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Industrial valves — Gearbox for valves

Robinetterie industrielle — Réducteur pour appareil de robinetterie

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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).

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For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 153, *Valves,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 69, *Industrial valves*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Industrial valves — Gearbox for valves

1 Scope

This document provides basic requirements for gearboxes to operate industrial valves for manual and automated on/off and modulating duties, this includes manual override gearboxes. It includes guidelines for classification, design and methods for conformity assessment.

It does not cover gear systems which are integral part in the design of valves and subsea gearboxes.

Other requirements or conditions of use different from those indicated in this document are agreed between the purchaser and the manufacturer or supplier (first party), prior to order.

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.

ISO 5210, *Industrial valves — Multi-turn valve actuator attachments*

ISO 5211, *Industrial valves — Part-turn actuator attachments*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

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
gearbox
self-contained gear unit for torque/thrust/speed/orientation change that can be manually operated by handwheel/lever and/or automated with an actuator

3.2
ambient temperature
temperature of the environment surrounding the *gearbox* (3.1)

3.3
end of travel
predefined position related to a fully open or a fully closed condition

3.4
end stop
mechanical device designed to stop the *gearbox* (3.1) drive train movement

3.5
endurance
lifetime without failure at specified conditions and tested by the type test

3.6
indicating arrangement
device, externally visible, showing the position of the valve obturator

3.7
rated torque
classification defined by the *gearbox* (3.1) manufacturer used to define the maximum gearbox operating torque capability

3.8
rated thrust
maximum thrust for linear output actuators, available for valve operation, as stated by the manufacturer or maximum thrust for multi-turn output actuators, the actuator can withstand as stated by the manufacturer

[SOURCE: ISO 22153:2020, 3.7]

4 Classification

4.1 General

Gearboxes are classified per kind for operation and rotation and/or linear movement as detailed in 4.2 and 4.3.

4.2 Kind of operation

There are three kinds of operation:

— manual: gearbox designed for manual operation only, typically this has only one input, normally by a handwheel;

— automated: gearbox designed for automated operation, typically this has only one input, normally by an actuator for example according to ISO 22153;

— manual override: gearbox designed for overriding automated operation, typically this has two inputs. The primary input is normally an actuator. The secondary input is normally by a handwheel. The secondary input is normally disengaged when the gearbox is being used in automated mode and is engaged when manual operation is required, e.g. on loss of power.

4.3 Kind of rotation

There are two kinds of rotation:

— part-turn: gearbox which transmits torque to the valve for a rotation of less than one revolution;

— multi-turn: gearbox which transmits torque for a rotation of at least one revolution and may be capable of withstanding thrust to the valve.

5 Design requirements

5.1 Endurance

The basic design requirements for automated gearboxes duty classification are given in Table 1.

Table 1 — Automated duty classification

Class	Duty	Definition
A	On-off	The gearbox is required to drive the valve through its entire travel from the fully open position to the fully closed position or vice-versa.
B	Inching/positioning	The gearbox is required to occasionally drive the valve to any position (fully open, intermediate and fully closed).
C	Modulating	The gearbox is required to frequently drive the valve to any position between fully open and fully closed.
D	Continuous modulating	The gearbox is required to continuously drive the valve to any position between fully open and fully closed.

The gearbox shall be designed to meet the endurance criteria defined in Table 2 or Table 3.

If the gearbox is provided in an automated version or required for a future automation, it shall be designed to have a minimum endurance in accordance with Table 2 or Table 3.

Gearboxes shall be type-tested in accordance with A.2 to A.5.

Table 2 — Part-turn gearboxes

Rated torque[a] (Nm)	**Manual**	**Automated**		
	On-off (number of cycles)[b]	**Class A and B on-off and inching/positioning** (number of cycles)[b]	**Class C modulating** (number of starts)[c]	**Class D continuous modulating** (number of starts)[c]
Up to 125	500	10 000	1 800 000	10 000 000
126 – 1 000	500	10 000	1 200 000	10 000 000
1 001 – 4 000	500	5 000	500 000	5 000 000
4 001 – 32 000	300	2 500	250 000	T.B.A.[d]
Above 32 000	250	1 000	T.B.A.[d]	T.B.A.[d]

[a] Based on ISO 5211.

[b] One cycle consists of nominal 90° angular travel in both directions (i.e. 90° to open and 90° to close). The gearbox is able to transmit 100 % of the rated torque for at least 4,5° at each end of travel or for at least 9° at either opened or closed position in both directions. The average load cannot be below 30 % of the rated torque for the remaining travel (see Annex B). For angular travel other than 90°, the endurance is agreed between the purchaser and the manufacturer or supplier. During testing a deviation of +20 % and −5 % in load is accepted.

[c] One start consists of a movement at least 1 % in either direction, with a load of at least 30 % of the rated torque.

[d] T.B.A. means to be agreed between manufacturer/supplier and purchaser.

Table 3 — Multi-turn gearboxes

Rated torque[a] Nm	**Max allowable thrust**[a] kN	**Manual**	**Automated**		
		On-off (number of cycles)[b]	**Class A and B on-off and inching/positioning** (number of cycles)[b]	**Class C modulating** (number of starts)[c]	**Class D continuous modulating** (number of starts)[c]
Up to 100	≤40	500	10 000	1 800 000	10 000 000
101 - 700	≤150	500	10 000	1 200 000	10 000 000
701 – 2 500	≤325	250	5 000	500 000	5 000 000
2 501 – 10 000	≤1 100	250	2 500	250 000	T.B.A.[d]
Above 10 000	>1 100	150	1 000	T.B.A.[d]	T.B.A.[d]

[a] Based on ISO 5210.

[b] One cycle consists of 25 turns in both directions (i.e. 25 turns to open and 25 turns to close). The gearbox is able to transmit 100 % of the rated torque for at least 2,5 turns at the closed position in both directions. The average load cannot be below 30 % of the rated torque for the remaining travel (see Annex B). During testing a deviation of +20 % and –5 % in load is accepted.

[c] One start consists of a movement at least 1 % in either direction, with a load of at least 30 % of the rated torque.

[d] T.B.A. means to be agreed between manufacturer/supplier and purchaser.

5.2 Structural integrity

The gearbox shall be capable of withstanding twice the input torque required for achieving the rated output torque/thrust without failure of its external structure.

5.3 Self-locking/braking

The physical concept of self-locking only applies to particular gearbox designs and is not securing positions under all conditions, e.g. vibrations. If the position of the gearbox shall be stable with torques applied to the output, the gearbox and/or additional components might need to be designed for these applications.

Braking, locking devices or assemblies might be integral parts of gearboxes and/or additional components provided by the supplier to the customer/end-user, in order to secure any given position within the stroke or cycle (in particular in the fully closed position).

In order to provide better positioning, and limit overshooting of positions, active braking or other solutions can be necessary to incorporate into the gearbox and/or additional components.

5.4 Mechanical advantage

5.4.1 General

Mechanical advantage is the given ratio between the output and input torque. The mechanical advantage is intended as a mean value measured at the rated torque. The mechanical advantage is considered after an appropriated running in as per manufacturer's indication.

5.4.2 Manual gearboxes and manual override gearboxes

The mechanical advantages of manual gearboxes declared by the manufacturer shall be those that occur at rated torque. A tolerance of ±15 % shall be allowed for production units, for gearboxes other than worm gearboxes the tolerance shall be ±7,5 %.

When sizing a manual override gearbox, the torque needed by the valve and the torque required to move the actuator need to be taken into account.

5.4.3 Automated gearboxes

The mechanical advantages of automated gearboxes declared by the manufacturer shall be those that occur at rated torque. A tolerance of ±10 % shall be allowed for production units, for gearboxes other than worm gearboxes the tolerance shall be ±5 %.

5.5 Environmental conditions

5.5.1 General

The following environmental conditions shall apply, unless otherwise agreed between the manufacturer or supplier and purchaser.

The gearbox shall be designed for operation at ambient temperature in a range between -20 °C and +60 °C and with a relative humidity ≥90 % (25 °C).

5.5.2 Altitude

The gearbox shall be designed for operation at an altitude at least 1 000 m above sea level.

5.5.3 Enclosure protection

The gearbox shall have at least an enclosure protection type IP65 according to IEC 60529.

5.5.4 Corrosion protection

Gearboxes shall be protected against corrosion by proper material selection and/or surface treatment. The gearbox manufacturer's technical documentation shall specify the corrosion protection category according to Table 4.

Table 4 may be used to define the corrosion category in order to help actuator manufacturers to define the surface treatment for corrosion protection. Test assessment and test procedures are the responsibility of the manufacturer.

Table 4 — Categories

Corrosion category	Typical environments	
	Exterior	**Interior**
C2 (low)	Atmospheres with low level of pollution, mostly rural areas	Unheated buildings where condensation may occur, e.g. depots, sport halls.
C3 (medium)	Urban and industrial atmospheres, moderate sulphur dioxide pollution and coastal areas with low salinity	Production rooms with high humidity and some air pollution, e.g. food-processing plants, laundries, breweries, dairies
C4 (high)	Industrial areas and coastal areas with moderate salinity	Chemical plants, swimming pools, coastal ship and boatyards
C5 (very high)	Industrial areas with high humidity and aggressive atmosphere and coastal areas with high salinity	Buildings or areas with almost permanent condensation and with high pollution.
CX (extreme)	Offshore areas with high salinity, industrial areas with extreme humidity and aggressive atmosphere, and subtropical and tropical atmospheres.	Industrial areas with extreme humidity and aggressive atmosphere.
Categories for water and soil		
Category	**Examples of environments and structures**	
Im 1 (immersed in fresh water)	River installations, hydro-electric power plants	
Im 2 (immersed in sea or brackish water)	Immersed structures without cathodic protection (e.g. harbour areas with structures like sluice gates, locks or jetties)	
Im 3 (soil)	Buried tanks, steel piles, steel pipes	
Im 4 (immersed in sea or brackish water)	Immersed structures with cathodic protection (e.g. offshore structures)	
NOTE Table 4 is based on ISO 12944-2:2017. The gearbox corrosion protection can also be achieved by systems/methods which deviate from those specified in ISO 12944-5.		

5.5.5 Vibration, shock and seismic conditions

Gearboxes complying with this document are designed without any specific reference to vibrations, shock and/or seismic conditions. If exceptional severe vibration, shock and/or seismic conditions need to be considered, testing shall be agreed between the manufacturer/supplier and the purchaser.

5.6 Gearbox attachment

5.6.1 Part-turn gearboxes

The output interface for part-turn gearboxes shall comply with ISO 5211. The input interface for automated part-turn gearboxes shall comply with ISO 5210. The input interface for manual override part-turn gearboxes shall comply with ISO 5211.

The output drive of part-turn gearboxes may be an integral part or an attached and removable component, to allow it to be machined to suit the shaft of the valve when required. The material of the drive component shall be clearly indicated in the manufacturer or supplier documentation.

5.6.2 Multi-turn gearboxes

The output interface for multi-turn gearboxes shall comply with ISO 5210. The input interface for automated multi-turn gearboxes shall comply with ISO 5210.

The output drive of multi-turn gearboxes may be an integral part or an attached and removable component to allow it, when required, to be machined to suit the stem of the valve. The material of the drive component shall clearly be indicated in the manufacturer or supplier documentation.

5.7 Primary closing direction

The primary closing direction shall be clockwise (CW) unless otherwise specified, as viewed from the gearbox side of the attachment according to ISO 5210 or ISO 5211.

5.8 Other requirements

5.8.1 Manual operation

The closing and/or opening direction shall be clearly and permanently marked.

5.8.2 Position indicator for part-turn gearboxes

Part-turn gearboxes shall be equipped with an indicating arrangement or device to clearly show the obturator position.

5.8.3 End stop for part-turn gearboxes

Part-turn gearboxes shall be supplied with end stops for both rotation directions (close and open position). The closed position stop shall be independently adjustable (minimum adjustment range ±3° of travel).

5.8.4 Gearing lubricant

The lubricant provided for the gearbox shall meet endurance requirements as detailed under 5.1 without loss of lubricant or replacing lubricant.

The method of lubrication (grease, oil and/or self-lubricating materials) shall be under the responsibility of the manufacturer and shall suit the specified ambient conditions and the operation of the gearbox when mounted in any orientation.

5.8.5 Noise

The noise value of the gearbox on its own shall not be greater than sound pressure levels of 80 dB(A) in the condition of no load running, using a noise dosimeter at a1 m distance faced to the gearbox.

6 Optional equipment

When specified, the following options shall be fitted to the gearbox subject to agreement between the manufacturer or supplier and the purchaser. If the options can be connected electrically, the electrical rating shall be stated in the technical documentation.

a) A position indicator for multi-turn gearboxes.

b) A position transmitter in order to enable continuous indication of the valve position at a remote location. It may be analogue or digital type.

c) The limit switches in order to enable the indication on open/close and/or intermediate position of the valve.

d) Fireproofing, i.e. a fire protection in order to insulate the gearbox from the heat of a fire for a certain period.

e) Manual lock, i.e. a device that inhibits the manual operation of the gearbox.

f) Overpressure relief valve, i.e. a safety relief valve sized in order to avoid overpressure generated from a possible leakage from the valve.

g) Drain plug, i.e. a plug suitable for water/condensate drainage.

h) Lubrication system, i.e. a system suitable for oil/grease lubrication filling.

i) Manual override switch in order to monitor the manual operation.

j) The valve coupling might be a separate part from the output drive of the gearbox.

7 Type and production test

7.1 General

The manufacturer or supplier shall validate gearboxes according to this document by:

— carrying out all the type tests (7.2 and Annex A) to ensure all criteria are met;

— controlling the production process (7.3) to ensure the required performance levels are continuously maintained.

The manufacturer or supplier shall ensure that all the requirements of this document are met. If the verification of a requirement is necessary on a supplied product, it shall be done by carrying out the corresponding test.

7.2 Type tests

The type tests shall correspond to all requirements stated in Clause 5. Type test shall be carried out on gearboxes that are representative of the current production.

Type tests results shall be recorded in a test report, detailing the type, quantity and sizes of the gearboxes tested and the test equipment and measuring devices used.

To qualify a range of gearboxes, of the same design principle and of the same classification/designation, manufactured under the same process and from the same or equivalent materials, the type tests may be carried out on a limited number of representative sizes by applying the following rule:

— when a gearbox having a nominal output torque and/or thrust "x" is qualified, all gearboxes having nominal output torques and/or thrust between 50 % x and 200 % x (i.e. between $x/2$ and 2 x) are considered qualified.

The manufacturer shall repeat affected type tests when the design or the production process have been modified and affect the functional performances.

The type test shall be carried out by the manufacturer or supplier or by an independent body (third party).

A full report of these tests shall be retained by the manufacturer or supplier as evidence of conformance. The type tests to be performed shall be those given in Table 5.

7.3 Control of production process

The type and production tests given in Table 5 and Annex A are indications for manufacturer or supplier in order to comply with the requirements of this document.

Table 5 — Type and production tests

Item	Requirement	Clause	Type tests	Production tests
1	Design	5	See Clause 5.	—
1.1	Enclosure protection	5.5.3	Verify test reports of manufacturer.	Random test
1.2	Corrosion protection	5.5.4	Verify test reports of manufacturer.	—
2	Marking	8	See Clause 8.	Yes
3	Endurance	5.1	Endurance test	—
3.1	Structural integrity	5.2	Overload test	—
3.2	Mechanical advantage	5.4	Mechanical advantage	—
3.3	Closing direction	5.7	Yes	Yes
4	Output torques/thrusts	—	Validate manufacturer's design values.	—
5	Setting of travel limiting device	5.8.3	Validate manufacturer's design.	Yes[a]
6	Position indicator	5.8.2	Validate manufacturer's design.	Yes
7	Documentation	9	See Clause 9.	See Clause 9.

[a] When specified.

8 Marking

8.1 Mandatory markings

Each gearbox shall be marked legibly and indelibly with the following permanent indications:

a) manufacturer/supplier's name and/or trademark;

b) model type and designation;

c) gearbox commission and/or serial number and reference to year of manufacture (e.g. WW/YY or MM/YY);

d) gearbox rated torque (Nm)/thrust (kN);

e) enclosure protection (IP designation);

f) hazardous protection (when applicable);

g) reference to this document (i.e. ISO 22109);

h) other mandatory marks.

8.2 Optional markings

Each gearbox may be marked legibly and indelibly with the following permanent indications:

a) ambient temperature range;

b) gearbox attachment designation (ISO 5210 or ISO 5211);

c) angular travel (for part-turn gearboxes only);

d) corrosion category (e.g. C2);

e) gearbox lubricant.

9 Documentation

9.1 General

The language of the relevant documentation shall be agreed between the manufacturer/supplier and the purchaser.

9.2 Mandatory documentation

The manufacturer/supplier shall provide the following:

a) transport and storage instructions;

b) installation, commissioning, operating and maintenance instructions;

c) mandatory/contractor documentation.

9.3 Optional documentation

The manufacturer/supplier may provide the following:

a) detailed overhaul instructions;

b) itemized spare parts list;

c) list of recommended spare parts.

10 Packaging

Gearboxes shall be packed and cushioned and/or fixed in boxes in order to prevent movement. The packing shall be suitable for the environmental and structural demands of shipment method and storage. As a minimum, the outside of the packaging shall be marked to identify the manufacturer and product within. The marking shall be indelible and waterproof.

Annex A
(normative)

Endurance test procedure

A.1 General

Gearboxes complying with this document shall be type-tested in agreement with A.2 to A.5.

A.2 Test equipment

The test rig shall allow the attachment of the gearbox and shall be suitably designed to allow the full travel of the gearbox. It shall provide means of applying a measurable torque/thrust at the gearbox output.

The test rig shall be equipped with the following calibrated devices, as minimum:

a) an instrument for measuring the applied torque/thrust and the operating stroke;

b) an instrument for measuring the input torque to be applied at the gearbox input in shaft;

c) an operating cycle counter.

A.3 Test conditions

The test shall be conducted at room temperature (between 15 °C and 30 °C), under the conditions given in 5.5.

A.4 Test procedure

The operating cycle shall be specified by the manufacturer, in accordance with 5.1.

A.5 Acceptance criteria

At the end of the test, results shall comply with the following criteria:

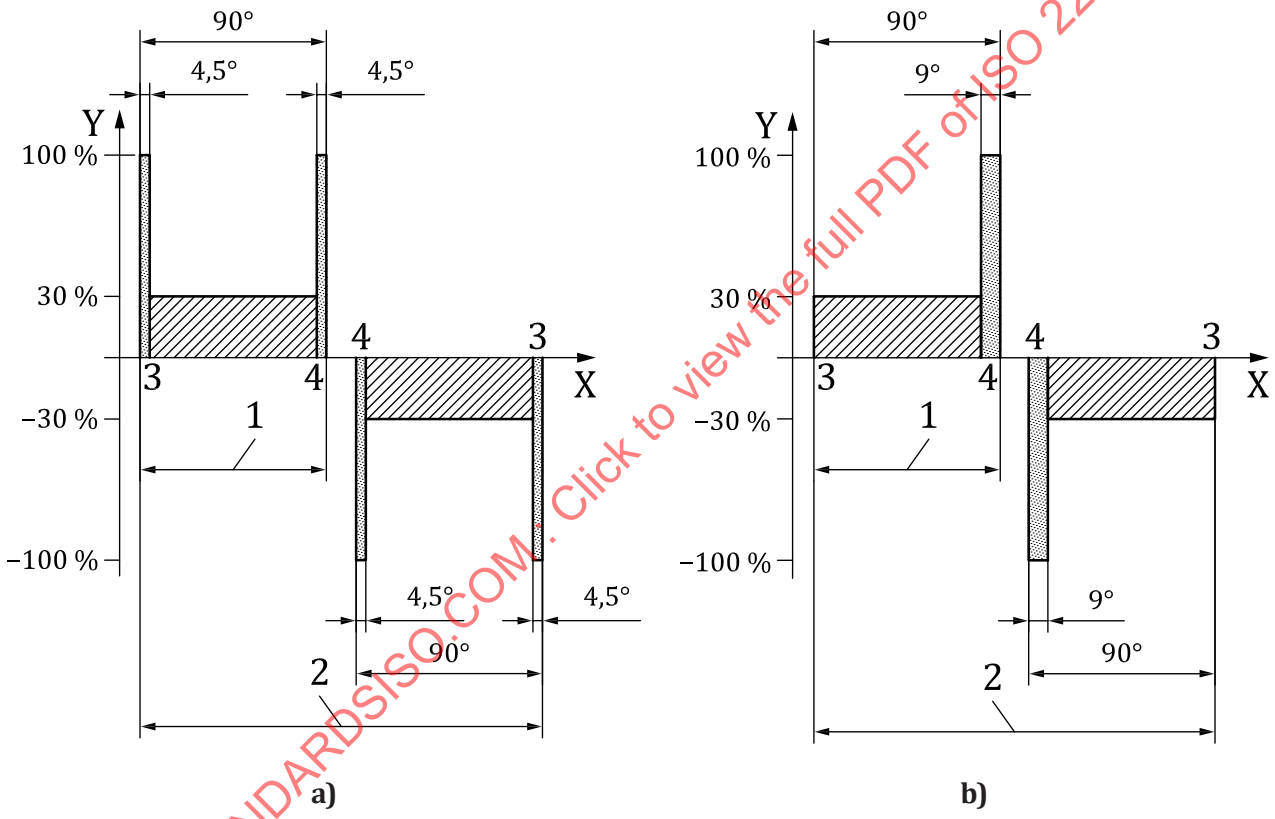
The mechanical advantage along the stroke shall remain between 80 % and 120 % of the initial values which are considered after a proper break-in.

Annex B
(informative)

Load profiles

B.1 Part-turn load profile

One cycle consists of nominal 90° angular travel in both directions (i.e. 90° to open and 90° to close). The actuator shall be able to transmit 100 % of the rated torque for at least 4,5° at each end of travel [see Figure B.1 a)] or for at least 9° at either opened or closed position in both directions [see Figure B.1 b)]. The average load shall not be below 30 % of the rated torque for the remaining travel.



Key

X time
Y torque
1 travel
2 cycle
3 open
4 close

Figure B.1 — Part-turn load profile