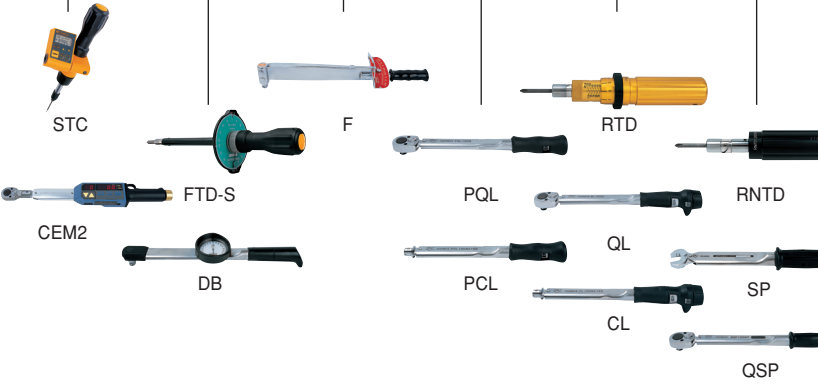
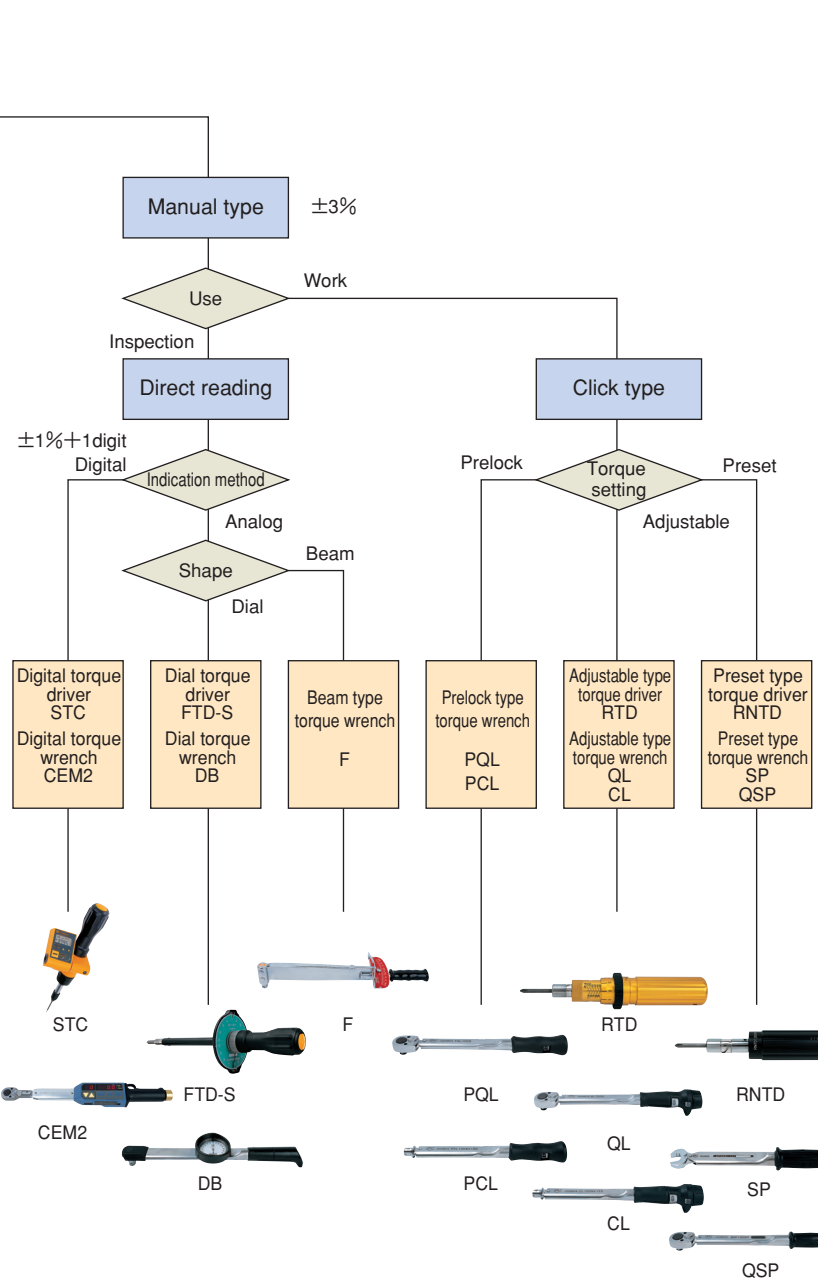
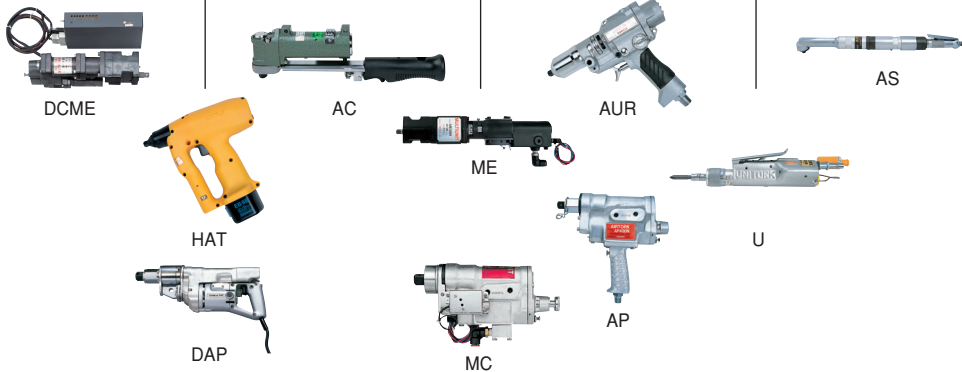
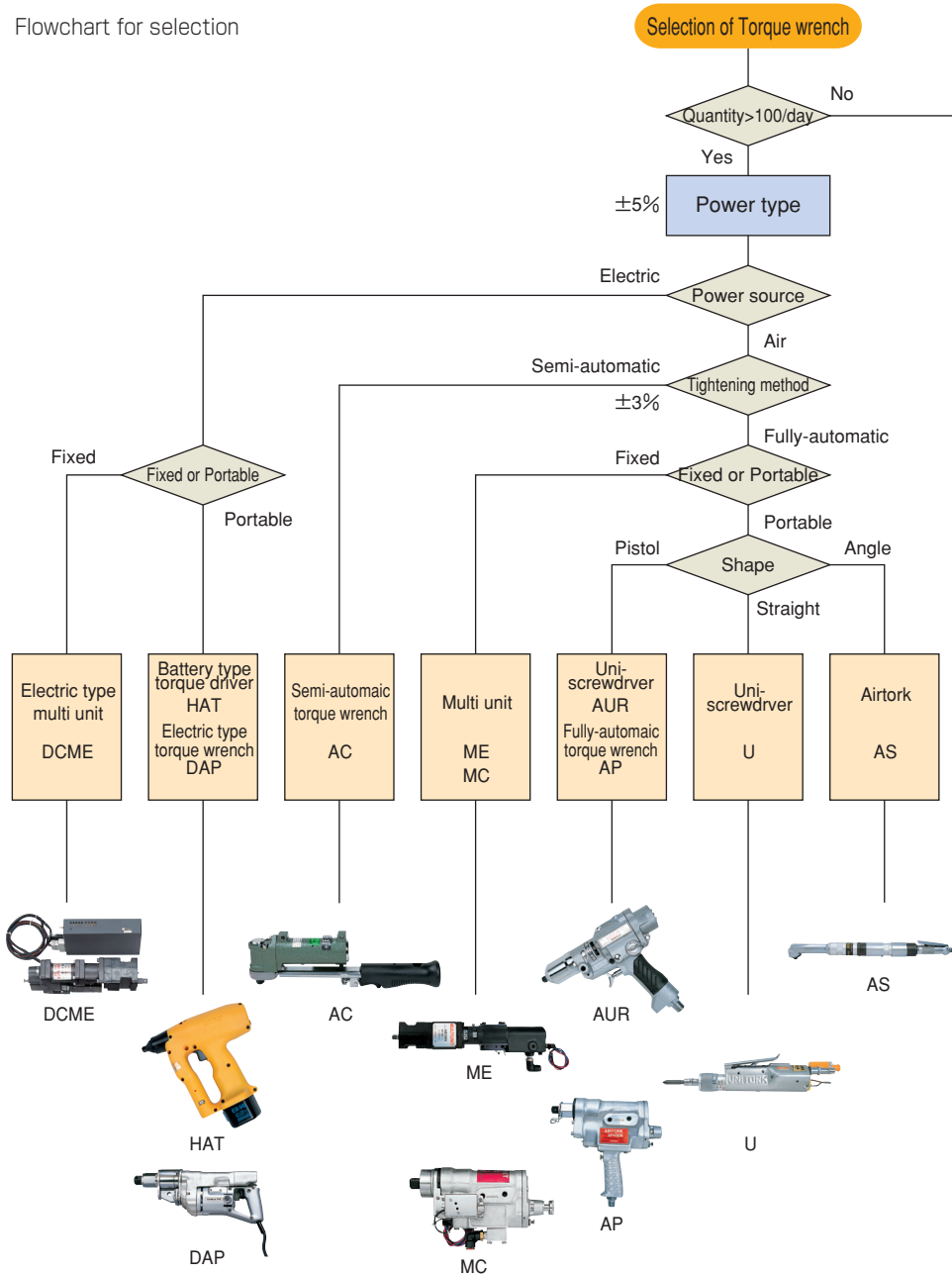
Table 5-1 Selection of tightening tools

I. Screw joint item	
Number, Degree of importance	Important screws, general
Specification of screw	Nominal Class of strength
	Head shape Number of tightening threads Screw thread (P =)
Limit of strength	Male screw, Female screw, number of bolts tightened (Tmax =)
Tightening torque	N·m/kgf·cm/lbf·in
Tolerance	Class ± %、T= ~
Washer	None, Flat washer, Spring washer (string, Normal)
Surface treatment	None, Parker, plating (Zn, Cr,)
Lubrication	None, machine oil, Wax based oil, double sulfurous molybdenum
Number of bolt tightened	Pieces/day (Time limit Sec/piece, None)
Number of bolt simultaneously tightened	Pieces
Coefficient of joint	Hard, Medium, Soft (e =)
Tightening space	Socket Usable Not usable
	On the bolt mm, Around the bolt mm, Swing Total length mm
Direction of tightening	Upwards, from the side, Downward
II. Tightening Tool Type	Manual, Power, Manual+Power
Manual Type	Signal type, Direct reading/ Adjustable type, Preset type
Head shape	Square drive, Open end head, Ring head/fixed ratchet/interchangeable head
Capacity, type	T / weight kg, overall length mm, Manual force N
Power, Power Source	Compressed air (Pressure Mpa or above), Electric (V), Hydraulic
Type	Portable, Fixed / Single Axes Multiple Axes
Number of rotations	r.p.m (at)
Torque control method	Direct control (scaled, Non scaled), Direct control, Maximum capa
Capacity, type	T / Straight, Pistol, Angle
Tightening Tool Type	
Time required to tighten	sec/piece
Cost of tightening	\$ or c/piece
Accessory parts	Socket (×), Bit
	Hose diameter

5. Selection of Tightening Tools

5-2 Selection of Models

Flowchart for selection



5. Selection of Tightening Tools

5-3 Selection of Manual Tools

(1) Selection process

- ① Type... Purpose of use (torque measurement or large quantity tightening)
Beam type, Dial type, Adjustable type, Preset type
- ② Model... Head shape,
Fixed square drive, Ratchet, Open end, Ring head, Interchangeable head
- ③ Capacity... Torque value for use and/or frequency of use

$$\text{Setting of hand force } P = \frac{T}{L}$$

P: Hand force [N]
T: Set torque [N·m]
L: Effective length [mm]

Table 5-2 Selection of manual tools

Type	Reading type			Signal type		
	Plate	Dial	Digital	Adjustable	Preset	
Structure	Read the deflection of the beam	Read the torsion from the torsion bar, which is magnified by the dial	Read the digital display for the output of the strain gauge	When the torque reaches the preset value an audible click and impulse is felt	When the torque reaches, the preset value	
Main applications	Basic tightening work, inspection repair	Precise tightening work, research and testing	Precise tightening work, research and testing	Basic tightening work at mass production plants	Tightening work at mass	
Comparison of types	Measuring torque	○	◎	○	×	
	Ordinary tightening for multiple purpose	○	○	△	×	
	Tightening a number of screws of same type	×	×	×	○	
	Accuracy	○	◎	◎	○	○
	Ease of work	△	◎	◎	◎	◎
Price	◎	△	×	○	◎	
Type	Torque wrench	◎F, SF, QF, FR, QFR, CF	DB, DBE, T	CEM2	◎QL, QLE, CL, CLE, PQL, TIQL, TIQLE	SP, RSP, QRSP, QSP, CSP, BQSP, BCSP
	Torque driver		(ATG)MTD, FTD-S	STC	◎LTD, RTD, MLD	NTD, RNTD

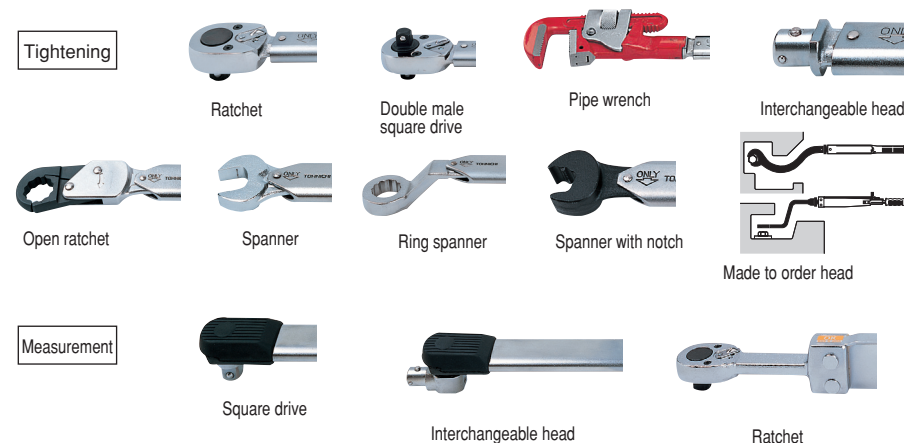
These marked "◎" are standard torque wrenches or drivers that are widely used.

(2) Selection of tools by application

Table 5-3 Selection of tools by application

Application	Wrench	Manual tools		Power tools	
		Torque driver	Torque wrench	Pneumatic tool	Electric tool
General usage		RTD, LTD, AMRD, BMRD, AMLD, BMLD	QL, QLE, CL, CLE	—	—
Mass-production		RNTD, NTD	SP, QSP, (PQL), CSP, QRSP, BQSP	—	—
"Pokayoke" system		Made to Order: LTDLS	QLLS, PQLLS, QSPLS, SPLS, MPQL, FM96MC, CNA-4	AURLS, ACLS	—
For Insulation		RTDZ	PQLZ	—	—
Inspection		MTD, FTD-S, STC	DB, CDB-S, T, SF, F, CF, QF, CEM2	—	—
Semi Automatic		—	—	A, AC	—
Tightening by power tool		—	—	AUR, U, AS, AP	DAP, HAT
Multiple tightening		—	—	MG, MF, ME, MC	DCME
Monitoring system		—	Made to Order: Torque wrench with sensor + Display	METC, MCTC + Display	DCMETC + Display

Head shape



(3) Best capacity

Table 5-4 Best capacity

Tightening torque	Best usage range (Against max. capacity)	Note
Below 200 [N·m]	40~90%	Available at max. capacity if within 100 [pcs. a day]
Over 200 [N·m]	40~70%	

Note) The operator may feel fatigue if the wrench is used around maximum capacity. Also, the operator may feel fatigue due to the weight of the wrench if it is used at the low end of the range. Best capacity is to use under the target of 70% of maximum capacity.

Example) When QL200N T=80 [N·m], then

$$P = \frac{\text{Setting torque}}{\text{Effective length}} = \frac{80}{400 \div 1000} = 200 \text{ [N]}$$

Table 5-5 Case of tightening torque: 80 [N·m]

Moderation	Torque wrench to use	Mass [kg]	Hand force [N]	Result
△	QL200N	1.40	200	Heavy
○	QL140N	0.78	250	Good
△	QL100N	0.68	308	Hand force is big.
◎	TILQL180N	1.00	160	Light and hand force is small.

5. Selection of Tightening Tools

5-4 Selection of Power Tools

(1) Selection process

- ① Power (air, electric, hydraulic)
- ② Shape (holding by hand, fixed, head shape, reaction force support)
- ③ Capacity (tightening torque value, tightening accuracy)
- ④ Tightening time (rotation)

Table 5-6 Selection of power torque tools

	Air			Electric			
	Manual		Fixed	Power		Fixed	
	Hand type	With reaction		Hand type	With reaction		
Structure	Auto stop by toggle mechanism	With reaction arm to get reaction on tightening auto stop by toggle mechanism	Built-in automatic equipment auto stop by toggle mechanism tightening completion signal by LS	Auto stop by toggle mechanism Drive by electric motor	With arm to get reaction on tightening	Built-in automatic equipment auto stop by multiple tightening driver	
Main purpose	General tightening	Tightening of middle, large screw each bolt in factories	Auto tightening or multiple units each bolt in factories	General tightening for small screw	Tightening of middle, screw inside and outside	Auto tightening or units for huge tightening in factories	
Model comparison	Small screw	◎	×	○	◎	×	△
	Middle screw	△	○	◎	△	○	◎
	Large screw	×	◎	◎	×	◎	△
	General multi purpose tightening	○	◎	×	○	○	×
	Same screw huge quantity tightening	△	△	◎	△	△	◎
	Rotation(auto shift)	◎	○	◎(○)	○	△	◎(○)
	Weight	◎	○	○	○	△	○
	Noise	○	△	○(△)	◎	○	○(△)
	Accuracy	○	○	○(◎)	○	○	○(◎)
	Operation	○	○	◎	○	○	◎
Price	◎	○	△	○	○	△	
Model	U,AUR,AS	AP	MG,MF,ME,MC,AME	HAT	DAP	DCME	

(2) Tightening time of tool

Table 5-7 Tightening time of tool [sec/piece]

Screw joint		Manual		Power	Power+Manual			
Screw, tightening torque	Turns of ridge	Simultaneous tightening [Pieces]	Direct reading	Click	Full automatic direct control	Impact wrench +click	Semi automatic	
			(DB50N)	(QL50N)			(ASH40N)	(QL50N)
M8 (P1.25) T=22 [N·m] (e=10)	10	1	9.6	8.0	3.2	5.4	4.0	3.5
	10	4	7.2	6.5	1.9	3.0	2.3	2.3
	16	1	14.6	12.6	4.6	7.3	6.7	5.6
	16	4	12.5	10.6	2.5	4.0	4.0	3.6

Prepare the test conditions by inserting the screw in the tapped hole and placing the tool on table. Measure the time interval from the start of tightening until the tool has been returned to the table and tightening completed. For manual tools, you may tighten the screw with your hand.

6. Torque Tools are Measurement Equipment

6-1 Torque Tools are Measurement Equipment

(1) All measurement equipment

Torque tools are categorized into measurement equipment same as calipers and dial gauges.

Beam type torque wrench



Dial type torque wrench



Caliper



Dial gauge



(2) ISO standard

ISO9001:2000 Extract

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 actions taken,

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; where no such standards exist, the basis used for calibration or verification shall be recorded;
- b) be adjusted or re-adjusted as necessary;
- 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.