



A BRIEF WRITE UP ON ELECTRO-HYDRAULIC ACTUATORS FOR MAIN STEAM VALVES FOR 660/800 MW RATING STEAM TURBINE SETS

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1 INTRODUCTION:

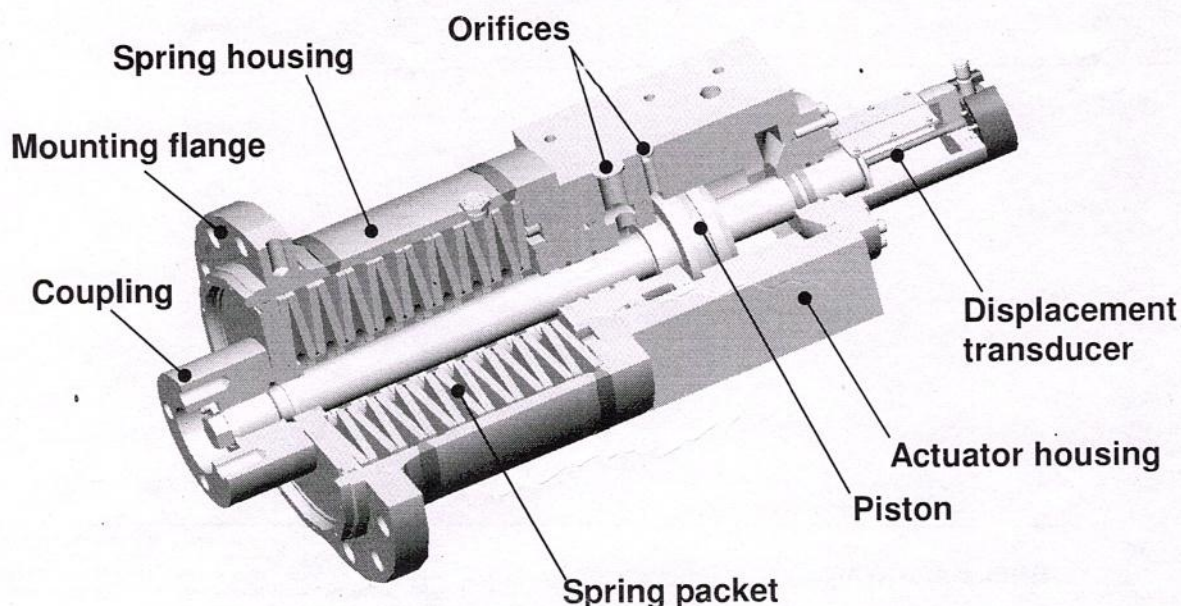
The steam turbine output is controlled by adjusting steam mass flow rate by turbine valves. There are total 9 nos. turbine valves viz. 2 nos. HP stop valves, 2 nos. HP control valves, 2 nos. IP stop valves, 2 nos. IP control valves and 1 no. overload control valve. These turbine valves are hydraulically actuated. In the case of a turbine trip, turbine valves interrupt the steam flow into the turbine instantly.

There is dedicated Electro-hydraulic actuator for each turbine stop and control valve. Hence **total 9 nos. actuators are envisaged**. All the actuators are operated with 160 bar high pressure fire resistant fluid supplied from centralized Hydraulic Power Supply Unit (HPSU).

Electro-hydraulic actuators mainly consists of Hydraulic pistons, Disc spring, Servo valves, Pilot valve, Trip solenoid valve, Cartridge valve, Check valves, Filter etc. Servo valve/Pilot valve transmit the electrical input signal of the turbine controller output into a hydraulic signal and amplify it, guide the control fluid flow to the hydraulic actuators so that the required steam flow rate can be regulated/stopped.

Cartridge valves mounted on the control blocks of actuators assemblies takes care that hydraulic actuators can close the steam valves within a very short time.

A typical cross section drg. of actuator is shown below.



BHEL HARIDWAR

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2 STOP VALVE ACTUATOR (HP, IP):

The stop valve actuator is an Electro-Hydraulic Actuator with control fluid supply from HPSU. The actuator comprises an operating cylinder, control unit & valve position transmitter to monitor the opening and closing of the actuator/valve. Turbine stop valve is coupled with control piston of power cylinder. The control piston which is pressure loaded in opening direction and pressure relieved on the opposite side, moves in power cylinder. The closing force is supplied to the control piston by a cup – spring stack housed inside the actuator. The actuator is connected to the HPSU through control fluid supply and return lines. A filter along with D.P. switch is fitted in pressure line (upstream side) to prevent ingress of contamination from the pipe lines. A terminal box is also provided for wiring purpose.

2.1 CONTROL UNIT (MANIFOLD):

The control unit is mounted on the power cylinder and comprises of the Pilot valve, Trip solenoid valves, cartridge valves, check valves and orifices. All these control elements are connected via a control plate to the power cylinder through internal fluid ducts.

2.2 MODE OF OPERATION:

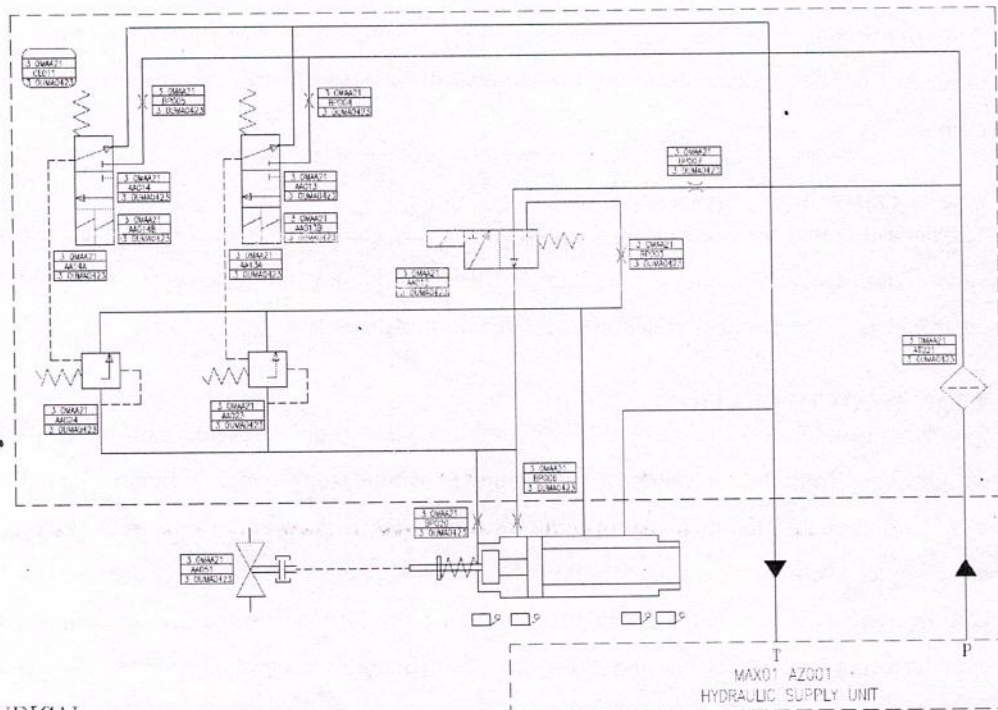
The trip solenoid valves (with double coils for redundancy) are energized with the help of output current signal from the controller for the opening of turbine stop valve. The fluid is fed to the power cylinder and pushes the piston in opening direction against the spring force. Stop valve is rapidly closed by de-energizing the trip solenoid valves, in that case the pressure over the discs of the logic cartridge valves is reduced, causing these valves to be opened by the pressure from the power cylinder being applied beneath the discs, thereby initiating the rapid closure of valve. Pilot valve remains in de-energized state during opening/rapid closing of the turbine stop valve. Pilot valve is energized only in case of normal closing of the turbine stop valves, keeping trip solenoid valves in energized state. The flow of oil to the actuator is realized through orifices. The sizing of these orifices is done based on the closing time of actuator. A leakage sensor is also provided in the leakage tray of actuator. It gives the signal to control room in case of leakage through actuator.

POSITION MONITORING:- 2 no. Position Transmitters and Limit Switches for Open and Close position of the valve are provided in each actuator.



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SYSTEM DIAGRAM HP/IP STOP VALVE ACTUATOR





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3 CONTROL VALVE ACTUATOR:

The control valve actuator is an Electro-Hydraulic Actuator with control fluid supply from HPSU. The actuator comprises an operating cylinder, control unit and valve position transmitters. Turbine control valve is coupled with the control piston of power cylinder. The control piston which is pressure loaded in opening direction and pressure relieved on the opposite side, moves in power cylinder. The closing force is supplied to the control piston by a cup – spring stack housed inside the actuator. The actuator is connected to the HPSU through control fluid supply and return lines. A filter along with D.P. switch is fitted in pressure line (upstream side) to prevent ingress of contamination from the pipe lines. A terminal box is also provided for wiring purpose.

3.1 CONTROL UNIT (MANIFOLD):

The control unit comprises of servo valve, trip solenoid valves, cartridge valves, check valves and orifices. In addition a filter along with D.P. switch is also fitted to the pilot control of servo-valve. All these control elements are connected via a control plate to the power cylinder through internal fluid ducts.

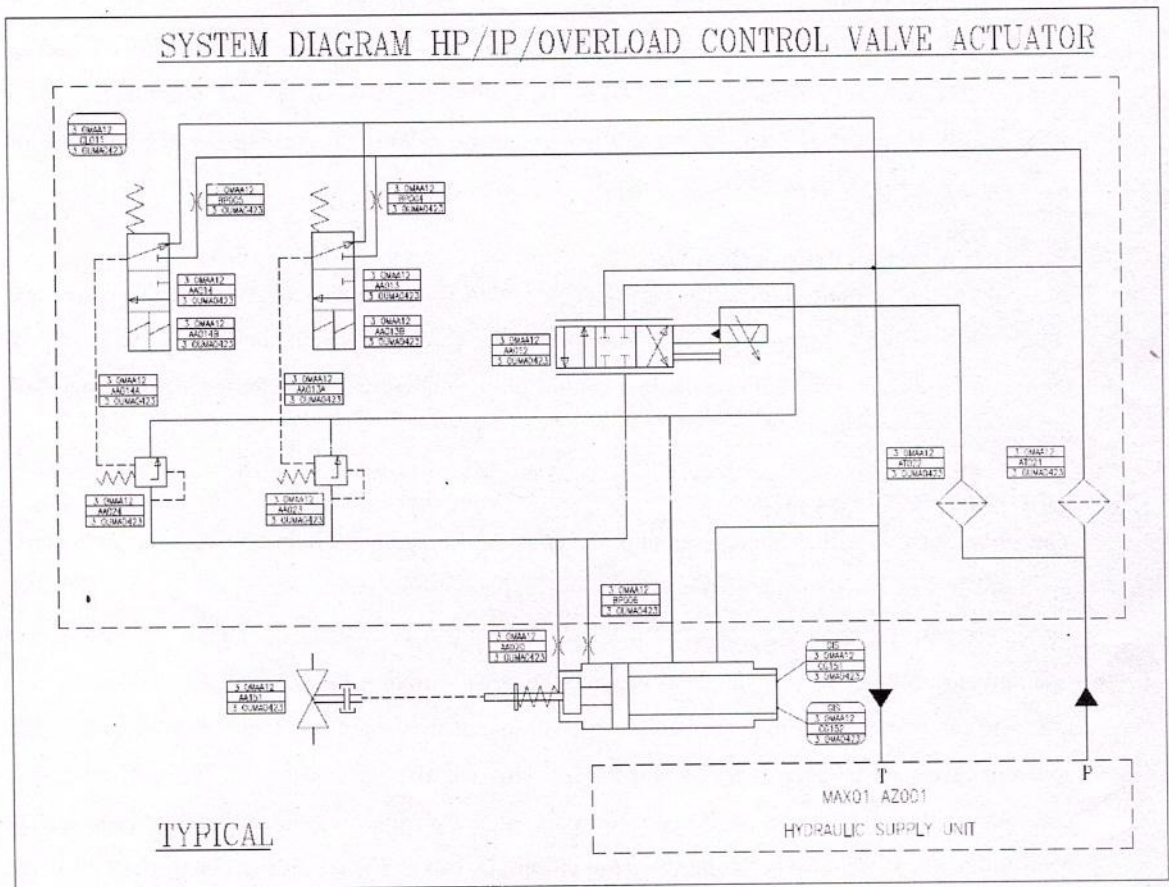
3.2 MODE OF OPERATION:

The servo valve is a high grade continuously operating directional control valve with particularly good steady state and dynamic characteristics and high amplification. Servo valve which is controlled through a position controller, controls the flow of fluid to both sides of the control piston as a function of the output signal from the controller, thereby positioning the actuator. The analog position of the actuator is feedback to the controller by position transmitters. In the event of rapid closure, trip solenoid valves are de-energized and thus the pressure over the discs of the logic cartridge valves is reduced, causing these valves to be opened by the pressure from the power cylinder being applied beneath the discs, thereby initiating the rapid closure of valve. The cartridge valves operated by the trip solenoid valves (with double coils for redundancy) are opened with minimum travel time and the piston chamber is connected to the drain. The flow of oil to the actuator is realized through orifices. The sizing of these orifices is done based on the closing time of actuators. A leakage sensor is also provided in the leakage tray of actuator. It gives the signal to control room in case of leakage through actuator.

POSITION MONITORING:- 2 no. Position Transmitters are provided in each actuator.



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4 SCOPE OF SUPPLY PER TG SET:

Sl. No.	Item description	Quantity per TG set
4.1	ELECTRO-HYDRAULIC ACTUATORS:	
4.1.1	STOP VALVE ACTUATORS WITH COMPLETE CONTROL BLOCKS (TYPE: SVA-250-98-352) FOR HP STOP VALVES (HORIZONTALLY MOUNTED VALVE)	2 NOS. (ARRANGEMENTS WILL IN MIRROR IMAGE)
4.1.2	CONTROL VALVE ACTUATORS WITH COMPLETE CONTROL BLOCKS (TYPE: CVA-200-80-347) FOR HP CONTROL VALVES (HORIZONTALLY MOUNTED VALVE)	2 NOS. (ARRANGEMENTS WILL IN MIRROR IMAGE)
4.1.3	STOP VALVE ACTUATORS WITH COMPLETE CONTROL BLOCKS (TYPE: SVA-560-208-92) FOR IP STOP VALVES (VERTICALLY MOUNTED VALVE)	2 NOS. (ARRANGEMENTS WILL IN MIRROR IMAGE)
4.1.4	CONTROL VALVE ACTUATORS WITH COMPLETE CONTROL BLOCKS (TYPE: CVA-500-170-104) FOR IP CONTROL VALVES (HORIZONTALLY MOUNTED VALVE)	2 NOS. (ARRANGEMENTS WILL IN MIRROR IMAGE)
4.1.5	CONTROL VALVE ACTUATOR WITH COMPLETE CONTROL BLOCK (TYPE: CVA-125-50-324) FOR OVERLOAD CONTROL VALVE (HORIZONTALLY SUSPENDED VALVE);	1 No.
4.2	SPECIAL TOOLS AND TACKLES FOR ASSLY & DIS-ASSLY. FOR ACTUATORS	1 SET
4.3	COMMISSIONING SPARES	1 SET
4.4	TRAINING & SUPERVISION DURING ERECTION & COMMISSIONING AT SITE:	REQUIRED FOR EACH SET

Pre-qualification requirements for "Electro-hydraulic actuators for main turbine valves" for indent no.**20191426 Rev.00 dated 06.08.2019 & 20191937 Rev. 00 dated 22.08.2019**

Sl. No.	Pre-qualification requirements	Vendor response
1	The vendor should have the experience of Design, Engineering, Manufacturing, Testing & Supply of Electro-hydraulic actuators for main turbine valves for Coal fired Steam turbines of name plate rating 660 MW or above , at two Steam Turbine units, with parameters listed at point no. 2, 3 & 4 below. The vendor to confirm. In support of experience, vendor to submit details of their past supply in the experience list format as per Annexure-1 (copy enclosed).	
2	The applicable main Steam parameters for the Coal fired Steam Turbine units (referred at point 1 above) shall not be less than as follows. The vendor to confirm. Main Steam pressure (Rated condition) > 247 kg/cm ² Main Steam temperature (Rated condition) ≥ 565 deg C	
3	The normal working pressure of control fluid inside the Electro-hydraulic actuators (referred at point 1 above) should be ≥ 160 bar. The vendor to confirm.	
4	The quick closing time (Trip time) of Electro-hydraulic actuators (referred at point 1 above) should be ≤ 170 Milli second . The vendor to confirm.	
5	Operational philosophy of Electro-hydraulic actuators (referred at point 1 above) should be " Oil pressure to open & Spring force to close ". The vendor to confirm.	
6	The Electro-hydraulic actuators supplied by the vendor (referred at point 1 above) should be operated from an independent Hydraulic power supply unit, which is supplying the oil/FRF to all actuators at pressure ≥ 160 bar. The vendor to confirm.	
7	The vendor should be the manufacturer of Electro-hydraulic actuators and should also have the in-house testing facilities for testing (like stroke test, timing test, hydraulic test etc.) of Electro-hydraulic actuators for main turbine valves. The vendor to confirm.	
8	The vendor should have the experience of satisfactory operation of Electro-hydraulic actuators for main turbine valves (referred at point 1 above) at two Coal fired Steam turbine units, for minimum one year as on date of purchase enquiry. In support of above, vendor has to submit either of the following: a- Copy of Purchase orders, Test reports of the project and Commissioning protocols at project site; b- Certificates of satisfactory operation from their client / End user.	
9	Vendor shall confirm supply of servo valve (for CV actuators) suitable for accepting +/-50mA command from BHEL's DCS. Servo valves shall be proven and satisfactorily operating in two machines for steam turbine admission control valves application. BOM and commissioning report/ protocol to be furnished in support of provenances.	

Note:

1- Collaborator approved vendors are deemed to have qualified the PQR.

2- Against vendor's replies, BHEL reserves the right to ask for more information / documents/clarifications. Vendor's offer shall not be considered if vendor fails to furnish the document / information / clarifications as mentioned above or vendor doesn't meet the acceptance criteria (mentioned above from sl. no. 1 to 9).

3- A brief write up on **Electro-hydraulic actuators for main turbine valves** is also enclosed as **Annexure 2**.

Sr. Engineer/CIE

Manager/CIE

AGM/CIE

Sr. Engineer/STE-TG

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DGM/STE-TG

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15/10/19

Annexure – 1 (Experience list format)

Sl. No.		Parameters	Steam Turbine unit 1	Steam Turbine unit 2
1.	Name of the station and its Location		*	*
2.	Client name and its address, Fax no. & Tel. No.		*	*
3.	Name and designation of the responsible person in client's organization		*	*
4.	Contract No. & Date		*	*
5.	Name plate rating in MW of individual Steam turbine unit	≥ 660 MW	*	*
6.	Starting date of work/ Date of order			
7.	Actual date of supply		*	*
8.	Date of Commissioning of system/ package		*	*
9.	Whether the system/ equipment are in successful operation as on date of bid opening		*	*
10.	Brief Scope of work			
11.	Designed by		*	*
12.	Manufactured by		*	*
13.	Control fluid used			
14.	Main Steam pressure (Rated condition)	≥ 247 kg/cm ²	*	*
15.	Main Steam temperature (Rated condition)	≥ 565 deg C	*	*
16.	Normal working pressure of control fluid	≥ 160 bar	*	*
17.	Operation philosophy	Oil pressure to open & Spring force to close	*	*
18.	Spring type			
19.	EHA's for turbine valves :			
19.1	HP Stop valve actuator:			
a)	Actuator piston diameter			
b)	Piston rod diameter			
c)	Damping stroke			
d)	Total actuator stroke, including over stroke			
e)	Actuator opening time			
f)	Actuator closing time (Trip time)	$\leq 170 \pm 10\%$ ms	*	*
g)	Spring size & no. of springs			
h)	Model no & make of EHA open/close (Pilot) valve			
i)	Model no. & make of EHA solenoid trip valve			
19.2	HP control valve actuator:			
a)	Actuator piston diameter			
b)	Piston rod diameter			
c)	Damping stroke			
d)	Total actuator stroke, including over stroke			
e)	Actuator opening time			
f)	Actuator closing time (Trip time)	$\leq 170 \pm 10\%$ ms	*	*
g)	Spring size & no. of springs			
h)	Model no. & make of EHA Servo valve			
i)	Make and model no. of EHA solenoid trip valves			

19.3	IP stop valve actuator:			
a)	Actuator piston diameter			
b)	Piston rod diameter			
c)	Damping stroke			
d)	Total actuator stroke, including over stroke			
e)	Actuator opening time			
f)	Actuator closing time (Trip time)	$\leq 170 \pm 10\% \text{ ms}$	*	*
g)	Spring size & no. of springs			
h)	Model no & make of EHA open/close (Pilot) valve			
i)	Model no. & make of EHA solenoid trip valve			
19.4	IP control valve actuator:			
a)	Actuator piston diameter			
b)	Piston rod diameter			
c)	Damping stroke			
d)	Total actuator stroke, including over stroke			
e)	Actuator opening time			
f)	Actuator closing time (Trip time)	$\leq 170 \pm 10\% \text{ ms}$	*	*
g)	Spring size & no. of springs			
h)	Model no. & make of EHA Servo valve			
i)	Make and model no. of EHA solenoid trip valves			
19.5	Overload control valve actuator:			
a)	Actuator piston diameter			
b)	Piston rod diameter			
c)	Damping stroke			
d)	Total actuator stroke, including over stroke			
e)	Actuator opening time			
f)	Actuator closing time (Trip time)	$\leq 170 \pm 10\% \text{ ms}$	*	*
g)	Spring size & no. of springs			
h)	Model no. & make of EHA Servo valve			
i)	Make and model no. of EHA solenoid trip valves			

Note:

(i)- Vendor to fill the applicable data in the format given above.

(ii)- Further the data against sl. no. 1, 2, 3, 4, 5, 7, 8, 9, 11, 12, 14, 15, 16, 17, 19.1.f, 19.2.f, 19.3.f, 19.4.f & 19.5.f (marked as *) are to be **mandatorily** filled by the vendor.