

**USER MANUAL  
MAIN VALVES  
N° 2189 C**

# DESCRIPTION

# FOREWORD

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This manual cancels and replaces manuals 2189A, 2190A and 2191A.

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# CHARACTERISTICS

## INTRODUCTION

### ↳ General presentation

For large size hydraulic turbines, conversion, in hydraulic control, of the signal sent by the electronic speed governor cannot be performed by a single-stage actuator, as this would require excessively high electrical powers for the governor and the electrodynamic motor of the actuator.

- Conversion is thus performed in two stages:

the actuator converts the electrical input signal into a proportional hydraulic output signal

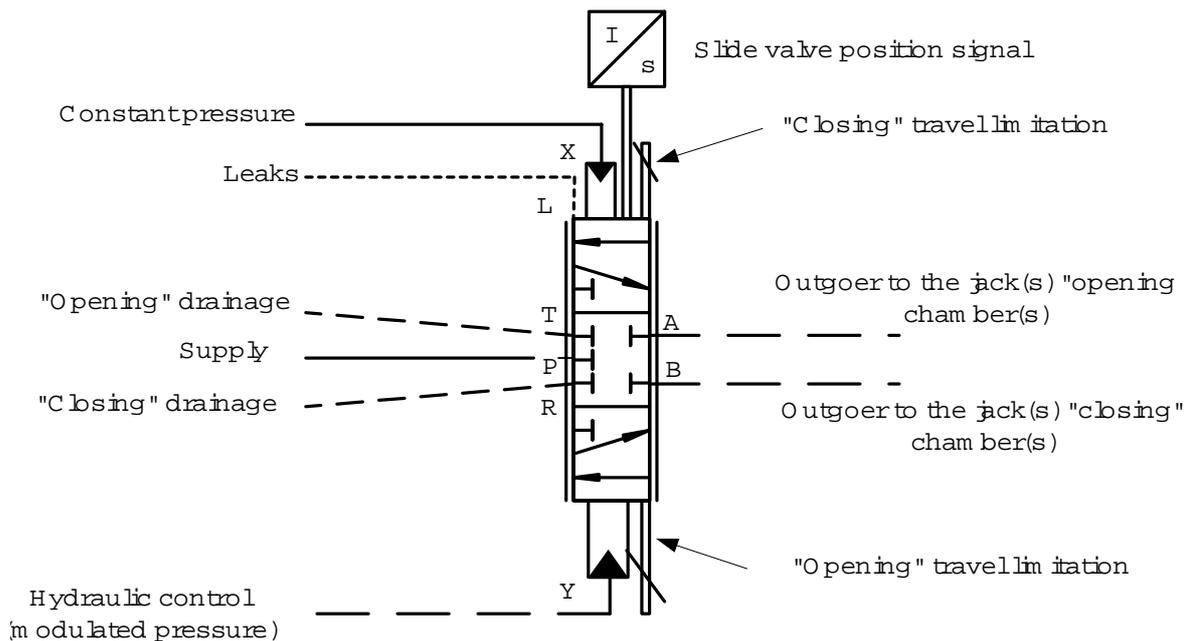
- the main distributing valve, the hydraulic amplification stage.

### ↳ Scope

The main hydraulic distributing valves have been designed by ALSTOM Power to supply the jack opening and closing chambers of the hydraulic turbine guide vanes.

On the governing diagrams, the main hydraulic distributing valve is represented as follows

**CETOP representation:**



➔ **Safety on closing**

For hydraulic turbine control, the search for operating safety requires, in virtually all cases, closing of the inlet valves in event of a malfunction.

On all the distributing valve models, such safety is ensured by the double device described below:

- 1) Mounting the distributing valves in the vertical position and closing by lowering the slide valve under its own weight.
- 2) Hydraulic pressure permanently exerted on the slide valve and closing ensured by drainage of the bottom chamber.

Drainage is produced by devices such as:

- natural tendency of the actuator on a power cut
- return by spring of the safety solenoid valve on solenoid supply failure
- action of a distributing valve controlled by the overspeed detector.

	<b>D 50 D</b>	<b>D 80 D</b>	<b>D 100 D</b>	<b>D 150 D</b>
Slide valve weight (kg)	3,3	14,8	28	64
Tendency to close (kg)	9,7 Pn	24,75 Pn	25 Pn	25 Pn

Pn = rated working pressure in bar or 100 kPa

The ratio between both controlling sections (constant pressure and modulated pressure) is 1/2.

➔ **Standardised designation of openings**

According to the technologies used, the openings may be placed differently on the distributing valve. However, in relation with the safety problem mentioned above, opening marking is always the same:

- reference P for the main pressure inlet
- reference A for supply of the jack opening chamber
- reference B for supply of the jack closing chamber
- reference T for the oil return from the opening chamber
- reference R for the oil return from the closing chamber (on some models, this output is grouped internally with T)
- reference X for the constant pressure inlet above the piston (on some models, this inlet is internal from P)
- reference Y for distributing valve control by modulated pressure from the actuator
- reference L for recovery of bottom leaks (opening sometimes combined with the chamber oil returns)
- reference V for recovery of top leaks.

## Composition of the main hydraulic distributing valve

The functional subassemblies of the main hydraulic distributing valve are:

- the slide valve
- all the parts (body, bottom, etc.)
- the position sensor of the slide valve used to control the latter in order to increase accuracy and stability of speed governing.

The following is guaranteed by the materials selected for the distributing valve manufacture :

- resistance to oxydation (water in oil)
- resistance to wear and tear of the active parts
- good friction (cast iron steel torque).

### ↳ Main components of a distributing valve

#### A ) Components present in all distributing valves

- 1 ) Slide valve
- 2 ) Body
- 3 ) Bottom
- 4 ) Cover
- 5 ) Sensor
- 6 ) Opening stop
- 7 ) Closing adjustment rod

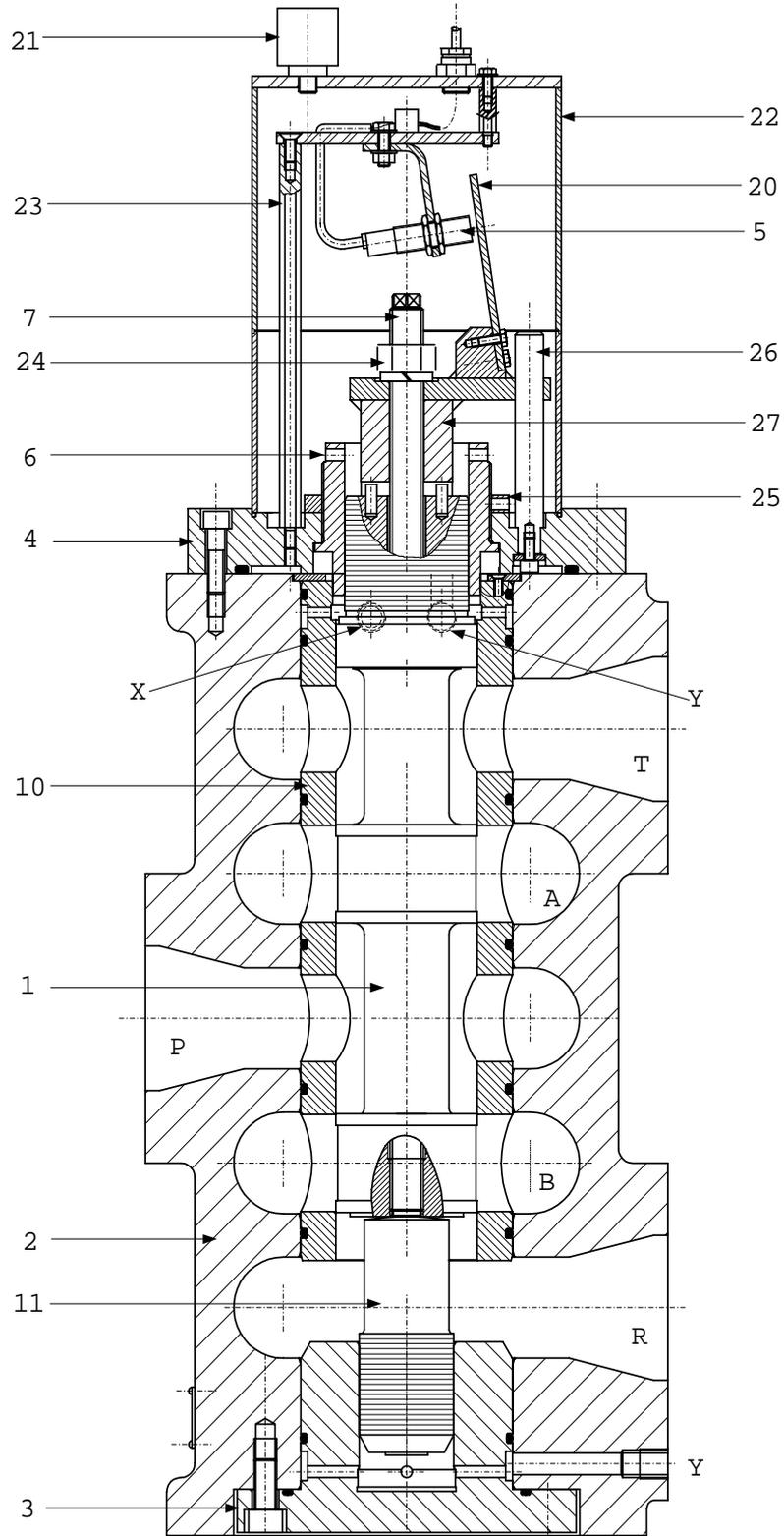
#### B ) Components present on large size distributing valves

- 10) Sleeve
- 11) Push rod

#### C) Detail parts

- 20) Target
- 21) Snifting valve
- 22) Top protective cover
- 23) Sensor support
- 24) Adjustment rod locking nut (7)
- 25) Opening stop locking nut (6)
- 26) Target support guide
- 27) Target support

**Cross-section of a distributing valve**



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## CHARACTERISTICS

## Configuration

According to the flow to be sent through, the main distributing valve is chosen in the standardised range: D50 ; D80 ; D100 ; D150.

For very large turbines, ALSTOM Power specially produces T250 distributing valves.

The letter D stands for Distributing Valve (note that for the largest distributing valve, all our documentation preferably uses the letter T for Slide valve).

The figure corresponds to the slide valve diameter in mm.

A letter is added, after the size, to specify the upgrades and different technologies used.

For example, adjustment by limiting slide valve travel or by restrictors.

Refer to the table below for the various possible configurations

The main hydraulic distributing valves are available in 4 standard configurations

Type	Adjustment	Sleeve	Openings	Number of collars	Opening chamber position (A,T)
D 50 D	Travel limitation	No	Side	3	Bottom part
D 80 D	Travel limitation	Yes	Side	3	Bottom part
D 100 D	Travel limitation	Yes	Side	4 (counting the push rod)	Top part
D 150 D	Travel limitation	Yes	Side	4 (counting the push rod)	Top part

For very large size machines, ALSTOM Power has special productions

Type	Adjustment	Sleeve	Openings	Number of collars	Opening chamber position (A,T)
T 250	Travel limitation	Yes	Side	4 (counting the push rod)	Top part
T 250 B	Travel limitation	Yes	Bottom surface	4	Top part

## TECHNICAL DATA

### Main data

The main data for hydraulic distributing valves are the flow coefficients (K) at full opening and closing.

They enable, using the formula below, calculation of the flows (Q) flowing through the distributing valves according to the pressure difference ( $\Delta P$ ) between the openings.

$$Q = K\sqrt{\Delta P}$$

Q = flow : dm<sup>3</sup>/s

$\Delta P$  = pressure difference (or head loss) : bar

K = flow coefficient : dm<sup>3</sup>/s/ $\sqrt{\text{bar}}$

### Coefficient K of the standard distributing valves

Type	Closing direction		Opening direction	
	Coefficient K on one channel	Coefficient K on 2 channels with identical flows on both channels	Coefficient K on one channel	Coefficient K on 2 channels with identical flows on both channels
<b>D 50 D</b>	5,9	4,2	5,9	4,2
<b>D 80 D</b>	19,8	14	19,8	14
<b>D 100 D</b>	38,2	27	29,7	21
<b>D 150 D</b>	48	34	35,3	25

## Other data

Type	D 50 D	D 80 D	D 100 D	D 150 D
Maximum operating pressure (bar)	160	100	70	70
Minimum pressure (bar)	14	10	12	12
Maximum flow (if corresponding head loss is acceptable) (dm <sup>3</sup> /s)	25	60	110	150
Sensor make and type	Télemécanique XCP H08362 4 ... 20 mA			
Supply voltage (supplied by the governor)	24 Vdc			
Sensor signal	4 ... 20 mA	4 ... 20 mA	4 ... 20 mA	4 ... 20 mA
"Opening" slide valve travel	12.5	20	15	20
"Closing" slide valve travel	12.5	30	25	30

## Dimensions and weights

Type	D 50 D	D 80 D	D 100 D	D 150 D
Height (mm)	500	878	1009	1326
Width (mm)	180	370	370	527
Depth (mm)	180	370	370	527
Weight (kg)	60	250	330	980

## ASSOCIATED EQUIPMENT

The hydraulic chain

The main hydraulic distributing valve is part of the turbine inlet valve control chain.

The hydraulic chain consists of the assemblies described below.

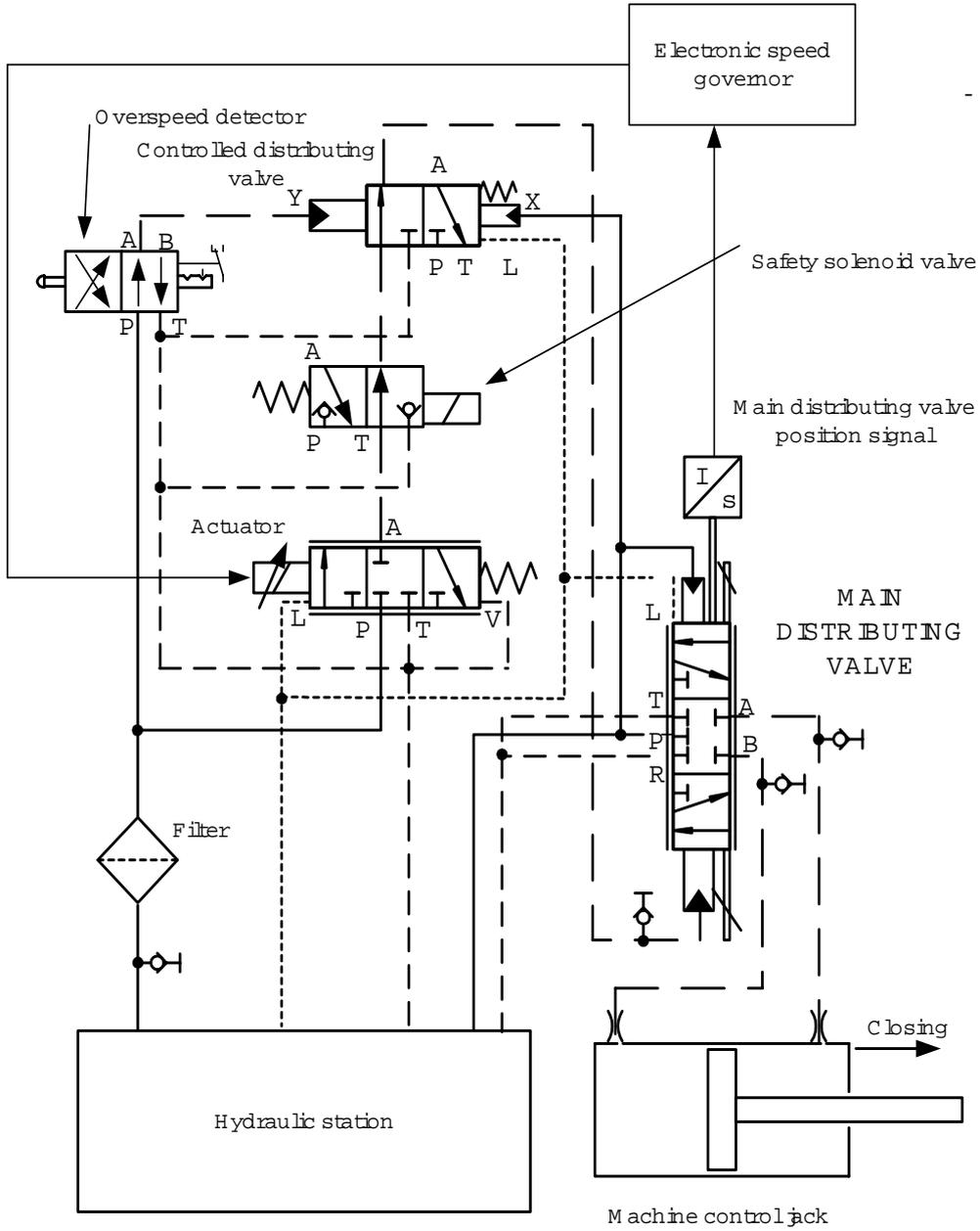
**A ) Control block consisting of:**

- the actuator that continually converts the electrical signal sent by the governor into a proportional hydraulic output signal
- the safety solenoid valve which, on an electricity supply cut, returns the main distributing valve to the closing position
- and, if necessary, a distributing valve controlled by overspeed, that acts like the safety distributing valve.

**B ) Main distributing valve****C ) Inlet valve control jack****D ) Hydraulic station, generating pressurised oil.**

The hydraulic chain is controlled by the electronic speed governor.

**Diagram of the equipment associated with a main distributing valve (Diagram shown with the turbine in operation).**



KEY :

- |           |                    |           |                 |
|-----------|--------------------|-----------|-----------------|
| —————     | Oil supply         | .....     | Leak return     |
| - - - - - | Modulated pressure | - - - - - | Drainage return |

# OPERATION

# PRINCIPLE

## At rest

In absence of modulated pressure, the slide valve of the main distributing valve is pushed downwards to the “ closing position ” by its own weight and by the pressure exerted constantly in the annular chamber at the top of the slide valve (port X).

The slide valve is on the mechanical closing limit stop.

## In operation

The flow, positive or negative, sent by the actuator supplies or drains the chamber under the slide valve causing the position of this valve to vary (port Y).

Each oil volume contained in the bottom chamber has a distributing valve slide valve position and thus a section uncovered at hydraulic distribution opening level.

### A ) Opening

The slide valve rises if the bottom chamber is supplied. This upwards movement:

- connects openings P and A
- connects openings B and R

and controls the jack in the opening direction of the inlet valve.

### B ) Closing

The slide valve drops if the bottom chamber is drained. This downwards movement:

- connects openings P and B
- connects openings A and T

and controls the jack in the closing direction of the inlet valve.

### C ) Equilibrium

The slide valve is maintained in an intermediate position by the modulated pressure, the ports are not connected, the jack stays in its position.

# INSTALLATION

# INSTALLATION

## Installation requirements

The device must be mounted vertically:

- suspended to a sturdy construction support and not subjected to vibrations or impacts for distributing valves D50C, D80C and D100C
- or placed on a support on the ground for distributing valves D80C, D100C and D150C

4 screws are used for fastening

### ↳ Support dimensions

	Type	D 50 D	D 80 D	D 100 D	D 150 D
<b>Suspended mounting</b>	D (mm)	151	220	320	
	e (mm)	12	25	25	/
	a (mm)	140	250	270	/
	d (mm) drilling/for screws	11 / M10	23 / M20	23 / M20	/
<b>Ground installation</b>	k drilling square	/	250	270	405
	d' diameter of holes	/	19	23	27
	Fastening screws diameter and length	/	M 16 / 40	M 20 / 60	M 24 / 60

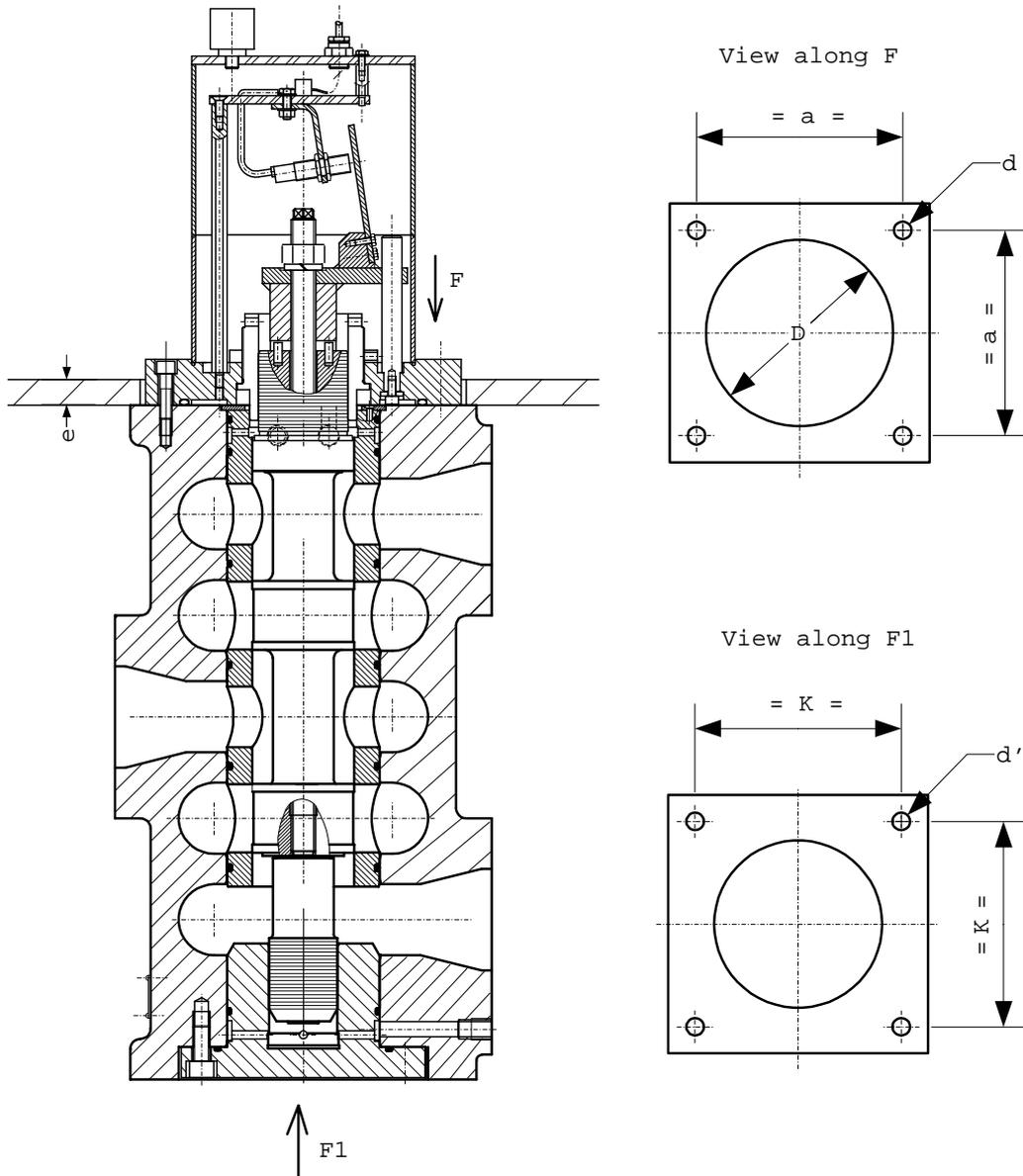
The device must be installed as close as possible to the jack.

No pressure is accepted in the leak return piping L.

If the leaks are collected, the collecting tube must be amply sized and ventilated.

INSTALLATION

*Vertical layout*



## Sizing the leak return pipes

### ↳ Mounting on hydraulic station

If the device is mounted on the governing tank, leaks are returned via a tube opening into atmospheric pressure 5 cm above oil level.

Tube diameter :

- DN 15 for distributing valves D50D, D80D and D100D
- DN 20 for distributing valves D150D

### ↳ Mounting on a rack (outside the hydraulic station)

If the device is mounted outside the governing tank, it must be installed at least 0.5 m above the maximum level of oil in the tank.

Internal leaks (L) are returned via a pipe running and opening into atmospheric pressure 5 cm minimum above oil level.

Tube diameter :

- DN 20 for distributing valves D50D, D80D and D100D
- DN 25 for distributing valve D150D

For lengths less than 5 m. Above, tube diameter to be increased by one size, or DN25 and DN30.

### ↳ Sizing the pressure pipes

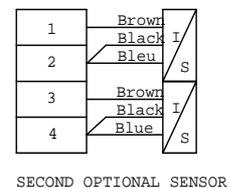
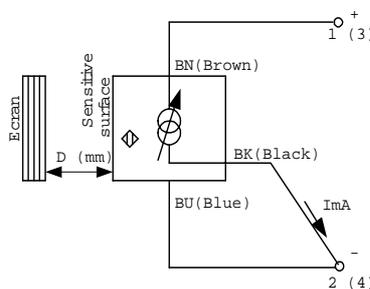
The outgoing pipes to the jack (A, B), the drainages (T, R), the pressure inlets (P, X) and the control (Y) should preferably be connected by rigid pipes.

The sizing of these pipes depends on maximum useful flow to comply with the operating times of the turbine inlet valves.

Maximum oil speed will be around 5 m/s.

 *Nota: For the D150D distributing valve, the drainage pipes must be separately reduced: head loss must be less than 3% of minimum pressure.*

### ↳ Cabling



Cable as shown in the diagrams above.

- 1.5 mm<sup>2</sup> shielded cable must be used.
- The shielding must be connected to the metal frames on the governor and the box side.

## Adjustments

### ↳ Safety restrictors

Fitting of restrictors on the jack allows a rough adjustment, while at the same time ensuring safety should the pipes break. These restrictors can be fitted in the union or in the pipe flush with the jack.

### ↳ Adjusting jack operating time

At the main hydraulic distributing valve, operating times are refined by limiting slide valve travel. Attention should be paid to counternut clamping; modification of adjustment modifies operating times and may lead to overpressure, negative pressure or overspeed that could have an adverse effect on the machine.

### ↳ Adjusting the position sensor

The sensor is adjusted in the workshop to deliver a current of 5 mA, with the slide valve in lower position, without limitation of travel.

# USE

## COMMISSIONING

On commissioning or following disassembly / reassembly of the live parts of the main hydraulic distributing valve, proper operation of the device must be checked.

- 1) Place the hydraulic and electrical circuits in normal operation.
- 2) Set the governor to manual control.
- 3) Position the jack at 30% opening, for example.
- 4) Check jack stability.

### ➔ Oil quality

All standard control oils (ISO 68); for special cases, consult ALSTOM Power.

### ➔ Filtration

The main hydraulic distributing valves tolerate oils with rough filtration (> 300 µm), performed by the suction filters.

As a rule, it is the finer filter, placed at the actuator intake that ensures, by bypass filtration at 50 µm, the overall cleanliness of the entire hydraulic circuit.

## SAFETY DEVICES

### ➔ Safety of personnel

Pressure

The hydraulic circuits are pressurised in operation. Prior to intervention, it is necessary to:

- isolate the part on which the operation is scheduled
- lock the devices used for isolation
- decompress & drain

### ➔ Moving parts

The main hydraulic distributing valves have no external moving parts.

### ➔ Electricity

The electrical sensor is supplied with 24 Vdc by the electronic speed governor.

### ➔ Safety of equipment

Through its tendency to close, the main hydraulic distributing valve acts as a safety device for turbine safety closing. It must therefore be in perfect working order and its maintenance must be guaranteed.

# MAINTENANCE

# STANDARD SERVICING

## Introduction

The actual main distributing valve normally requires no standard servicing: only monitoring of overall cleanliness of the hydraulic circuit and maintenance of oil qualities is necessary.

If, due to an incident, serious pollution were to occur, the operator may observe loss in governing quality due to gumming of the slide valve in the body.

In this case only should disassembly of the main distributing valve be considered.

## Preventive maintenance

Routine disassembly for inspection is pointless and we advise against it.

If the operator wishes to prepare a preventive maintenance programme, we recommend, after 100 000 hours of operation, scheduling the replacement of the position sensor.

## MOUNTING

### DISASSEMBLY

The disassembly procedure described below must be performed in exceptional circumstances only and undertaken with the greatest care. Results are guaranteed if this operation is assigned to ALSTOM Power.

#### ➔ Removing the main distributing valve

- 1) If necessary remove the cover (22).
- 2) Separate the electrical connection.
- 3) Ensure that pressure is zero in all main distributing valve connecting circuits.
- 4) Disassemble the unions of the various pipes.
- 5) Unscrew the 4 fastening screws.
- 6) Remove the main distributing valve and store it in a clean place.
- 7) Secure a protective plate in the place of the main distributing valve.

#### ➔ Disassembling the slide valve

- 1) Remove the cover (4).
- 2) The slide valve (1) is extracted from the top.

#### **A ) If necessary disassembly of the sleeve and push rod**

To work in good conditions, we recommend that you also disassemble the bottom part

- 1) Remove the bottom (3).
- 2) Remove the push rod (11) and the sleeve (10).

Acceptance criteria for a body-slide valve or sleeve-slide valve assembly

Distributing edges (at overlaps) must be sharp. The tolerated wear and tear not exceed 0.15 mm.

Scratches on collars shall not exceed 0.1 mm in depth.

### REASSEMBLY

If necessary reassembly of the sleeve and push rod

- 1) Oil the push rod (11) and the sleeve (10).

- 2) Put them back and replace the faulty seals.
- 3) Put back the bottom (3) with a new seal if the disassembled one is damaged.

➔ **Reassembly and assembly of the slide valve**

- 1) Oil the slide valve (1).
- 2) Insert it in the distributing valve.
- 3) Check that it operates effortlessly.
- 4) Put back the cover (4) with a new seal if the disassembled one is damaged.

➔ **Reassembly and assembly of the main distributing valve**

- 1) Stand the main distributing valve on its support.
- 2) Fix it in position using the 4 screws.
- 3) Put back the unions of the various pipes.
- 4) Perform the electrical connection.
- 5) If necessary, put back the cover (22).

## EXCHANGING THE DISTRIBUTING VALVES

Only main distributing valves of the same type can be exchanged.

We recommend that you exchange the complete main distributing valve.

If the failure is clearly identified as being electrical, only the sensor must be replaced.

## TROUBLESHOOTING HELP TABLE

SYMPTOM	POSSIBLE CAUSE	DETECTION	TROUBLE-SHOOTING
<b>System does not work during trial test</b>	Pressure not supplied to the distributing valve	Check pressure in the hydraulic governing circuit	Restart the hydraulic station
	The slide valve is jammed	Check that the slide valve slides freely	Clean the moving parts and replace them if necessary
<b>Insensitivity to setpoint variations</b>	The slide valve is gummed up	Check that the slide valve slides freely	Clean the moving parts and replace them if necessary
<b>Position feedback control impossible</b>	Sensor electricity supply is faulty	Measure supply voltage	Restart the governor. Check governor cabling to the distributing valve
	Inductive sensor is faulty	Measure the output signal	Replace the inductive sensor

### ↳ Lifetime

For normal working conditions (controlled oil contamination), the experience feedback shows that the service life is over 30 years with no heavy maintenance.







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