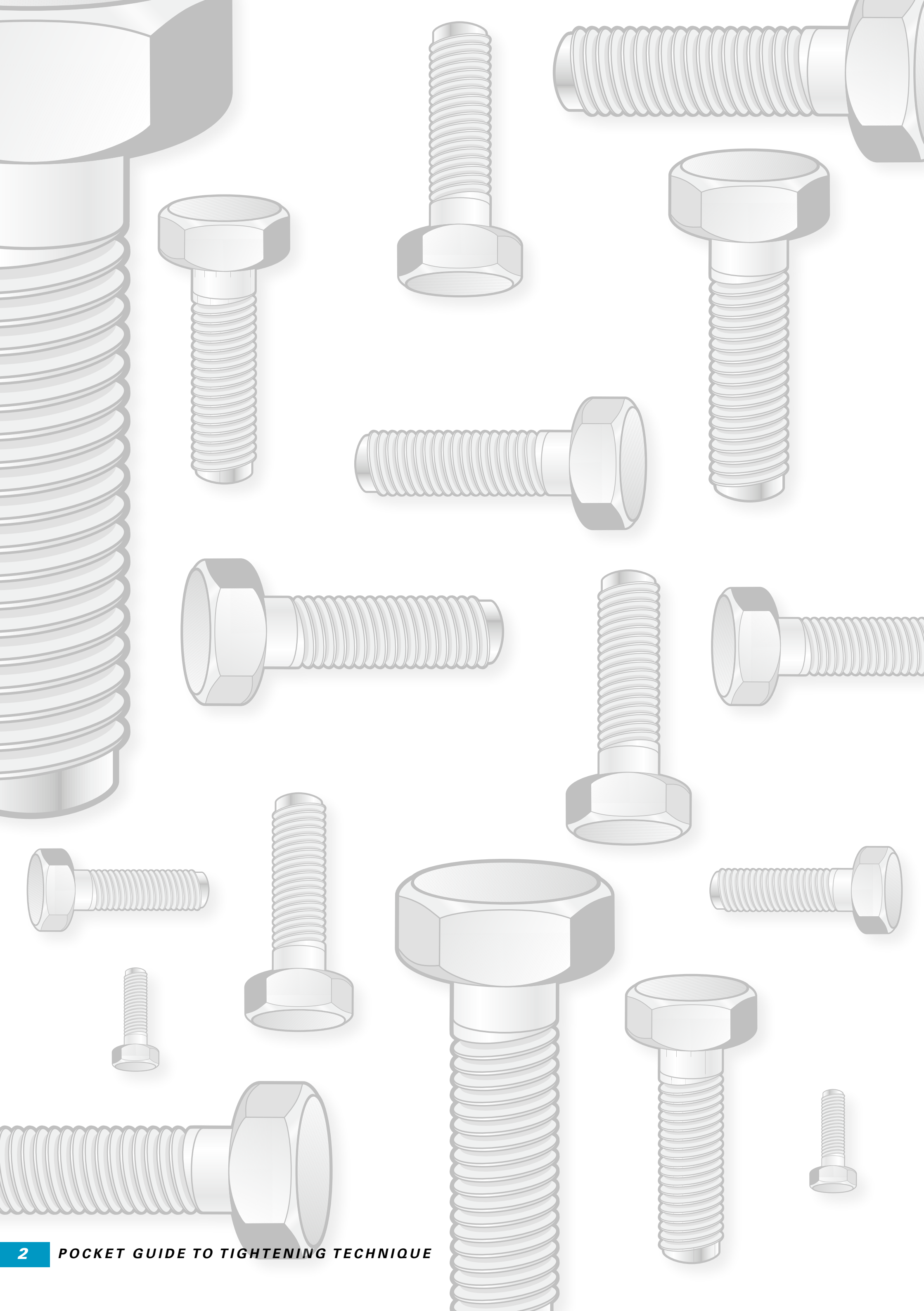
POCKET GUIDE TO TIGHTENING TECHNIQUE

Chapter 7-11

Atlas Copco



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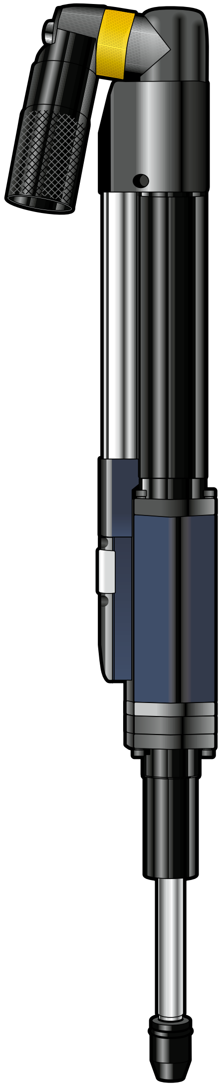
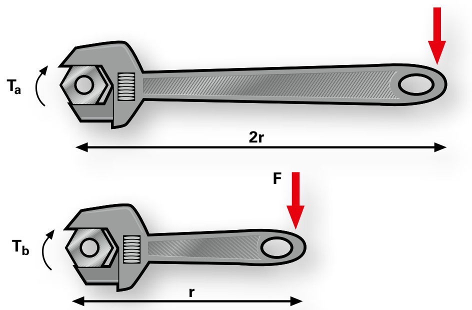


7. TORQUE AND ANGLE

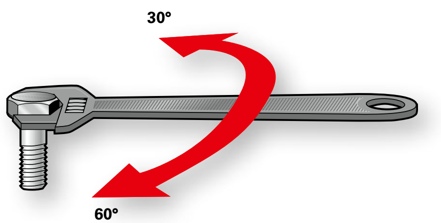
The tightening torque is for practical reasons the criteria normally used to specify the pre-stress in the screw. The torque, or the moment of force, can be measured either dynamically, when the screw is tightened, or statically, by checking the torque with a torque wrench after tightening.



Torque specifications vary considerably depending on the quality demands of the joint. A safety critical joint in a motor car, such as the wheel suspension, cannot be allowed to fail and is consequently subject to very stringent tolerance requirements. On the other hand a nut for securing the length of a workbench height adjustment screw is not regarded as critical from a clamping force point of view and no torque requirement may be specified.

A higher level of quality control is reached by adding the tightening angle to the measured parameters. In the elastic area of the screw this can be used to verify that all the members of a joint are present, e.g. that a gasket or a washer is not missing. Also, the screw quality can be verified by measuring the tightening angle, prior to snug level as well as for final torque-up.

In sophisticated tightening processes the angle can also be used to define the yield point and allow tightening into the plastic area of the screw.



8. MEASUREMENT METHODS

Knowing the tightening specifications for a screw joint the obvious question is; how does one know that the joint has been properly tightened?

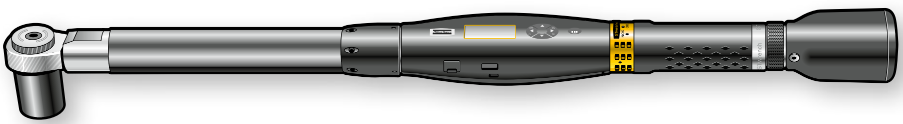
Torque measurements are made according to one of two principles – static measurement or dynamic measurement.

Static measurement means that the tightening torque is checked after the tightening process has been completed. The measurement is usually done by hand with a torque wrench which has either a spring loaded torque scale or a strain gauge transducer activated instrument.

A very common method for checking the tightening torque is to use a click wrench, which is a torque wrench equipped with a clutch that can be pre-adjusted to a specific torque. If the torque is greater than the preset torque value the clutch will release with a click. If the torque is less, final torque-up is possible until the wrench clicks. Over-tightening cannot be detected with the click wrench.

To measure the static torque the torque value must be read instantly as the screw starts to turn.

An electronic torque wrench can be used for a more sophisticated static measurement of the joint. The tool has strain gauge torque transducer which gives a high level of accuracy.



Electronic torque wrench (static measurement).

Dynamic measurement on the other hand means that the torque is continuously measured during the complete tightening cycle. This is usually the preferred method in production where power tools are used for tightening. The advantage over the static method is that dynamic measurement provides an indication of the tightening tool performance without the influence of relaxation in the joint and variations in resting friction. It also eliminates the necessity for subsequent checking.

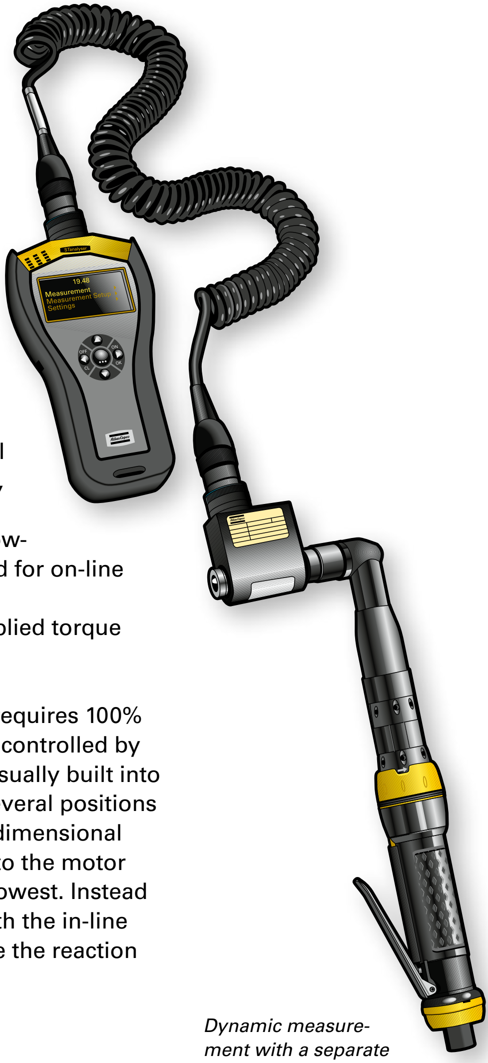
Dynamic measurement is done either directly by measuring with a built-in or a separate in-line torque transducer, or indirectly by current measurement of some sophisticated electric powered screwdrivers and nutrunners. In both cases torque measuring is only possible where the tools have direct torque transmission, i.e. not a pulsating force as is the case with impact wrenches and pulse nutrunners.

The in-line torque transducer is mounted between the driving shaft of the tool and the screw drive socket or bit. It is basically a drive rod with installed resistances, a so-called Wheatstone Bridge, which senses the elastic deformation of the body as a result of the torque applied and produces an electric signal that can be processed in a measuring instrument.

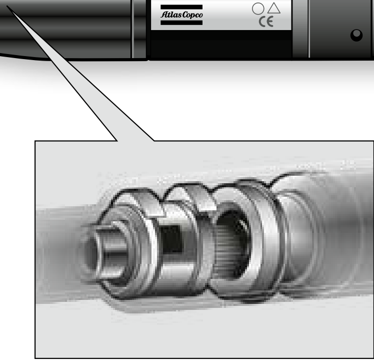
In-line transducers are also available with a built-in angle encoder for monitoring the tightening angle.

As the housing with its connector for the signal cable has to be held to prevent it from rotating, the in-line transducer is not practical for use in continuous monitoring in serial production. However, for tool installation and torque setting and for on-line quality checking, the in-line transducer is the instrument commonly used for reading the applied torque values.

In assembly line production where tightening requires 100% monitoring or if the tightening process itself is controlled by the torque readings, the torque transducer is usually built into the tightening tool. In geared tools there are several positions where the transducer can be installed, but for dimensional reasons it is advantageous to place it as close to the motor as possible where the forces involved are the lowest. Instead of putting the strain gauges on the shaft, as with the in-line model, the built-in torque transducer can utilize the reaction forces in the power train assembly of the tool.



Dynamic measurement with a separate in-line torque transducer.



Angle nutrunner with built-in transducer.

Angle encoders can also be incorporated in the tool design for registration of the joint characteristics during tightening or for advanced tightening control.

9. THE TIGHTENING PROCESS

The tightening process also has a major influence on the quality of the screw joint. A joint tightened by hand behaves completely differently from one tightened using a power tool.

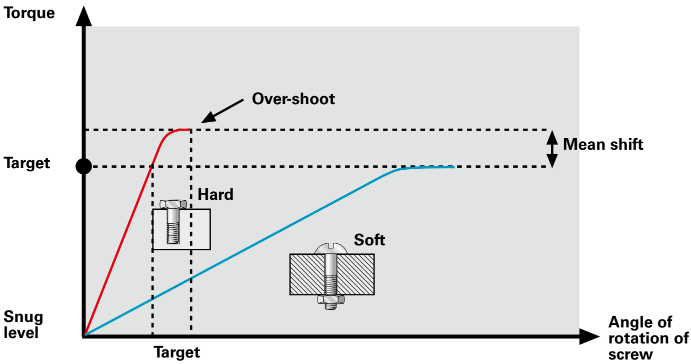
Also, different types of tools have a decisive influence on the result. Direct driven tools such as screwdrivers and nutrunners have a maximum capacity that is decided by the power output of the motor and gear ratio. They can be of the stall type, where final torque is determined by the torque produced when the tool has no more capacity to overcome the resistance to turn the screw. Nowadays they are usually equipped with a device which stops the tightening at a predetermined torque.

There are also other types of tightening tools common in industrial production today, i.e. impact wrenches and pulse nutrunners where the motor power is converted to torque output by charging and discharging the energy intermittently during the process. This means that very powerful tools can be designed with a limited weight and size and with almost no reaction torque to the operator. However, from a torque monitoring point of view these types do not lend themselves to dynamic measurement and are, consequently, not discussed in this context.

10. MEAN SHIFT

The fundamental reason for using a power tool for tightening a screw joint is to shorten the process time within the ability of the operator and quality requirements. It follows that a high rotational speed of the tool is of prime interest.

Most assembly tools are powered by a motor which gives a high speed during run-down of the screw, when the resistance is low, and slow down as the torquing up proceeds. On hard joints there is an almost immediate brake from idling speed to stall or shut-off speed. However, due to the inertia of all the rotating parts there is quite a lot of dynamic energy stored in the tool, the socket or power bit and the screw itself. This energy has to be discharged somehow and most of it is delivered to the joint in the form of added torque, so called "over-shoot".



Definition of mean shift and over shoot.

If the joint looked the same all the time there would not be a problem, but if the same tool is run on a soft joint, requiring much more time and energy to build up the torque, the dynamic effects are only marginal. The result is a difference in torque between the hard and the soft joint which can be considerable. This difference is called the "mean shift".

In tools equipped with some kind of shut-off device the quality of the clutch also becomes decisive for the mean shift of the tool. As the tightening sequence is usually very short the time necessary for the clutch to react on the torque impulse will have an equally important influence on the final torque as the dynamic effect, i.e. the shut-off delay gives a much higher torque over-shoot on the hard joint than on the soft.

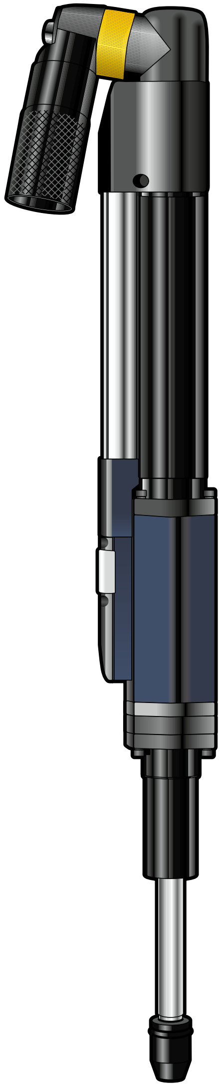
11. STANDARDS FOR MEASUREMENT

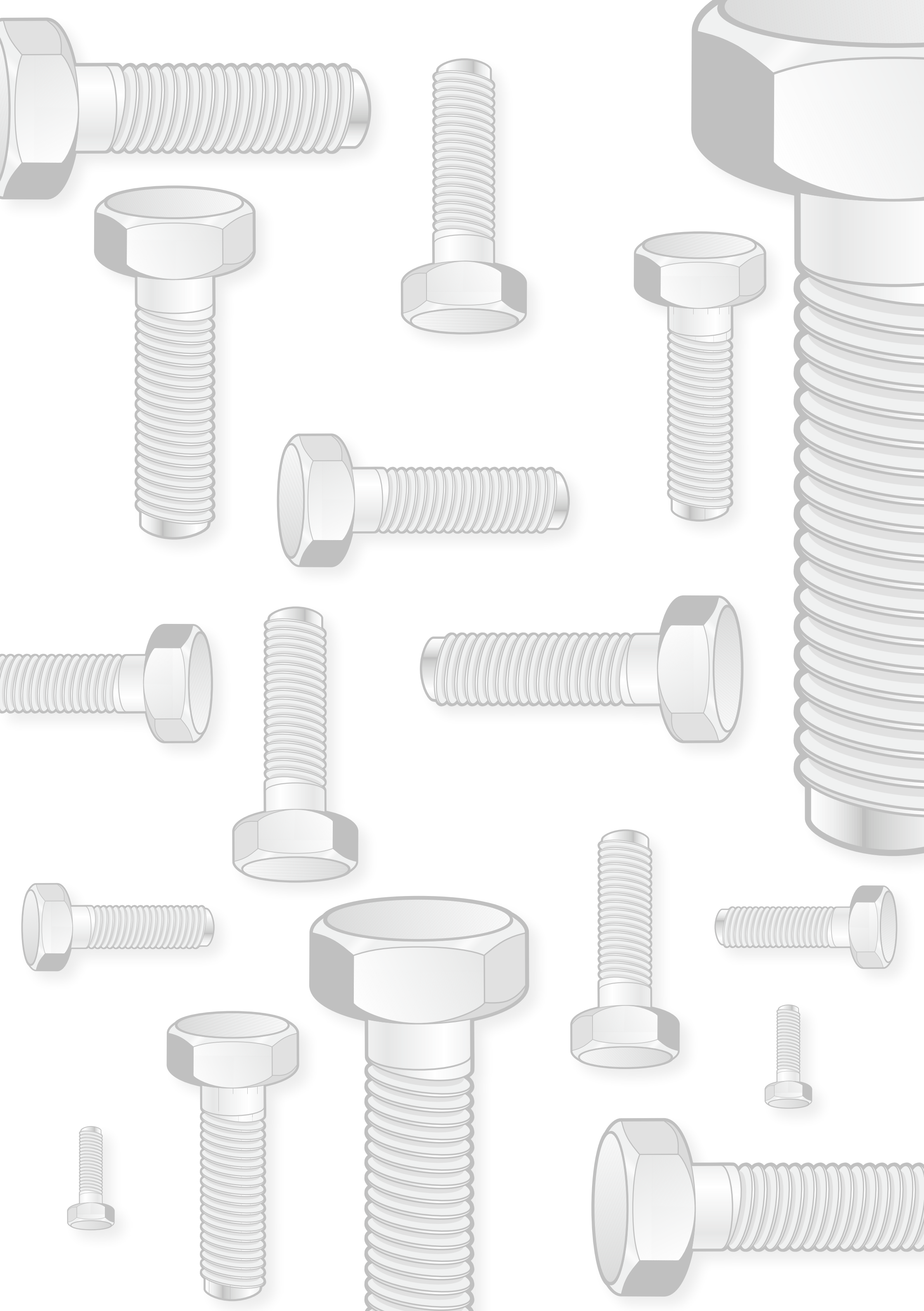
The variations in tightening torque which depend on joint hardness have made it necessary to establish common measurement standards in order to define the capability of a tool to meet certain quality specifications and to be able to compare different tool types with the specifications.

The common standard used today is ISO 5393 – "Rotary tools for threaded fasteners – Performance and test method".

STAY TUNED FOR NEXT WEEKS CHAPTERS...

13. **Errors in tightening**
14. **Damaged threads**
15. **Missing joint components**
16. **Relaxation**
17. **Prevailing torque**





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