INTERNATIONAL STANDARD

ISO 5393

Third edition
2017-11

Rotary tools for threaded fasteners — Performance test method

Outils rotatifs pour éléments de fixation filetés — Méthode d'essai des caractéristiques de fonctionnement

Reference number
ISO 5393:2017(E)

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 118, *Compressors and pneumatic tools, machines and equipment*, Subcommittee SC 3, *Pneumatic tools and machines*.

This third edition cancels and replaces the second edition (ISO 5393:1994), which has been technically revised.

Introduction

The test method specified in this document is designed to measure the performance of power assembly tools in a laboratory environment. It is not intended as a routine in-plant inspection test.

This document is intended

— to enable the producers of power tools to offer their products under standardized technical specifications, and

— to give users of threaded fasteners a method for evaluating and specifying the performance of power assembly tools.

As with the previously published versions, this 2017 version of the document remains a fundamental test procedure, with no attempt to set acceptance criteria. Any minimum performance requirements are the responsibility of the user to meet the demands of the particular application for which the tool is intended for use.

Additional elements have been introduced with this version to address preferred test torque levels, tool performance over a defined number of operating cycles and a method to determine the precision of any torque measurement system which may be included as part of the assembly tool.

As with the previously published versions, this document is applicable to tightening tools of any power source within its scope. This version more clearly addresses electric powered tools which have become more commonly used in the workplace.

This version includes some changes to the specifications for the test joints and for the test method. These changes reflect the practical experience gained through the use of the document and are intended to improve the reproducibility of the test method. Results obtained using this version is not expected to be significantly different than results obtained using the previous version.

Information regarding rated torque, test torque and torque adjustment range: The scope (see last paragraph) allows a test to be performed at any test torque level (see 3.18). A manufacturer defines a tool's rated torque (see 3.11) and its torque adjustment range (see 3.21). Clause 6 describes a method to identify torque scatter over a defined range of torque adjustment. In theory, a manufacturer could offer a tool with a defined rated torque of 100 Nm, and may choose to identify the performance over a defined torque adjustment range of 60 Nm to 80 Nm (perhaps to satisfy a customer or market requirement). In that case, as specified in Clause 6, performance tests will be carried out at 60 Nm and 80 Nm, and should the manufacturer want to identify the tool's performance over a defined number of operating cycles, the operating cycle test would be performed at 80 Nm (the upper limit of the defined range of torque adjustment, as specified in 7.2.2). Results of the performance tests would then be valid only for that defined range of torque adjustment.

Rotary tools for threaded fasteners — Performance test method

1 Scope

This document specifies a laboratory performance test method for power assembly tools (referred throughout the document as “tool”) for installing threaded fasteners.

It provides a method for the measurement of torque repeatability (scatter)

— over a range of torque rates as specified in this document,

— over a range of torque adjustment as defined by the manufacturer, and

— over a number of operating cycles as defined by the manufacturer.

It provides a method for the measurement of the precision of the built-in torque measurement system for tools incorporating such a feature. See Annex E.

It gives instructions on equipment parameters, what to test for and how to evaluate and present the test data.

It is applicable to tools

— of any power source, e.g. pneumatic, hydraulic, and electric, including battery-powered,

— which apply torque in a generally continuous manner, and

— within the torque range 0,5 Nm to 2 000 Nm. Outside this range, it is acceptable to modify the test method providing that the modification is documented in the test report.

It is not applicable to

— impact or impulse wrenches,

— ratchet wrenches or wrenches with ratcheting clutches, and

— other tools which advance fasteners in discontinuous increments, overcoming static friction at each increment.

It allows a test to be performed at any test torque level; however, in order to minimize the number of test joints necessary for a wide range of test torque levels, a list of preferred test torque levels is provided in Annex A.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EURAMET/cg-14/v.2.0: March–2011, *Guidelines on the Calibration of Static Torque Measuring Devices*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
angle
measure of the angular displacement through which a fastener is turned

Note 1 to entry: Expressed in degrees (°).

3.2
built-in torque measurement system
torque measurement system incorporated within a power assembly tool for tightening threaded fasteners with which the torque delivered at the output drive is measured within the tool for display, storage or control purposes

3.3
combined mean torque
$\bar{T}_{comb}$
midpoint of the *combined torque scatter* (3.5) of a tool between the lowest and highest predictable torque readings, encompassing 99,73 % or more of all possible readings

3.4
combined precision of the indicated torque
predicted range of deviation of the value indicated by the *built-in torque measurement system* (3.2)

Note 1 to entry: From the value indicated by the in-line measuring instrument.

Note 2 to entry: Encompassing 99,73 % or more of all possible torque deviations of indicated torque, taken on a range of joints of varying torque rate, from a defined high torque rate through and beyond a defined low torque rate.

Note 3 to entry: Characterized both by the mean shift of indication and the scatter of the torque difference.

3.5
combined torque scatter
ΔT_{comb}
predictable range of torque values delivered by a tool on a range of joints having a specified high *torque rate* (3.23) and a specified low torque rate at the same setting of the tool torque adjustment

Note 1 to entry: The indicated values encompassing 99,73 % or more of all possible torque readings.

Note 2 to entry: For practical purposes, combined torque scatter of a tool is the total probable range of torque of a tool run on all joints used in practice at the same setting of the tool torque adjustment.

3.6
combined torque scatter as a percentage of the combined mean torque
single numerical value designating the predictable range of torque values as delivered by a tool on a range of joints, having a specified high *torque rate* (3.23) and a specified low torque rate at the same setting of the tool torque adjustment

3.7
indicated torque
T_{Ind}
torque indicated by the power tool's *built-in torque measurement system* (3.2)

3.8
mean shift
difference in *mean torque* (3.9) of a tool run on threaded joints of two different *torque rates* (3.23) at the same setting of the tool torque adjustment

3.9
mean torque
$\bar{T}$
arithmetic average of several torque readings on a specific joint under stated conditions, calculated by dividing the sum of the readings by the number of readings

3.10
non-shut-off tool
power assembly tool for tightening threaded fasteners, which delivers an output torque as long as power is applied to the motor

Note 1 to entry: A stall tool is an example of a non-shut-off tool.

3.11
rated torque
highest *mean torque* (3.9), as defined by the manufacturer, attainable by a tool tested on a low torque-rate joint (L)

Note 1 to entry: In accordance with 5.2.4.

3.12
run-down
period of angular rotation without corresponding torque increase

Note 1 to entry: This allows the tool to reach operating speed.

3.13
automatic shut-off tool
power assembly tool for tightening threaded fasteners, which is provided with a torque control mechanism which shuts off or disconnects the power to the tool when predetermined set output torque level is attained

3.14
standard deviation
s
measure of the scatter based on the mean-squared deviation from the arithmetic mean derived from a sample of a statistical population

3.15
6*s*
range of probability, plus and minus three *standard deviations* (3.14) from the mean, derived from a sample of a statistical population

Note 1 to entry: For a normally distributed statistical population, 99,73 % of all members of that population are encompassed.

3.16
6*s* torque scatter
predictable range of torque over which a tool performs using a single torque-rate joint under controlled conditions

Note 1 to entry: For the practical purposes of this document, 6*s* torque scatter is the total probable range of torque of a tool run on a single joint at the same setting of the tool torque adjustment.

3.17
6*s* torque scatter as a percentage of the mean torque
single numerical value designating the predictable range of torque over which a tool performs on a single torque-rate joint under controlled conditions

3.18
test torque level
mean torque (3.9) level to which a test tool is adjusted on a low torque-rate joint (L)

Note 1 to entry: In accordance with 5.2.4.

3.19
tightening time
time required for the tool to complete the tightening process, beginning at 10 % of the *test torque level* (3.18) and ending at the peak dynamic torque

3.20
torque
T
product of the force turning the fastener and the perpendicular distance between the line of force and the centre of the fastener

Note 1 to entry: Expressed in newton metre (N·m).

Note 2 to entry: For the purposes of this document, peak measured torque during a tightening cycle, measured with the in-line measuring instrument as specified in 5.2.3.

3.21
torque adjustment range
range over which a power tool can be adjusted from the rated torque to the lowest *mean torque* (3.9) recommended by the manufacturer

3.22
torque difference
D
difference between the torque indicated by the power tool's *built-in torque measurement system* (3.2) and the in-line torque measurement system

Note 1 to entry: The calculation of torque difference is specified in Annex E.

Note 2 to entry: The in-line torque measurement system is specified in 5.2.3.

3.23
torque rate
increase in torque with angular displacement while advancing a fastener in a threaded joint

Note 1 to entry: Expressed in newton metre per revolution (N·m/r).

4 Symbols

Symbol	Description	Subscript	Description
D	torque difference	comb	combined over H and L joints
$\bar{D}$	mean torque difference	D	torque difference
ΔD	6s difference scatter	$_H$[a]	on the H joint
n	number of readings	i	ith reading
s	standard deviation	Ind	indicated
T	torque	$_L$[a]	on the L joint
$\bar{T}$	mean torque		
ΔT	6s torque scatter		
[a] As specified in 5.2.			

5 Determination of torque scatter

5.1 General rules for performance tests

5.1.1 Measurements

All measurements carried out in conformity with this document shall be performed by personnel trained in the use of the equipment utilizing instrumentation, which is calibrated against existing standard methods.

5.1.2 Ambient conditions

Unless otherwise noted, the ambient conditions shall, during the test, be kept within the following limits:

— ambient temperature: 22 °C ± 5 °C;

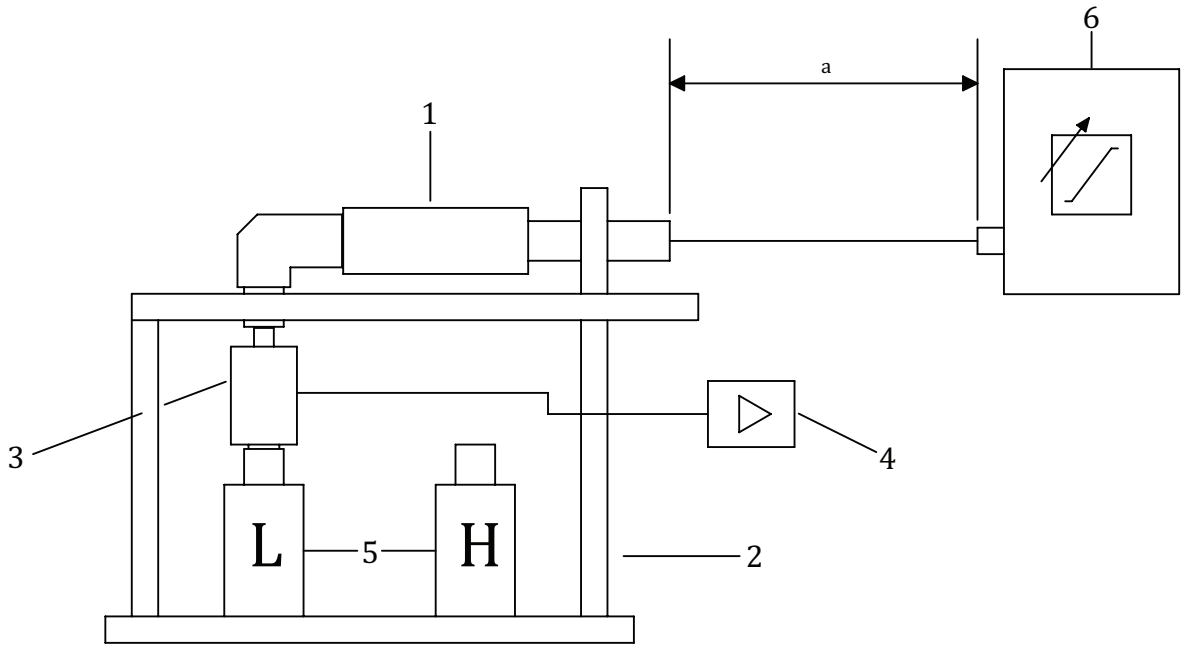
— relative humidity: below 90 %.

5.1.3 Test installation

The tool shall be connected to the test joint through the measuring instrument. The alignment of these three elements is important to reduce the influences on measured peak torque.

The tool shall be rigidly fixed in the test stand to prevent any influence by the operator.

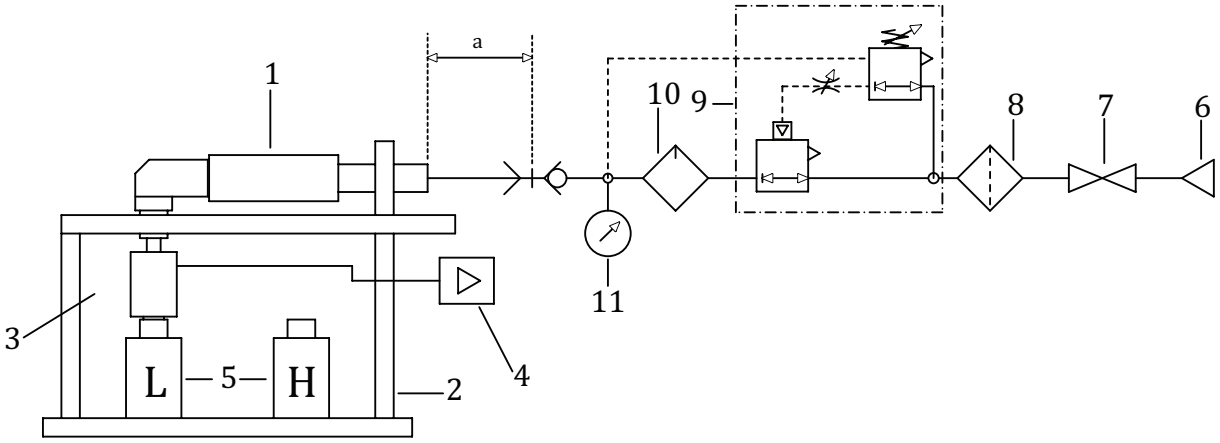
Diagrams of typical test installations are shown in Figure 1, Figure 2 and Figure 3.



Key

1 test power tool
2 test power tool support fixture
3 torque/angle transducer
4 amplifier with peak detection and visual display or print-out capability
5 test fixture (L joint or H joint)
6 power tool control electronics
a Cable length should not exceed 10 m.

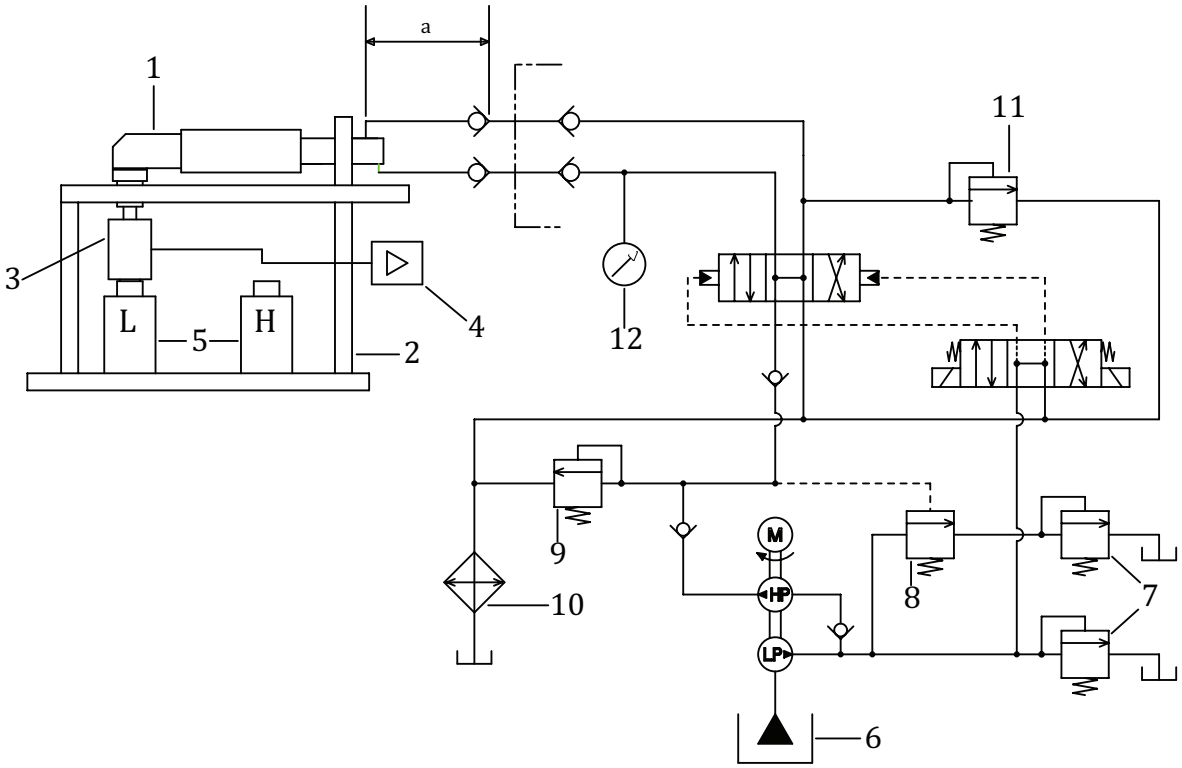
Figure 1 — Typical test installation for electric tool



Key

1 test power tool
2 test power tool support fixture
3 torque/angle transducer
4 amplifier with peak detection and visual display or print-out capability
5 test fixture (L joint or H Joint)
6 compressed air supply
7 shut-off valve
8 filter
9 pressure control [feedback pilot regulator and pilot operated regulator (with optional flow control)]
10 lubricator
11 pressure gauge
a 3-m hose length.

Figure 2 — Typical test installation for pneumatic tool



Key

1 test power tool
2 test power tool support fixture
3 torque/angle transducer
4 amplifier with peak detection and visual display or print-out capability
5 test fixture(L joint or H joint)
6 hydraulic reservoir
7 low pressure relief valve
8 unload valve
9 high pressure relief valve
10 cooler
11 relief valve
12 pressure gauge
a Hose length should not exceed 10 m.

Figure 3 — Typical test installation for hydraulic tool

5.1.4 Test tool

The test tool shall be adjusted to within 5 % of the test torque level on the low torque-rate joint (L) in accordance with the manufacturer's instructions. The torque adjustment shall be constant throughout the test. In the case of an automatic shut-off tool, the adjustment shall be such that the shut-off mechanism operates each time.

Once the control settings have been adjusted for the test torque level, all control settings shall be constant throughout the test.

A list of preferred test torque levels is provided in Annex A. Adjusting the torque to a preferred test torque level is recommended in order to minimize the number of test joints necessary for testing.

5.1.5 Test tool condition

The test tool shall be in good working condition and lubricated in accordance with the manufacturer's specification. Before the start of the test, it shall be ensured that the tool under test is at ambient temperature.

The tool shall be tested under the manufacturer's specified input conditions and used in accordance with the manufacturer's instructions.

5.1.6 Power media

5.1.6.1 Pneumatic power

The air pressure shall be documented in the test report. The air supply shall include lubrication in accordance with the manufacturer's instructions.

The performance of pneumatic tools is affected by the ambient conditions such as atmospheric pressure and temperature. For this reason, unless otherwise specified, the following conditions shall be maintained:

— atmospheric pressure: 960 ± 100 mbar;

— compressed air temperature: 20 °C ± 5 °C.

Actual values shall be recorded if they are outside of these limits.

During performance tests of pneumatic tools, it is necessary to state the inlet air pressure. If not stated, the inlet air pressure is 6,3 bar(g)[1]. The air supply shall be free from fluctuations that would influence the result.

During performance tests of pneumatic tools, a 3-m hose of the tool manufacturer's specification shall be attached to the tool inlet. The air pressure at the inlet of this hose shall be kept within the following limits:

— free-running conditions: between the static value and 2 % below;

— approaching the test torque level: ±2 % of the static value.

NOTE A lubricator with insufficient flow properties can affect these values.

No pressure adjustments shall be made to the pilot regulator during the course of a given test.

5.1.6.2 Hydraulic power

Hydraulic tools shall be tested under rated input conditions. The maximum hydraulic pressure observed during the test shall be recorded.

The supply pressure shall be free from fluctuations that would influence the result. The typical hose length should not exceed 10 m.

5.1.6.3 Electric power

5.1.6.3.1 Mains

This includes all tools requiring an external continuous supply. It includes both a.c. and d.c. motor driven tools. Mains electric tools shall be tested under rated input conditions. The supply voltage shall

1) 1 bar = 0,1 MPa = 100 kPa.