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Aerospace — Hydraulic power transfer units — General specifications

Aéronautique — Unités de transfert de puissance hydraulique — Spécifications générales

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Foreword

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ISO 22089 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 10, *Aerospace fluid systems and components*.

Introduction

Hydraulic power transfer units (PTUs) are designed to transfer hydraulic power, but not hydraulic fluid, between two independent hydraulic systems, or between hydraulic sub-systems.

This International Standard establishes the general requirements for PTUs, including:

— design requirements;

— test requirements.

Aerospace — Hydraulic power transfer units — General specifications

1 Scope

This International Standard establishes the general requirements for hydraulic Power Transfer Units (PTUs).

This International Standard covers uni-directional and bi-directional PTUs.

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

2 Normative references

The following referenced documents are indispensable for the application 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 2093, *Electroplated coatings of tin — Specification and test methods*

ISO 2669, *Environmental tests for aircraft equipment — Steady-state acceleration*

ISO 2671, *Environmental tests for aircraft equipment — Part 3.4: Acoustic vibration*

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

ISO 3601-1, *Fluid power systems — O-rings — Part 1: Inside diameters, cross-sections, tolerances and designation codes*

ISO 7137, *Aircraft — Environmental conditions and test procedures for airborne equipment*

ISO 7320, *Aerospace — Couplings, threaded and sealed, for fluid systems — Dimensions*

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

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

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

ISO 8625-1, *Aerospace — Fluid systems — Vocabulary — Part 1: General terms and definitions related to pressure*

ISO 8625-2, *Aerospace — Fluid systems — Vocabulary — Part 2: General terms and definitions relating to flow*

ISO 8625-3, *Aerospace — Fluid systems — Vocabulary — Part 3: General terms and definitions relating to temperature*

ISO 11218, *Aerospace — Cleanliness classification for aeronautical fluids*

3 Terms and definitions

For the purposes of this document the terms and definitions given in ISO 8625-1, ISO 8625-2 and ISO 8625-3 and the following apply.

3.1
Power Transfer Unit (PTU)
hydraulic device that is able to transfer hydraulic power between two independent hydraulic systems (or sub-systems) without transferring hydraulic fluid

NOTE The PTU generally consists of two rotating groups, housed separately and connected by a driveshaft. Hydraulic energy supplied to the hydraulic motor from one system drives the pump, providing hydraulic power to the other system.

3.2
uni-directional PTU
hydraulic pump that transfers hydraulic power between two independent hydraulic systems (or sub-systems), in one direction only, such that the pump and motor cannot reverse their functions

3.3
bi-directional PTU
hydraulic pump that transfers hydraulic power between two independent hydraulic systems (or sub-systems) in either direction

NOTE The PTU acts to provide hydraulic power to the system that is experiencing the greater power demand using hydraulic power from the other (lower demand) system. The pump and motor can reverse their functions such that the pump can function as a motor and vice-versa, depending on the direction of operation.

3.4
purchaser
organization that has the engineering responsibility for the hydraulic system that includes the PTU and who approves the supplier for the design, development and manufacture of aerospace PTUs

NOTE Typically, the purchaser is an aircraft manufacturer, an equipment manufacturer that has hydraulic system responsibility or a modification centre. The purchaser is responsible for the compilation of the detail specification.

3.5
detail specification
document that specifies the following:

a) technical requirements;

b) acceptance and qualification test requirements;

c) reliability requirements;

d) quality requirements;

e) packaging requirements;

f) other requirements.

3.6
supplier
manufacturer of the PTU, responsible for the design, production and qualification of the PTU

3.7
ports of the uni-directional PTU

3.7.1
pump case drain port
(if included) port that drains internal leakage flow to the reservoir

3.7.2
pump inlet port
port that receives flow from the hydraulic reservoir to supply the pump

3.7.3
pump discharge port
port that supplies pressurized flow to the system

3.7.4
motor case drain port
(if included) port that drains motor internal leakage flow to the reservoir

3.7.5
motor supply port
port that receives flow from the hydraulic system to power the motor

3.7.6
motor return port
port that returns flow to the reservoir

3.7.7
shaft seal port
port that routes any shaft seal leakage from the PTU to an overboard drain, collector tank, etc.

3.8
ports of the bi-directional PTU

3.8.1
case drain port
(if included) port that drains internal leakage flow to the reservoir

3.8.2
HP port
port that receives flow from the hydraulic system to power the motor, or supplies pressurized flow to the system

NOTE When the PTU half is acting as a pump, the HP port supplies pressurized flow to the system. When the PTU half is acting as a motor, the HP port receives flow from the hydraulic system.

3.8.3
LP port
port that returns flow to the reservoir or flow from the hydraulic reservoir to supply the pump

NOTE When the PTU half is acting as a pump, the LP port receives flow from the hydraulic reservoir. When the PTU half is acting as a motor, the LP port returns flow to the reservoir.

3.8.4
shaft seal port
port that routes any shaft seal leakage from the PTU to an overboard drain, collector tank, etc.

3.9
design operating pressure
normal maximum steady pressure

NOTE Excluded are reasonable tolerances, transient pressure effects such as may arise from:

— pressure ripple;

— reactions to system functioning;

— demands that may affect fatigue.

3.10
break-out pressure
minimum difference between the pump and motor differential pressures at which the PTU motor will start operating under conditions specified in the detail specification

NOTE Typically, the PTU will not act to provide power until a threshold breakout differential pressure between systems (or sub-systems) has been exceeded.

3.11
rated case-drain pressure
nominal pressure at which the PTU pump and motor cases are required to operate continuously in the system

3.12
maximum transient case pressure
maximum pressure peak that can be imposed by the hydraulic system on the pump or motor case drain port

3.13
maximum transient discharge pressure
pressure recorded during a discrete transient event [normally found whilst cycling from full-flow pressure to rated pressure (zero flow)]

3.14
maximum pump case drain pressure
maximum continuous pressure developed by the PTU pump to enable case drain fluid to return to the reservoir

3.15
maximum inlet pressure
maximum steady state inlet pressure at which the PTU pump might be required to operate during a system failure or during a system high-flow transient condition

3.16
minimum inlet pressure
lowest inlet pressure, specified by the purchaser, for which the supplier ensures that the PTU pump might be required to operate without cavitation during a system failure or during a system high-flow transient condition

NOTE For the purposes of this International Standard, cavitation is assumed to occur when there is a 2 % reduction in discharge flow with reducing inlet pressure.

3.17
rated inlet pressure
minimum pressure measured at the inlet port of the PTU pump at which the PTU is required to provide the performance without any degradation, with all the other parameters at their rated values, except for the fluid temperature, which is the minimum continuous temperature

3.18
maximum full-flow pressure for category C PTUs
maximum discharge pressure at which the pump control will not be acting to reduce pump delivery flow, at rated temperature, rated motor supply and return pressures, pump rated inlet and case drain pressure

NOTE Maximum full-flow pressure is not applicable to categories A and B PTUs.

3.19
rated discharge pressure for categories A and B PTUs
minimum discharge pressure that is met with rated motor differential pressure applied, at the minimum steady state discharge flow just prior to stall and with all other parameters at rated conditions

3.20
rated discharge pressure (or stall pressure) for category C PTUs
nominal pressure that the PTU pump is required to maintain at rated temperature, rated inlet pressure, rated case drain pressure and at zero discharge flow when the PTU is operated continuously with rated motor differential pressure

3.21
pressure pulsations
oscillations of the pump discharge pressure, occurring during nominally steady operating conditions, at a frequency equal to the number of pistons times the drive shaft speed, or a multiple thereof

NOTE 1 The amplitude of the oscillations is the difference between the average minimum and the average maximum oscillations recorded during a one-second trace.

NOTE 2 This is a characteristic of the PTU and the system operating together, not solely a PTU characteristic.

3.22
rated motor return pressure
rated return pressure of the system that is supplying the PTU

3.23
rated motor supply pressure
rated pressure of the system that is supplying the PTU

3.24
maximum motor case drain pressure
pressure developed in the PTU motor when the maximum system return pressure is applied to the PTU motor case drain port

3.25
maximum motor supply transient pressure
peak value of the PTU motor supply pressure during the operation of the PTU

3.26
no-load break-out pressure
minimum motor differential pressure required to initiate and sustain rotation of the PTU at zero pump differential pressure with all pump ports at the rated inlet pressure

3.27
rated differential pressure
differential pressure, measured between the PTU motor supply and return ports, required to produce the PTU pump maximum full-flow pressure when the motor is at the rated supply pressure

3.28
stall pressure
minimum opposing differential pressure which stops the rotation of the PTU drive shaft, or reduces the speed to that required to maintain PTU internal leakage, with the pressure at the PTU motor supply port at its rated and the motor operating return and rated case drain pressures

NOTE Some PTUs have a built-in bypass flow (also known as an idle circuit) to ensure that the pump/motor never stops rotating when it is selected to run.

3.29
rated temperature
maximum continuous temperature of the fluid to be supplied at the supply port of the PTU motor and the inlet port of the PTU pump expressed in degrees centigrade

3.30
rated discharge flow
flow rate measured at the PTU pump discharge port under conditions of:

— rated temperature;

— rated motor supply flow rate;

— rated inlet pressure;

— rated case drain pressure;

— maximum full-flow pressure;

— using the hydraulic fluid specified in the detail specification

NOTE The flow is measured in the compressed state.

3.31
rated supply flow
flow rate measured at the PTU motor supply port under conditions of:

— rated temperature;

— rated pump discharge flow rate;

— motor operating differential pressure;

— rated case drain pressure;

— maximum full-flow pressure (category C PTU only);

— using the hydraulic fluid specified in the detail specification

NOTE The flow shall be measured in the expanded state.

3.32
rated displacement
maximum theoretical volume of fluid generated by one revolution of the PTU pump drive shaft and/or as the maximum theoretical volume of fluid consumed by one revolution of the PTU motor drive shaft expressed in millilitres per revolution

3.33
volumetric efficiency
ratio of the PTU pump output flow to the PTU motor input flow when the PTU is operating at rated conditions or any other operating conditions if so specified in the detail specification

NOTE It is derived from the following equation:

$$\text{PTU volumetric efficiency (\%)} = [(Q_p \times D_m)/(Q_m \times D_p)] \times 100$$

where

Q_p is the PTU pump discharge flow in litres per minute;

Q_m is the PTU motor supply flow in litres per minute;

D_p is the PTU pump rated displacement in millilitres per revolution;

D_m is the PTU motor rated displacement in millilitres per revolution.

3.34
overall efficiency
ratio of the PTU pump output fluid power to the PTU motor input fluid power when the PTU is operating at rated conditions or any other operating conditions if so specified in the detail specification

NOTE It is derived from the following equation:

$$\text{PTU overall efficiency (\%)} = [(\Delta P_p \times Q_p)/(\Delta P_m \times Q_m)] \times 100$$

where

ΔP_p is the differential pressure between the PTU pump discharge and inlet ports in kilopascals;

ΔP_m is the differential pressure between the PTU motor supply and return ports in kilopascals;

Q_p is the PTU pump discharge flow in litres per minute;

Q_m is the PTU motor supply flow in litres per minute.

3.35
maximum no-load speed
rotational speed reached by the PTU pump and motor with the motor operating at rated conditions (rated fluid temperature and motor supply flow) and with the PTU pump delivering fluid in a system that is unpressurized

3.36
rated speed
speed at which the PTU will operate continuously at the rated motor flow, at rated temperature and at rated motor differential pressure expressed as a number of revolutions of the PTU drive shaft per minute

3.37
response time
time interval between the moment when an increase (or decrease) of the PTU pump discharge pressure begins and the subsequent time when the discharge pressure reaches its first maximum (or minimum) value, when connected to a specified circuit

NOTE This is only applicable to category C PTUs, and the response time will be different if the PTU is operating continuously or intermittently.

3.38
stability
freedom from persistent or quasi-persistent oscillation or “hunting” of the PTU (cyclic variations in speed) at any frequency which can be traced to the discharge control mechanism, within stated limits in the detail specification

NOTE This is only applicable to category C PTUs, and does not apply to conditions of intermittent rotation.

3.39
first article inspection
process that conducts the following:

— verifies that the parts of a component comply with the drawings;

— verifies that the manufacturing processes have been compiled and are adhered to;

— verifies that the assembly processes have been compiled and are adhered to;

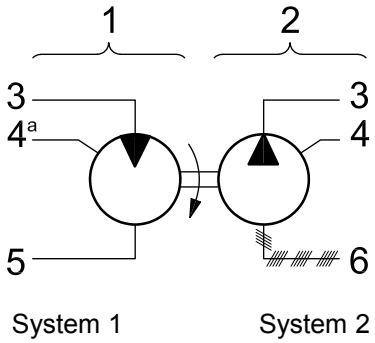
— verifies that the acceptance test of the component is in accordance with the test procedure, and that the results of the test are in agreement with the test requirements

3.40
rated endurance of the PTU
total number of hours and cycles of operation to be included in the endurance phase of its qualification testing

4 Classification

The Power Transfer Units covered by this International Standard are categorized as follows:

— Category A: uni-directional PTU that comprises a fixed displacement hydraulic motor driving a fixed displacement hydraulic pump, as shown in Figure 1.



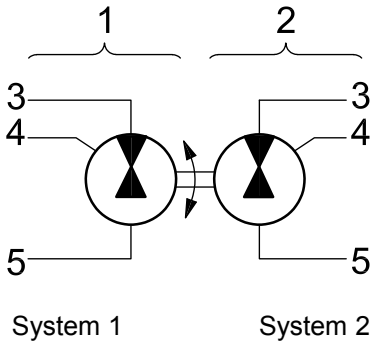
Key

1 system 1
2 system 2
3 pressure
4 case drain
5 return
6 inlet

[a] The case drain can be incorporated into the motor return.

Figure 1 — Uni-directional Power Transfer Unit

— Category B: bi-directional PTU that comprises a fixed displacement hydraulic motor/pump driving a fixed displacement hydraulic motor/pump, as shown in Figure 2.

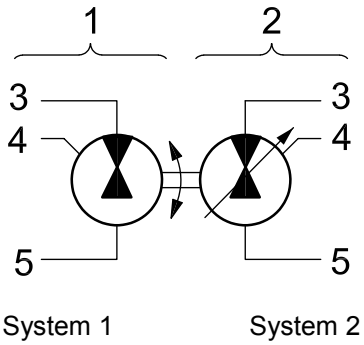


Key

1 system 1
2 system 2
3 pressure
4 case drain
5 return/inlet

Figure 2 — Bi-directional fixed displacement Power Transfer Unit

— Category C: bi-directional PTU that comprises a fixed displacement hydraulic motor/pump driving a variable displacement hydraulic motor/pump, as shown in Figure 3.



Key

1 system 1
2 system 2
3 pressure
4 case drain
5 return/inlet

Figure 3 — Bi-directional variable displacement Power Transfer Unit

The detail specification shall state the PTU category.

5 General requirements

5.1 General

The detail specification shall take precedence in the case of a conflict between the requirements of this International Standard and the detail specification.

5.2 Hydraulic system characteristics

The PTU shall be designed for installation in hydraulic systems as defined in the detail specification. This shall include the characteristics of the hydraulic system in which the PTU is to be used. This should include:

— the volume under pressure on each side of the PTU (category C PTUs only);

— acoustic resonance frequencies of the high pressure side of each system (or sub-system) (category C PTUs only);

— the pump inlet supply characteristics, including the location of the PTU relative to the reservoir;

— pressure drop-flow characteristics for the PTU motor supply and return pipelines over the operating temperature range;

— case drain routing details;

— details of PTU controllers, for example, the shut-off valve, flow control valve;

— the size and pre-charge of accumulators.

This is to enable the supplier to ensure that the PTU is correctly integrated into the hydraulic system by conducting a detailed dynamic analysis of the PTU operation.