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Aerospace — Constant displacement hydraulic motors — General specifications

Aéronautique et espace — Moteurs hydrauliques à cylindrée fixe — Spécifications générales

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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 9206 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*.

Annex A of this International Standard is for information only.

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Aerospace — Constant displacement hydraulic motors — General specifications

1 Scope

This International Standard lays down the general specifications for constant displacement hydraulic motors to be installed in aircraft, which transform hydraulic power into mechanical energy in the form of a rotational torque.

Primary and secondary function motors (see clause 3) are covered in this International Standard; actuators with internal rotation angle limits and low-speed motors are not covered in this International Standard.

This International Standard shall be used in conjunction with the detail specification particular to each application.

NOTE — A schematic summary is provided in annex A for easy reference to the contents of this International Standard.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2093 : 1986, *Electroplated coatings of tin — Specification and test methods.*

ISO 2653 : 1975, *Environmental tests for aircraft equipment — Ice formation.*

ISO 2669 : 1978, *Environmental tests for aircraft equipment — Steady state acceleration.*

ISO 2671 : 1982, *Environmental tests for aircraft equipment — Acoustic vibration.*

ISO/TR 2685 : 1984, *Aircraft — Environmental conditions and test procedures for airborne equipment — Resistance to fire in designated fire zones.*

ISO 3323 : 1987, *Aircraft — Hydraulic components — Marking to indicate fluid for which component is approved.*

ISO 3601-1 : 1988, *Fluid systems — Sealing devices — O-rings — Part 1: Inside diameters, cross-sections, tolerances and size identification code.*

ISO 3601-3 : 1987, *Fluid systems — Sealing devices — O-rings — Part 3: Quality acceptance criteria.*

ISO 6771 : 1987, *Aerospace — Fluid systems and components — Pressure and temperature classifications.*

ISO 7137 : 1987, *Aircraft — Environmental conditions and test procedures for airborne equipment.* [1)]

ISO 7320 : 1985, *Aerospace — Fluid systems port connection, seal and fitting end — Dimensions.*

ISO 8077 : 1984, *Aerospace process — Anodic treatment of aluminium alloys — Chromic acid process 20 V DC, undyed coating.*

ISO 8078 : 1984, *Aerospace process — Anodic treatment of aluminium alloys — Sulfuric acid process, undyed coating.*

ISO 8079 : 1984, *Aerospace process — Anodic treatment of aluminium alloys — Sulfuric acid process, dyed coating.*

ISO 8081 : 1985, *Aerospace process — Chemical conversion coating for aluminium alloys — General purpose.*

ISO 8399-1 : — [2)], *Aerospace — Accessory drives and mounting flanges (Metric series) Part 1: Design criteria.*

ISO 8399-2 : — [2)], *Aerospace — Accessory drives and mounting flanges (Metric series) Part 2: Dimensions for couplings with spigot.*

1) Endorsement, in part, of the publication EUROCAE ED-14B/RTCA DO-160B (a document published jointly by the European Organisation for Civil Aviation Electronics and the Radio Technical Commission for Aeronautics).

2) To be published.

ISO 8921 : — [1], *Aerospace — Electroplated cadmium coatings on high-strength steels (maximum tensile strength 1 450 to 1 850 MPa).*

3 Classification

The hydraulic motors covered by this International Standard are classified in two categories:

— **Category A**: primary function motors, for example flight controls, slats, flaps, adjustable planes, transfer units, constant speed drives, etc.;

— **Category B**: secondary function motors, for example hoists, guns, radars, doors, etc.

The motor category shall be specified in the detail specification.

4 Functional requirements

4.1 Hydraulic fluid

The hydraulic fluid of the system on which the motor is to be installed shall be specified in the detail specification.

4.2 Pressures

4.2.1 Rated supply pressure

The rated supply pressure shall be defined as the system rated pressure.

The rated supply pressure shall be specified in the detail specification.

4.2.2 Rated differential pressure

The rated differential pressure shall be defined as the differential pressure measured between the motor inlet and outlet ports required to produce rated torque.

The rated differential pressure shall be specified in the detail specification.

4.2.3 No-load break-out pressure

The no-load break-out pressure shall be defined as the differential pressure required for starting the output shaft, without interruption, with the drain port at the rated return pressure.

The no-load break-out pressure shall be specified in the detail specification.

4.2.4 Rated case drain port pressure

The rated case drain port pressure shall be defined as the maximum pressure at which the motor is required to operate continuously.

The rated case drain port pressure shall be specified in the detail specification.

4.2.5 Case and return port proof pressure

In order to take into account accidental transitory separation of the components, it is required that the case be designed to withstand, without damage, the pressure resulting from integral bypassing of the rated flow towards the outlet and drain ports. Unless otherwise specified in the detail specification, the case components shall withstand, without damage, an internal pressure at least equal to or greater than 5 000 kPa (50 bar) or 150 % of the maximum pressure specified in the detail specification, whichever is the greater of these two values.

4.2.6 Inlet port proof pressure

Unless otherwise specified in the detail specification, statically, the motor shall withstand, without structural failure, being pressurized to 1,5 times the rated pressure.

In the case of a bi-directional motor, both ports are subject to independent proof pressure surges.

4.2.7 Inlet port burst pressure

Unless otherwise specified in the detail specification, statically, the motor shall withstand, without structural failure, being pressurized to 2,5 times the rated pressure, once during its service life.

In the case of a bi-directional motor, both ports are subject to independent burst pressure surges.

4.3 Rated temperature

The rated temperature of the motor shall be defined as the maximum fluid temperature at the inlet port of the motor; it shall be expressed in degrees Celsius.

The rated temperature is related to the maximum temperature (see ISO 6771) of the hydraulic system in which the motor is to be used and shall be one of the values given in table 1. The rated temperature shall be specified in the detail specification.

The minimum continuous fluid temperature at the motor inlet port shall be specified in the detail specification.

1) To be published.

Table 1 — Temperature relationship

Hydraulic system	Maximum system temperature °C	Rated temperature of motor °C
Type I	70	70
Type II	135	135
Type III	200	200

4.4 Rated displacement

The rated displacement of a motor shall be defined as the maximum theoretical volume of fluid generated by one revolution of its output shaft; it shall be expressed in cubic centimetres per revolution.

The rated displacement shall be calculated from the geometrical configuration of the motor, without allowing for the effects of

a) permissible manufacturing tolerances;

b) distortions of the motor structure;

c) the compressibility of the hydraulic fluid;

d) internal leakage;

e) temperature.

The rated displacement is used to indicate the size of the motor rather than its performance.

4.5 Rated consumption

The rated consumption of a motor shall be defined as the flow rate measured at the inlet port, at rated temperature, rated speed and rated differential pressure.

The rated consumption shall be expressed in cubic decimetres per second and its value shall be specified in the detail specification (with, in parentheses, the corresponding value in cubic decimetres per minute).

4.6 Leakage

4.6.1 Case drain flow

The motor shall provide for case drain flow. The maximum drain flow rate shall be specified in the detail specification with

a) the motor turning at rated torque and speed;

b) the motor turning at zero torque;

c) the motor stalled, shaft locked at any position.

If required, minimum case drain flow rates shall be specified in the detail specification.

4.6.2 Shaft seal leakage

The maximum shaft seal leakage shall be specified in the detail specification.

4.6.3 External leakage

No leakage from the motor case nor from any case static seal sufficient to form a drop shall be permitted.

4.7 Speed and direction of rotation

4.7.1 Direction of rotation

Unless otherwise specified in the detail specification, the hydraulic motors shall operate satisfactorily in either direction of rotation. It shall not be necessary to alter the motor to effect a change in the direction of rotation, but it should merely be necessary to reverse the direction of flow.

4.7.2 Rated speed

The rated speed of a motor shall be defined as the maximum speed at which the motor is required to operate continuously at rated temperature and at rated differential pressure. The rated speed shall be expressed as the number of revolutions of the motor output shaft per minute.

The rated speed of the motor shall be specified in the detail specification. As an indication, the maximum recommended values are given in the nomograph in figure 1.

4.7.3 Overspeed

The overspeed value is equal to 125 % of the rated speed.

4.7.4 Maximum no-load speed

The maximum no-load speed shall be defined as the speed reached at rated conditions with no opposing torque.

The maximum no-load speed shall be specified in the detail specification.

4.8 Torque

4.8.1 Rated torque

The rated torque of the motor shall be defined as the minimum torque value at rated operating conditions.

The rated torque shall be specified in the detail specification.

4.8.2 Break-out torque

The break-out torque shall be defined as the minimum torque against which the motor will start at operating conditions specified in the detail specification. The specification shall be met at any angular position of the output shaft.

The break-out torque shall be specified in the detail specification.

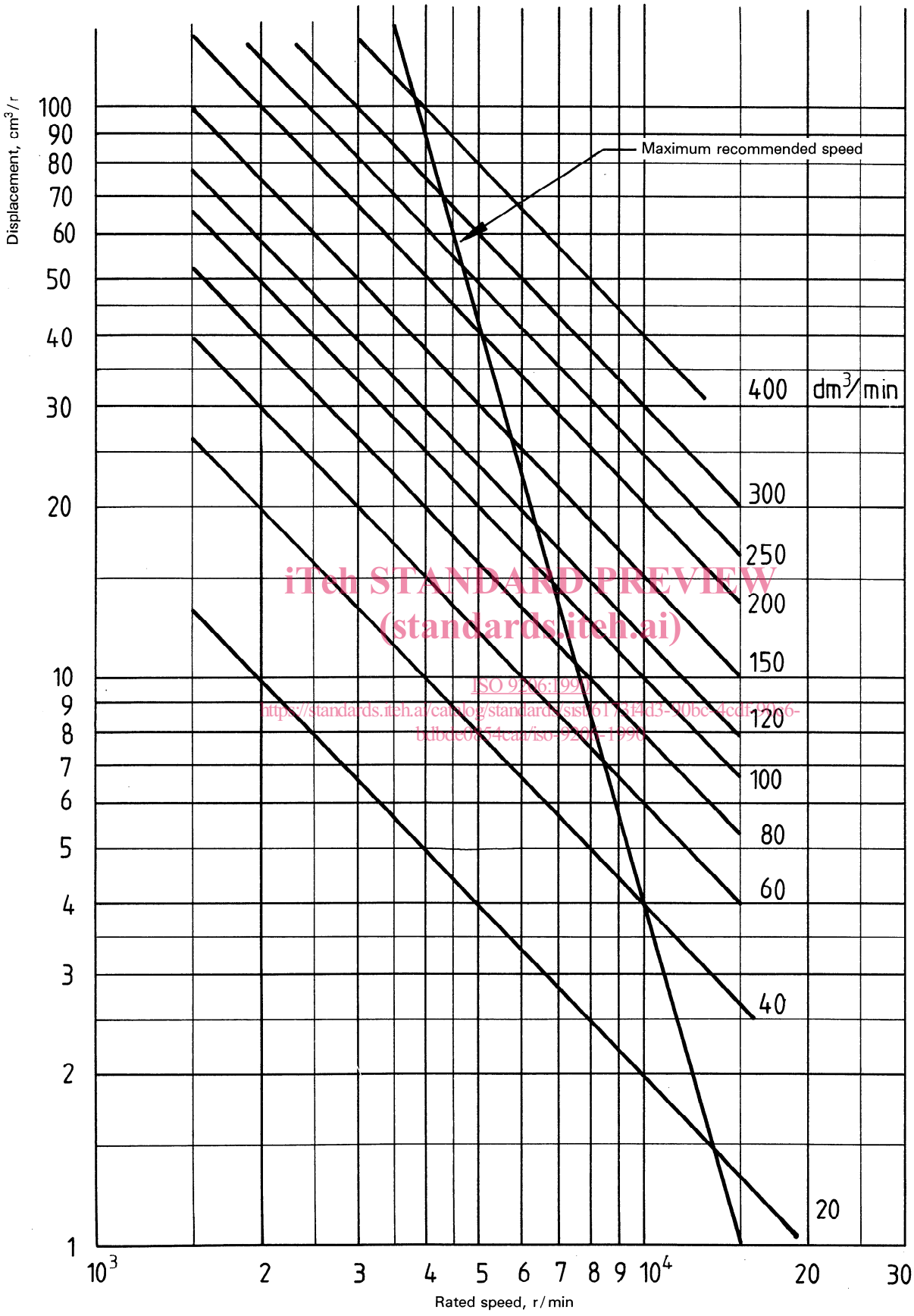

Figure 1 — Nomograph of maximum recommended values for rated speeds against displacement

4.8.3 Stalling torque

The stalling torque shall be defined as the minimum opposing torque which stops the rotation of the outlet shaft at the rated supply pressure and for outlet port and case drain port pressures specified in the detail specification.

The stalling torque shall be specified in the detail specification.

4.8.4 Torque pulsations

The motor shall be designed to deliver continuous torque without excessive amplitude ripple (considered as being over ± 10 %) when the motor is operated within the rated speed range at any of the conditions specified in clause 9 as specified in the detail specification.

4.9 Efficiency

The efficiency of a motor shall be defined as the ratio of output power to input power when the motor is operating at rated conditions or any other operating conditions if so specified in the detail specification. In general it is expressed as a percentage.

NOTE — The above ratio is commonly referred to as "overall efficiency" and includes the volumetric efficiency.

The compressibility of the fluid shall be taken into account when calculating the efficiency.

The following efficiency values shall be specified in the detail specification:

a) overall efficiency of the motor when new;

b) overall efficiency of the motor after endurance testing.

4.10 Dynamic characteristics

If requested by the purchaser, the motor polar moment of inertia and motor impedance shall be supplied to assist in developing system dynamic performance.

4.11 Dynamic braking

The motor shall be designed to withstand, at rated conditions, with no operating damage and with no reduction in performance, a braking torque which stops it in 0,02 s.

4.12 Rapid reversals

If required by the application, the motor shall withstand at conditions specified in the detail specification, without damage, rapid reversals of direction of rotation.

4.13 Passive operation

Passive operation of the motor (for example in redundant systems), without fluid supply, shall be specified in the detail specification.

4.14 Noise level

At rated operating conditions, the motor shall have a maximum noise level. If applicable, its value, together with the measuring procedure, shall be specified in the detail specification.

4.15 Rated endurance

If the duration and conditions of the endurance test are not specified in the detail specification, they shall comply with the specifications given in table 2.

The type of operation shall be specified in the detail specification.

Table 2 — Duration and conditions of the endurance test

Category of motor (see clause 3)	Hydraulic system (see table 1)	Continuous operation h	Operation with alternating load cycles
A	Types I and II	750	2×10^6
	Type III	250	1×10^6
B	Types I and II		
	Type III	125	$0{,}5 \times 10^6$

5 Installation

5.1 Dimensions

The dimensions required for installing the motor in the aircraft shall be specified in the detail specification.

5.2 Mass

The motor dry mass and mass with hydraulic fluid shall not exceed the values specified in the detail specification.

5.3 Mounting

Unless otherwise specified in the detail specification, all motors shall incorporate a mounting flange in accordance with ISO 8399.

When the mounting flange complies with ISO 8399, the relationship between the maximum displacement of the motor and the type of mounting flange shall be in accordance with table 3.

Table 3 — Relationship between displacement and flange type

Maximum displacement cm^3/r	Flange type
2,5	150
5	200
10	300
15 20 30 40	350

The installation requirements shall be subject to agreement between the manufacturer and the installer.

5.4 Drive

Unless otherwise specified in the detail specification, an easily removable shaft shall include a shear section between the motor drive shaft and the accessory drive shaft; this shear shaft shall be held in place by means of a positive locking system. The end of the drive shaft shall comply with ISO 8399.

The shear torque, the loads other than those self-induced by the motor torque, and the coupling lubrication mode shall be specified in the detail specification.

5.5 Ports

Unless otherwise specified in the detail specification, the ports shall comply with ISO 7320.

The structure of the ports and the relevant areas of the motor case shall be such that it withstands a torque 2,5 times the maximum torque resulting from attaching or removing the unions and lines on installation or removing motors during maintenance operations; no permanent distortion nor alteration in the correct operation shall occur.

The inlet port corresponding to each direction of rotation, the case drain port, and seal drain port shall be clearly and indelibly marked on each motor.

6 Construction

6.1 Materials

All materials shall be compatible with the hydraulic fluid specified in the detail specification. Materials and processes used in the manufacture of these motors shall be of aerospace quality, suitable for the purpose and shall comply with the applicable official standards. Materials which comply with the motor manufacturer's material specifications are acceptable provided that these specifications are acceptable to the purchaser and include provisions for adequate testing. The use of the motor manufacturer's specifications does not constitute a waiver of other applicable standards.

6.2 Metals

6.2.1 General

All metals shall be compatible with the fluid used and any fluids with which it will be in contact, with the service and storage temperatures, and functional requirements to which the components will be subjected. The metals not in direct contact with the hydraulic fluid shall have the appropriate corrosion-resistant properties or they shall be suitably protected as specified in 6.4.

If the properties or operating safety of the motor are likely to be jeopardized by the use of the materials and processes specified above, other materials and procedures may be used subject to the purchaser's approval.

In this case, materials or processes shall be chosen to provide the maximum corrosion resistance compatible with the operating requirements.

6.2.2 Motors for type I systems

Except for the internal surfaces in constant contact with the hydraulic fluid, ferrous alloys shall have a chromium content of at least 12 % (m/m) or shall be suitably protected against corrosion as specified in 6.4. In addition, tin and cadmium platings shall not be used for internal parts or for internal surfaces in contact with the hydraulic fluid or exposed to its vapours. The grooves for external O-ring seals shall not be considered as internal surfaces in constant contact with hydraulic fluid. Magnesium alloys shall not be used.

6.2.3 Motors for type II and type III systems

Ferrous alloys used shall have a chromium content of not less than 12 % (m/m) or shall be suitably protected against corrosion as specified in 6.4. In addition, tin and cadmium platings shall not be used for internal parts which are in contact with the hydraulic fluid or exposed to its vapour. Magnesium alloys shall not be used.

6.2.4 Ferrous, copper and aluminium alloys

Ferrous alloys requiring corrosion-preventive treatment and all copper alloys, except for parts with bearing surfaces, shall receive surface plating selected from the following:

a) electrolytic cadmium plating (see ISO 8921);

b) electrolytic chromium plating;

c) electrolytic nickel plating;

d) electrolytic silver plating;

e) electrolytic tin plating (see ISO 2093);

f) electroless nickel plating.

Electrolytic tin or cadmium plating shall not be used for internal parts or internal surfaces in contact with the hydraulic fluid or exposed in its vapours, or on surfaces subjected to abrasion.

Where not indicated, the class and type of plating are at the motor manufacturer's discretion.

Other metal platings, the use of which has been proved to be satisfactory to the purchaser, such as 85 % electrolytic tin plating, 15 % cadmium alloys, shall be protected by anodizing. However, in the absence of abrasive conditions, they may be coated with chemical film.

Moreover, unless otherwise specified in the detail specification, all aluminium alloys shall be protected by anodizing (see ISO 8077, ISO 8078, ISO 8079 and ISO 8081).

Exceptions shall be submitted to the purchaser for approval.

6.3 Castings

Castings shall be of aerospace quality, clean, sound and free from cracks, blow holes, excessive porosity and other defects. Defects which do not positively prevent the use of the castings may be repaired at the foundry or during machining by peening, impregnation, welding or other procedures acceptable to the purchaser.

Inspection and repair of castings shall be carried out according to the quality control procedures and standards acceptable to the purchaser.

6.4 Corrosion-preventive treatment

The metals which themselves do not have sufficient corrosion-resistance properties shall be protected in a suitable way in accordance with the specifications laid down in the sub-clauses above so that they can withstand corrosion which may be due to contact with dissimilar metals, humidity, salt spray or high temperatures.

6.5 Seals

For type I system motors, static and dynamic seals shall, whenever possible, comply with ISO 3601-1 and ISO 3601-3.

For type II system motors, the static and dynamic seals shall comply with ISO 3601-1 and ISO 3601-3.

Seals and back-up rings used for type III system motors shall have been approved by the purchaser.

Subject to the purchaser's approval, non-standard seals may be used to demonstrate compliance with the specifications of this International Standard.

6.6 Lubrication

The hydraulic motor shall be self-lubricated, using only the circulating fluid.

6.7 Balance

The rotating parts of the hydraulic motor shall be inherently balanced in their own right, and the motor shall not vibrate in such a way that any part of the motor or of the driving mechanism breaks throughout the speed range up to the maximum no-load speed.

6.8 Parts with critical installation direction

Parts which are likely to cause incorrect operation or damage if the installation direction is reversed or if they are incorrectly located on assembly shall include mechanical means to prevent them from being installed incorrectly.

6.9 Self-contained failure

The motor shall be designed to completely contain all internal parts in the event of a failure due to an overspeed condition. Maximum overspeed conditions shall be specified in the detail specification. No loss of fluid from the motor shall occur as a result of the failure, other than the external and shaft seal leakages specified in the detail specification.

6.10 Marking

6.10.1 Nameplate

A nameplate shall be securely attached to the motor. The information marked in the spaces provided shall be as specified in the format given in table 4.

Table 4 — Format for nameplate

Constant-displacement hydraulic motor	
Part number :	
Name of firm :	
Serial number :	
Fluid :	
Rating :	
Displacement :	cm^3/r
Differential pressure :	kPa
Speed :	r/min
Torque :	N·m

Any additional data required shall be specified in the detail specification.

6.10.2 Fluid identification

The fluid for which the motor is approved shall be identified in accordance with ISO 3323.

6.11 Seal of guarantee

A manufacturer's non-metallic seal of guarantee shall be used to indicate if the motor has been tampered with internally.

7 Maintainability

7.1 Maintainability features

7.1.1 All wear surfaces shall be replaceable or repairable.

7.1.2 Connections, mounting and wiring provisions shall be designed to prevent incorrect coupling.

7.1.3 In addition to the specifications of 6.8, components which are not functionally interchangeable shall not be physically interchangeable.

7.1.4 The design shall permit line replacement of the unit or module of the unit, using standard tools only.

7.1.5 The design shall be such that special or unique equipment is kept to a strict minimum for shop repair, overhaul and maintenance checks.