Pre-Classroom

0	29/Aug/2022	1st issue	A.Hiraka	Cao Ba Dai	
REV	DATE	DESCRIPTION	Approved	Checked	Prepared

OWNER

VAN PHONG POWER COMPANY LIMITED

PROJECT

Van Phong 1 BOT Thermal Power Plant Project

OWNER'S ENGINEER

AFRY Switzerland Ltd.

Status
☐Approved
☐Approved with Comment
☐Not Approved
☐Reviewed
☐Reviewed with Comment

EPC CONTRACTORS

IHI–TESSC–CTCI–DHI CONSORTIUM

PROJECT DOCUMENT No

–

REV

–

DOCUMENT TITLE

TC-07 Maintenance for D-EHC (Main Turbine and BFP-Turbine)

EPC

Toshiba Energy Systems & Solutions Corporation

EPC DOCUMENT No.

EDU-2K000035

REV

0

Van Phong 1 BOT Thermal Power

Training for D-EHC System
0. Training Overview

TOSHIBA

Toshiba Energy Systems & Solutions Corporation

EDU-2K000035

Contents

Contents

EDU-2K000035

Van Phong 1 BOT Thermal Power

Training for D-EHC System
1. Outline of EHC

TOSHIBA

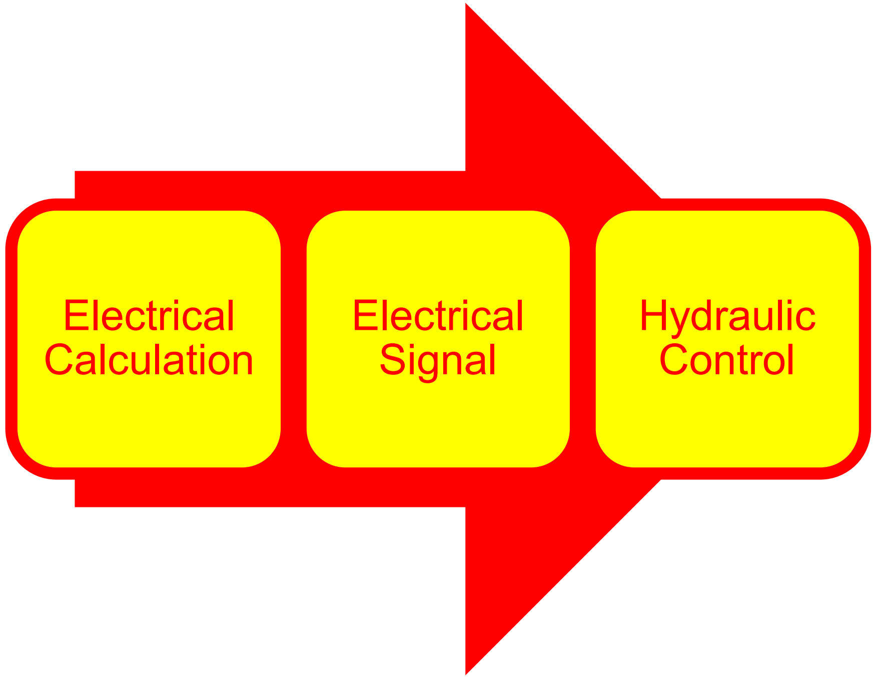
Toshiba Energy Systems & Solutions Corporation

EDU-2K000035

What is EHC?

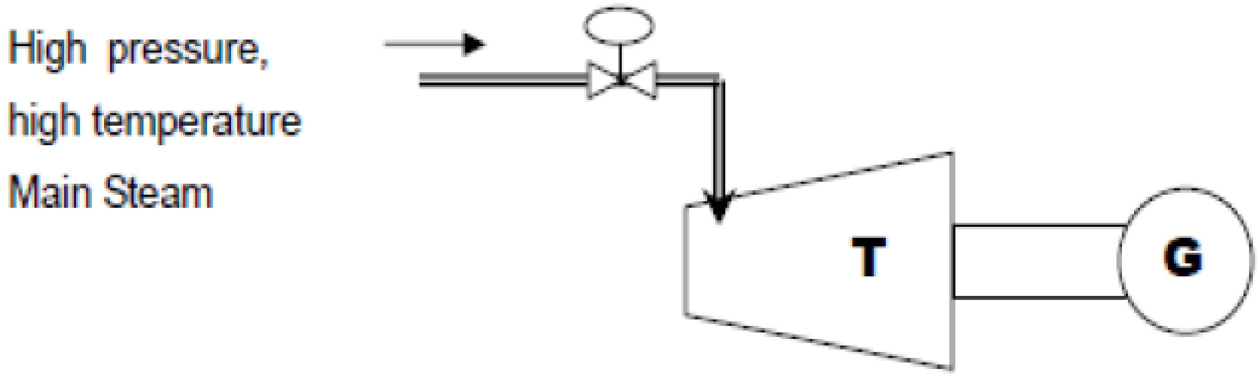
Electro Hydraulic Control System

Method of controlling Hydraulic circuit by electric signal

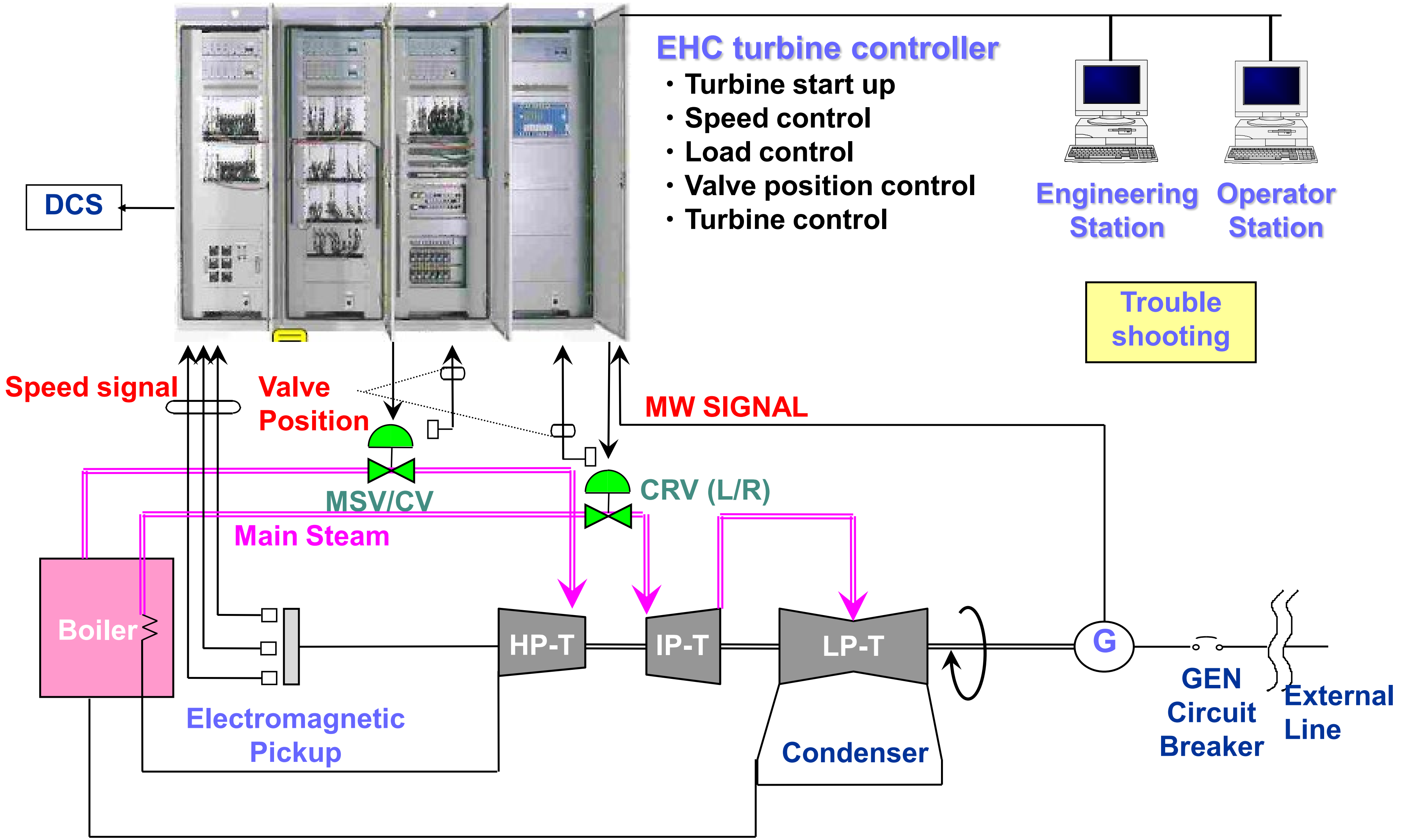


How turbine is controlled?

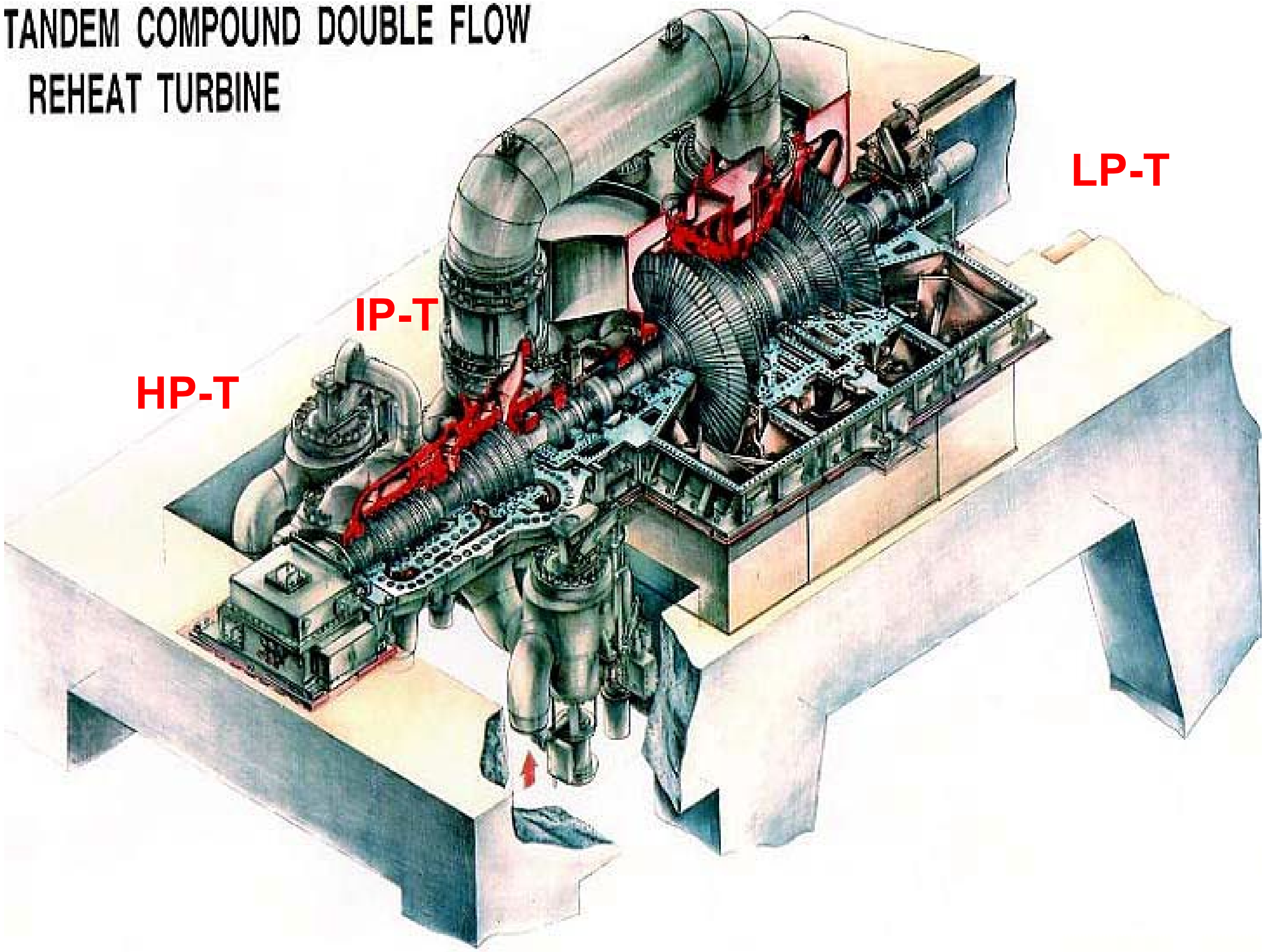
- Turbine rotating speed is controlled by amount of Main steam flow adjusted by control valve
- In order to control high pressure and temperature steam, huge power is required
- Therefore, hydraulic control valve is applied



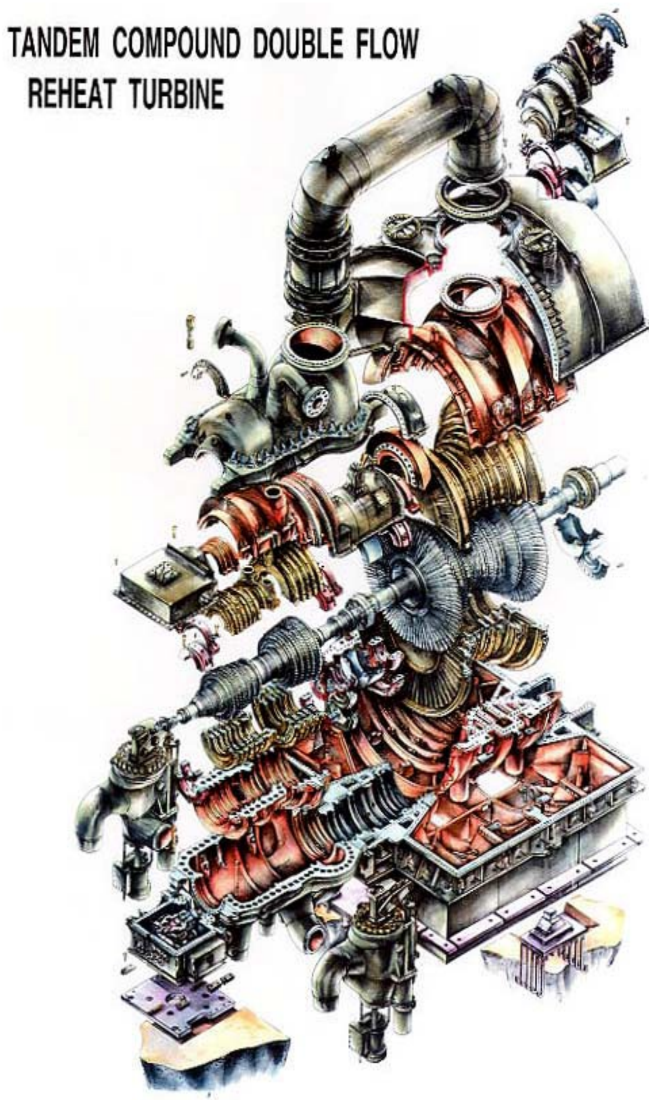
1. Outline of EHC System

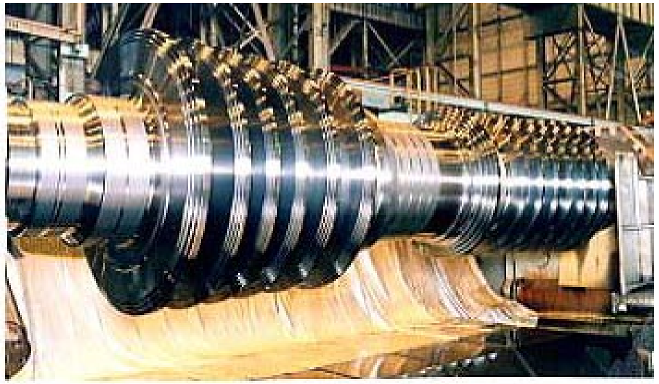


2. D-EHC control target (1/8)



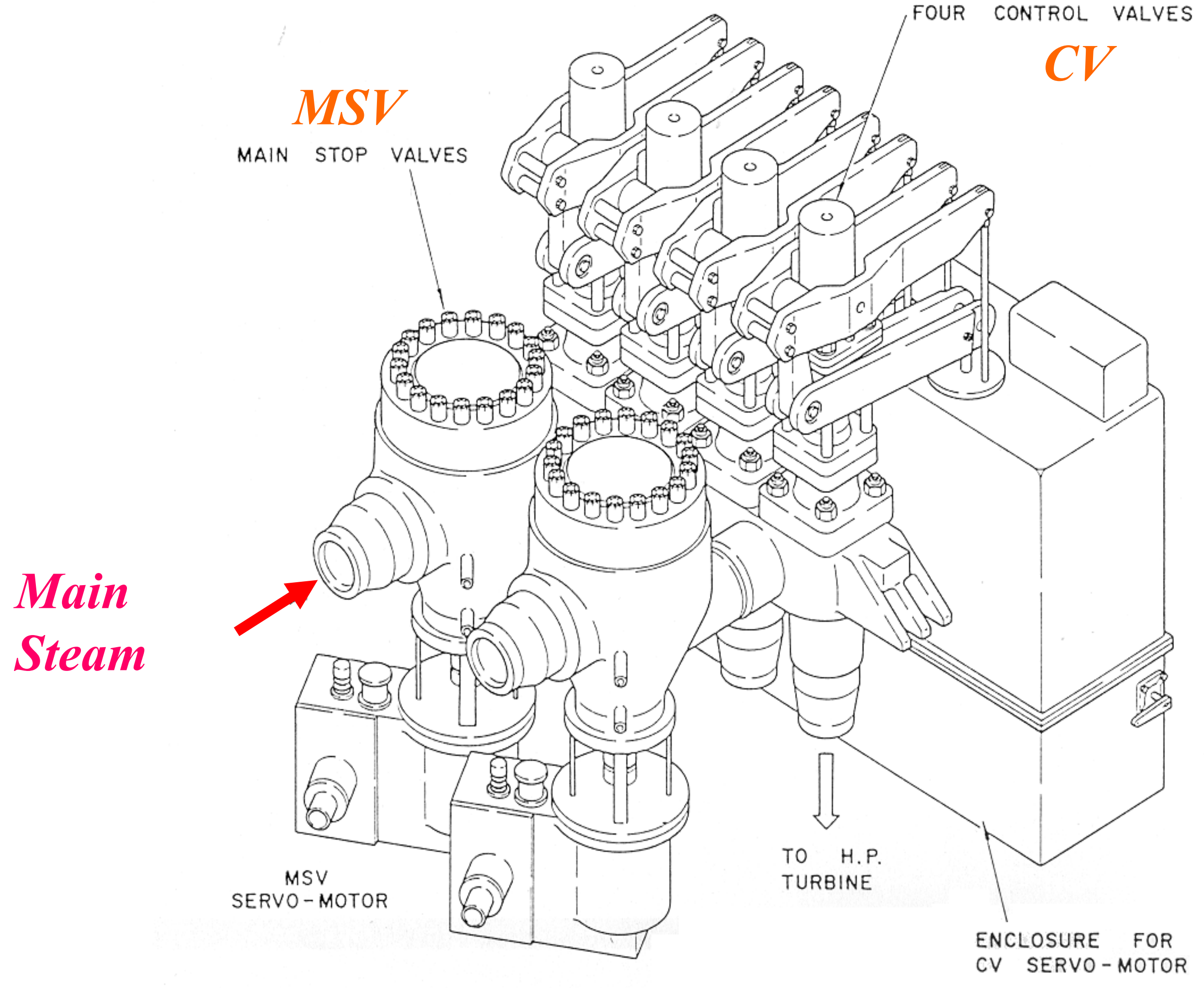
2. D-EHC control target (2/8)





2. D-EHC control target (3/8)

MSV / CV (DIRECT CONNECTED TYPE)



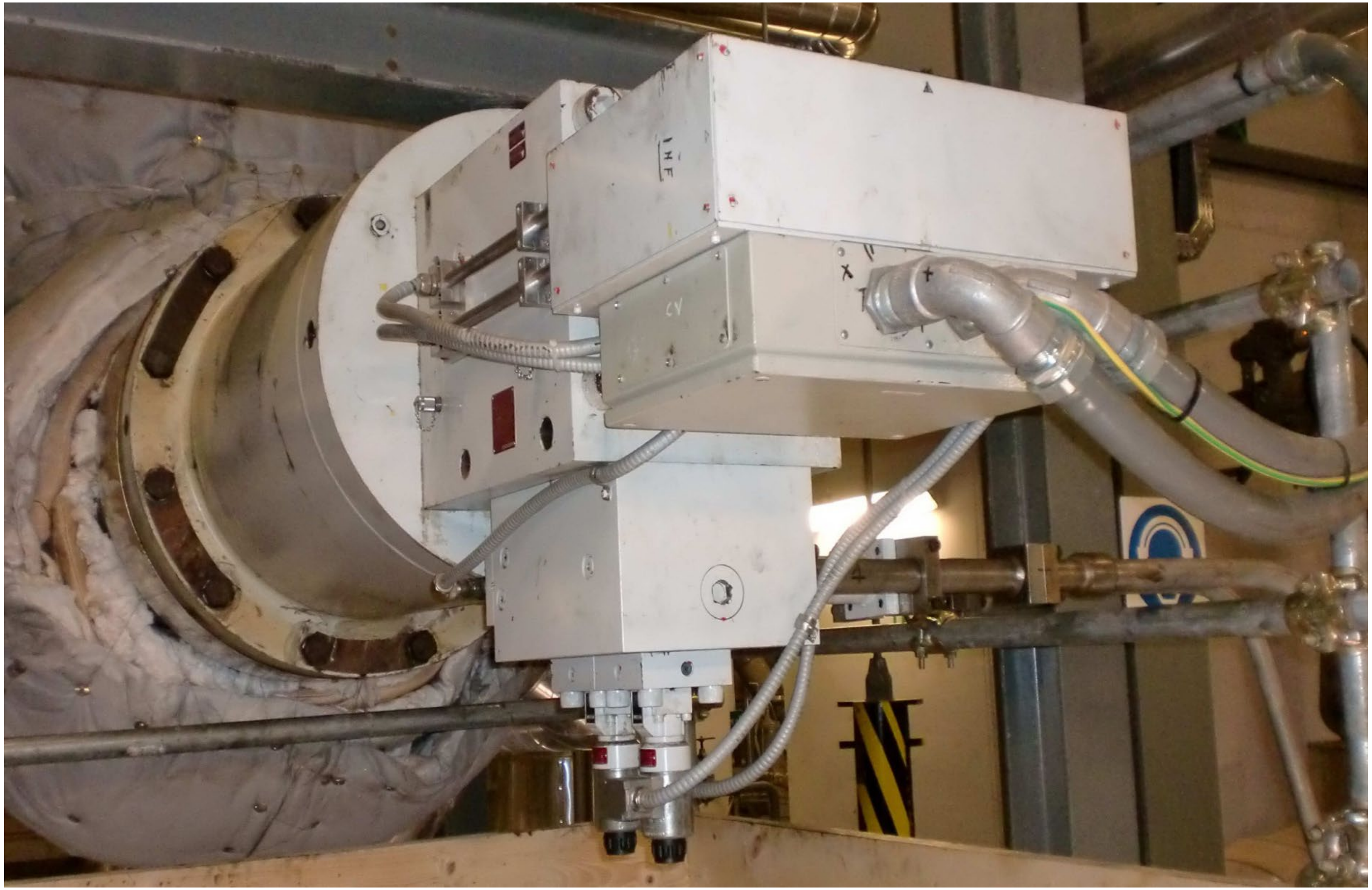
2. D-EHC control target (4/8)

MSV

EDU-2K000035

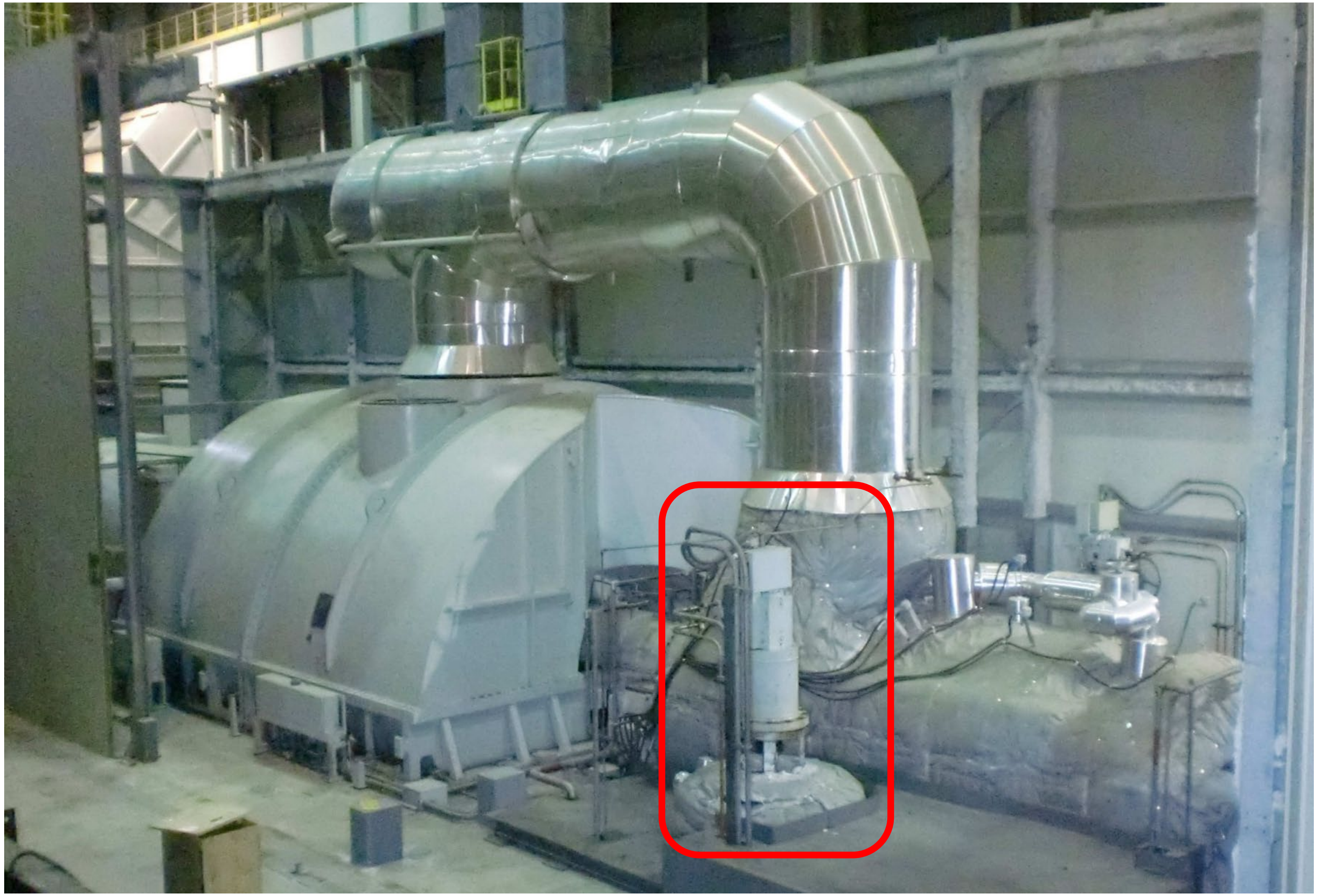
2. D-EHC control target (5/8)

CV



2. D-EHC control target (6/8)

ICV

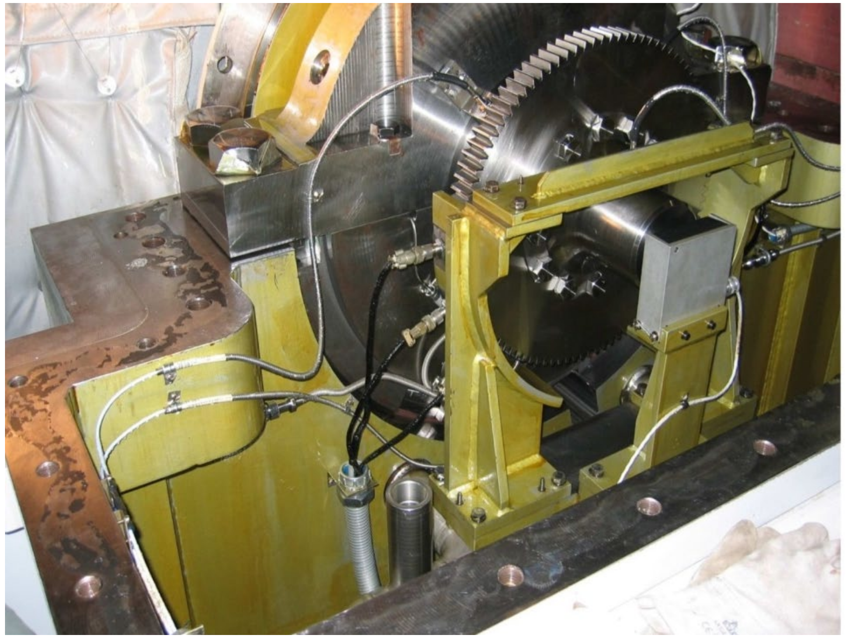


2. D-EHC control target (7/8)

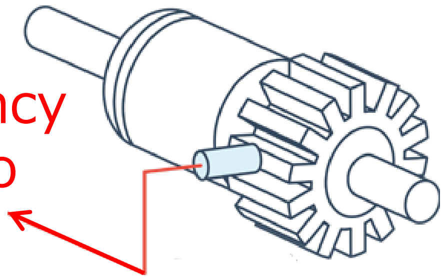
ICV（Enhanced)

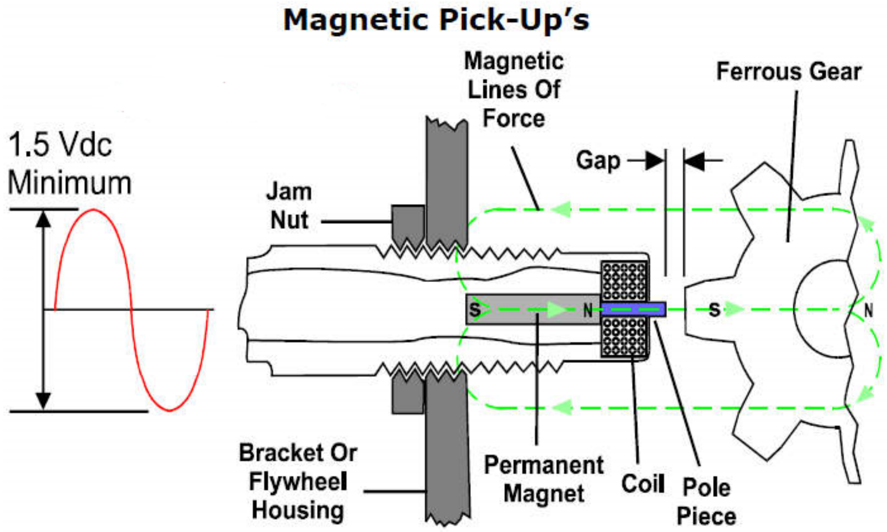
2. D-EHC control target (8/8)

Electro magnetic pick up (for turbine speed)

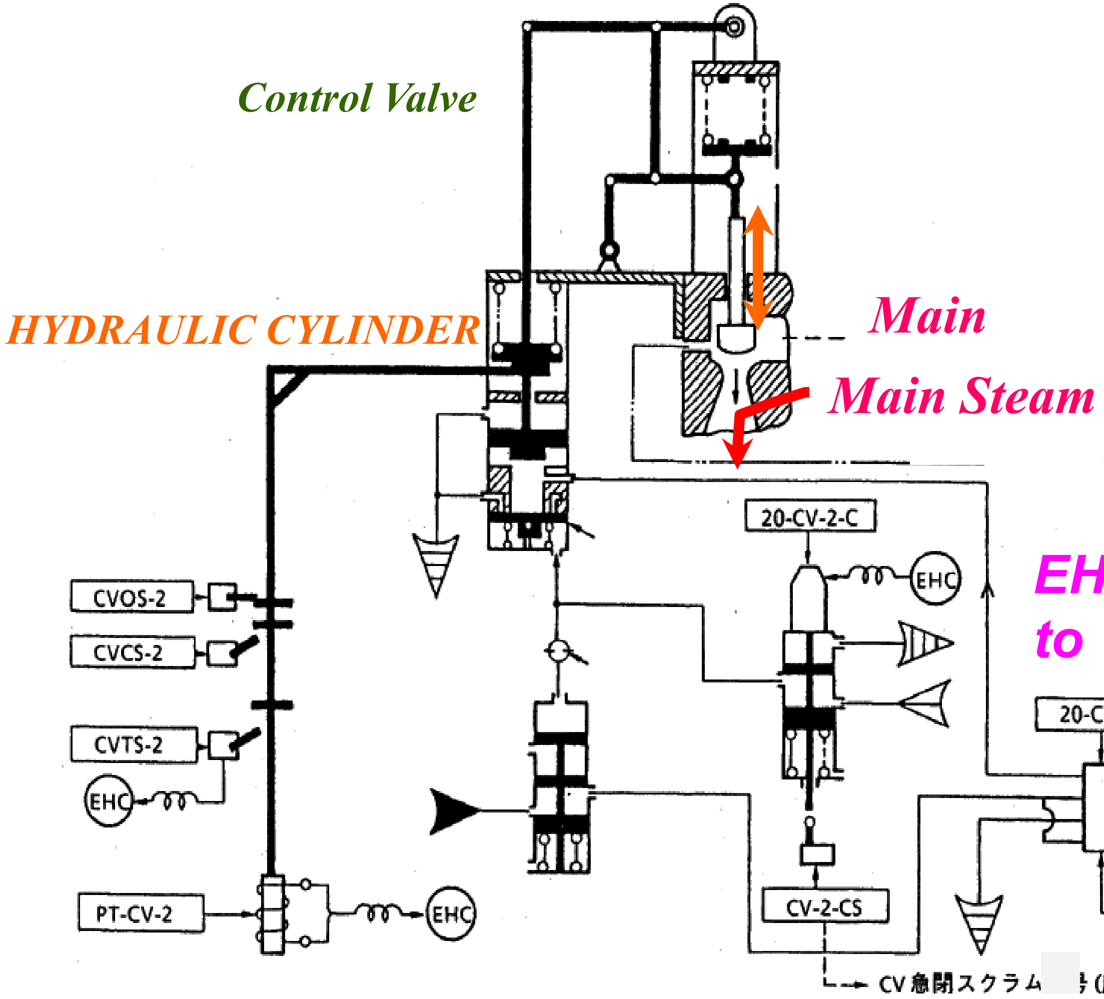


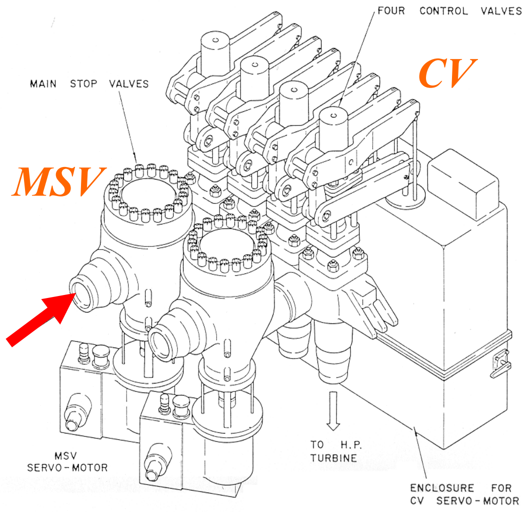
Frequency signal to EHC





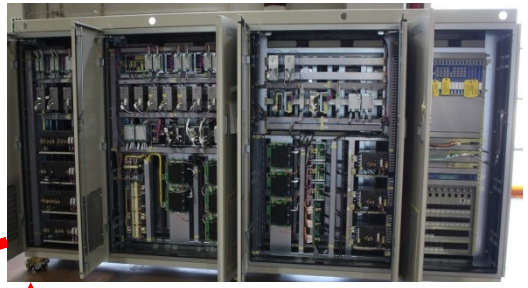
3. D-EHC turbine control architecture





EHC output "current signal" to "Servo valve"

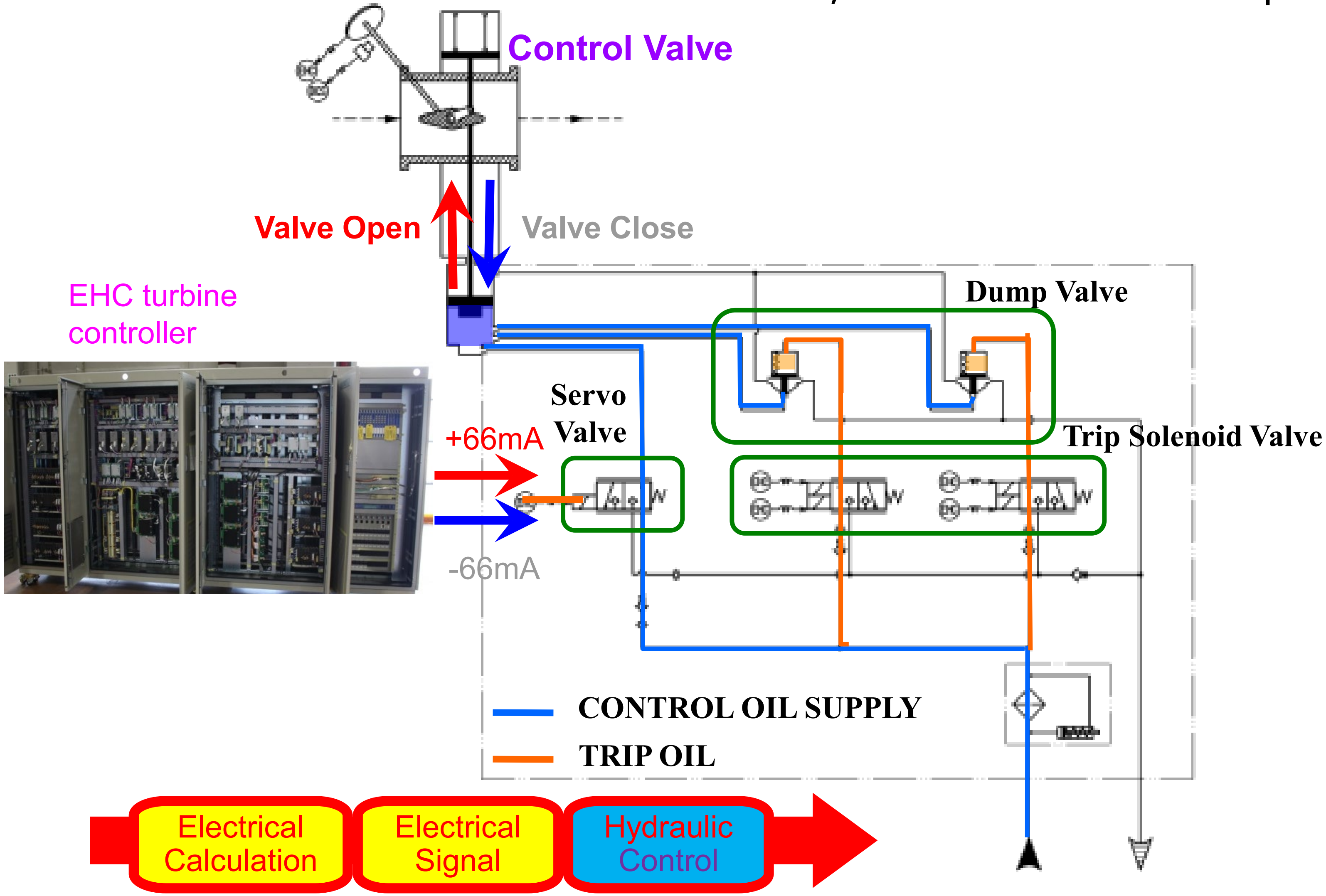
Servo Valve



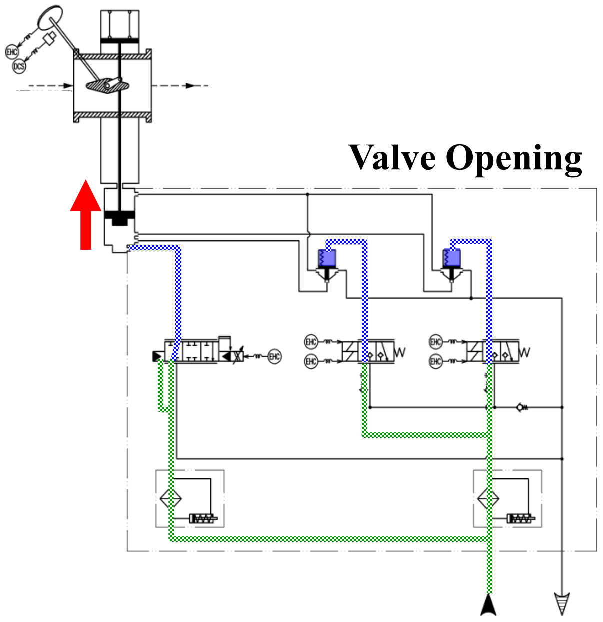
EHC input "speed signal" from Electromagnetic Pickup.

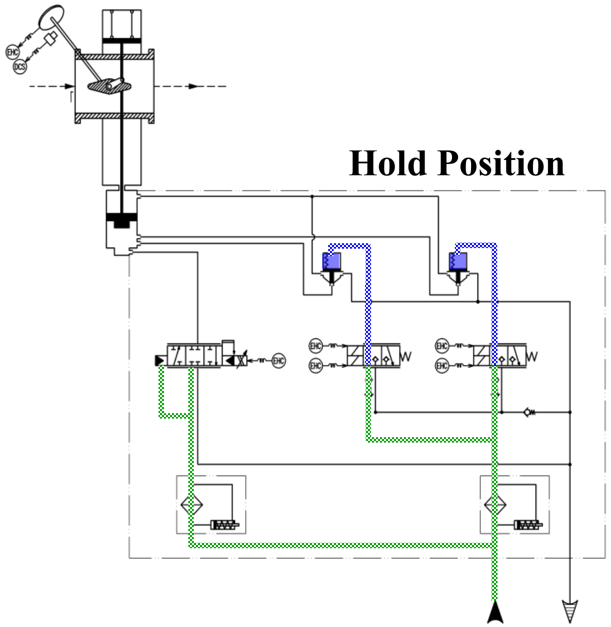
3.1 Control valve and oil system

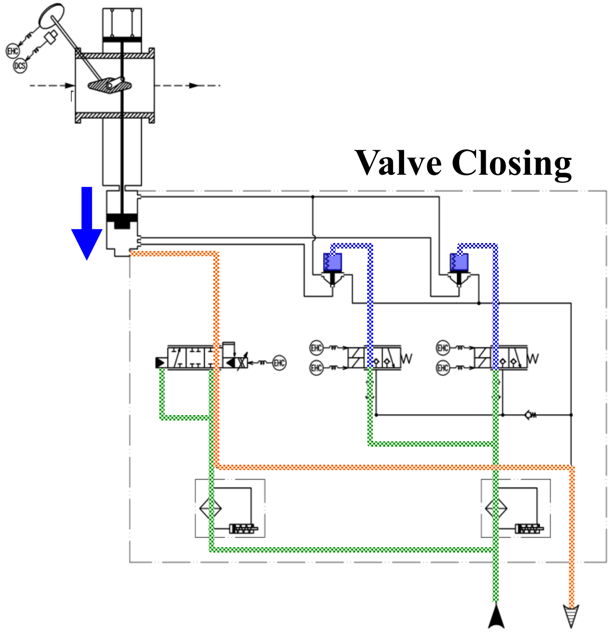
If control oil is fed into the control valve, control valve will open.



3.2 Valve actuation with servo valve







+66mA ：Fastest Opening

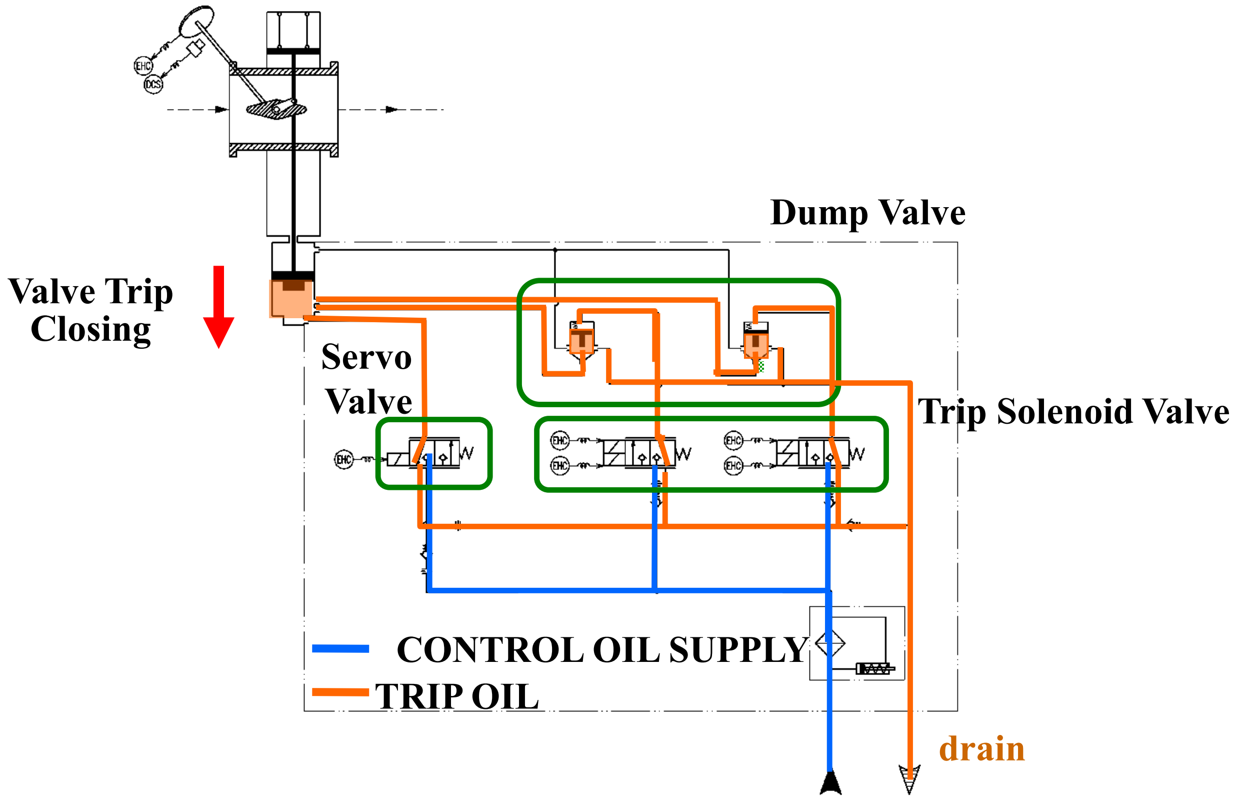
0mA（+ α）bias : Holding Position

- 66mA ：Fastest Closing

0mA : Closing Direction

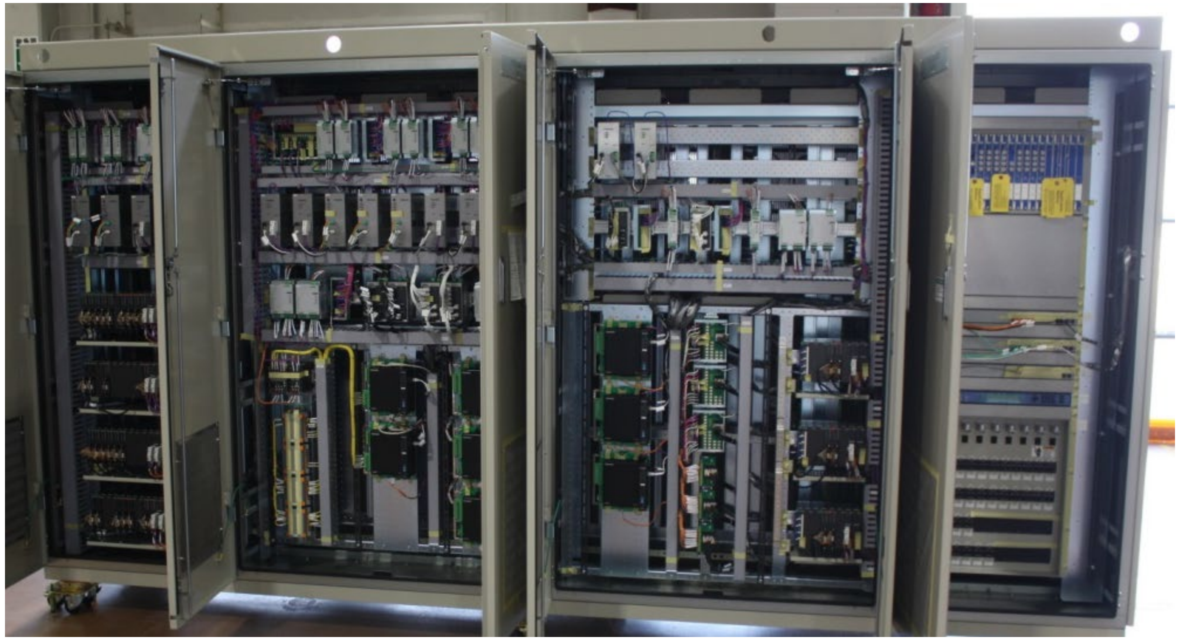
3.3 Valve actuation at turbine trip

During emergency situation, Trip solenoid valve is discharged, servo valve is deactivated, trip oil returns to the drain, then the Dump valve will open. If there is no control oil can reach the valve hydraulic chamber, control valve will be completely closed.



4. D-EHC control function

EHC CONTROL



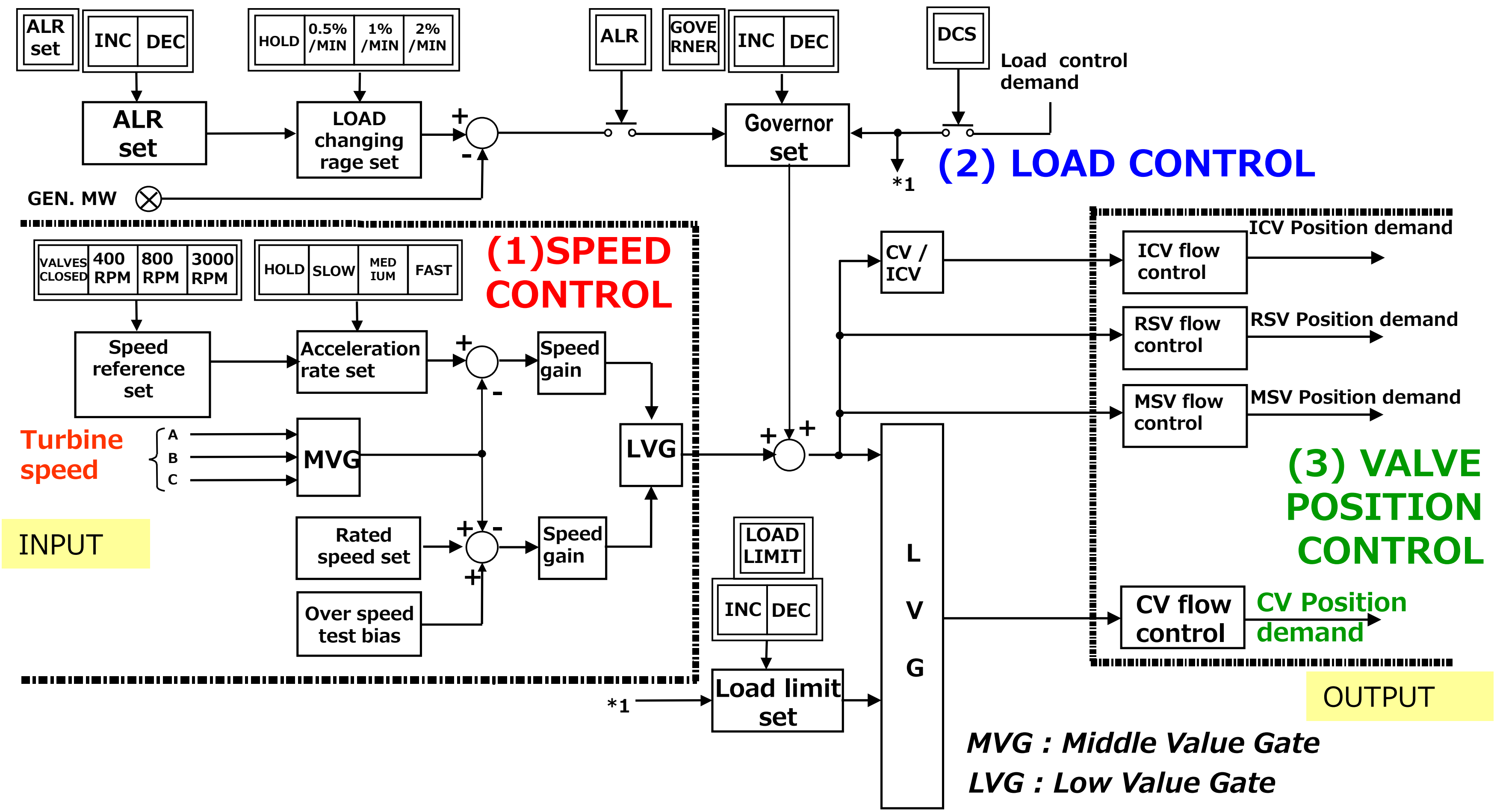
(A) *<u>During start up,</u>*

EHC controls turbine speed.

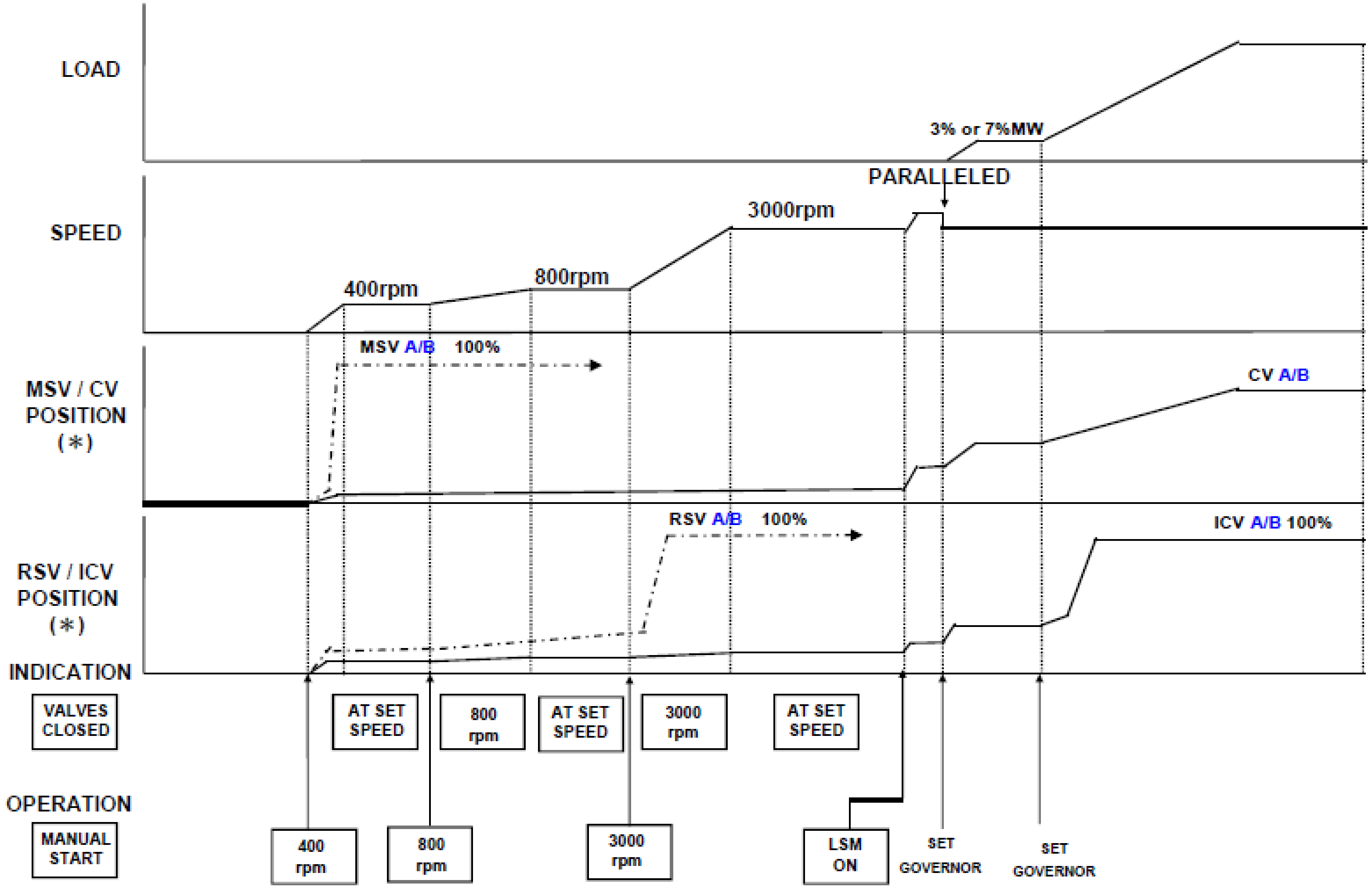
(B) *<u>After synchronization,</u>*

EHC controls load.

4.1 Outline of the D-EHC Function block

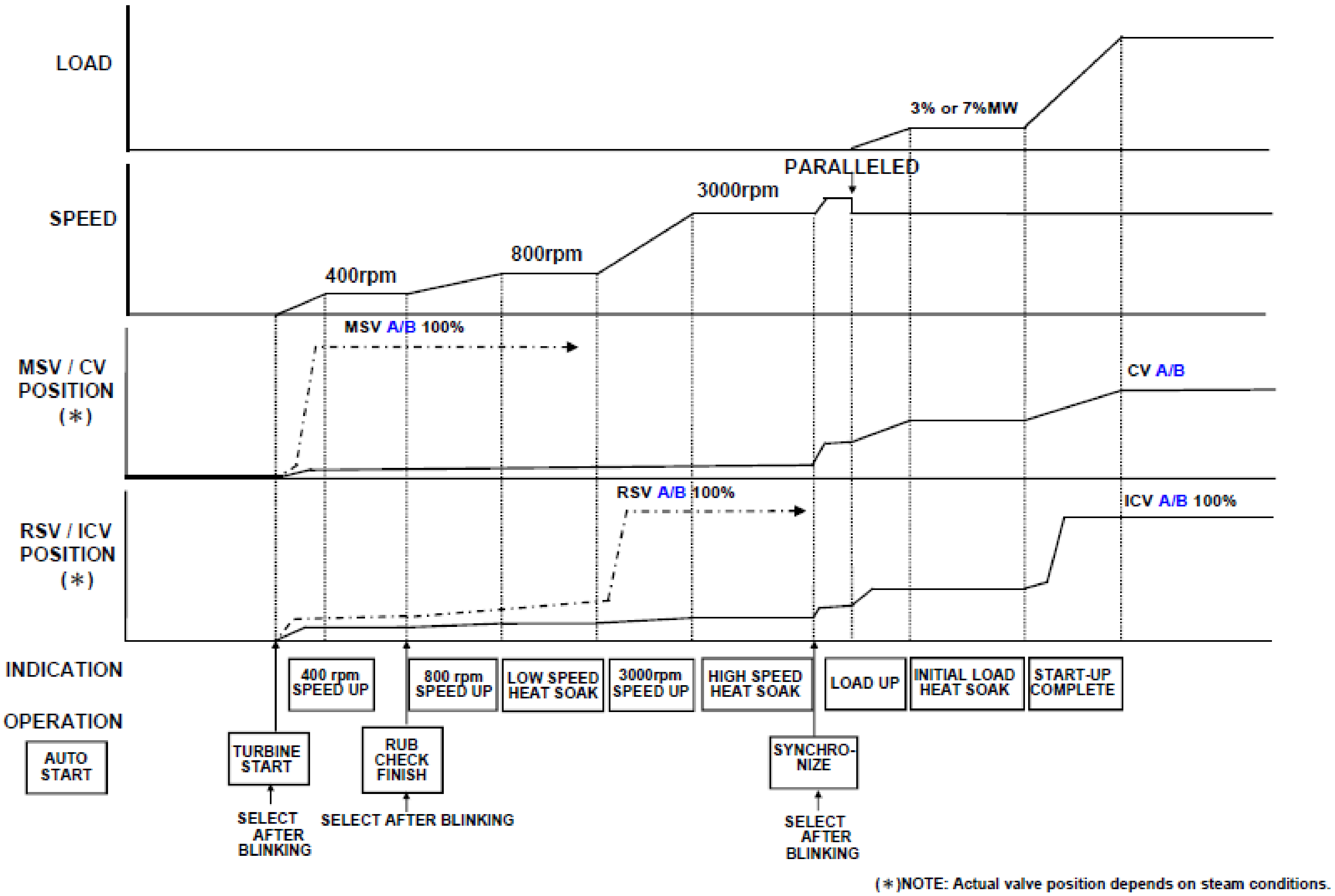


4.2 D-EHC Operation -Manual Turbine Start-up



(＊)NOTE: Actual valve position depends on steam conditions.

4.3 D-EHC Operation -Automatic Turbine Start-up



Van Phong 1 BOT Thermal Power

Training for D-EHC System
2. MT D-EHC Hardware Overview

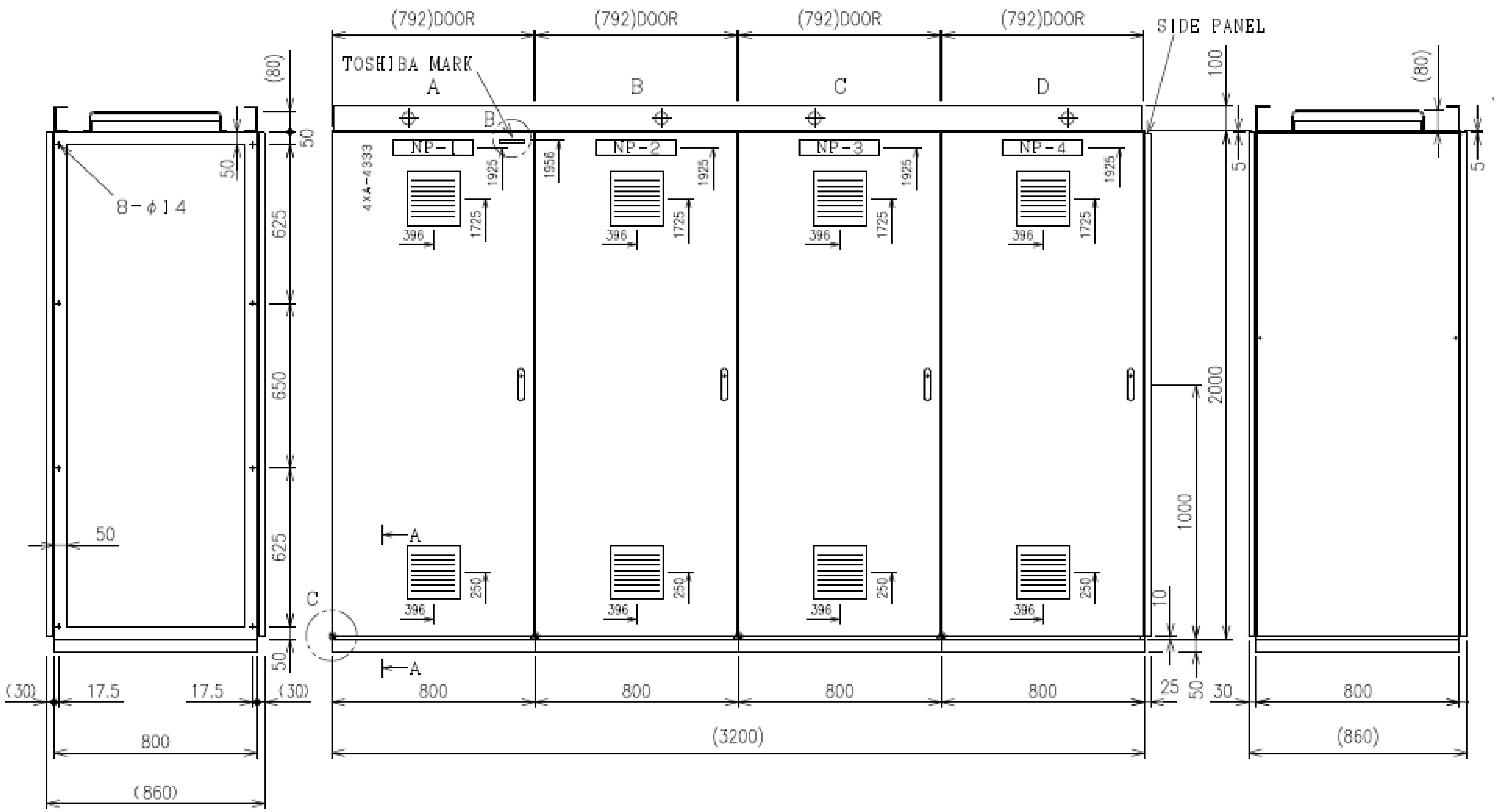
TOSHIBA

Toshiba Energy Systems & Solutions Corporation

Part 1.

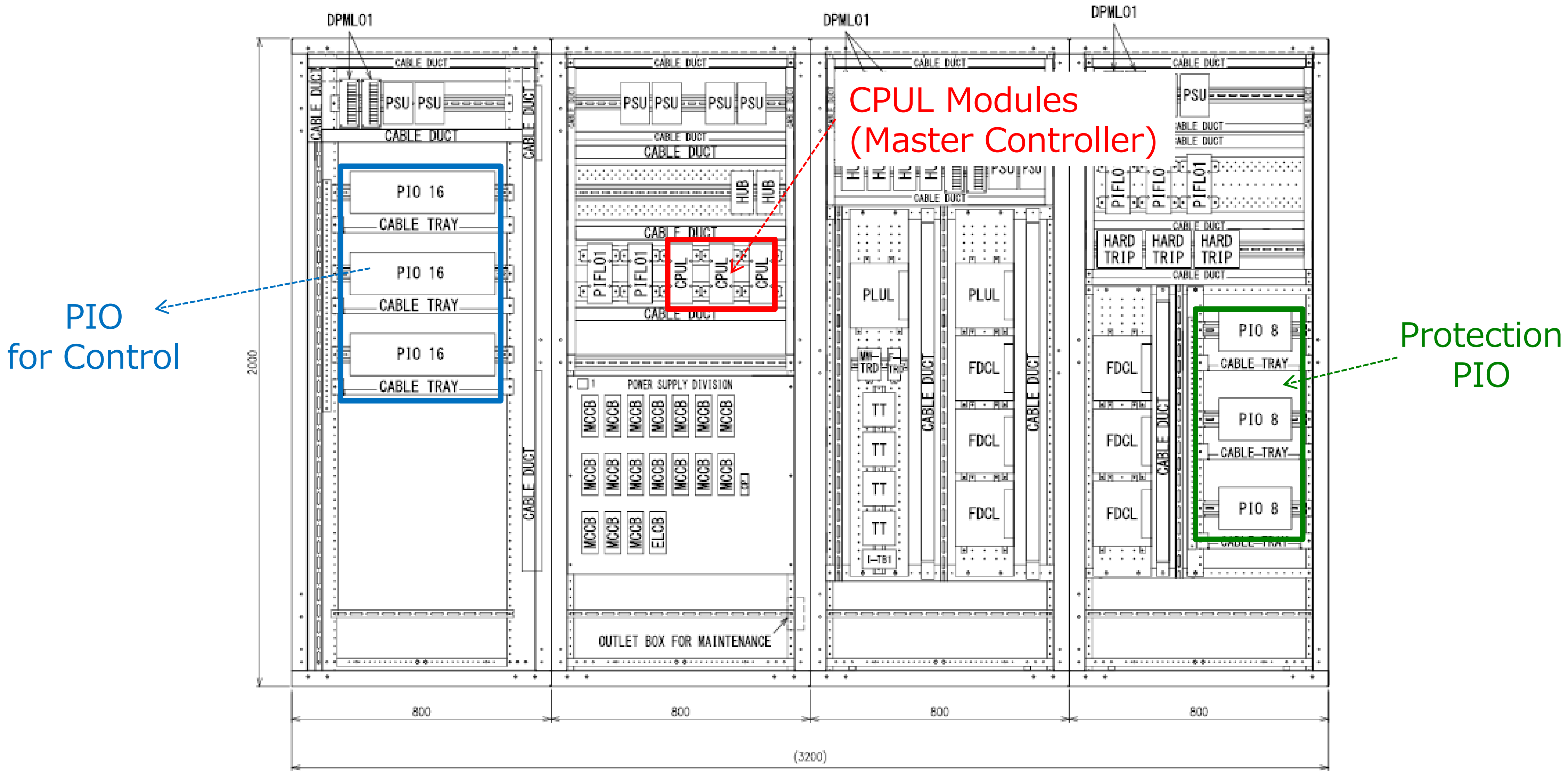
EHC Hardware Configuration

1.1 Outline of EHC Cabinet



- Protection Level IP21
- Steel panel, and frame
- Length: 3200mm(W) x 800mm(D) x 2000mm(H)
- Weight: 2000kg

1.2 EHC Cabinet Internal Arrangement (Front View)



1.3 EHC Cabinet Internal Arrangement (Rear View)

IO Terminal

IO Terminal IO Terminal

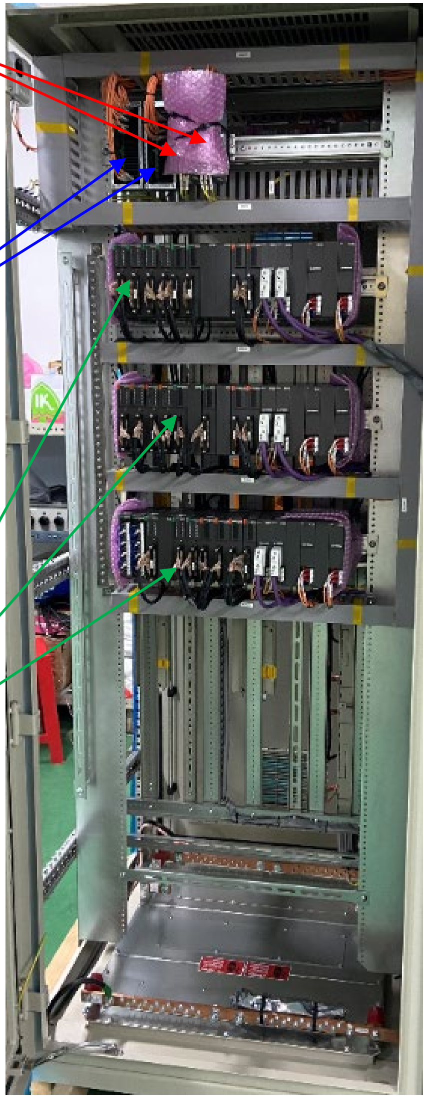
1.4 EHC Cabinet A Internal Arrangement

FRONT VIEW

Power Supply Modules

Power Supply Distribution Module (DPML)

PIO for Control



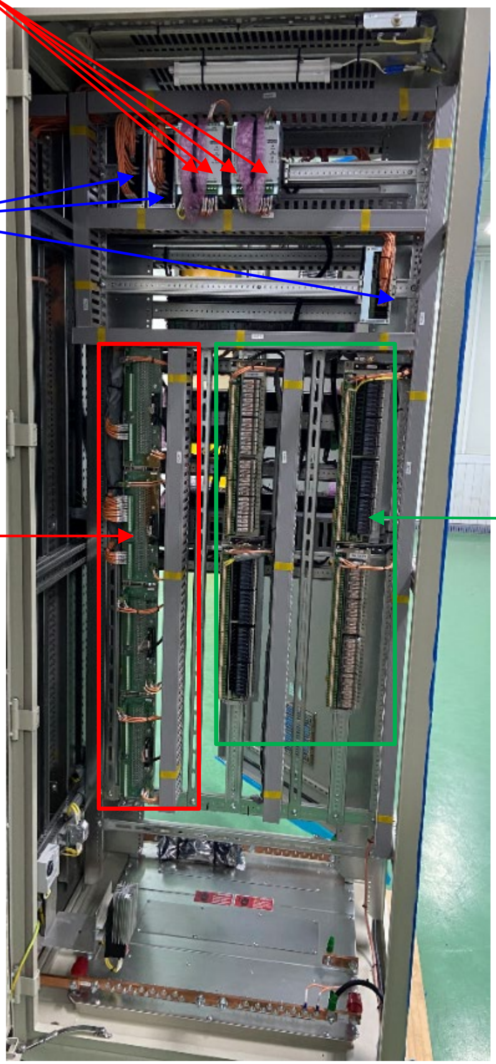
REAR VIEW

Power Supply Modules

Power Supply Distribution Module (DPML)

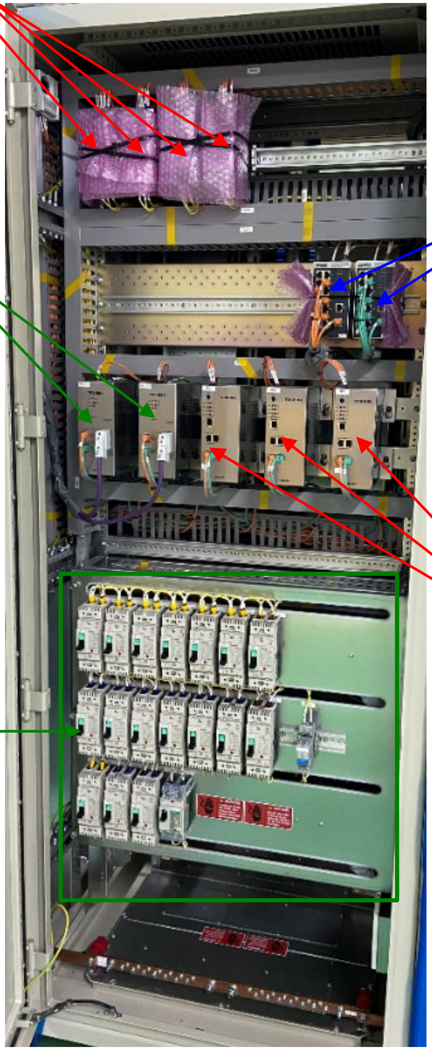
CTCL Modules (Digital Input)

CTCL Modules (Digital Output)

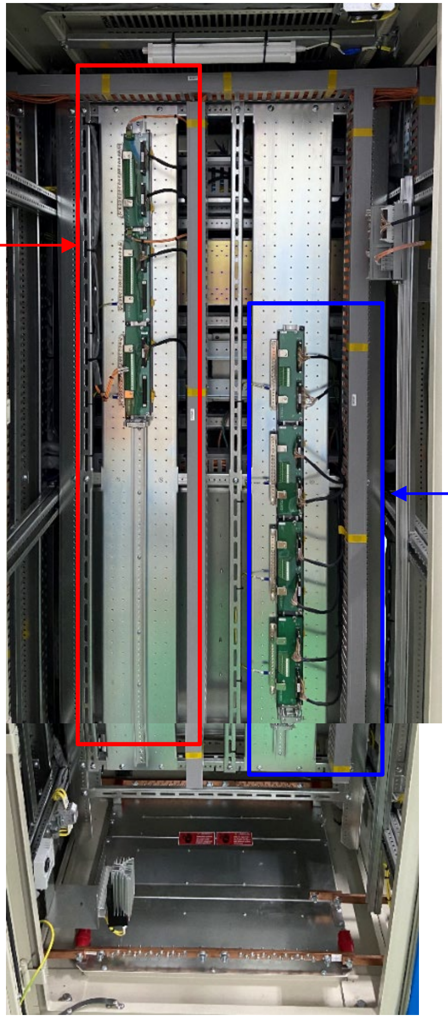


1.5 EHC Cabinet B Internal Arrangement

FRONT VIEW

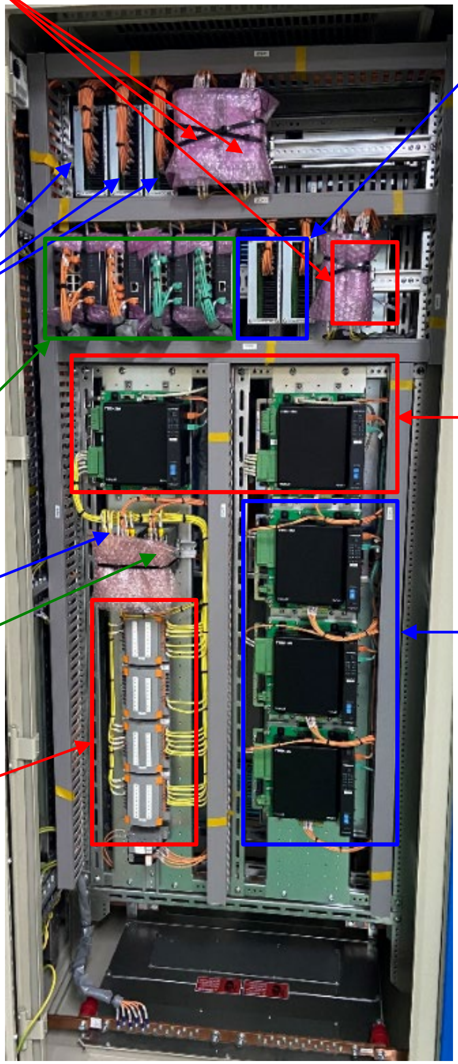


REAR VIEW

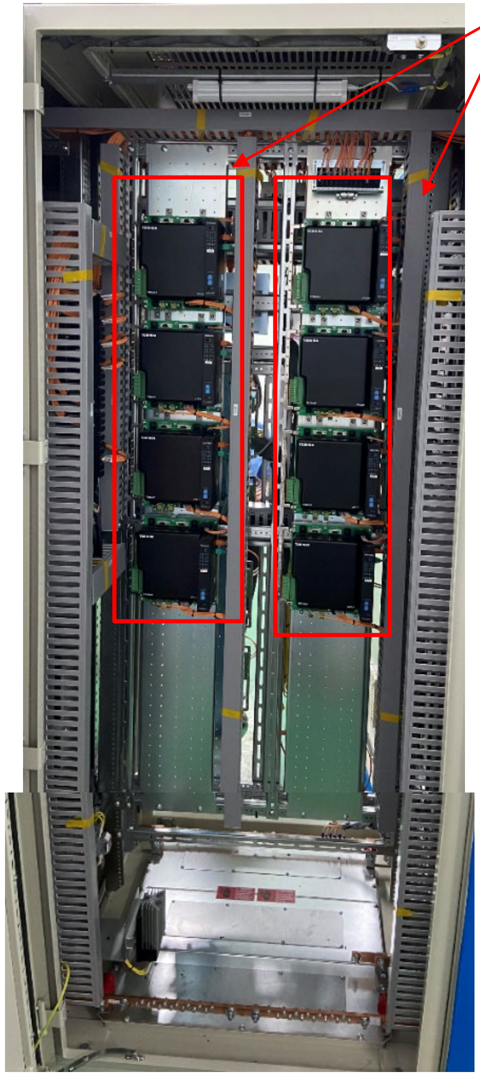


1.6 EHC Cabinet C Internal Arrangement

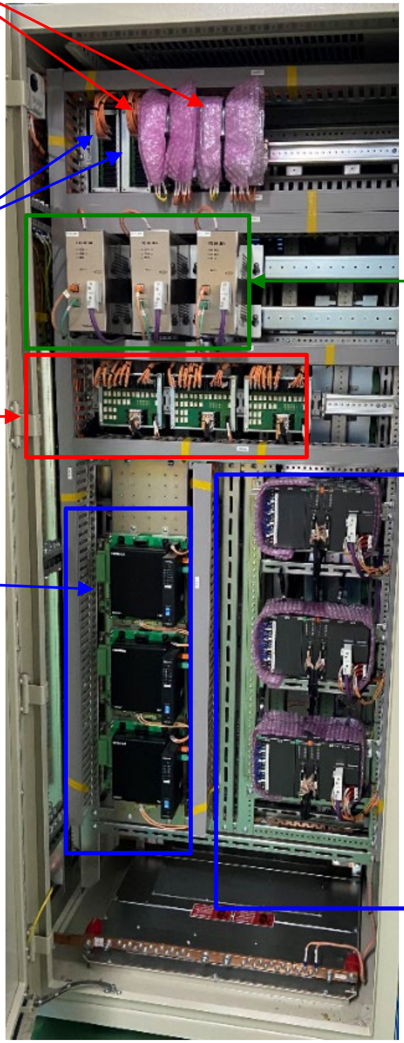
FRONT VIEW

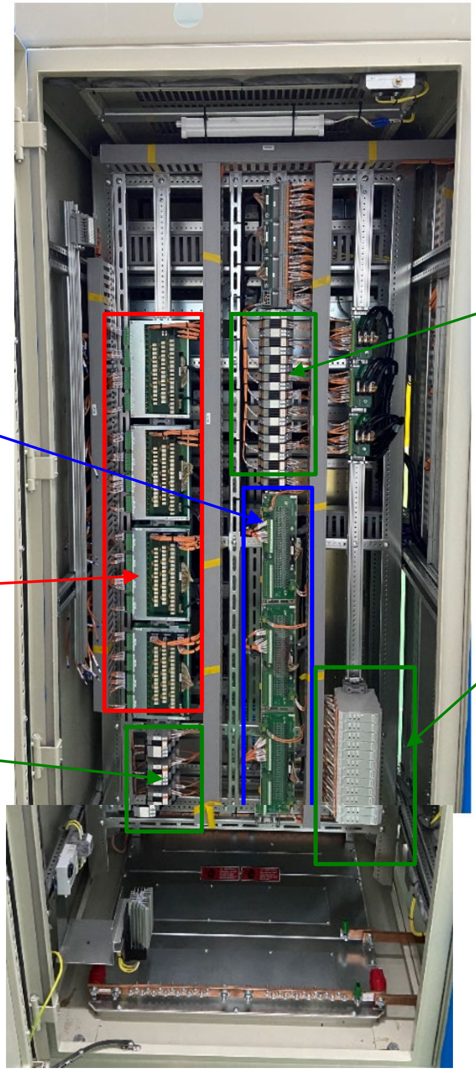


REAR VIEW



1.7 EHC Cabinet D Internal Arrangement





2. EHC Controller System Configuration

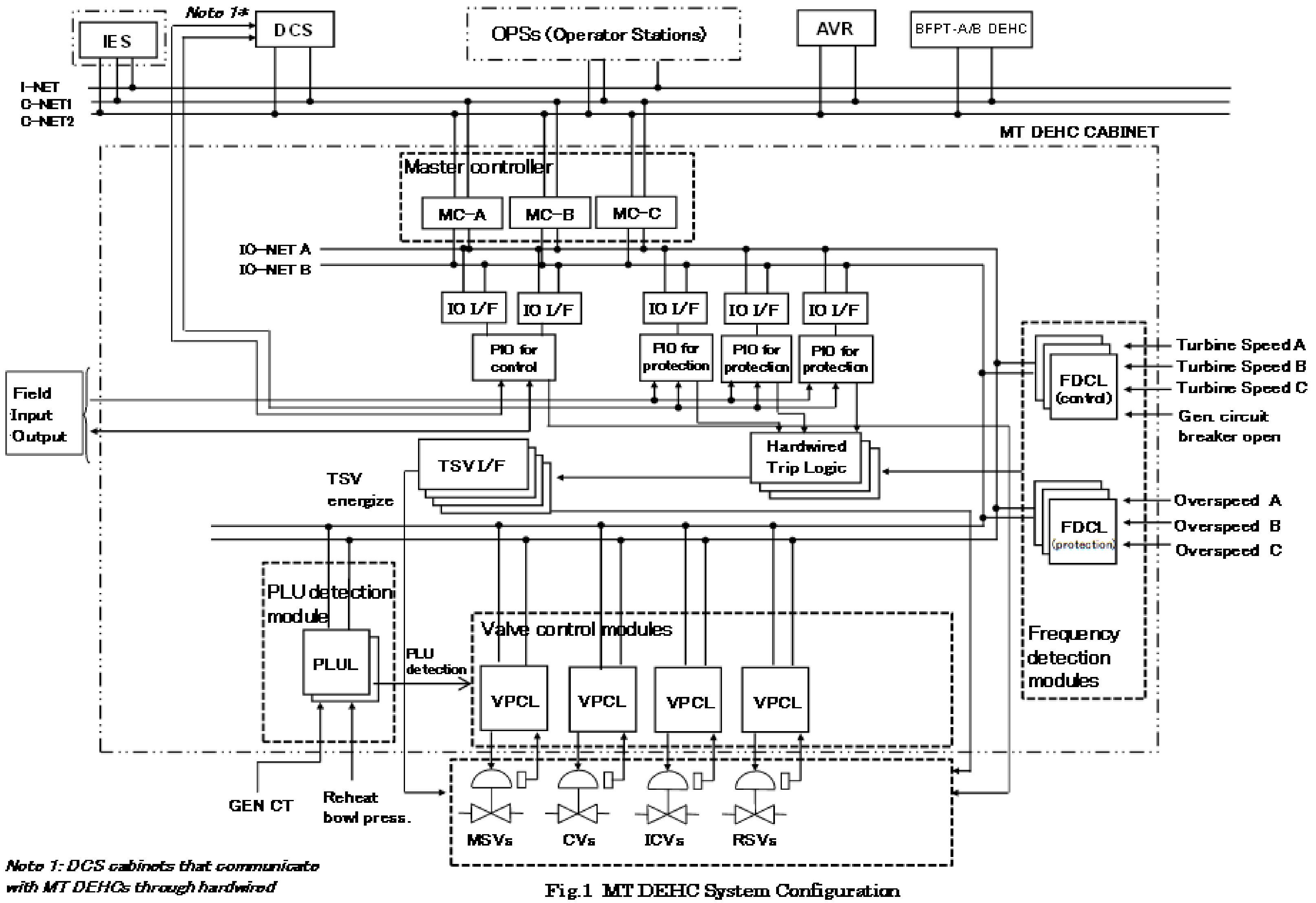


Fig.1 MT DEHC System Configuration

2.1 HIERARCHICAL CONFIGURATION (1/5)

1. Operator Station(OPS) ·· ··························Turbine Operation / Monitoring
 Include Server Station (SVS)
2. Integrated Engineering Station (IES) ···············Maintenance of EHC
3. Master Controller (MC) ······························EHC Primary Feedback Control
4. Valve Control Module (VPCL) ·······················Valve Position Control
5. Power Load Unbalance Detection Module (PLUL) ····PLU Detection
6. Frequency Detection Module (FDCL) ················Speed Signal Input /
 Overspeed Detection /
 EHC Heavy Failure Detection
7. Hardwired Trip Module (HTML) ······················Hardwired Trip Signal Input /
 Trip Signal Output to TSV Interface circuit
8. PIO Unit (IO Module and IO Interface) ··············Hardwired Signals Input & Output /
 Communication between Controller and IO Module
9. Protocol Converter (PIFL01) ························I/O Interface

2.1 HIERARCHICAL CONFIGURATION (2/5)

1. OPS Functions (Include SVS Functions)

・EHC Operation (Mouse)
・EHC Control Supervising
・Human-Machine Interface
・Graphic Display Service
・Historical data storage and retrieval function (SVS Function)
・Server function (SVS Function)

2. IES Functions

・EHC Control Logic Monitoring & Editing
・Error Log Gathering of EHC Controllers

2.1 HIERARCHICAL CONFIGURATION (3/5)

3. MC Functions (TOSMAP-DS/LX : Triple Redundant System)

・EHC Sequential Control
(Automatic Turbine Start-up, etc.)
・EHC Essential Regulating Control
(Speed Control, Load Control, etc.)
・Supplementary Control
(Automatic Load Regulator, etc.)
・Turbine Protection

2.1 HIERARCHICAL CONFIGURATION (4/5)

4. VPCL Functions (Single System)

・Interface with Valve Actuators and Sensors
・Valve Position Control

5. PLUL Functions (Duplex System)

・Interface with Generator CT and Reheat Bowl Pressure Sensor
・PLU Detection

6. FDCL Functions (Triple Redundant System)

・Interface with Turbine Speed Sensors
・Overspeed Detection
・EHC Heavy Failure Detection
・Interface with “Generator Circuit Breaker Open” Signal

2.1 HIERARCHICAL CONFIGURATION (5/5)

7. Hardwired Trip Circuit Functions (Triple Redundant System)

・Hardwired Trip Signal Input
・Trip Signal Output to TSV Interface Circuit

8. PIO Units functions (Triple redundant for protection signals / Single for control signals)

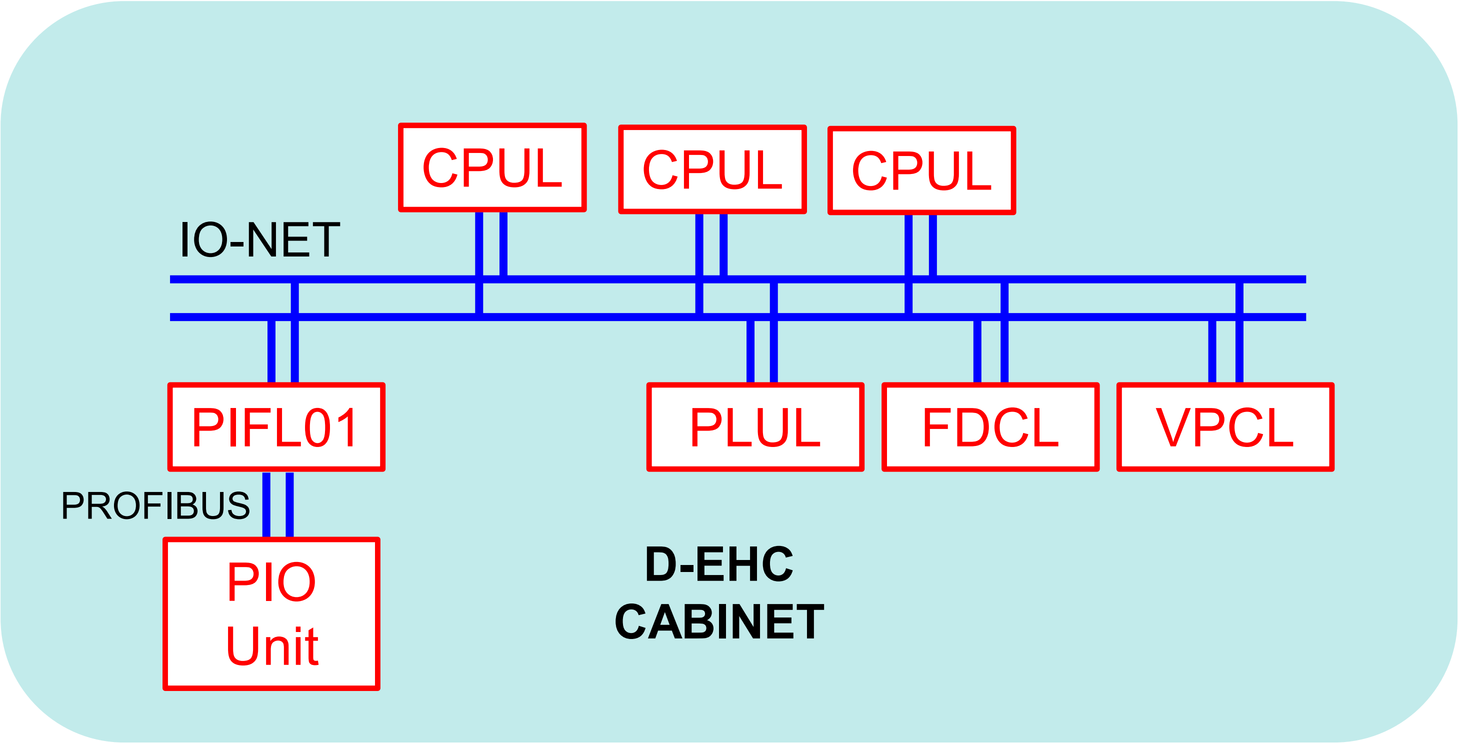
・Hardwired Signals Input & Output
・Communication between Controller and IO Module

9. Protocol Converter Functions (PIFL01 : Duplex System)

・PIFL01: Ethernet (CPUL) ↔ PROFIBUS (IO modules)

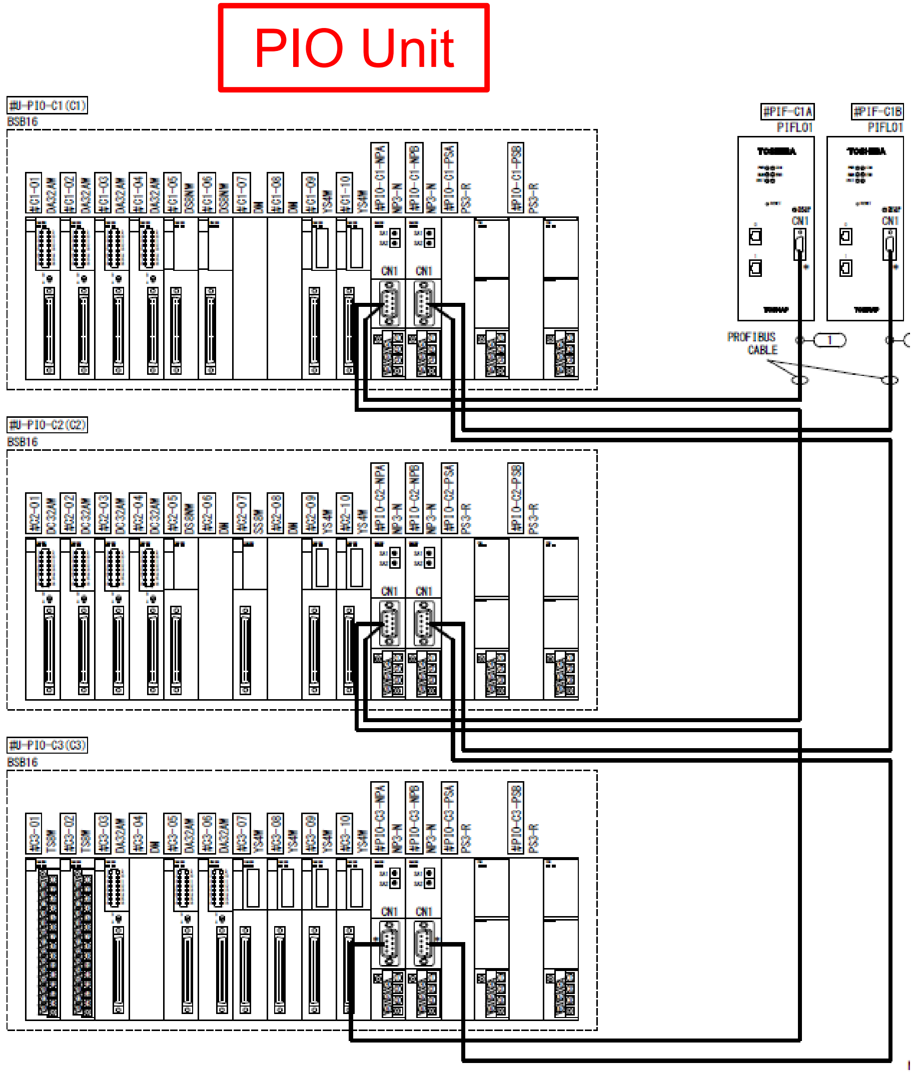
3. IO-Network Configuration

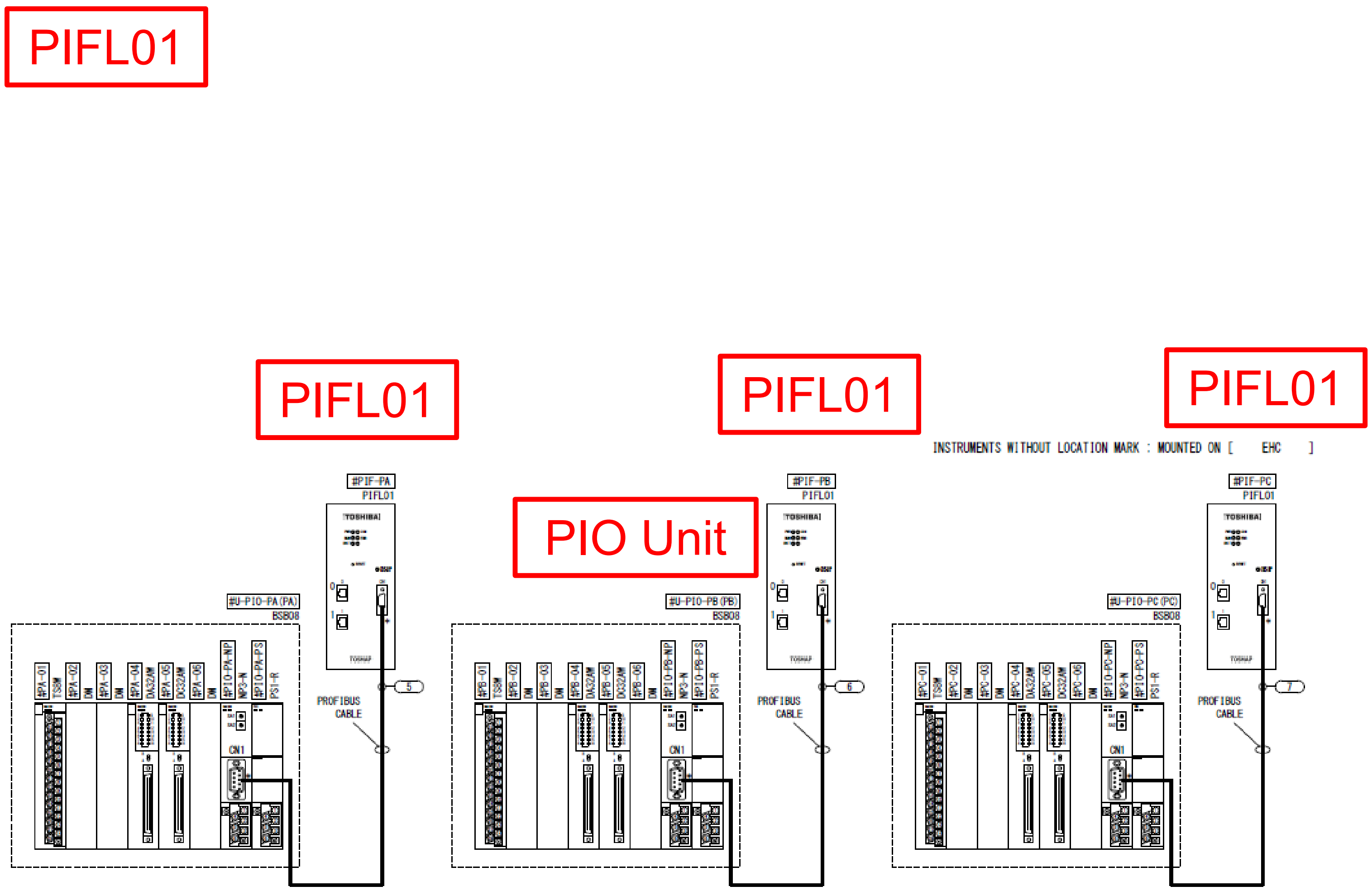
・Communication between Controller and IO Module



3. IO-Network Configuration (PROFIBUS)

・Communication between PIFL01 and PIO Unit

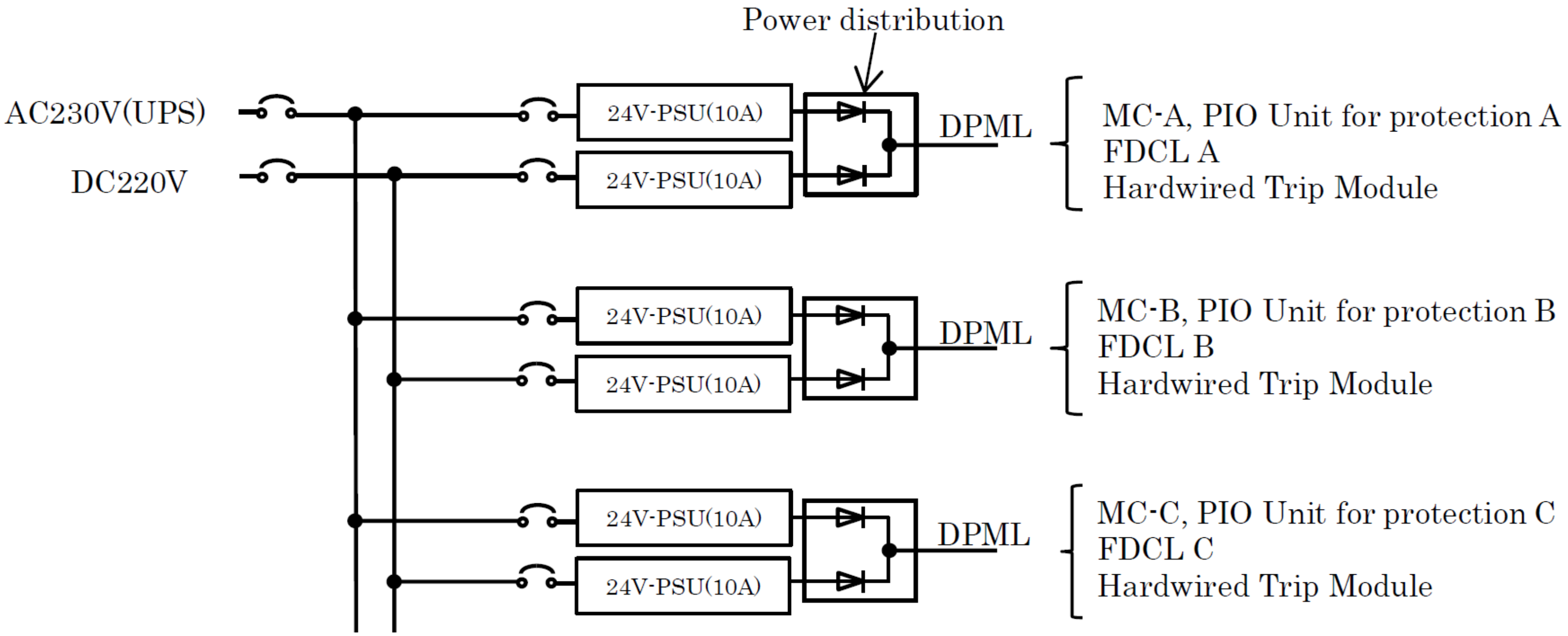




4. EHC Power Supply Configuration

Individual modules are powered with dual power supplies: AC230V and DC220V.

- Triple Redundant Master Controllers, PIO
- Triple Redundant FDCL A/B/C
- HTML (Hardwire Trip Module)



Part 2.

Modules Used in EHC System

Type of Module

For EHC M/C

1. CPU module(CPUL01)

Others

2. Protocol Converter module (PIFL01)
3. Frequency detecting module (FDCL01)
4. Power load unbalance detecting module (PLUL01)
5. Valve control module (VPCL01)
6. PIO Card

1. CPU module(CPUL01) (1/4)

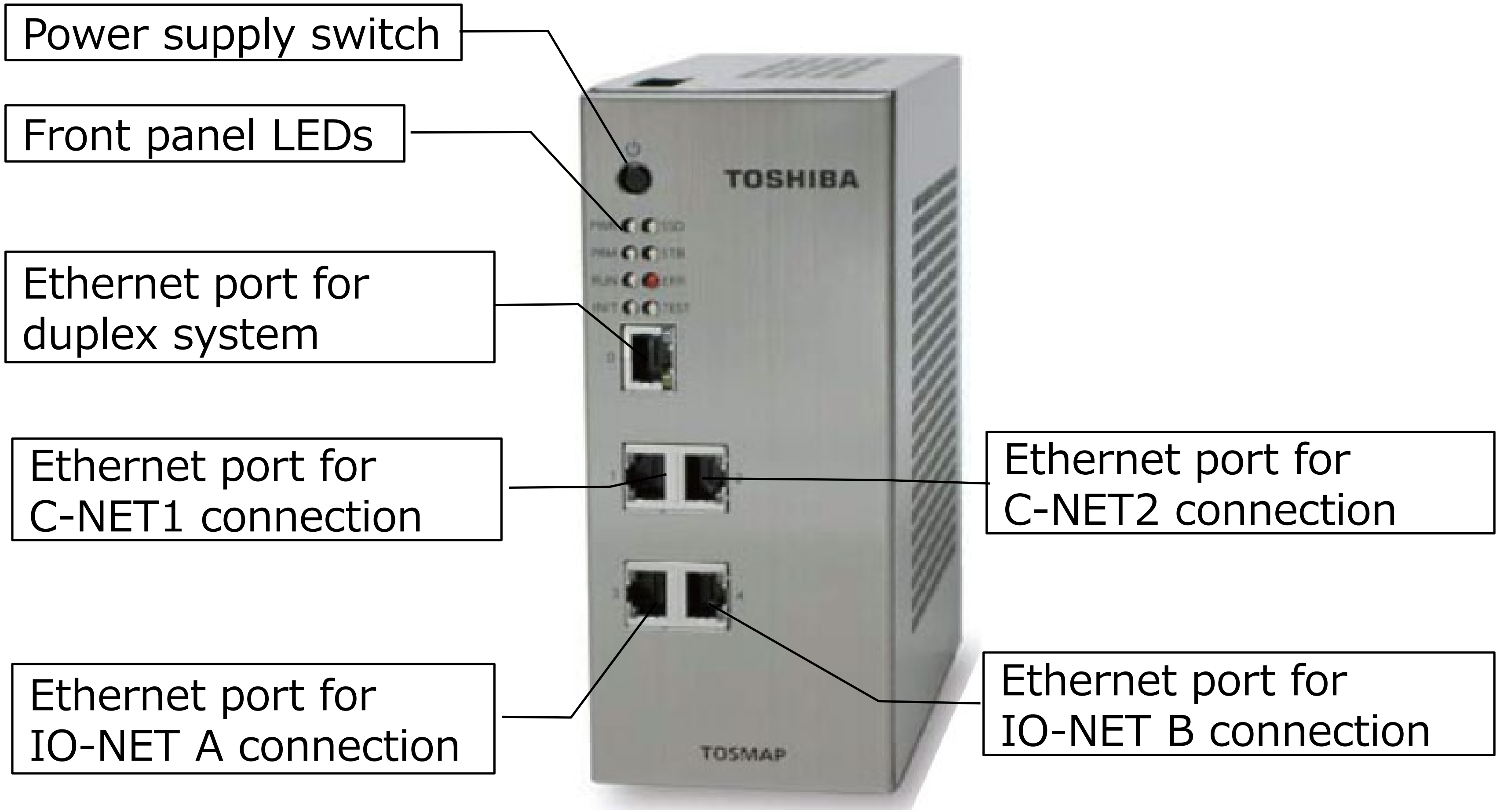
The CPU module performs control calculations.

CPUL is used for system controller and master controller.

It combines data acquired via PI/O cards, or EHC modules, with control logic stored in its own RAM.

A high performance 32-bit CPU is used which allows high precision control.

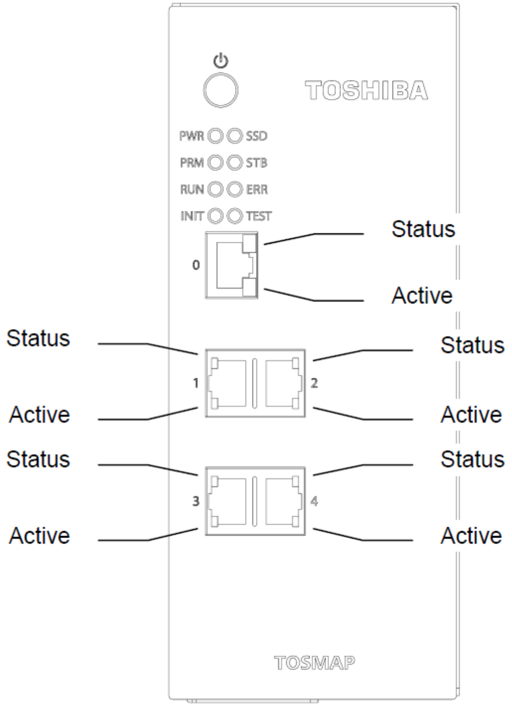
1. CPU module(CPUL01) (2/4)



Front View

1. CPU module(CPUL01) (3/4)

Locations of the LEDs



Functions of the LEDs of CPUL01

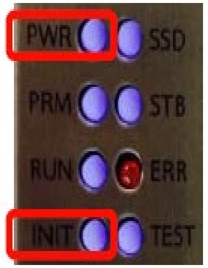
Name	Name	Description	Color
CPUL01 State	PWR	Turns on when the power switch is pressed and CPUL01 is booting up.	Blue
		Turns off when the power switch is pressed and CPUL01 is shutting down.	Off
	SSD	Turns on when the SSD data is accessed.	Blue
	PRM	Turns on when used as the regular system in a redundant structure.	Blue
	STB	Turns on when used as the stand-by system in a redundant structure.	Blue
	RUN	Turns on during the RUN/TEST mode.	Blue
	ERR	Turns on when a failure occurs.	Red
	INIT	Turns on during initialization or the INIT mode.	Blue
	TEST	Turns on during the Test mode.	Blue
LAN	Status	Turns on in green during the 1000BASE-T mode.	Green
		Turns on in orange during the 100BASE-TX mode.	Orange
		Turns off during the 10BASE-T mode.	Off
	Active	Turns on when the link is established. Blinks during transmission and reception.	Orange
		Turns off when the link is not established.	Off

1. CPU module(CPUL01) (4/4)

Push the Power PB on CPU module, after turning on the MCCB.

Power PB

CPUL01

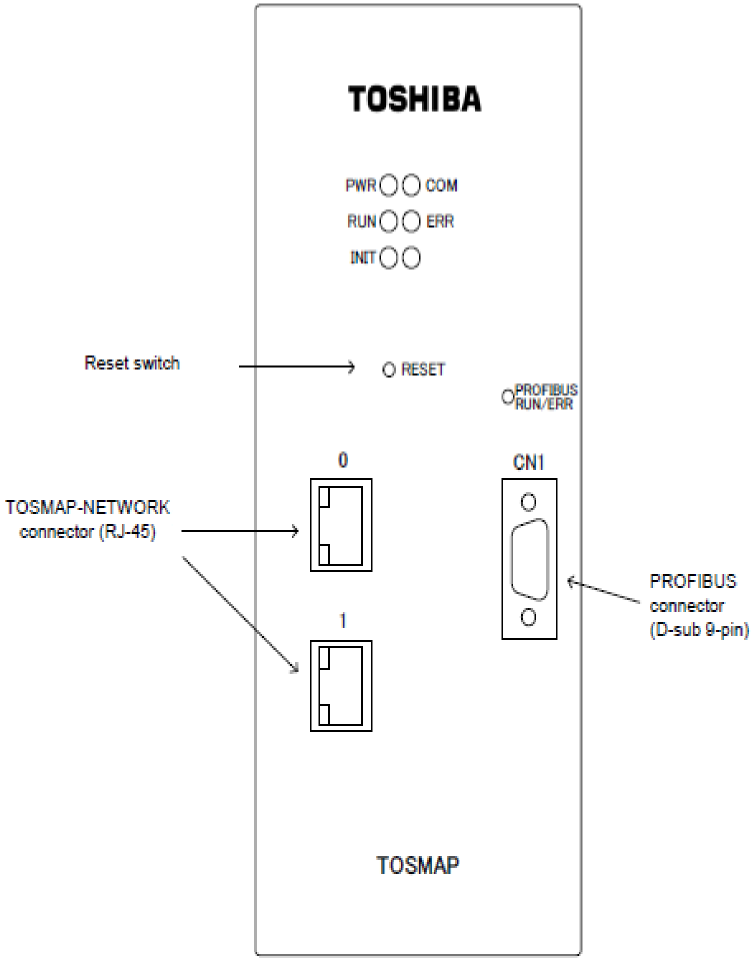


2. Protocol Converter module (PIFL01) (1/3)

The Protocol Converter module performs communication between Controller and PI/O modules.

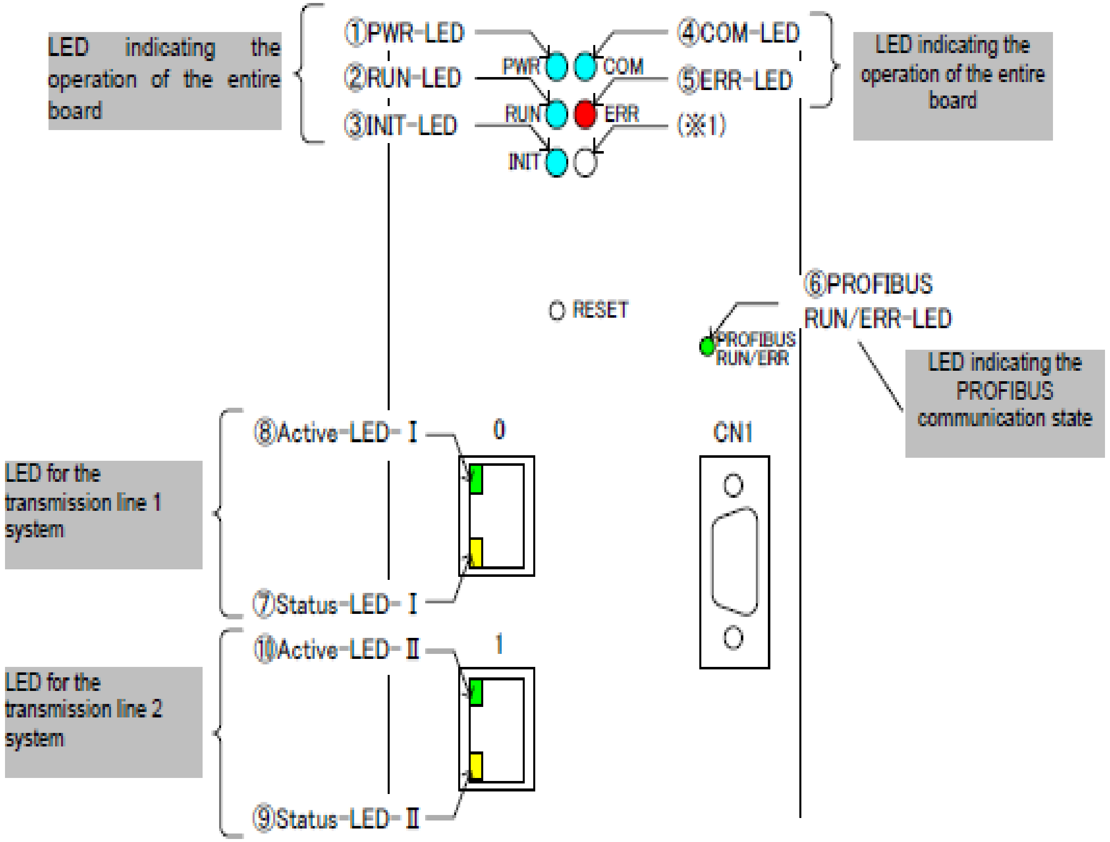
PIFL01 converts the protocols between Ethernet and PROFIBUS.

2. Protocol Converter module (PIFL01) (2/3)



Front View

2. Protocol Converter module (PIFL01) (3/3)



Locations of the LEDs

Functions of the LEDs of PIFL01

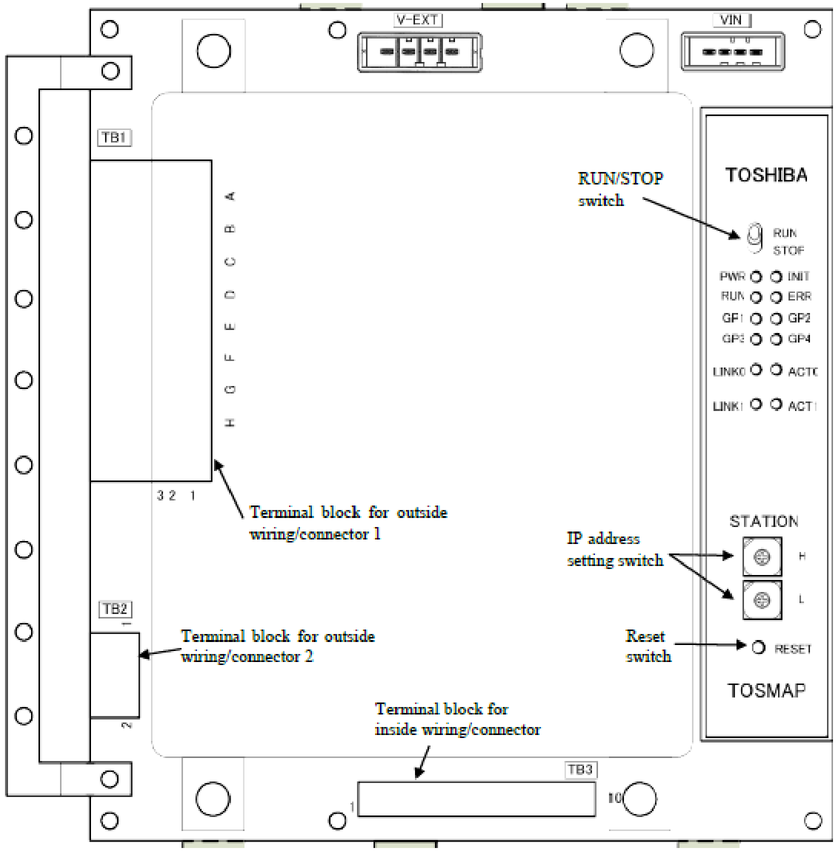
Name	Name	Description	Color	Location
Board state	PWR	On when energized.	Blue	1
	RUN	On in the normal operation state.	Blue	2
	INIT	On during initializing the board.	Blue	3
	COM	On during the PROFIBUS communication.	Blue	4
	ERR	On when an error occurs.	Red	5
PROFIBUS	PROFIBUS RUN/ERR	On or blink in green or red depending on the state of the PROFIBUS communication. (*2)	Green	6
Transmission line-I	Status	On in yellow for 1000BASE-T mode. On in green for 100BASE-TX mode. Off for 10BASE-T mode.	Yellow Green	7
	Active	On when linked. Blink during transmission or reception.	Green	8
Transmission line-II	Status	On in yellow for 1000BASE-T mode. On in green for 100BASE-TX mode. Off for 10BASE-T mode.	Yellow Green	9
	Active	On when linked. Blink during transmission or reception.	Green	10

3. Frequency detecting module　(FDCL01) (1/3)

The Frequency detecting module performs monitoring the speed sensor signals and detection of Overspeed.

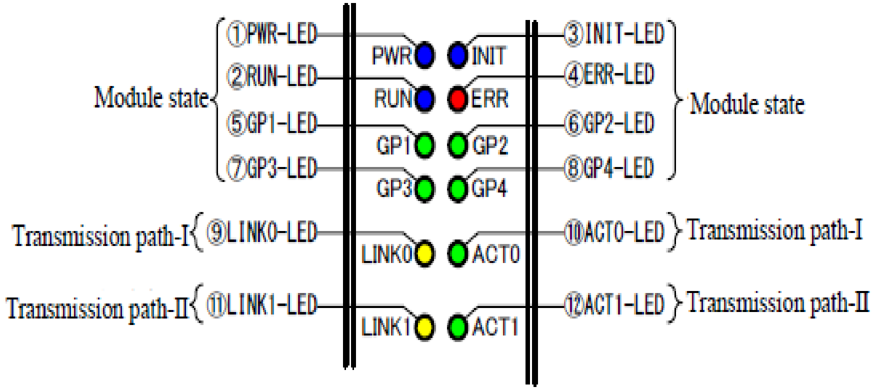
This module also detects CPU module failure.

3. Frequency detecting module (FDCL01) (2/3)



Outline Drawing (Front View)

3. Frequency detecting module (FDCL01) (3/3)



Locations of the LEDs

Functions of the LEDs of FDCL01

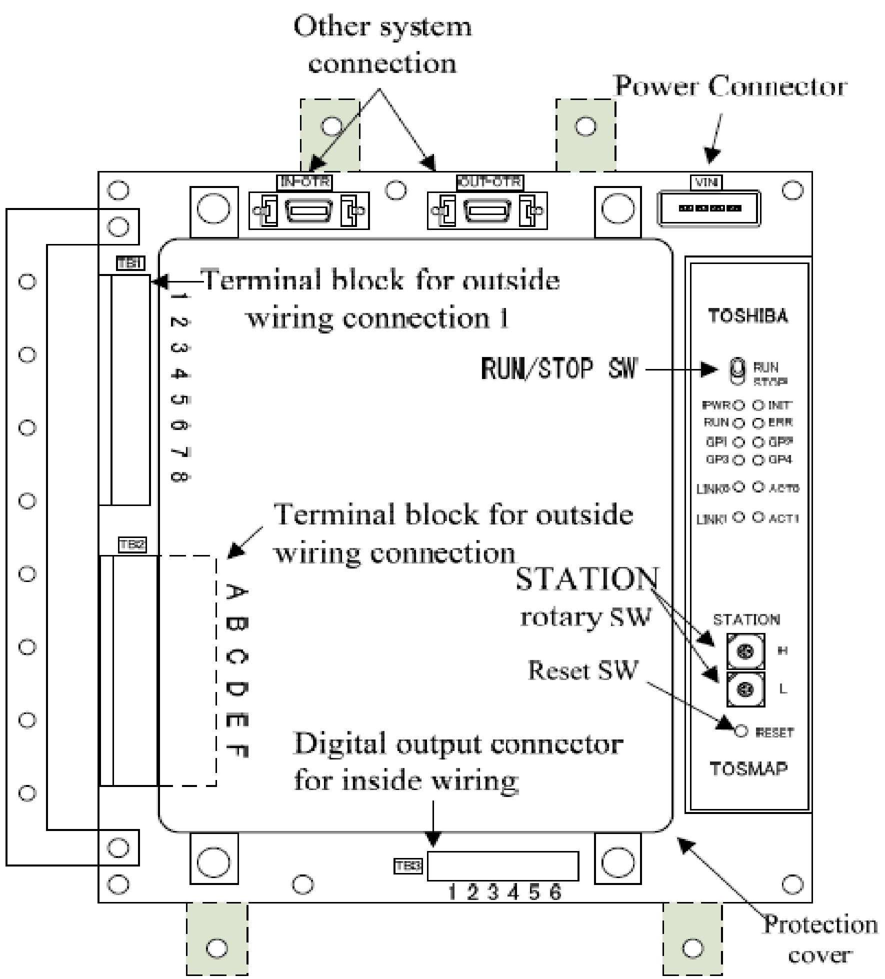
Name	Name	Description	Color	LED position
Module state	PWR	The LED turns on at power-on.	Blue	①
	RUN	The LED is on during normal operation.	Blue	②
	INIT	The LED is on during initialization inside the own board.	Blue	③
	ERR	The LED turns on at failure.	Red	④
	GP1	The LED is on during overspeed detection.	Green	⑤
	GP2	The LED is on during the overspeed detection test 1.	Green	⑥
	GP3	The LED is on during the overspeed detection test 2.	Green	⑦
	GP4	Unused	Green	⑧
Transmission path-I	LINK0	The yellow LED is on in the 1000BASE-T mode. The green LED is on in the 100BASE-TX mode. The LED is off in the 10BASE-T mode.	Yellow Green	⑨
	ACT0	The LED turns on when linked. The LED blinks during transmission & reception.	Green	⑩
Transmission path-II	LINK1	The yellow LED is on in the 1000BASE-T mode. The green LED is on in the 100BASE-TX mode. The LED is off in the 10BASE-T mode.	Yellow Green	⑪
	ACT1	The LED turns on when linked. The LED blinks during transmission & reception.	Green	⑫

4. Power load unbalance detecting module (PLUL01) (1/3)

The Power load unbalance detecting module performs detection of power load unbalance and output valve close signals to Valve control modules by hardwired signals.

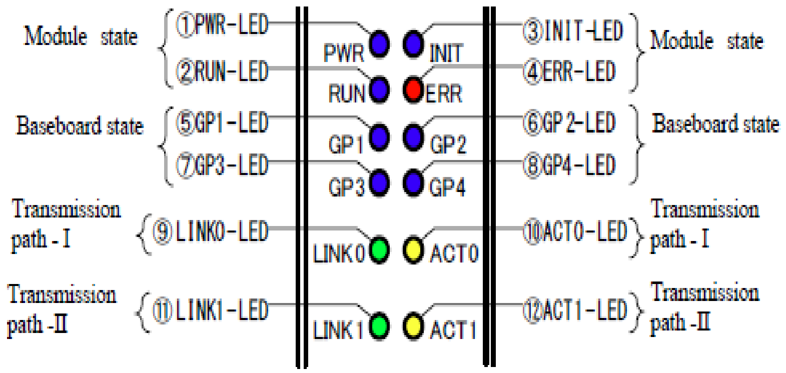
To calculate generator load and turbine power, Generator CT signals and turbine reheat bowl pressure signals are input to this module.

4. Power load unbalance detecting module (PLUL01) (2/3)



Outline Drawing (Front View)

4. Power load unbalance detecting module (PLUL01) (3/3)



Locations of the LEDs

Functions of the LEDs of PLUL01

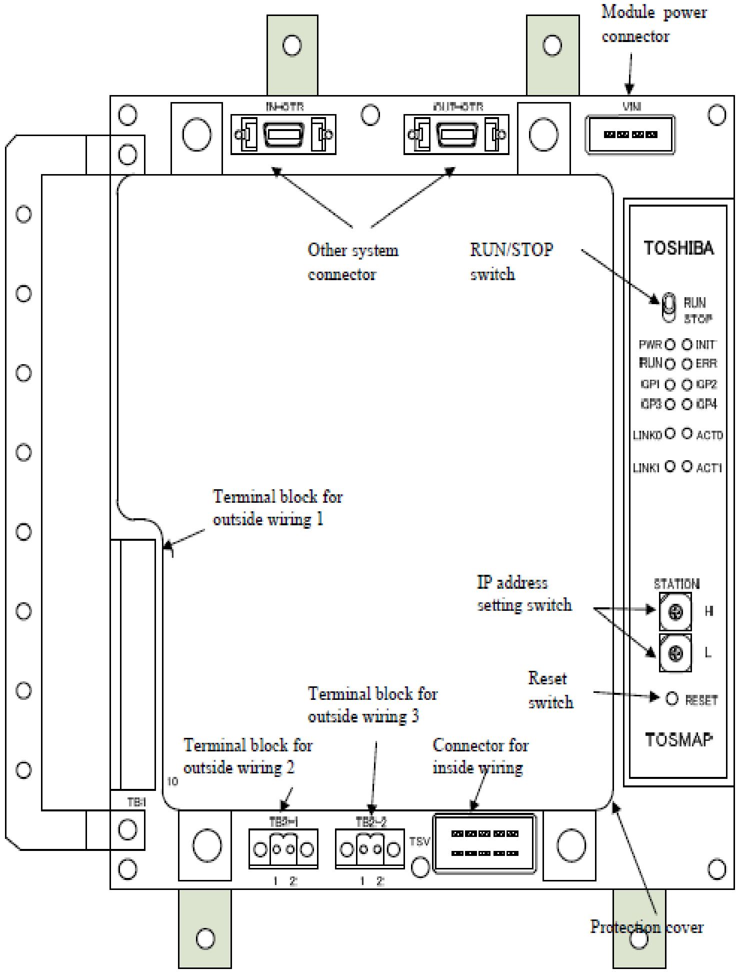
Name	Name	Description	Color	LED position
Board state	PWR	The LED turns on at power-on.	Blue	①
	RUN	The LED is on during normal operation.	Blue	②
	INIT	The LED is on during initialization inside the own board.	Blue	③
	ERR	The LED turns on at failure.	Red	④
	GP1	Unused	Blue	⑤
	GP2	Unused	Blue	⑥
	GP3	Unused	Blue	⑥
	GP4	Unused	Blue	⑥
Transmission path - I	LINK0	The yellow LED is on in the 1000BASE-T mode.	Green	⑦
		The green LED is on in the 100BASE-TX mode. The LED is off in the 10BASE-T mode.	Yellow	
	ACT0	The LED turns on when linked. The LED blinks during transmission & reception.	Yellow	⑧
Transmission path - II	LINK1	The yellow LED is on in the 1000BASE-T mode.	Green	⑨
		The green LED is on in the 100BASE-TX mode. The LED is off in the 10BASE-T mode.	Yellow	
	ACT1	The LED turns on when linked. The LED blinks during transmission & reception.	Yellow	⑩

5. Valve control module (VPCL01) (1/3)

The Valve control module performs calculation of valve position from LVDT signal and output servo current to control valves.

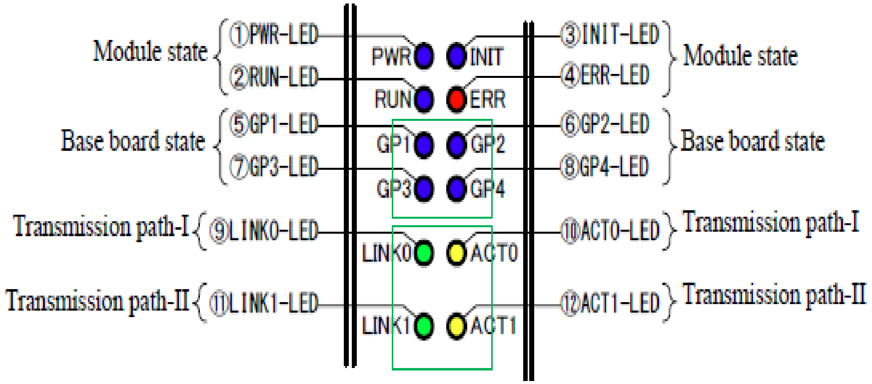
The demand of servo current is calculated by this module using valve position demand value from CPU modules.

5. Valve control module (VPCL01) (2/3)



Outline Drawing (Front View)

5. Valve control module (VPCL01) (3/3)



Locations of the LEDs

Functions of the LEDs of VPCL01

Name	Name	Description	Color	LED position
Module state	PWR	The LED turns on at power-on.	Blue	①
	RUN	The LED is on during normal operation.	Blue	②
	INIT	The LED is on during initialization inside the own board.	Blue	③
	ERR	The LED turns on at failure.	Red	④
	GP1	The LED is on when the own system is primary.	Blue	⑤
	GP2	The LED is on when the own system is secondary.	Blue	⑥
	GP3	Power amplifier error	Blue	⑦
	GP4	Unused	Blue	⑧
Transmission path-I	LINK0	The yellow LED is on in the 1000BASE-T mode.	Green	⑨
		The green LED is on in the 100BASE-TX mode. The LED is off in the 10BASE-T mode.	Yellow	
	ACT0	The LED turns on when linked. The LED blinks during transmission and reception.	Yellow	⑩
Transmission path-II	LINK1	The yellow LED is on in the 1000BASE-T mode.	Green	⑪
		The green LED is on in the 100BASE-TX mode. The LED is off in the 10BASE-T mode.	Yellow	
	ACT1	The LED turns on when linked. The LED blinks during transmission and reception.	Yellow	⑫

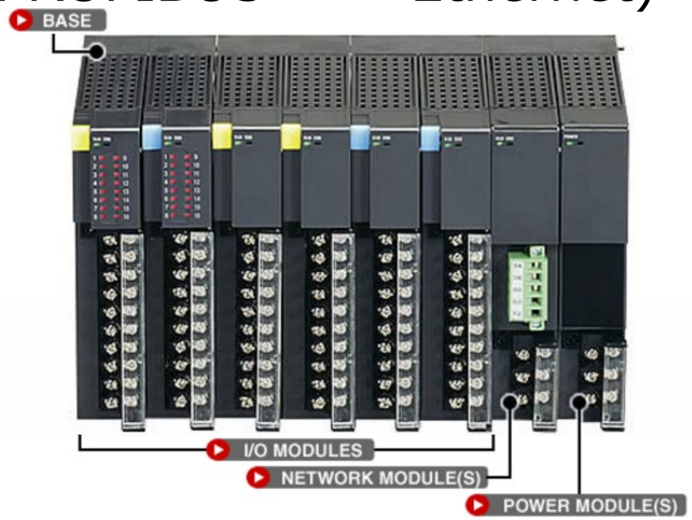
6. PIO Card (1/2)

PIO card acts as an interface between input/output relays/terminals and CPUL.

PIO card array used here is a M-System Series 3 products which provides both analog and digital input/output.

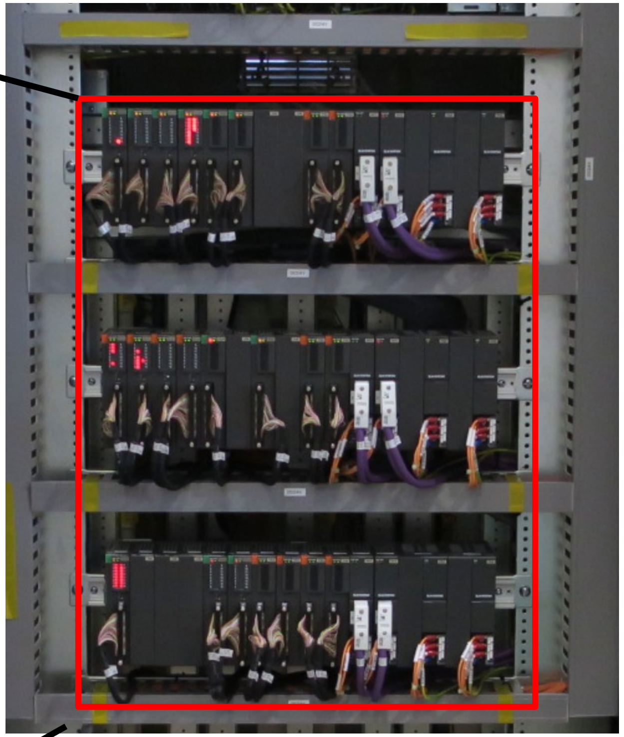
This system monitors valves' operation, pumps' operation, modules' power status, communicates with outside system by hardwires, etc.

PIO card receives commands from CPUL and returns its requested values via PIFL01 (PROFIBUS <-> Ethernet)



6. PIO Card (2/2)

SIGNAL TYPE	I/O CARD TYPE	I/O TERMINAL TYPE	SIGNAL LEVEL
ANALOG INPUT	R3Y-DS8NW-T	CTCL02G52	4-20mA
ANALOG INPUT	R3Y-SS8W-T	CTCL02G51	4-20mA
ANALOG OUTPUT	R3Y-YS4W-T	CTCL03G51	4-20mA
ANALOG INPUT	R3-TS8W	-	THERMOCOUPLE
DIGITAL INPUT	R3-DA32AW-T	-	CONTACT
DIGITAL OUTPUT	R3-DC32AW-T	-	CONTACT
DIGITAL INPUT	R3-DA32AW-T	CTCL04G53	CONTACT
DIGITAL INPUT	R3-DA32AW-T	PLC-OPT-48DC/48DC/100 CTCL04G51	CONTACT
DIGITAL INPUT	R3-DA32AW-T	-	CONTACT
DIGITAL OUTPUT	R3-DC32AW-T	CTCL07G51	CONTACT
DIGITAL OUTPUT	R3-DC32AW-T	CTCL05G51	CONTACT
PULSE INPUT	FDCL01G011	-	0-50Vrms PULSE
ANALOG INPUT	VPCL01G011	-	LVDT SIGNAL
ANALOG OUTPUT		-	SERVO SIGNAL
DIGITAL OUTPUT	VPCL01G011	VTML02 TSVL01	CONTACT



Van Phong 1 BOT Thermal Power

Training for D-EHC System
3. MT D-EHC Control Function Overview

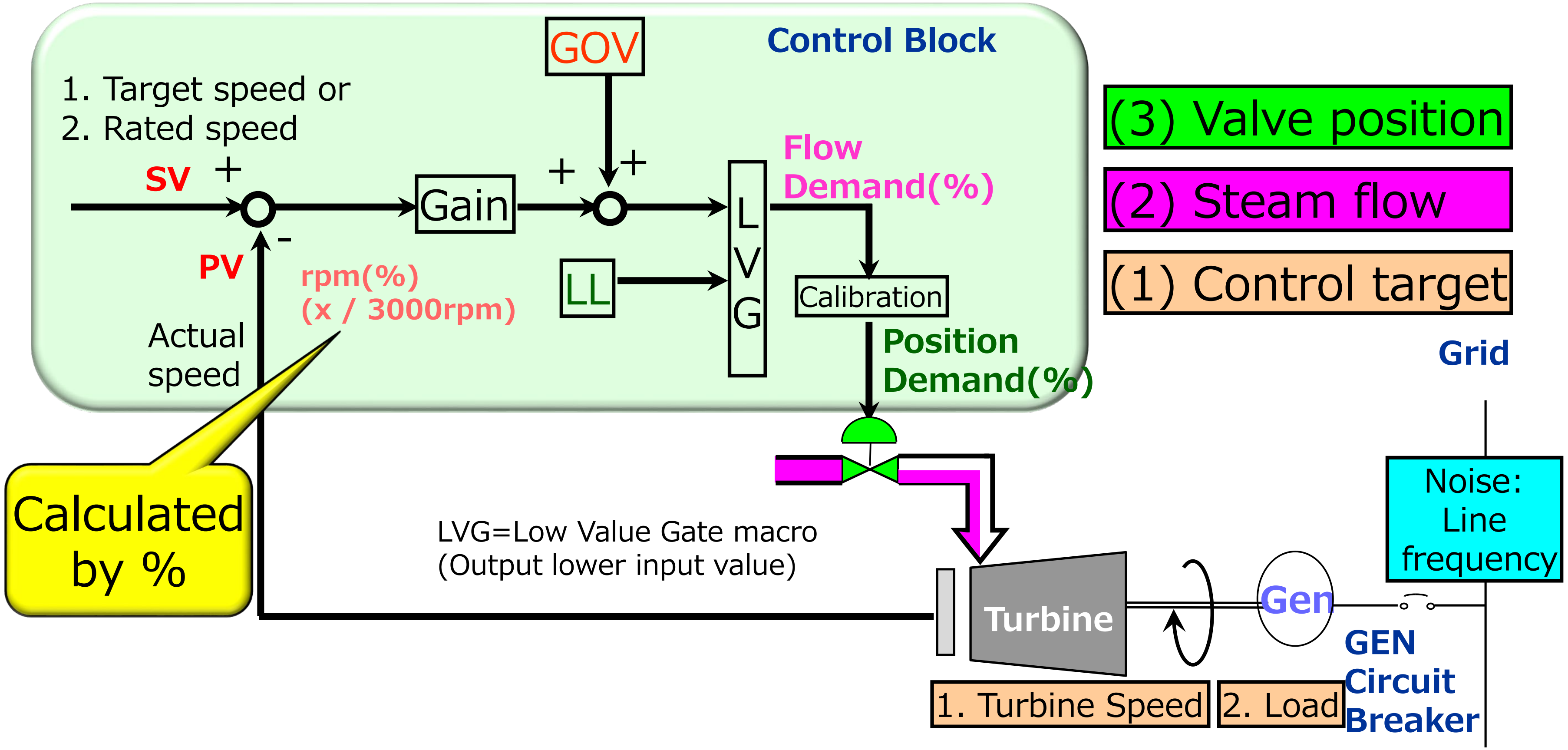
TOSHIBA

Toshiba Energy Systems & Solutions Corporation

EDU-2K000035

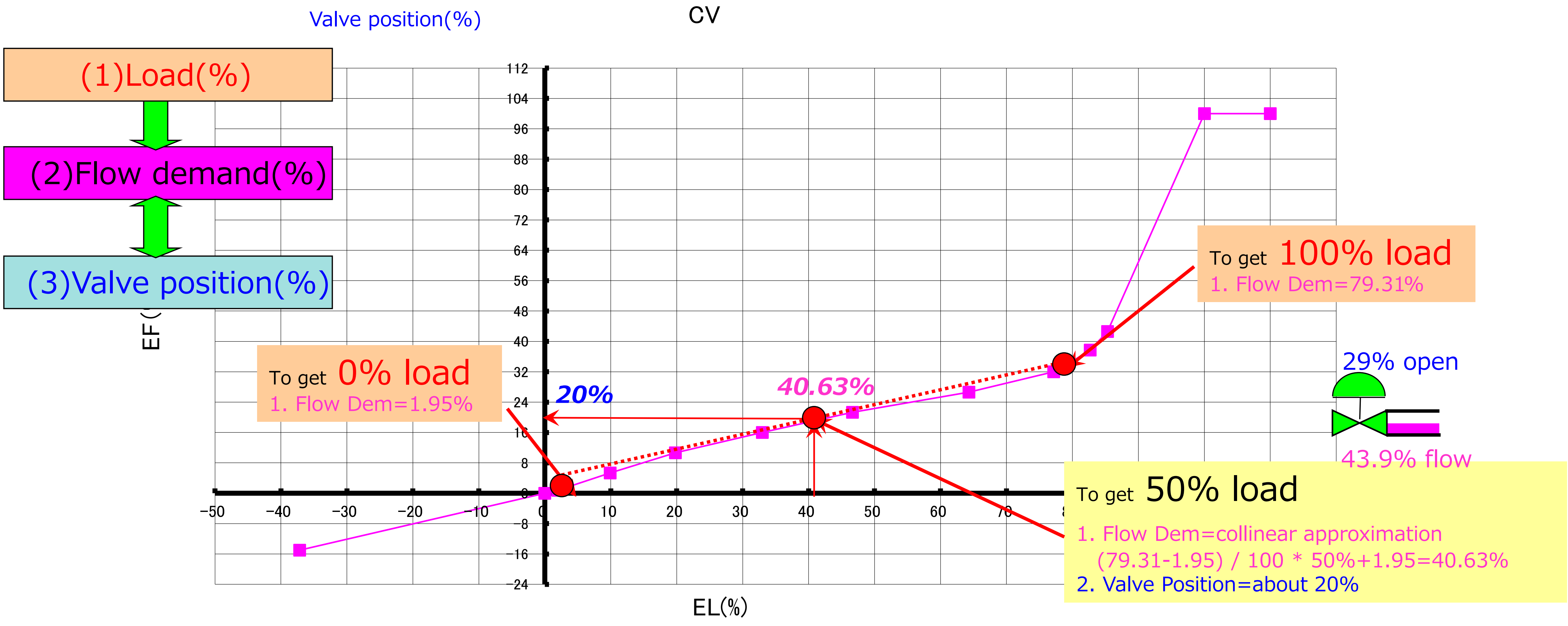
1. EHC control function block overview

In order to control **target** turbine speed and load,
EHC calculates required **steam flow** and decide **valve position.**
Control function block is shown below.



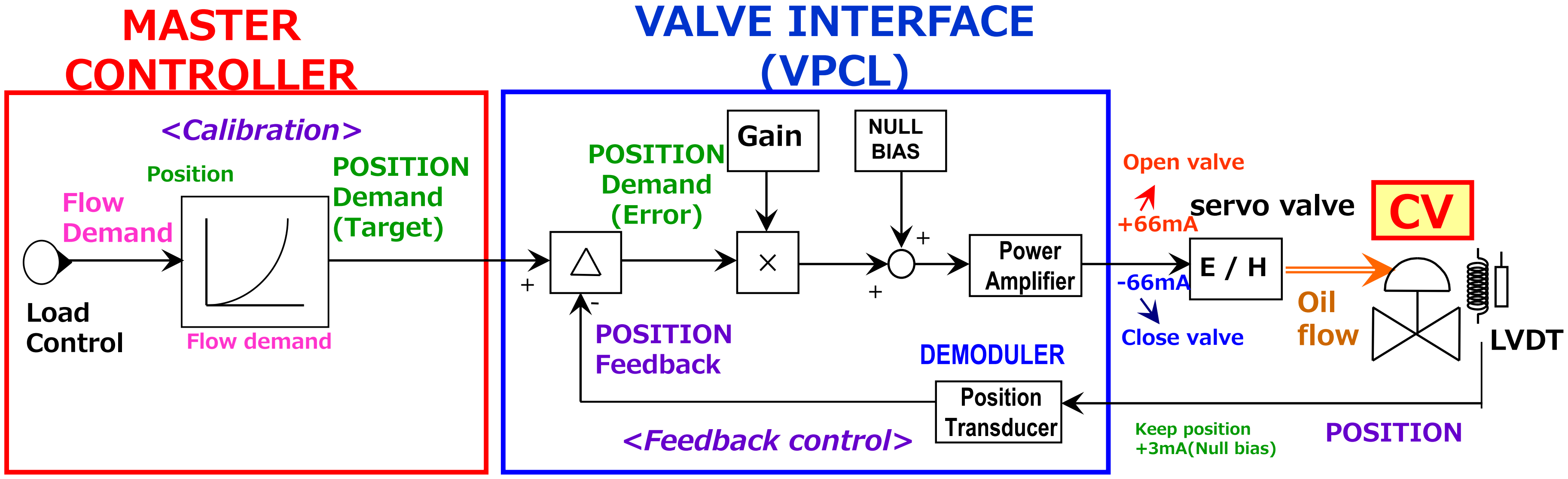
2. Relation among Load & Flow demand & Valve position

In order to get required load, flow demand and valve position are fixed by mechanical plant design with the following characteristic curve.



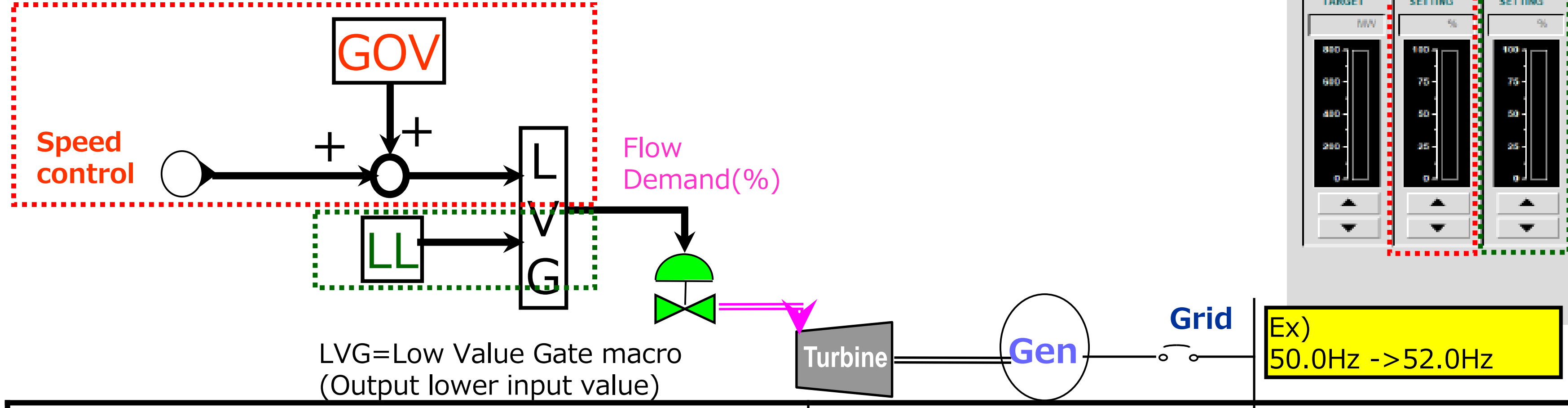
3. Signal flow from controller to servo valve

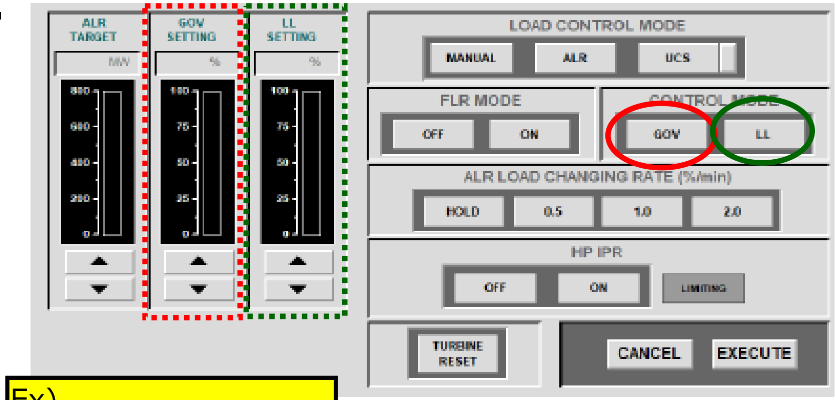
In Master controller, flow demand is calibrated to position demand signal by characteristic curve.
In Valve interface, position demand is subtracted by position feedback signal from LVDT, then position error signal is multiplied by gain and sent to Power Amplifier.
Valve interface sends current signal to servo valve to control CV position.



4. Difference between GOV control mode and LL control mode

Under the load control mode, there are GOV mode and LL mode to decide flow demand. The difference are shown below.

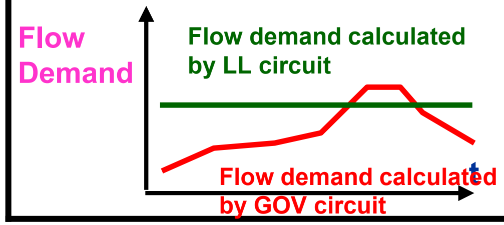




GOVERNOR operation

"With" speed control

If Grid changes from 50.0Hz to 52.0Hz,valve will be closed in order to control turbine speed decreased.

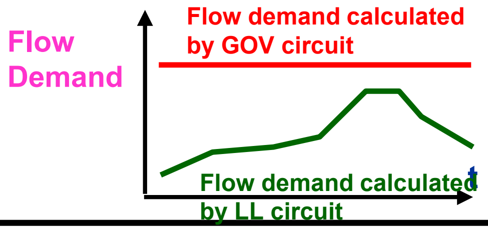


Affect line frequency

Load Limit operation

"Without" speed control

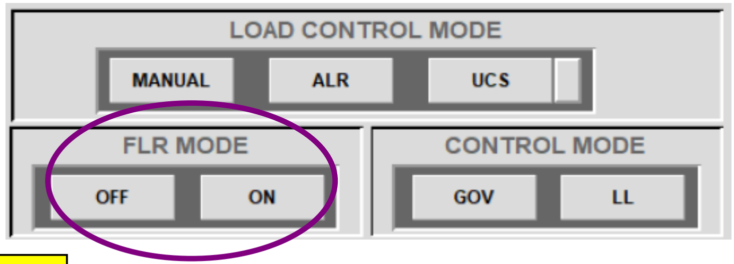
Even if Grid changes from 50.0Hz to 52.0Hz,valve position is not influenced by grid change.



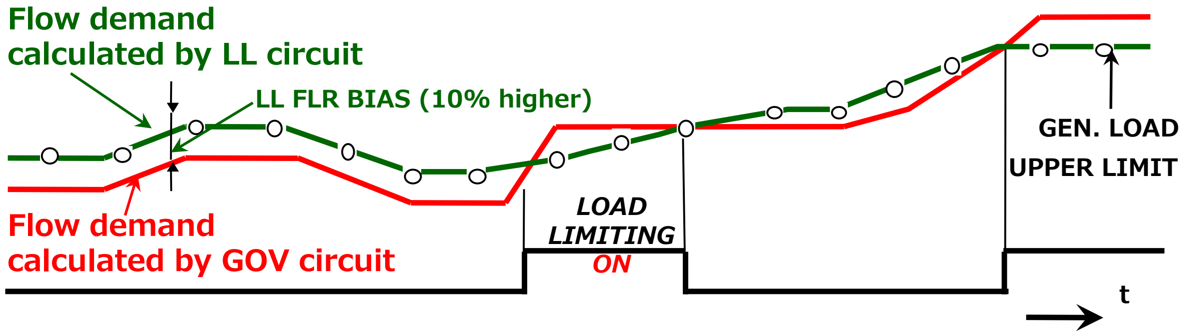
Does not affect line frequency

5. Explanation of FLR (1/2) (Follow up Load Regulator)

When FLR mode is ON, unselected mode (LL or GOV) stays 10% higher than selected mode because of the following reason.

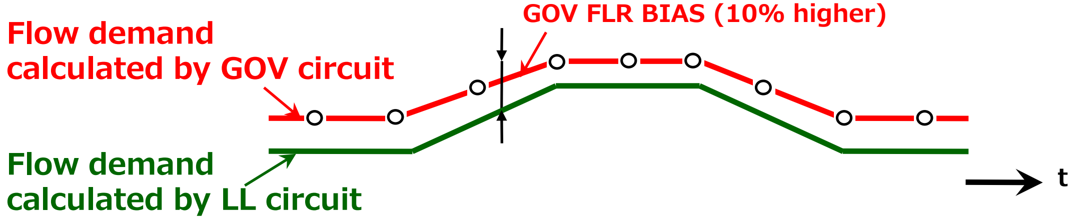


(1) Load limit Follow up Load Regulator



Purpose: To prevent CV from opening rapidly when grid frequency goes down during GOV mode

(2) Governor Follow up Load Regulator

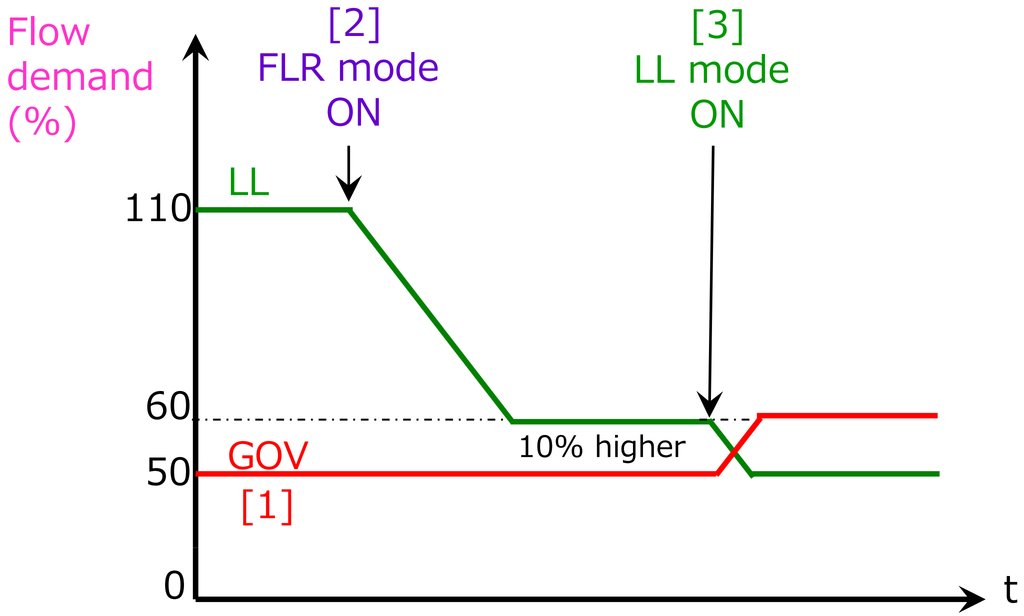


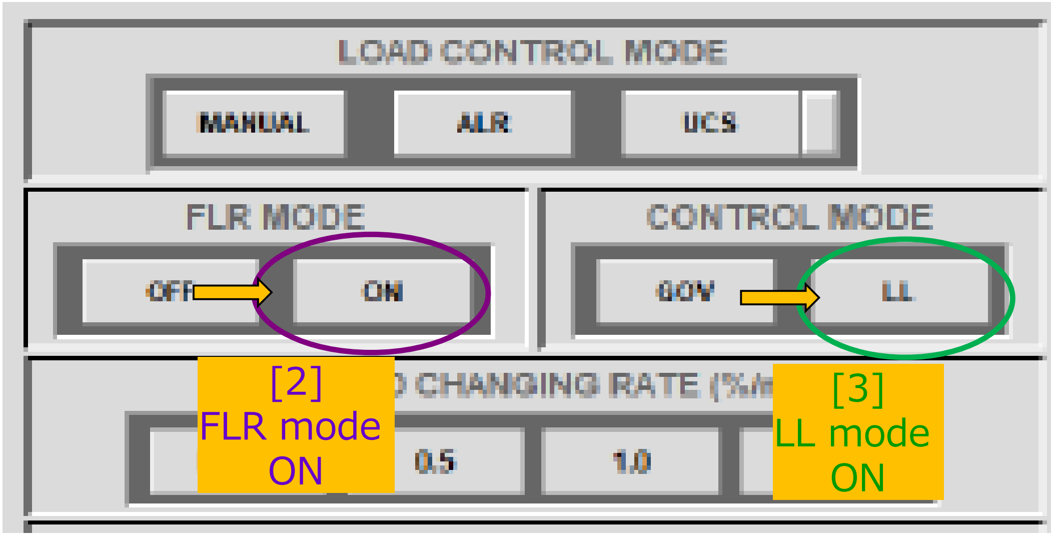
Purpose: To prepare for changing to GOV mode during LL mode

5. Explanation of FLR (2/2) (Follow up Load Regulator)

(3) Mode transfer

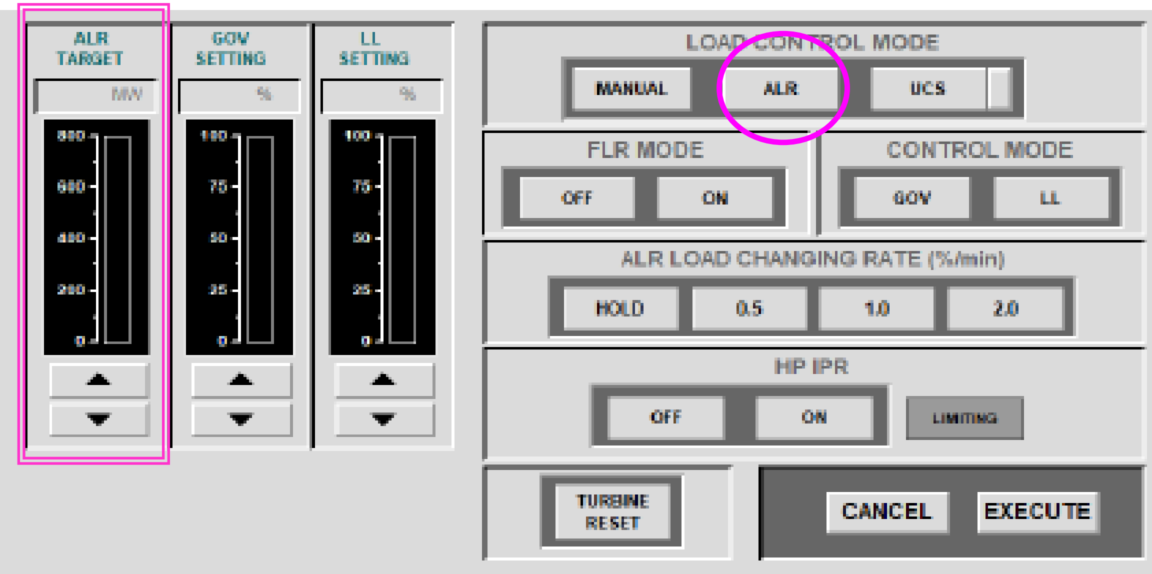
Example of FLR mode behavior is shown below.
[1] At first, GOV mode is selected and FLR is off status.
[2] When FLR mode is ON, LL demand decrease at 10% higher than GOV demand.
[3] If LL mode is selected, current GOV demand value is succeeded by LL demand automatically.

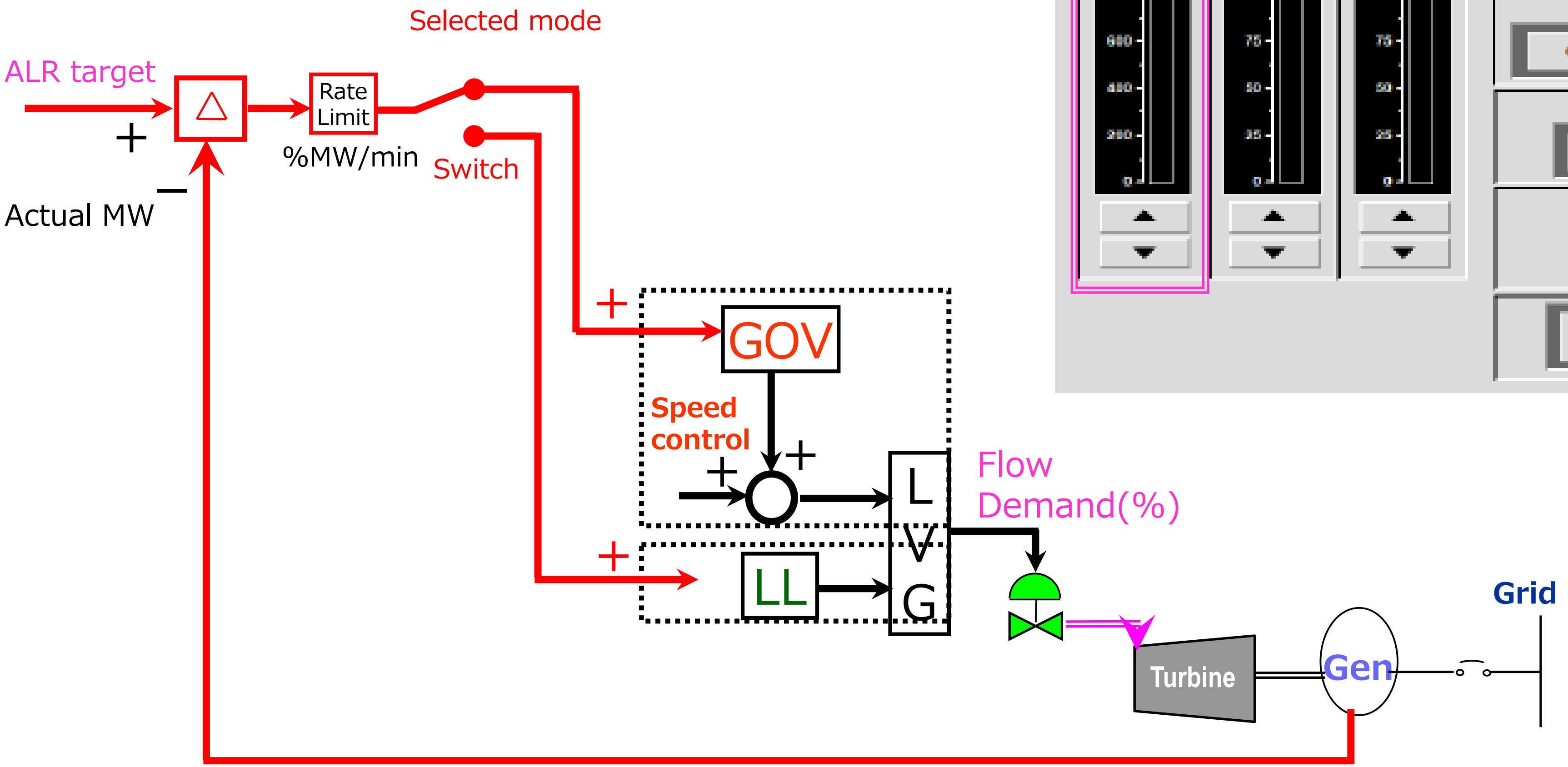




6. ALR (Auto Load Regulator) mode

ALR setter can set the target MW directly by the following additional block diagram.





Van Phong 1 BOT Thermal Power

Training for D-EHC System
4. MT D-EHC Detailed Control Function

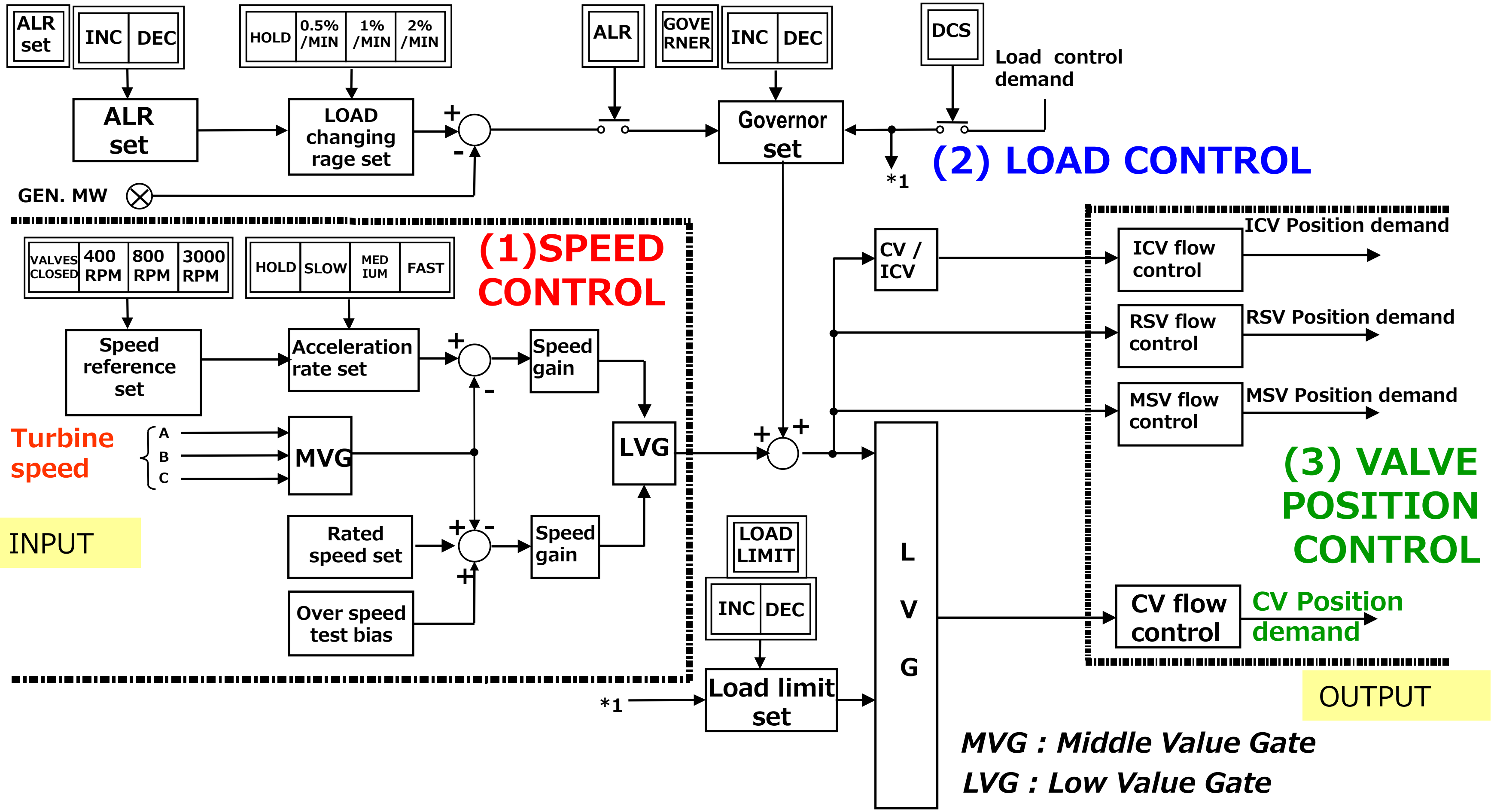
TOSHIBA

Toshiba Energy Systems & Solutions Corporation

EDU-2K000035

1. Outline of the D-EHC Function block

EHC control logic overview is shown below. Turbine speed is input to controller, and position demands calculated through 3 main control blocks are output from controller.

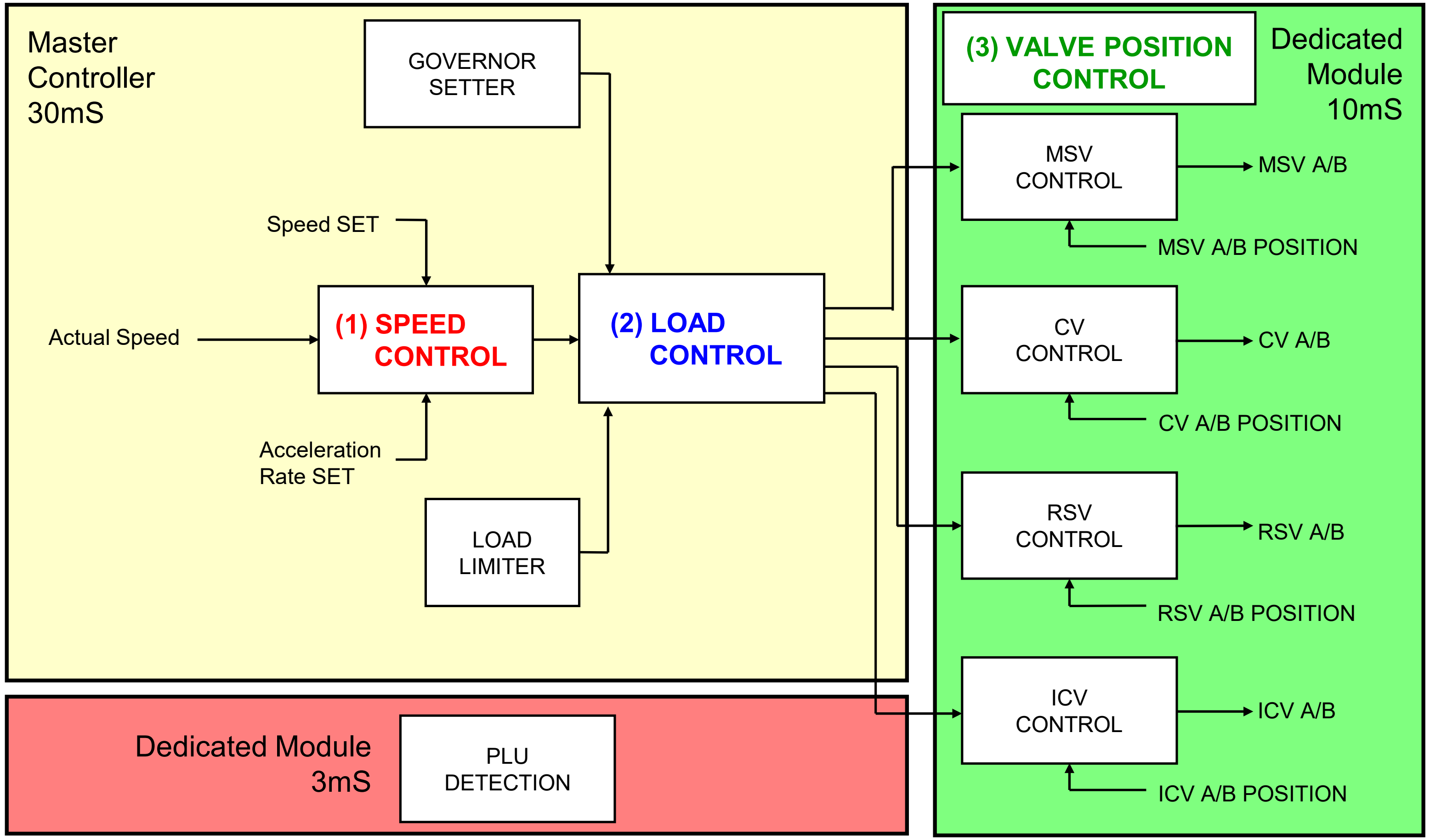


MVG : Middle Value Gate

LVG : Low Value Gate

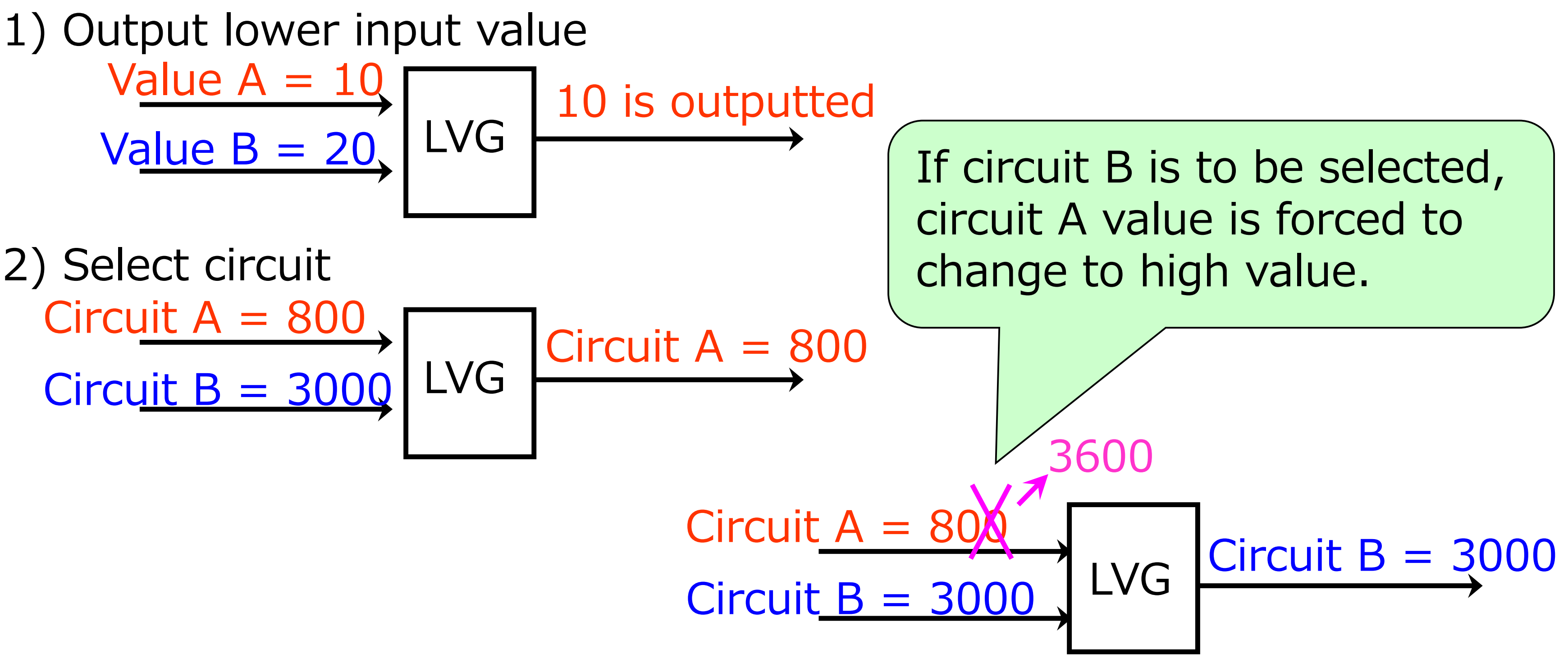
2. Control function calculation period

There are 3 kinds of logic calculation periods. For PLU function, very high speed calculation is required for protection. Valve position logic is calculated in every 10mS. Another logic is calculated in every 30mS.



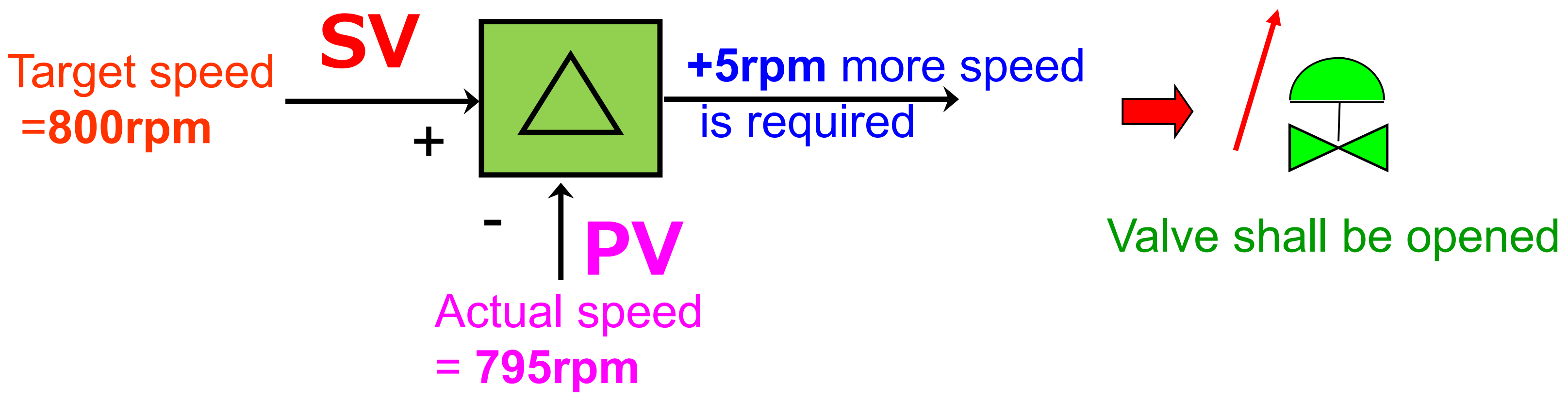
3. Explanation of LVG (Low Value Gate macro)

Before learning detailed logic, LVG (Low Value Gate) macro should be understood.
There is two purpose to use this macro.
No. 1) is basic usage.
No. 2) is used to change over the circuit (design technique).

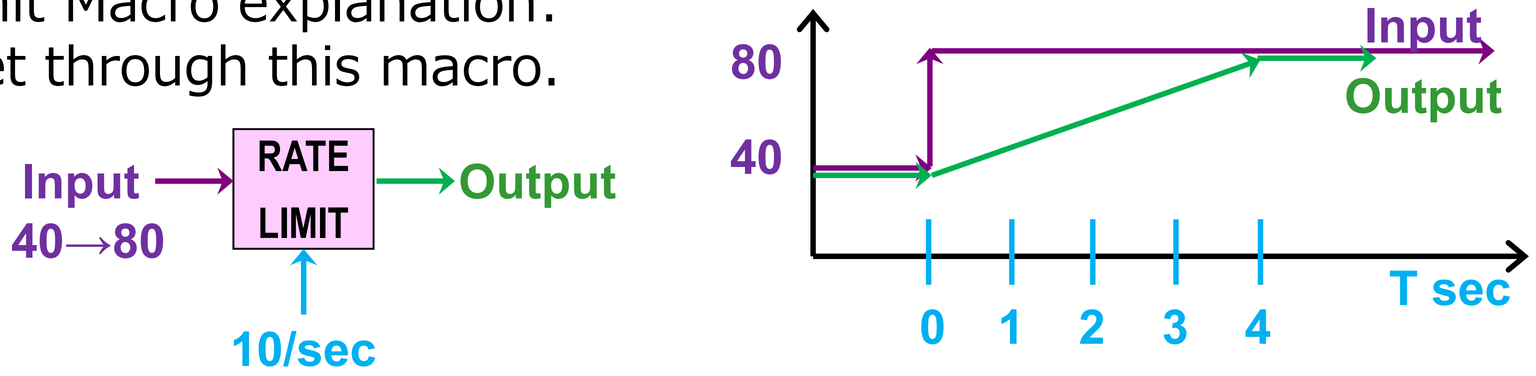


4. Speed control essence

Speed control block is calculated by subtraction actual speed from target speed. If actual speed is less than target speed, valve shall be opened to increase turbine speed.

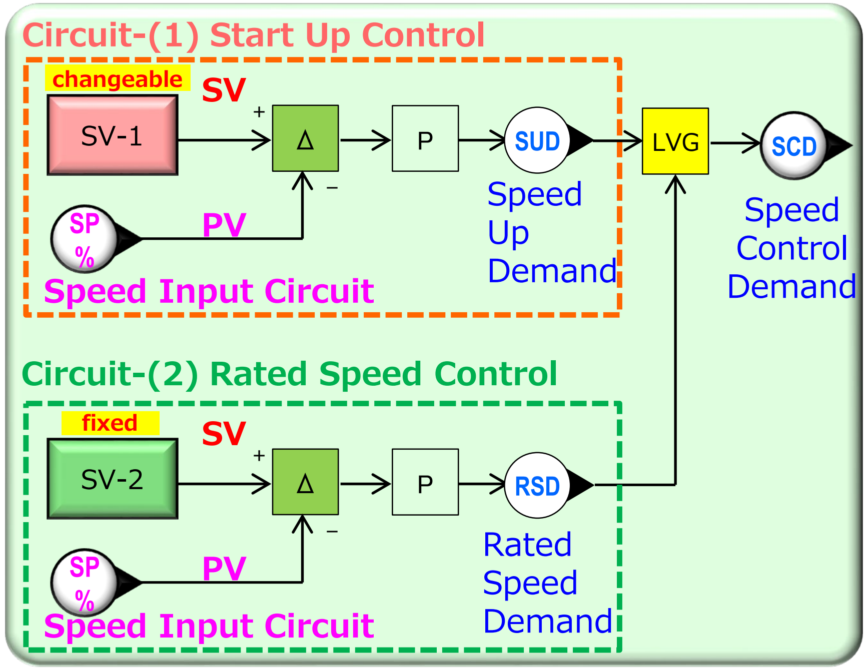


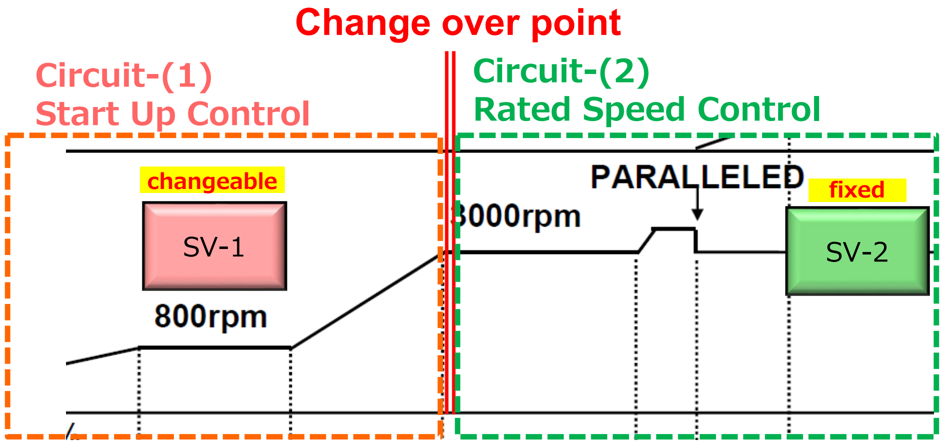
Rate limit Macro explanation:
SV is set through this macro.



4.1 Speed control block overview

There are 2 circuits for speed control which connect to LVG.



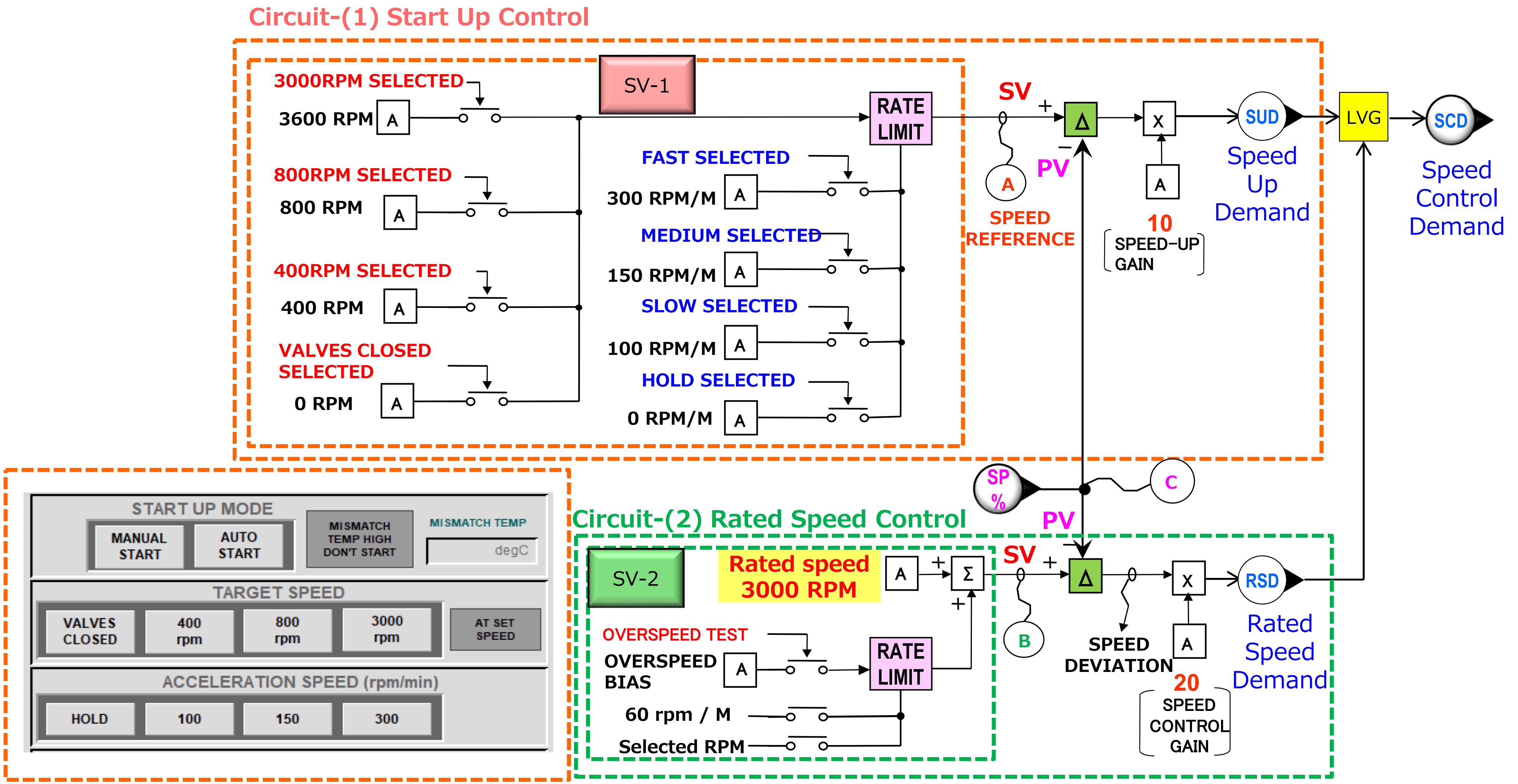


Turbine Start up curve

During turbine start up, circuit-(1) is used for speed control. Target speed is changeable.
After speed reaches to rated speed, circuit-(2) is used for speed control.
Target speed is fixed.

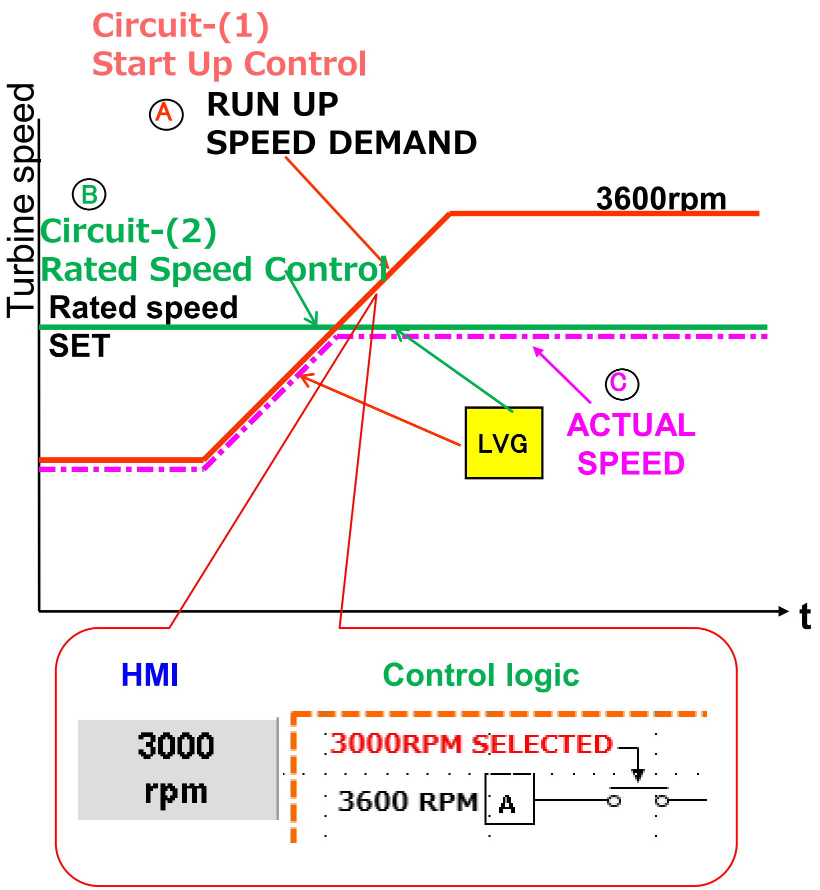
4.2 Speed control block in detailed

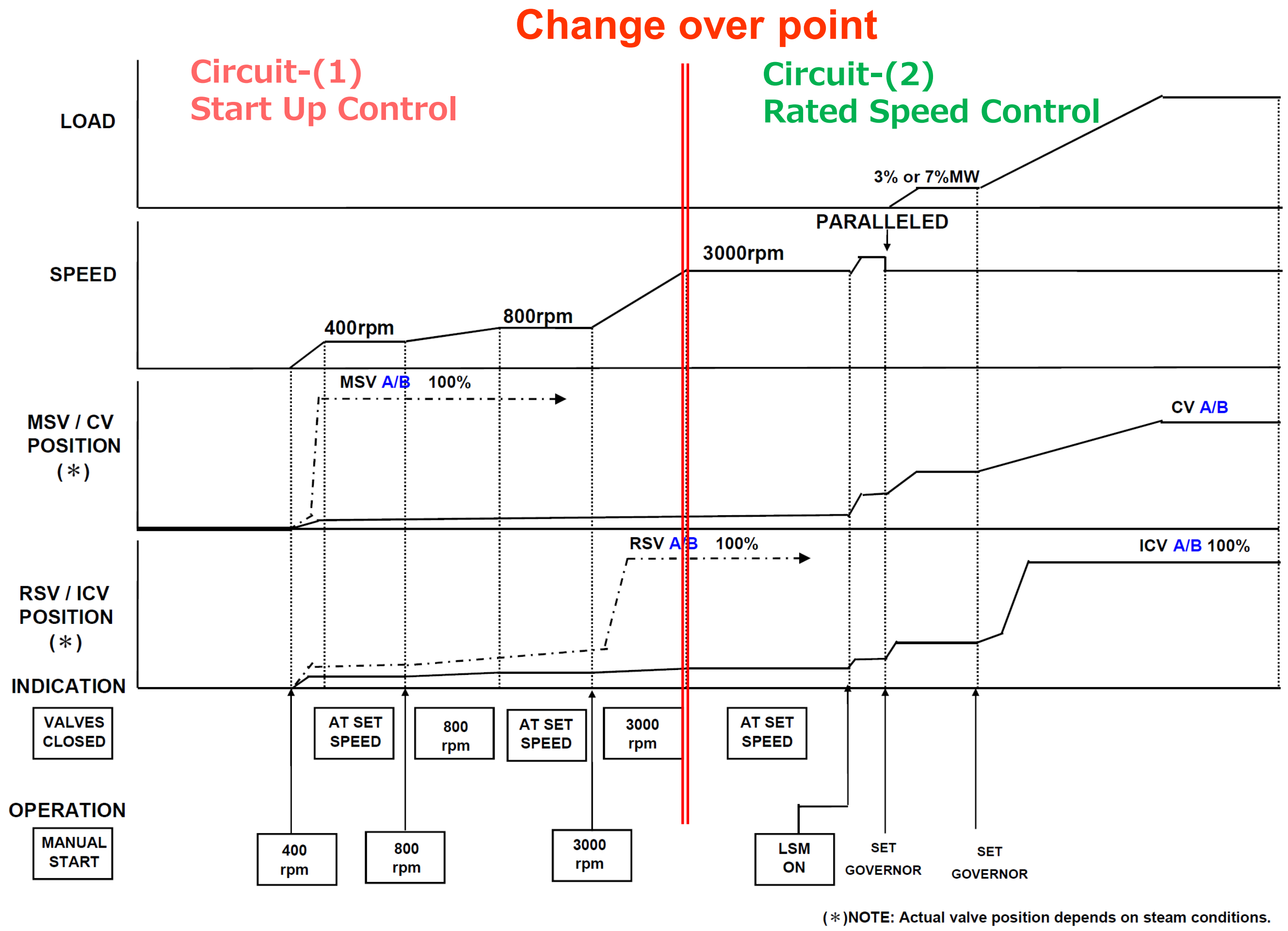
Set value is set as follows .



4.3 Speed control change over explanation

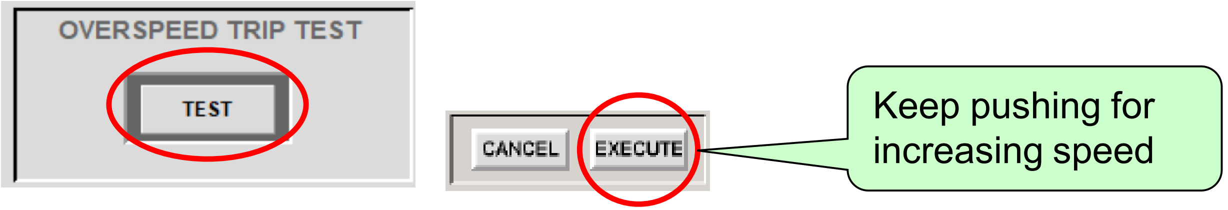
Circuit is switched over from (1) to (2), when speed demand exceed the rated speed. When rated speed set PB is pushed in HMI, 120% set value is actually set in control logic shown below, so change over occurs.





4.4 Over speed test

Purpose: To check emergency governor operation and operating point by raising the turbine speed setting and increasing the actual turbine speed. This test can be executed only when the generator circuit breaker is opened.



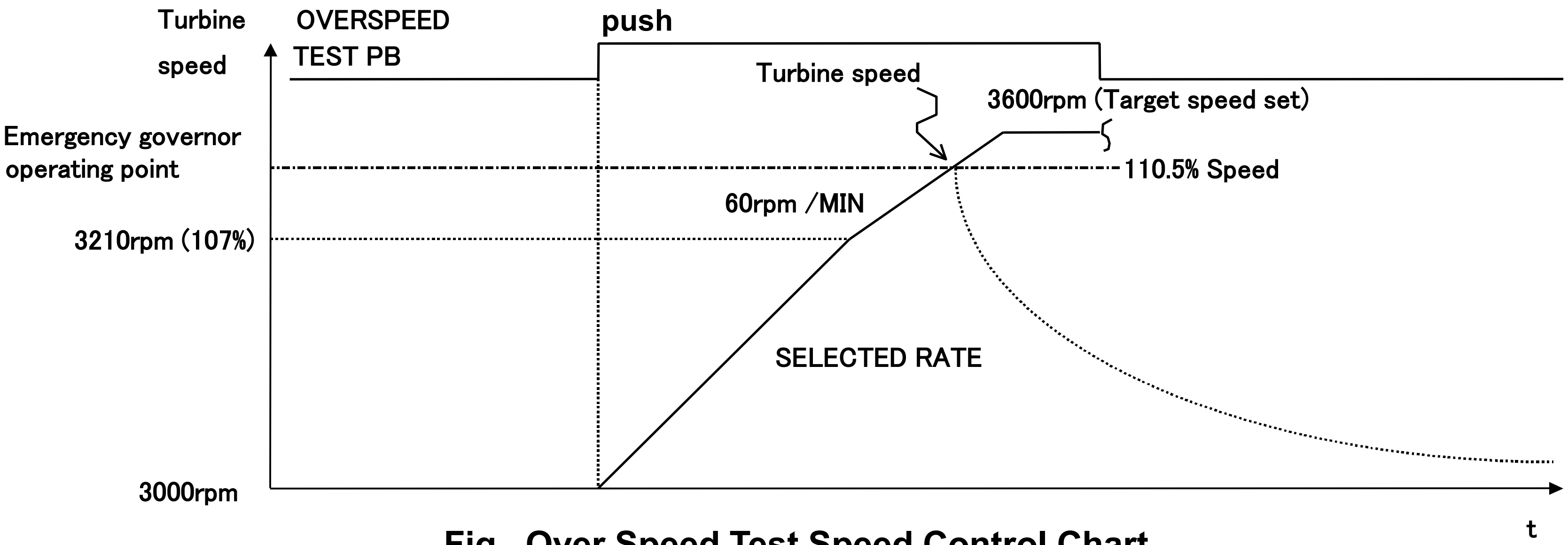
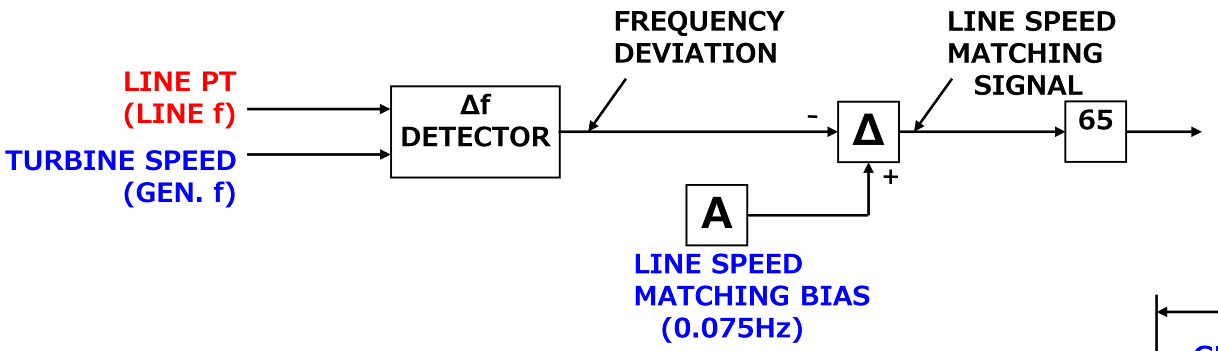
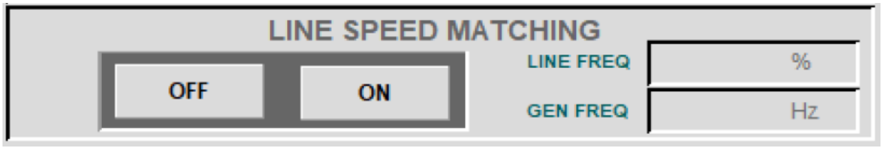


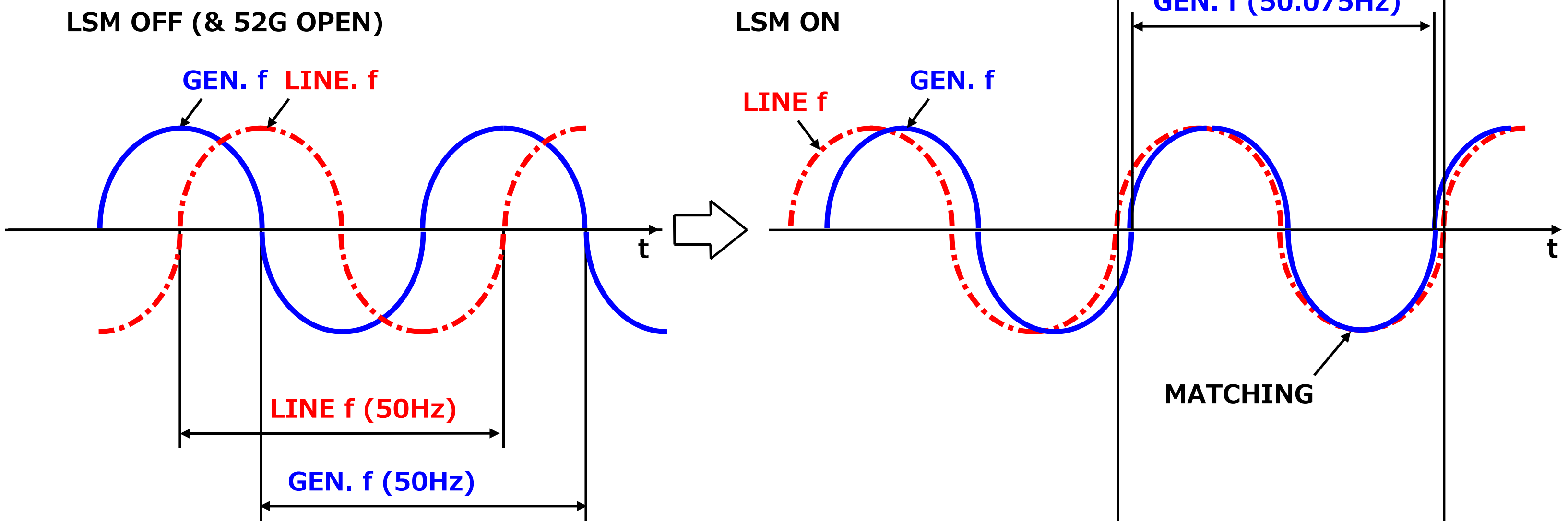
Fig. Over Speed Test Speed Control Chart

4.5 Line speed matching

Purpose: To synchronize to the Grid.
In order to prevent reverse power, Generator frequency should be set at 0.075Hz higher than line frequency.

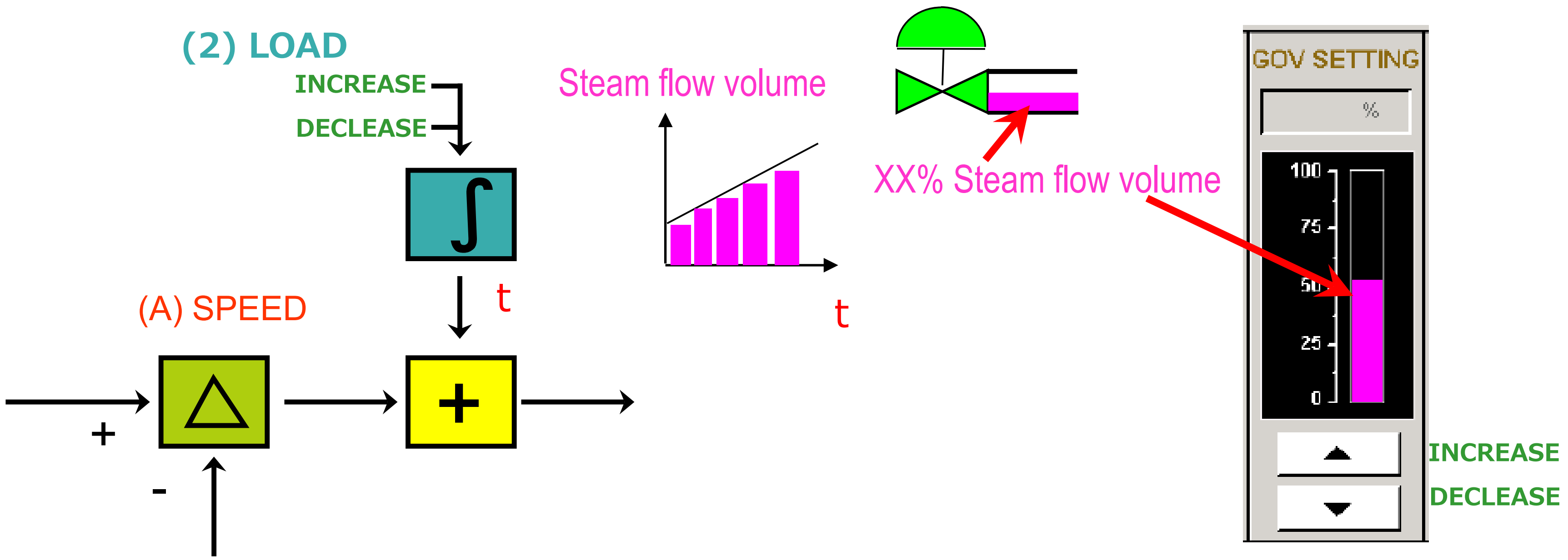




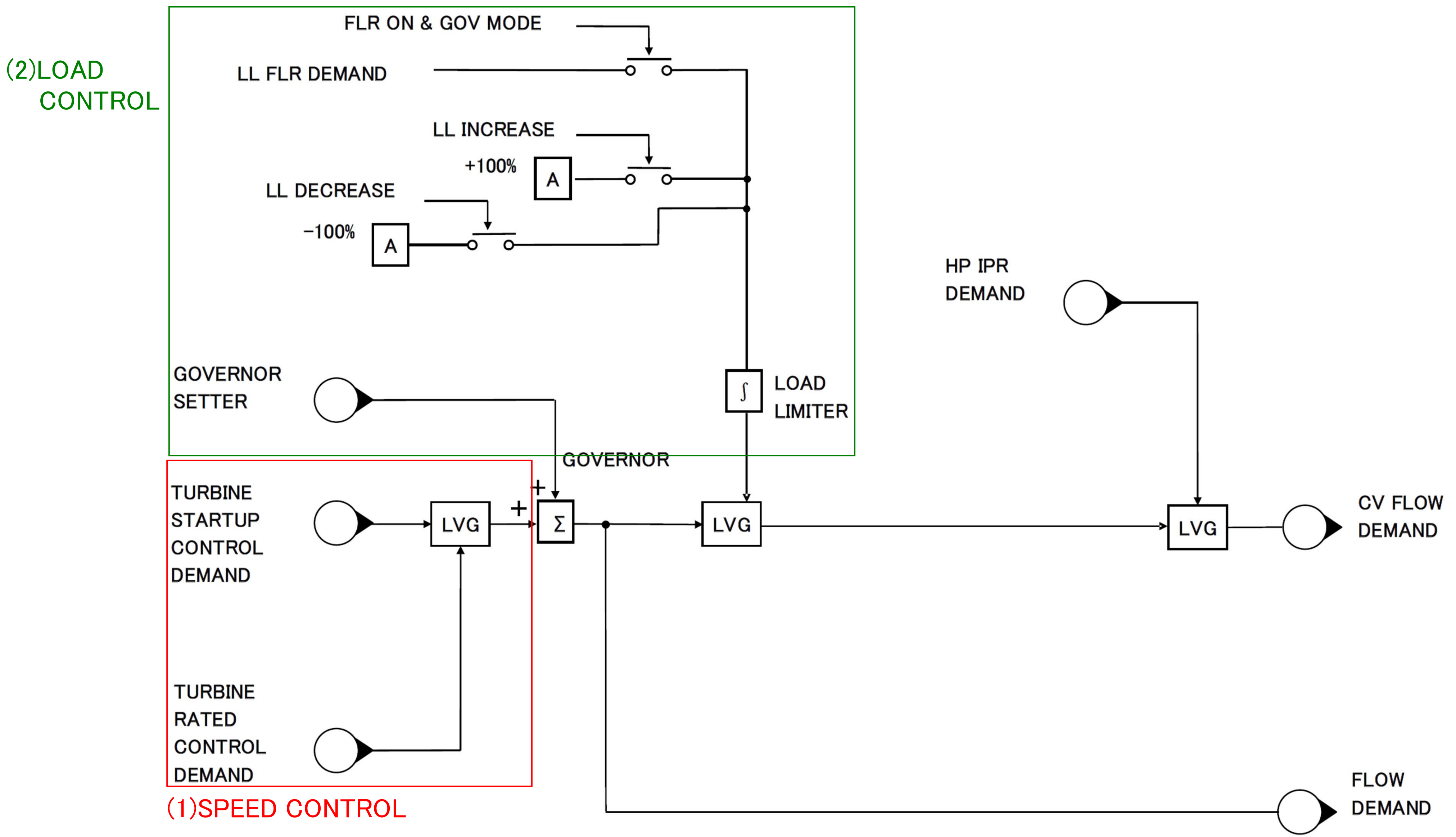


5. Load control essence

The load can be changed by GOV setter.
Operator can set the Steam flow volume with setter in HMI graphics.
Integral macro output the Fuel flow volume (%) with time constant “t”.

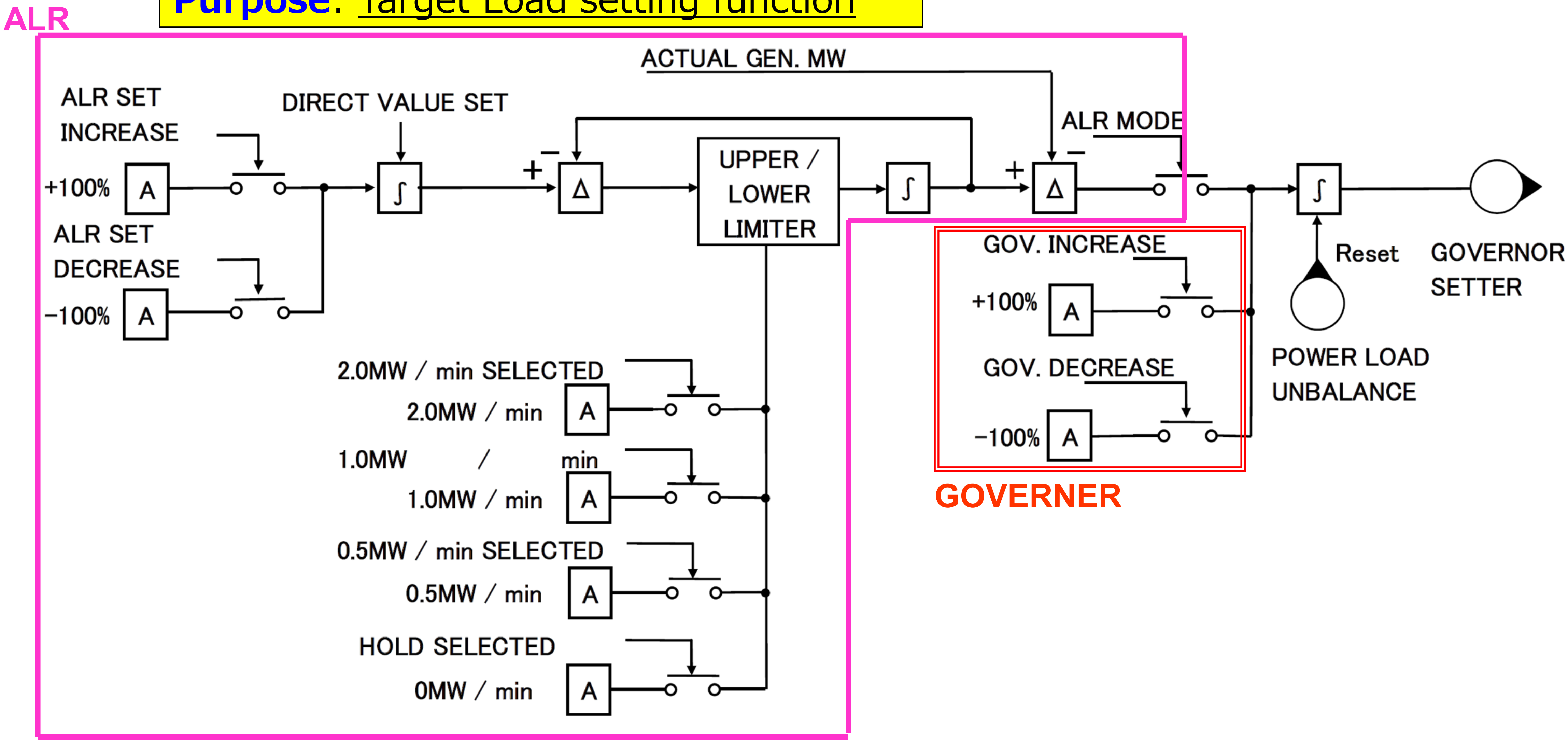


5.1 Load control block overview



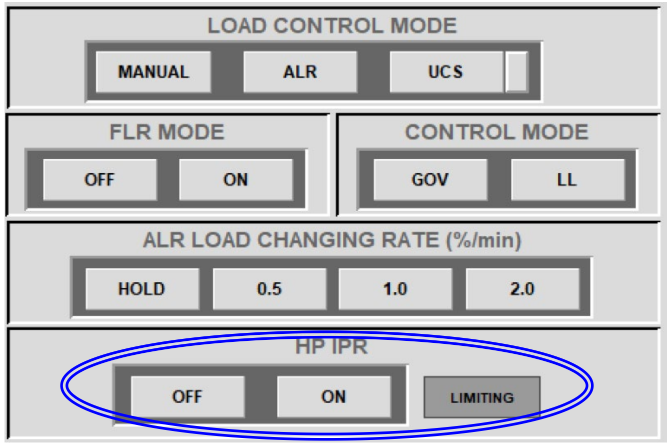
5.2 Governor and ALR (Automatic Load Regulator) block

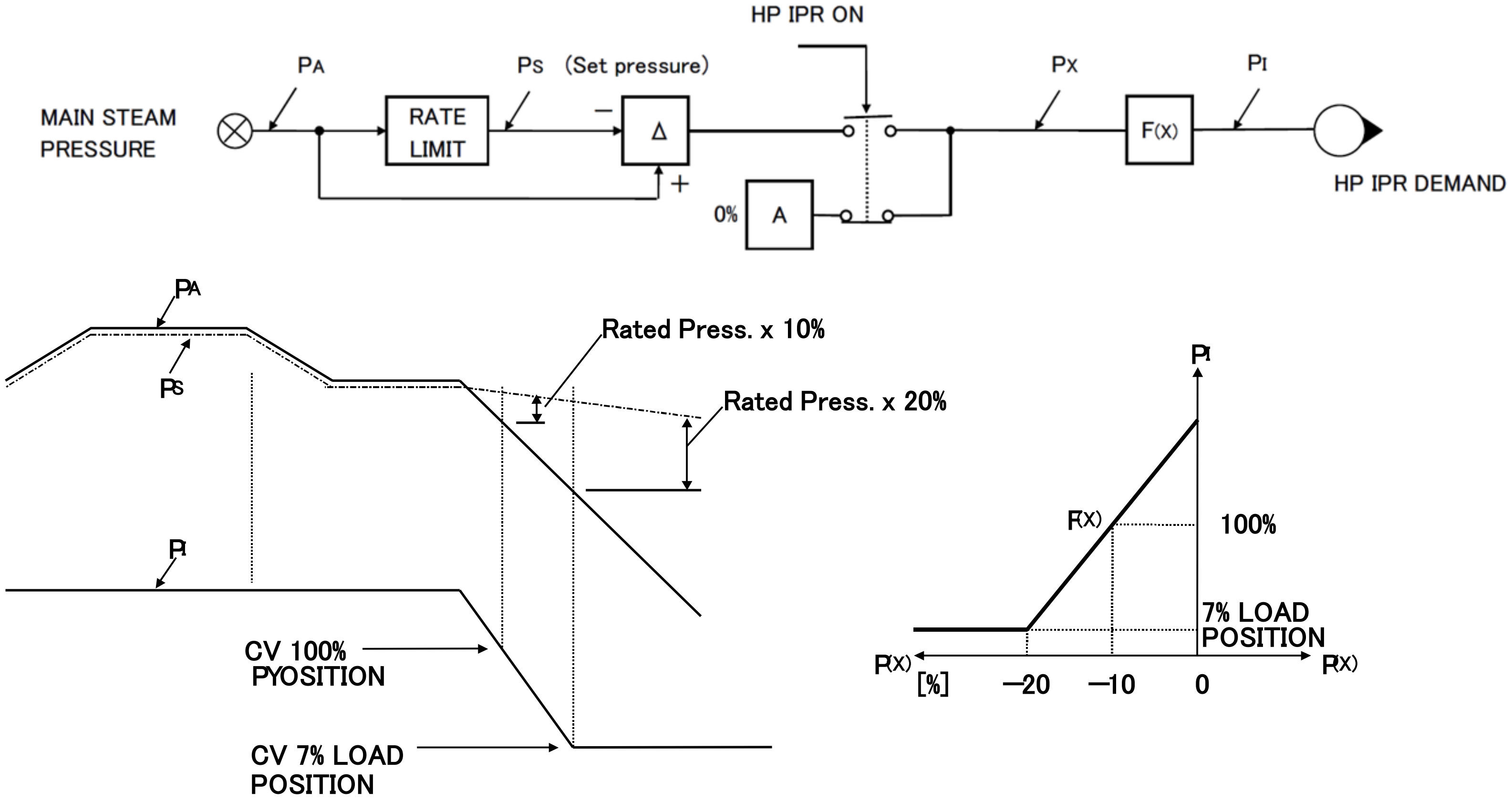
Purpose: Target Load setting function



5.3 IPR (Initial Pressure Regulator) [for protection]

Purpose: To prevent that the wet steam input to turbine
If steam pressure decrease suddenly, steam will be condensed.
Wet steam will damage to turbine, so CV shall be closed gradually by checking deviation of main pressure with IPR function .

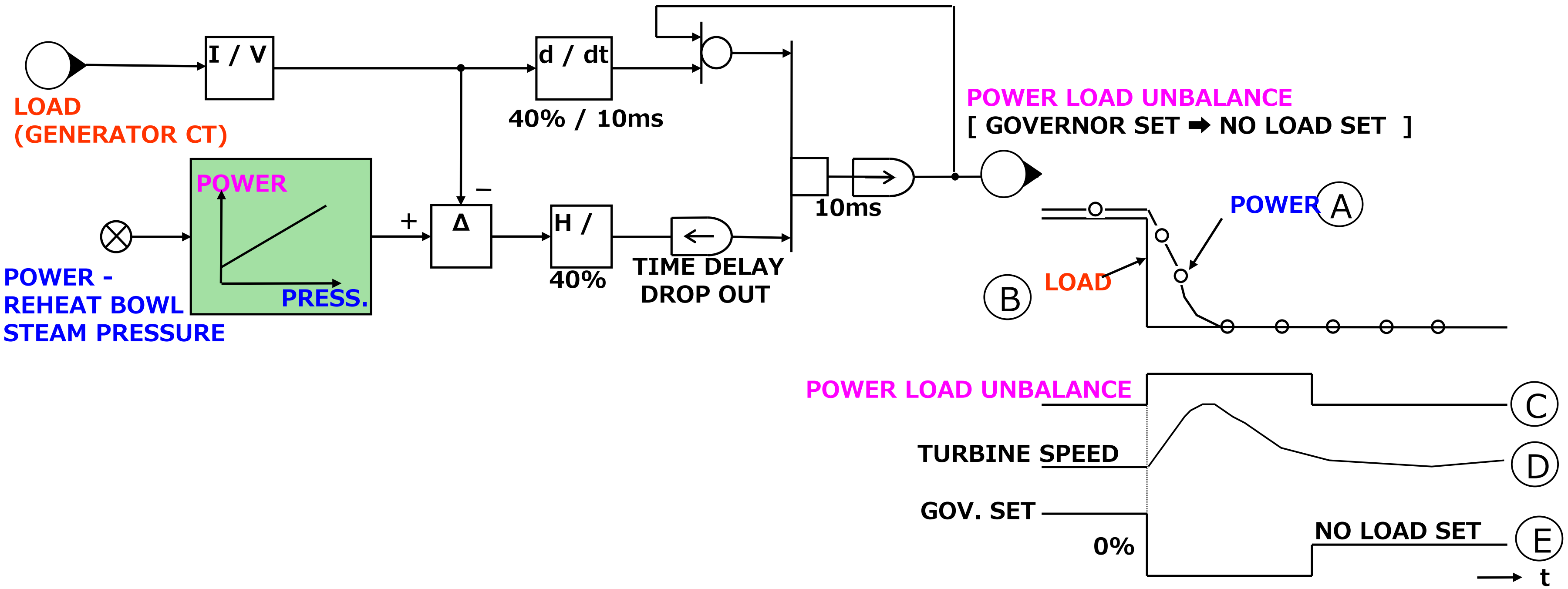




5.4 Power Load Unbalance [for overspeed protection]

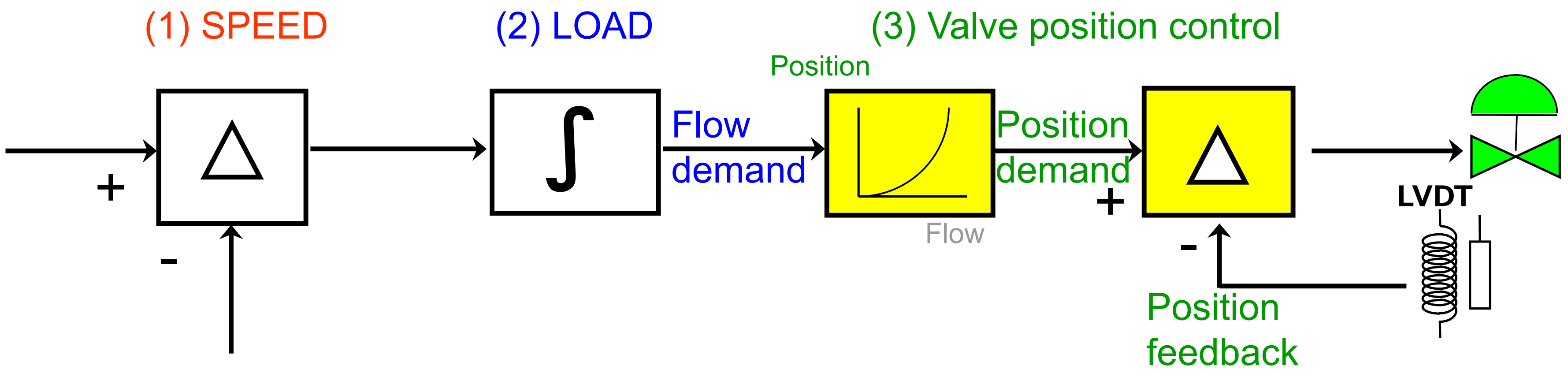
Purpose: To prevent over speed of the turbine after load rejection by closing CV and ICVs.

Generator current is input as load, and reheat bowl steam pressure is input to convert to turbine output power. If the generator current rapidly decreases at a rate of 40% / 10ms or more, and if the unbalance between power and load is 40% or more, the power load unbalance function operates.



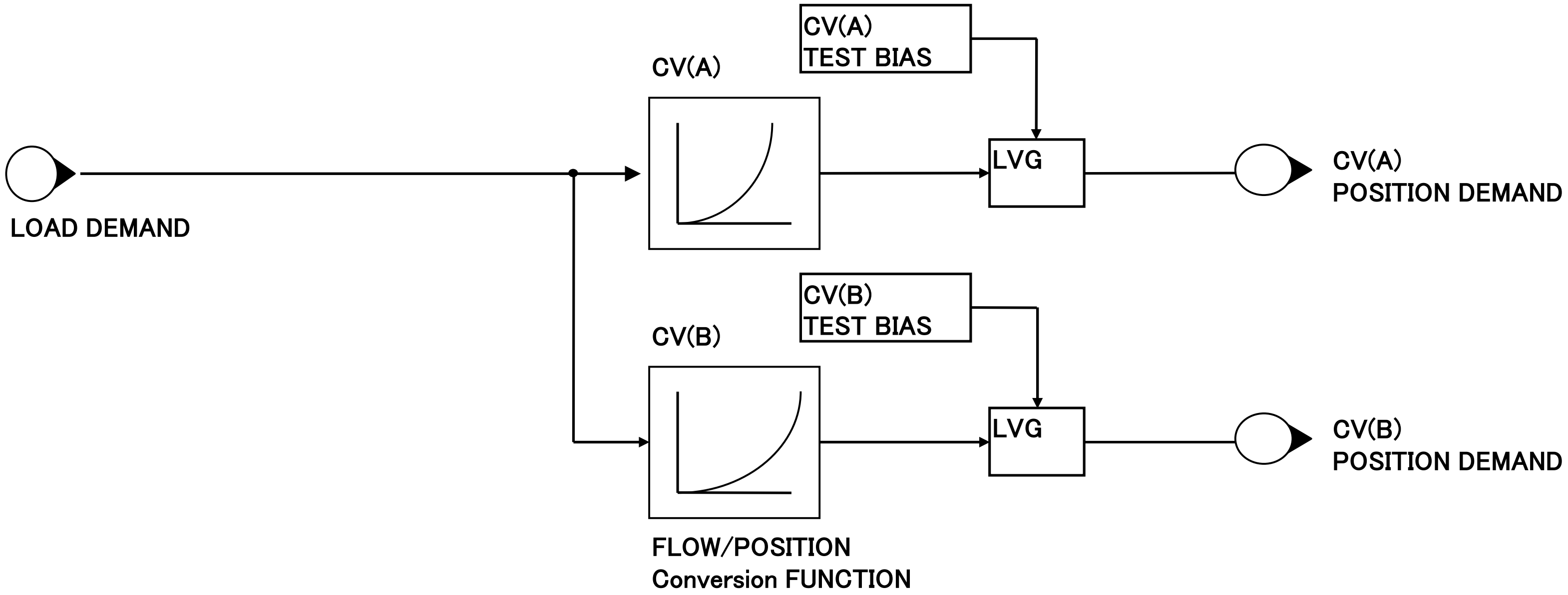
6. Valve position control essence

Valve position control block is calculated by valve calibration curve and position feedback signal.



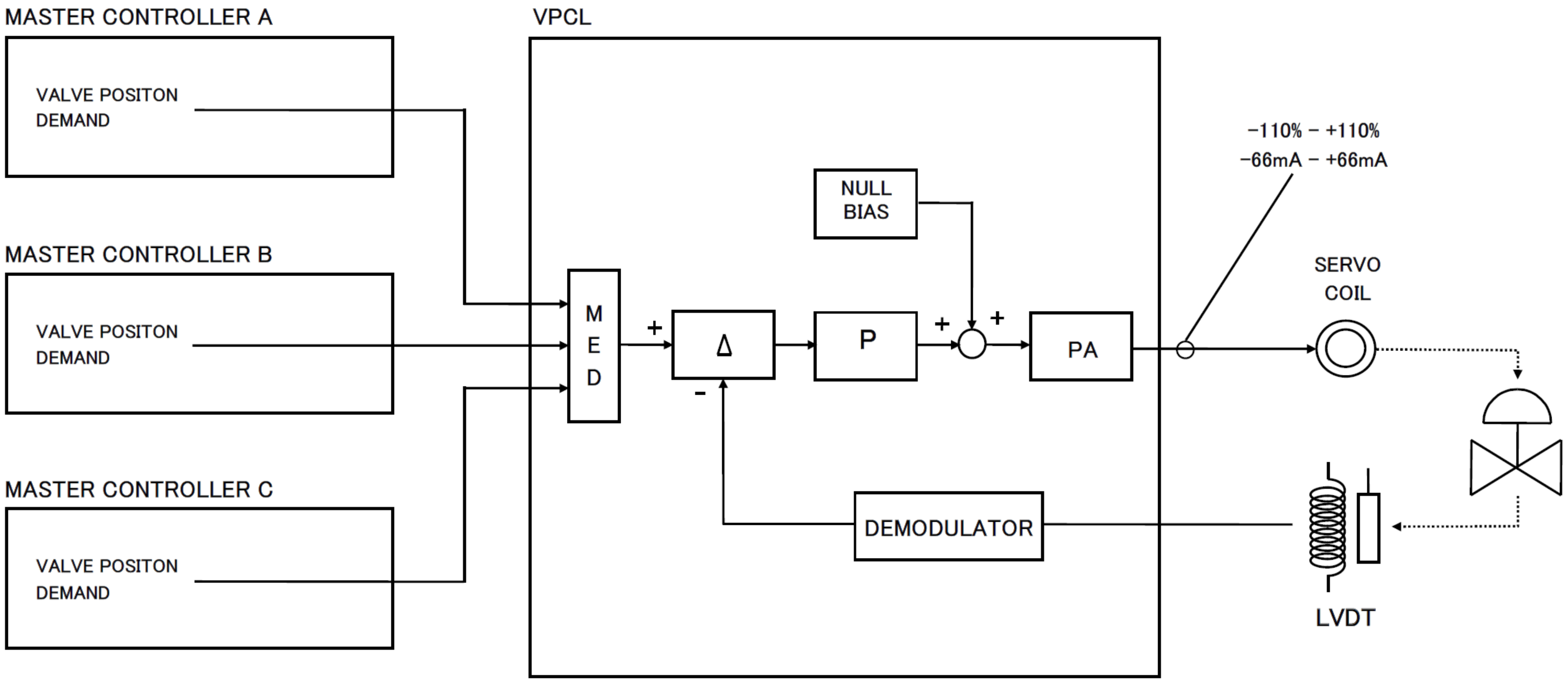
6.1 CV Position demand

Load demand is converted to position demand by valve calibration curve.



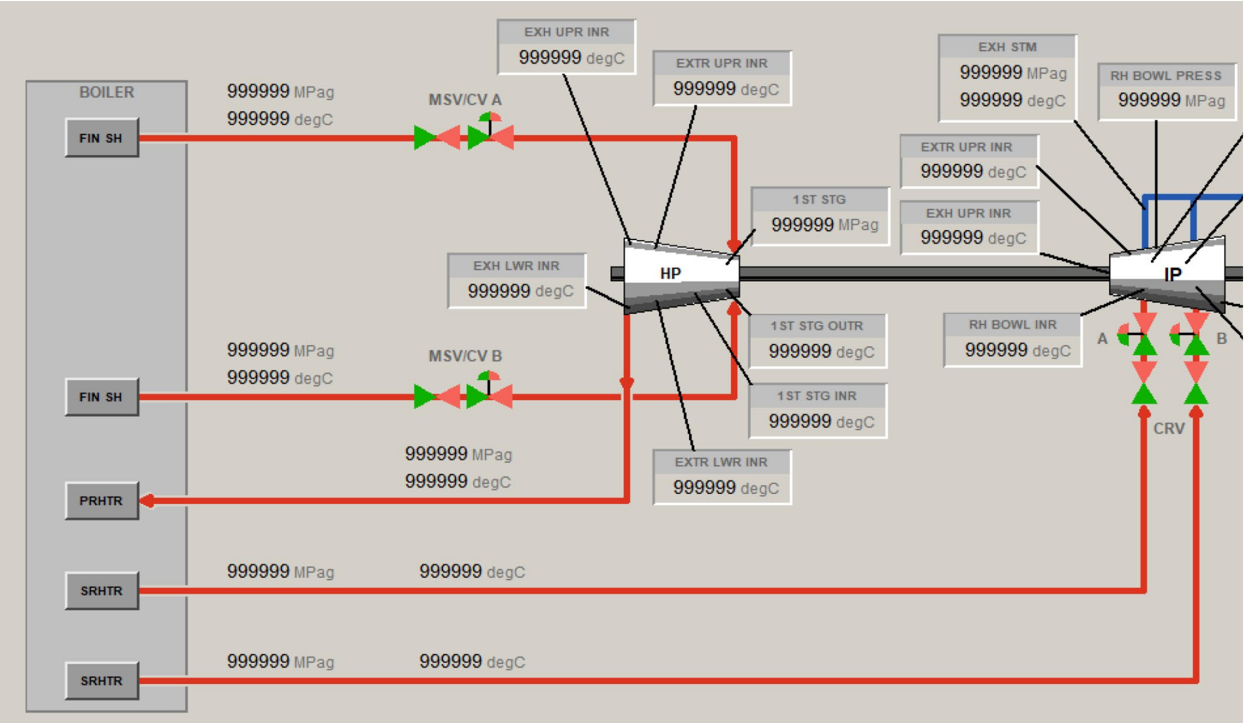
6.2 Valve position control block trough valve interface

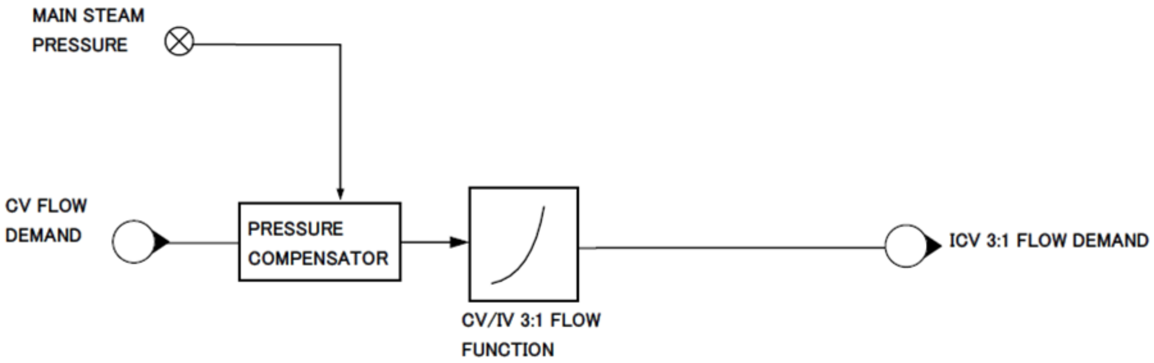
Position demand is subtract by feedback signal, then output to valve interface.
Master controller A, B and C send position demand independently.



6.3 3:1 flow function [for pipeline protection]

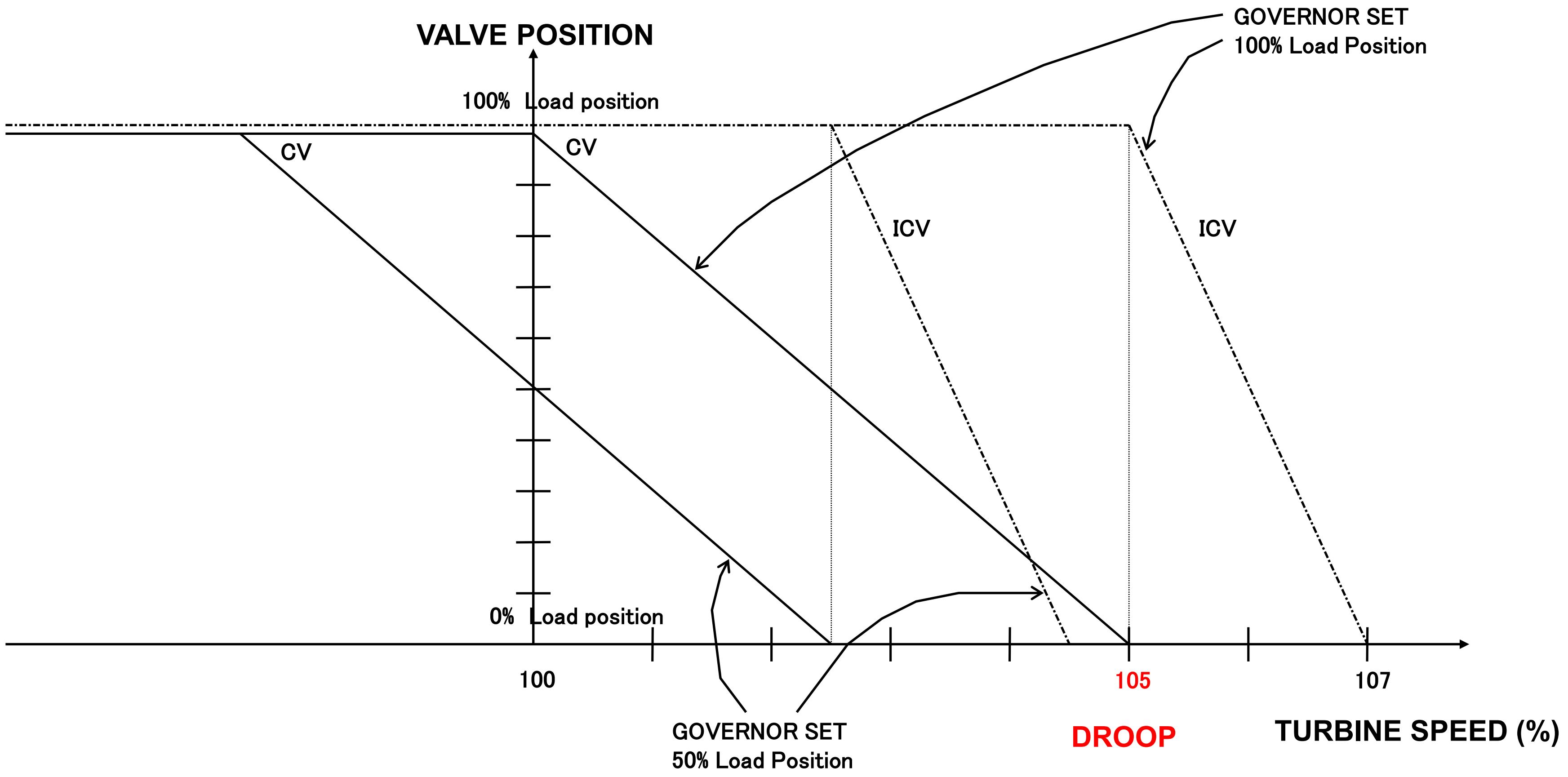
Purpose: To balance steam flow rate between inlet flow and exhaust flow.
If exhaust steam flow is much less than inlet steam flow, exhaust steam flow pipe line will be damaged because of temperature.
So with this function, ICV valve position is controlled.





6.4 Valve position vs. Turbine speed

CV POSITION = (Speed set – Turbine Speed) x GAIN + Governor Set



6.5 Explanation of DROOP concept

To explain conceptually, Flow demand and Valve pos. and Load are fully liner relation.

(2)Flow demand(100%)

(3)Valve position(100%)

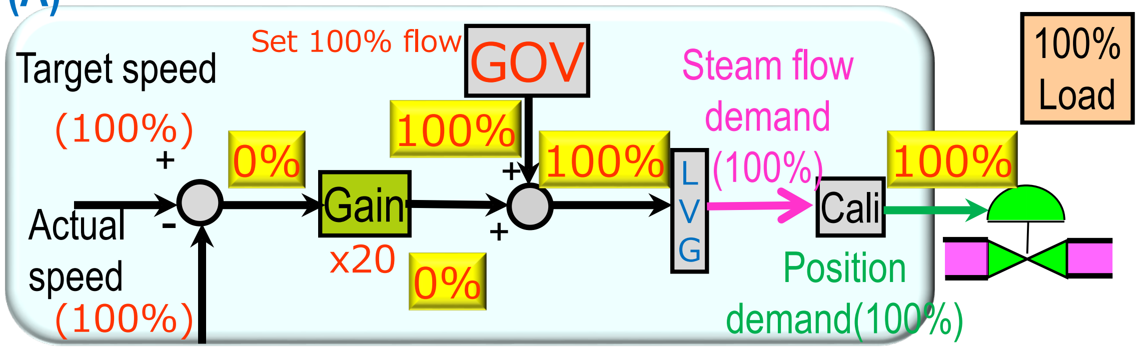
(100%Load)

Gain 100 / 5 = 20

Gain is calculated from droop.
(ex.)5% for explanation

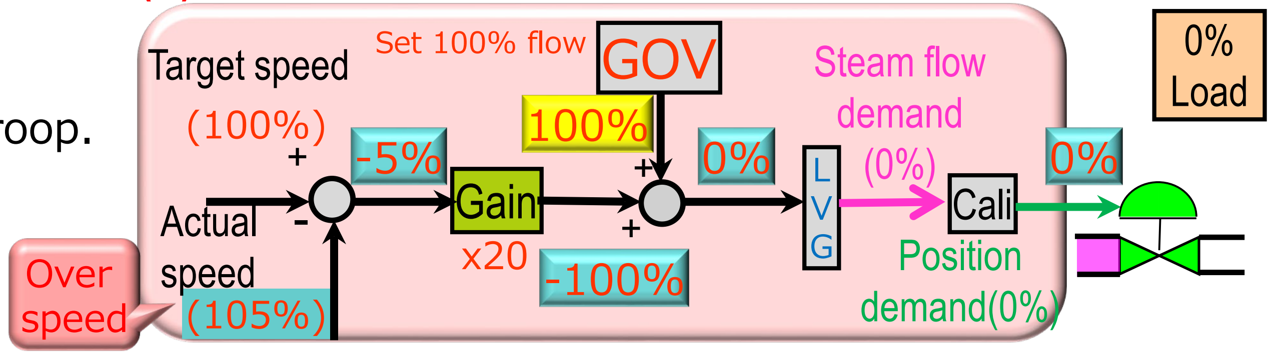
For VP PJ
DROOP = 5%

(A)



(A) Under the rated speed condition, flow demand is set at 100% by GOV and valve position is set at 100%. (100% load)

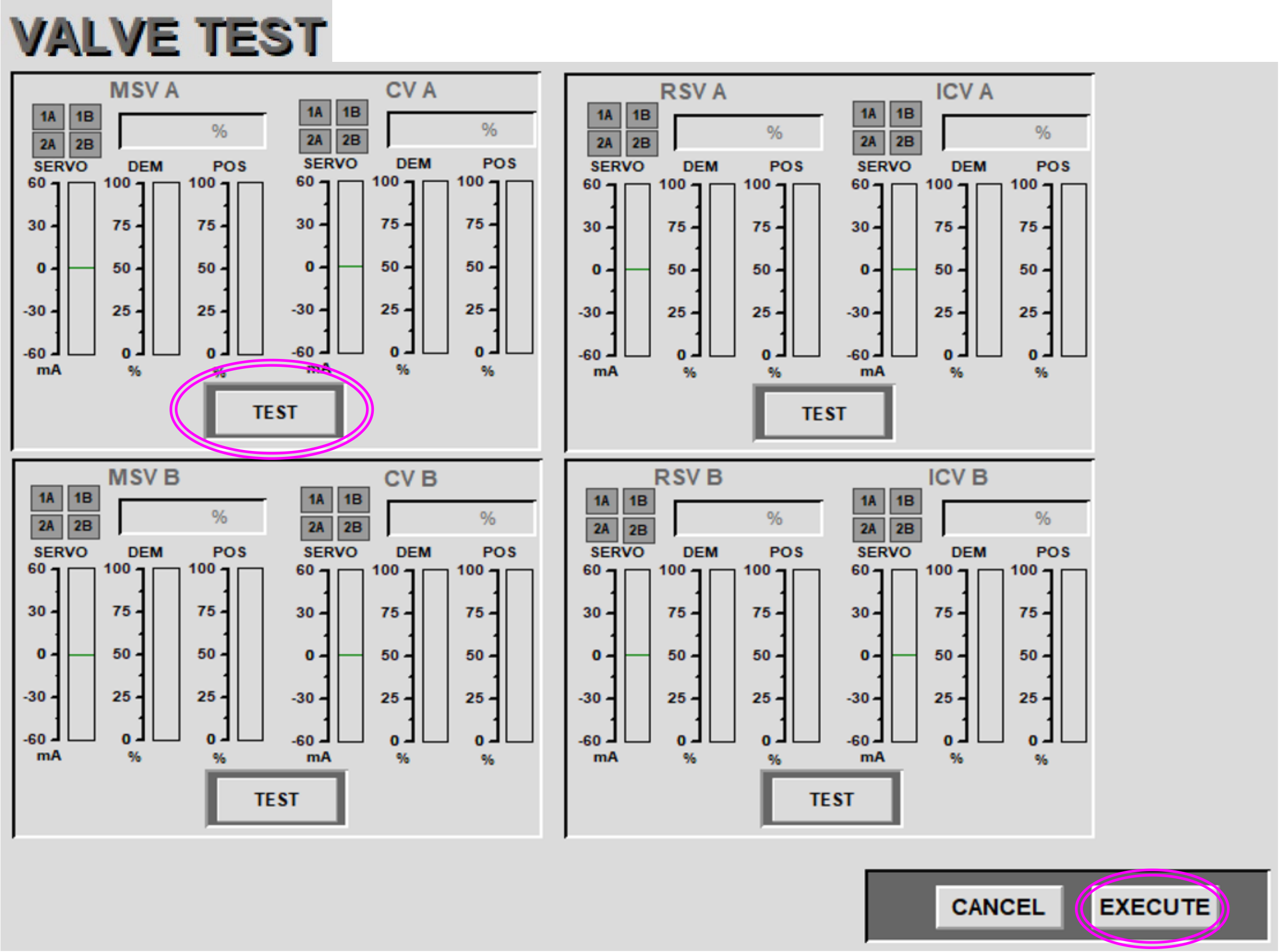
(B)

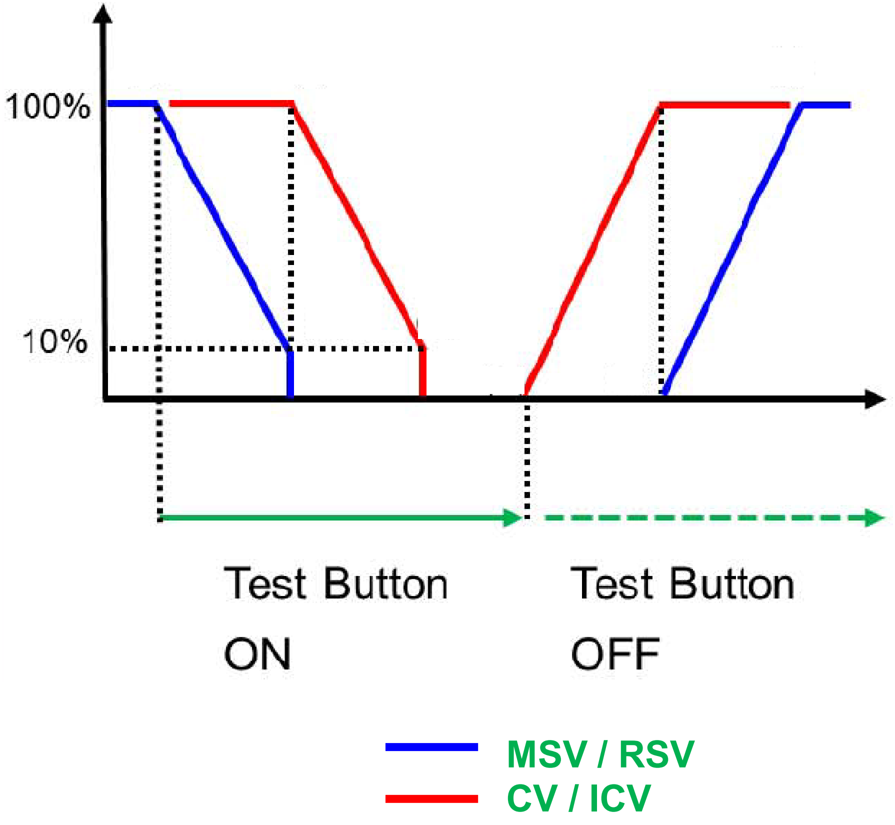


(B) If speed is exceed the rated speed at 105%, speed control block calculates -100% demand, then flow demand is set at 0%, and valve will be closed.

6.6 Valve Test

Purpose: To confirm the valve is not stick and close normally. (periodically)





7.1 Governor Follow up Load Regulator

Purpose: Preparation for change to GOV mode during LL mode.

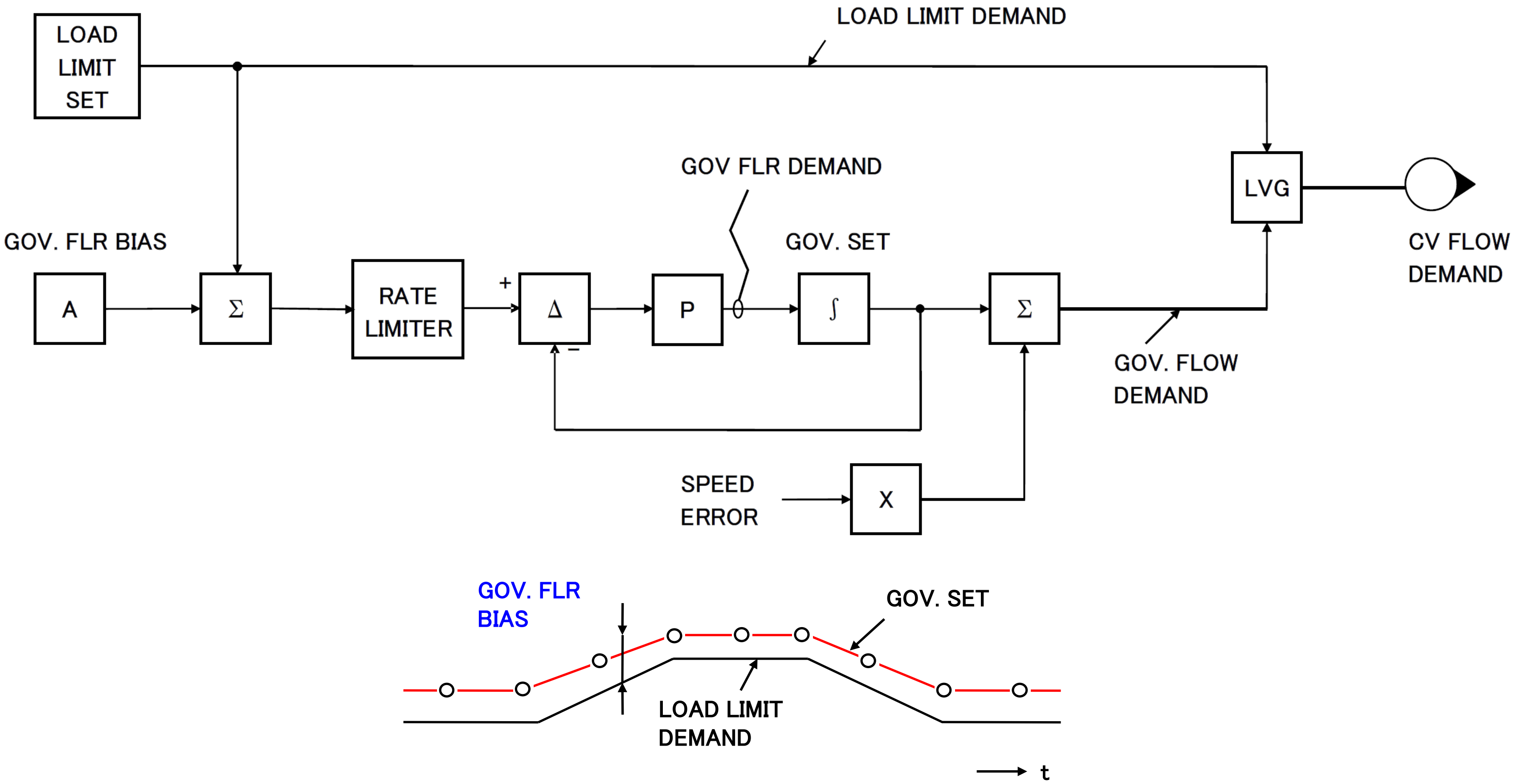
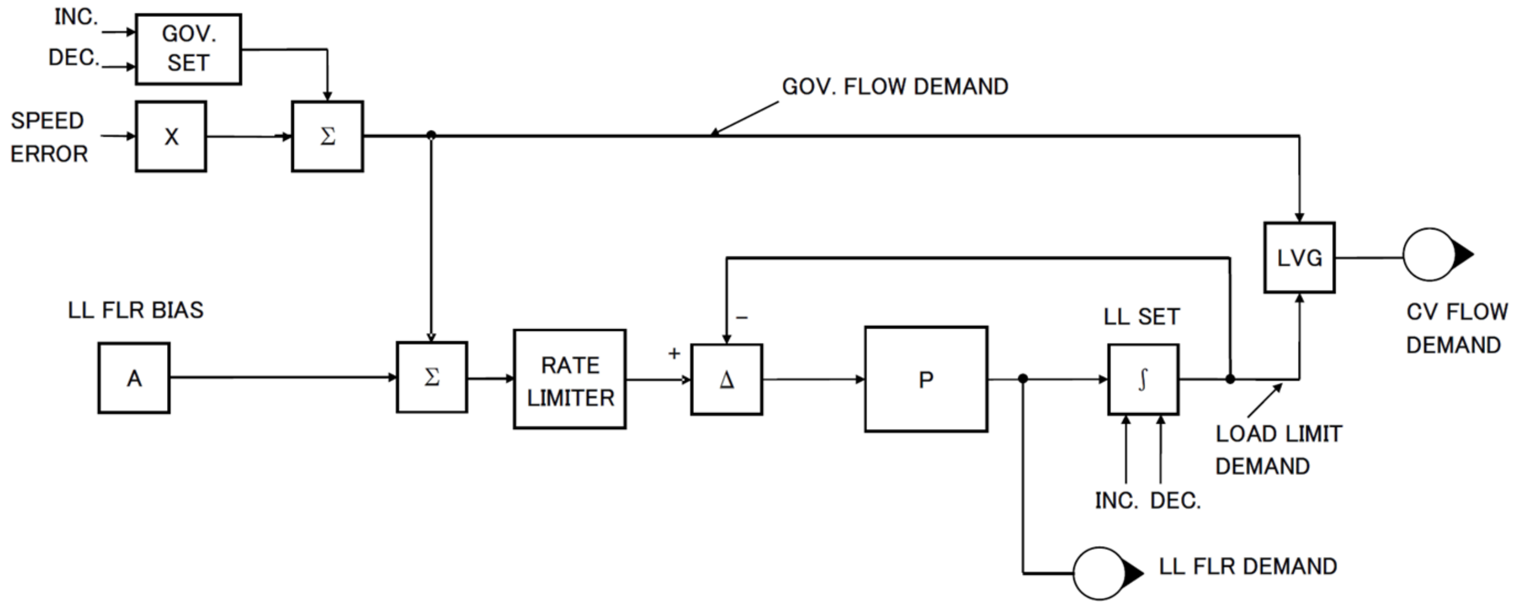
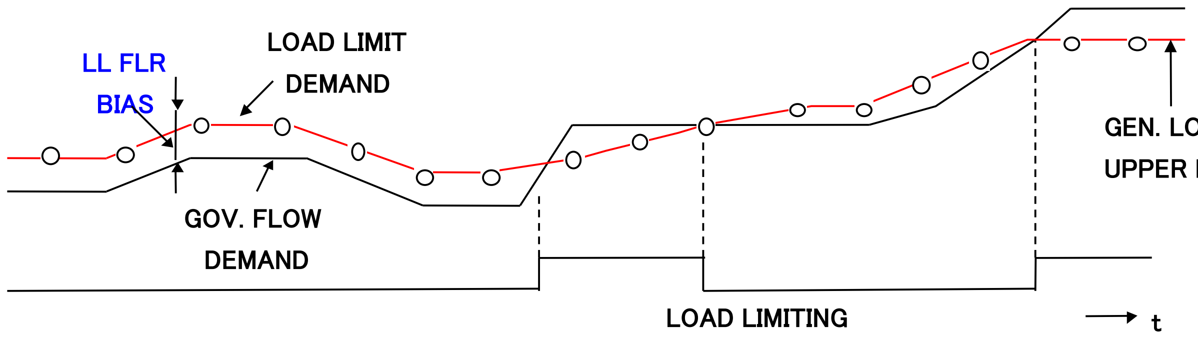


Fig. Governor Follow up Load Regulator block and regulating chart

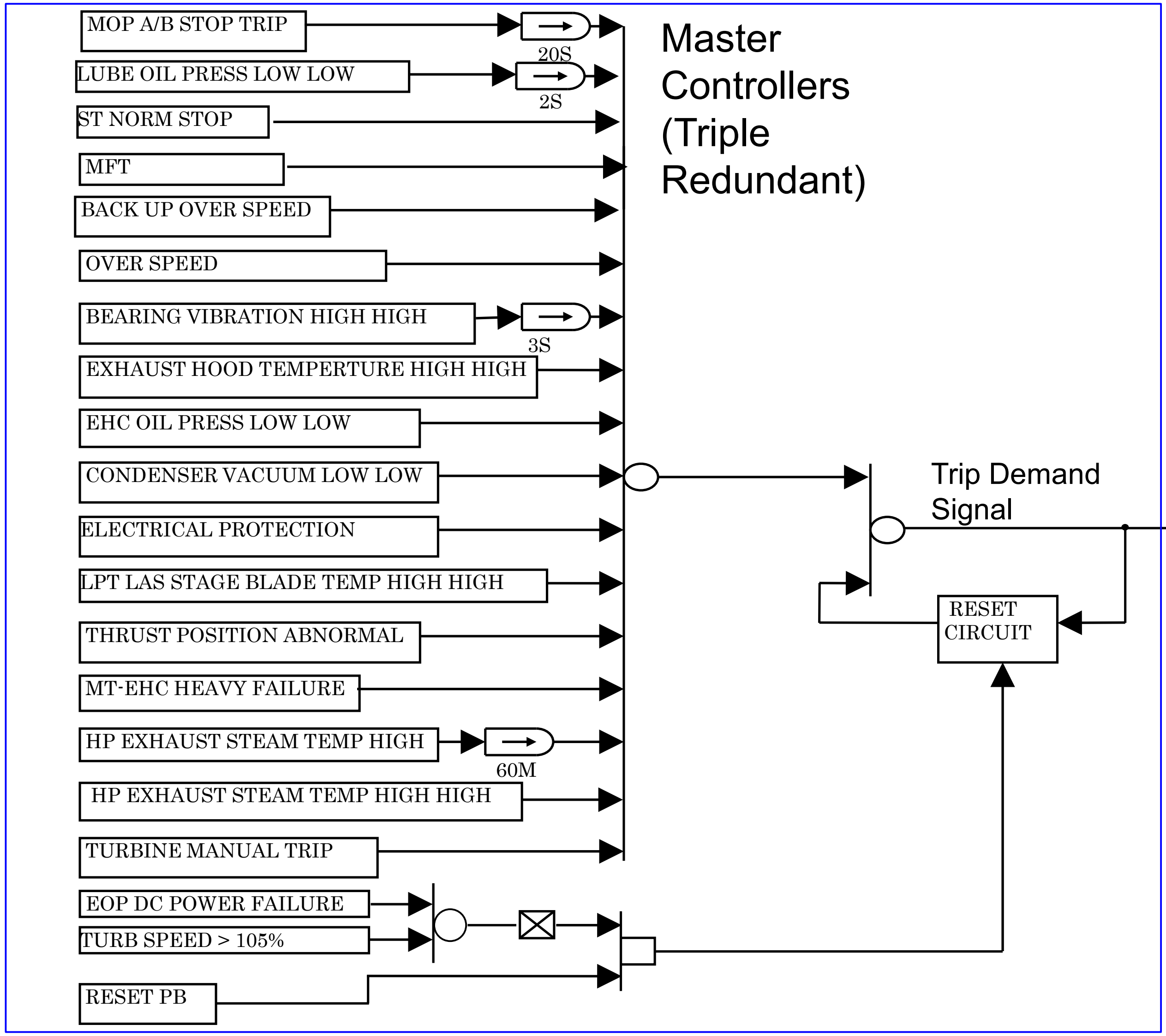
7.2 Load limit Follow up Load Regulator

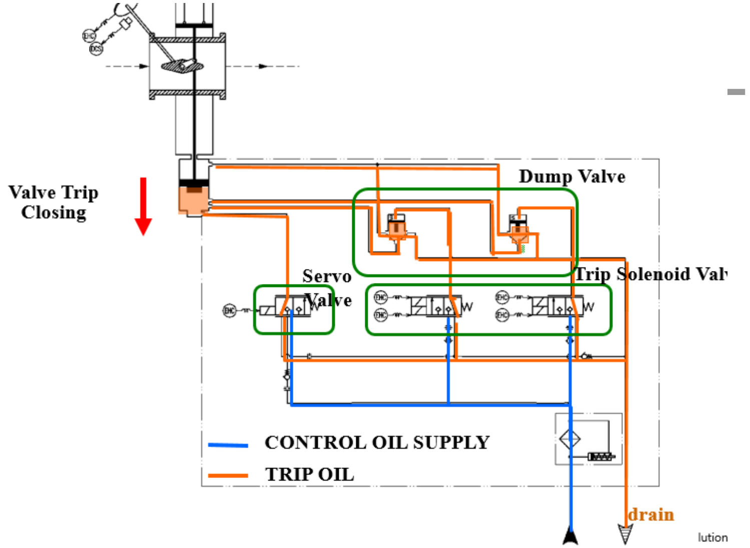
Purpose: Prevent CV to open rapidly when grid frequency goes down during GOV mode.

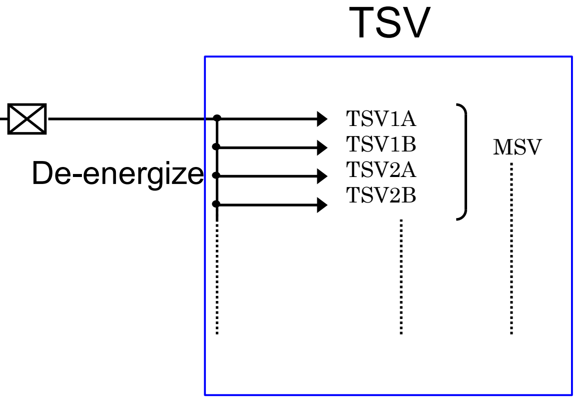




8. Turbine protection







If one of these trip condition occurs, Trip Logic Card will send a trip signal to de-energize Trip Solenoid Valve.

Van Phong 1 BOT Thermal Power

Training for D-EHC System
5. Software Simulator Explanation

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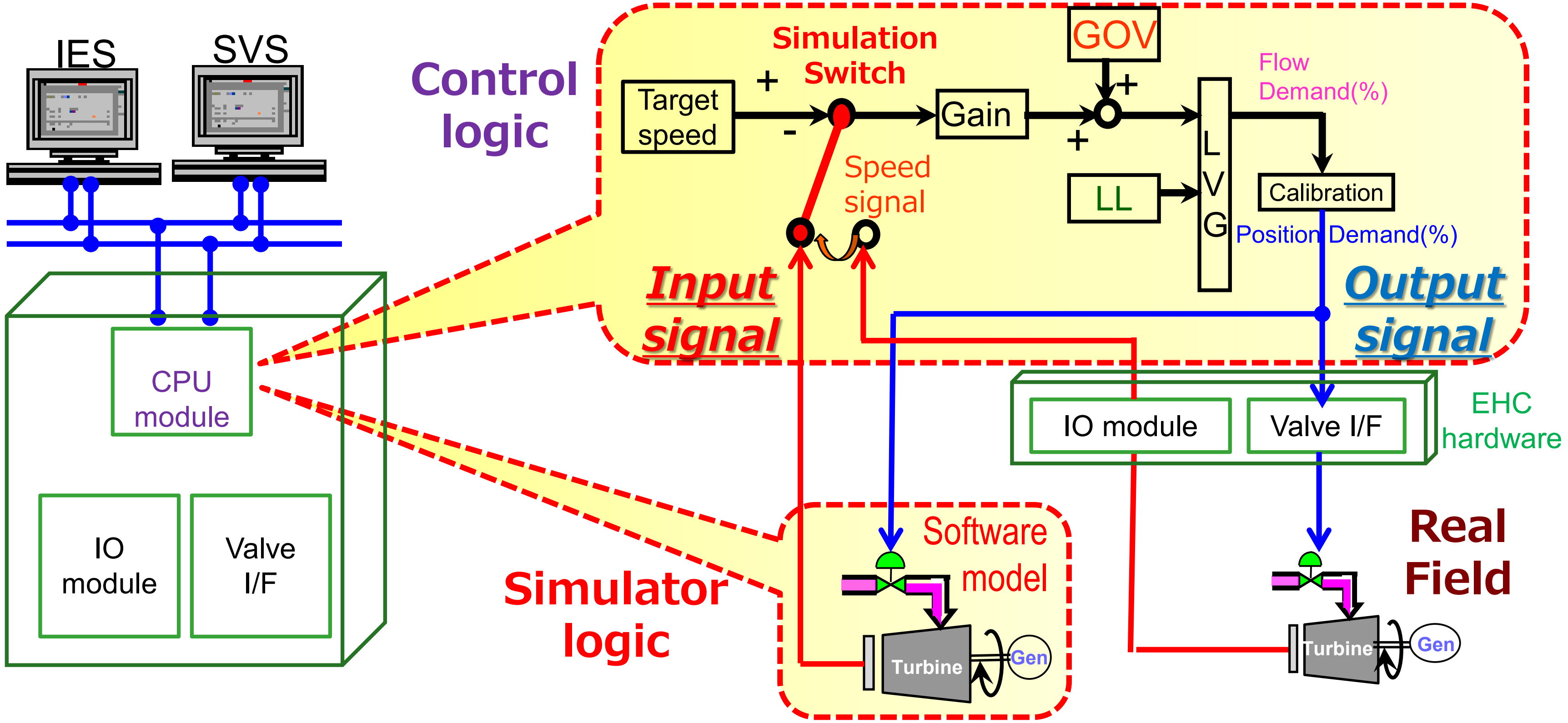
1. Software Configuration Explanation

1. Both real control logic and simulator logic are installed in the CPU module.
2. Output signal is outputted to both the simulator and the real field.
3. On the other hand, input signal can be selected by Simulation Switch (software) shown below.
   During the simulation test, input signals from the simulator are used to verify the control logic.



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Training for D-EHC System
6. Turbine Start-up & How to Read Mismatch Chart

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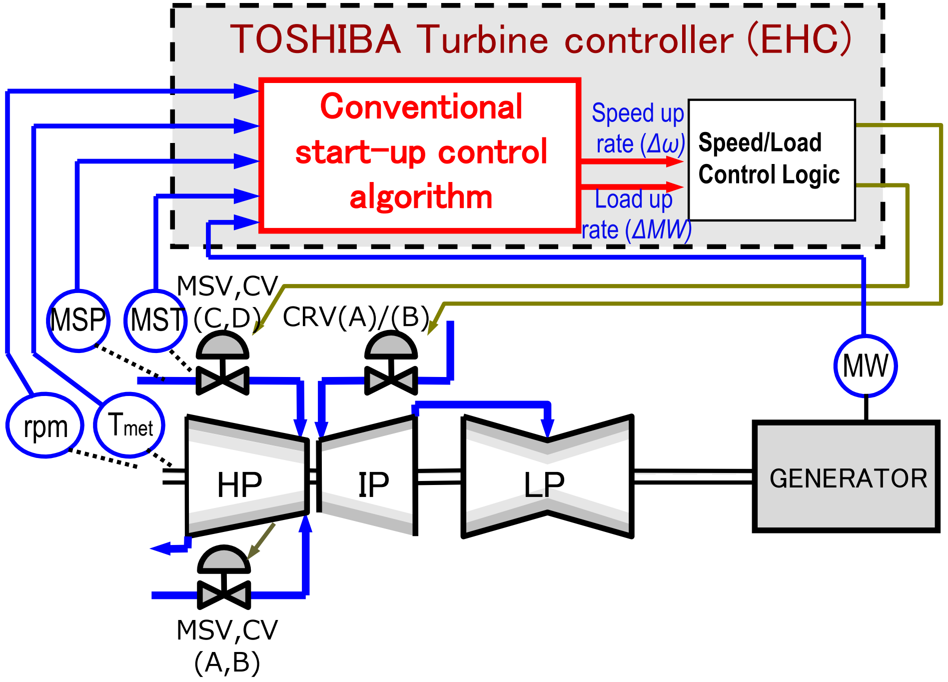
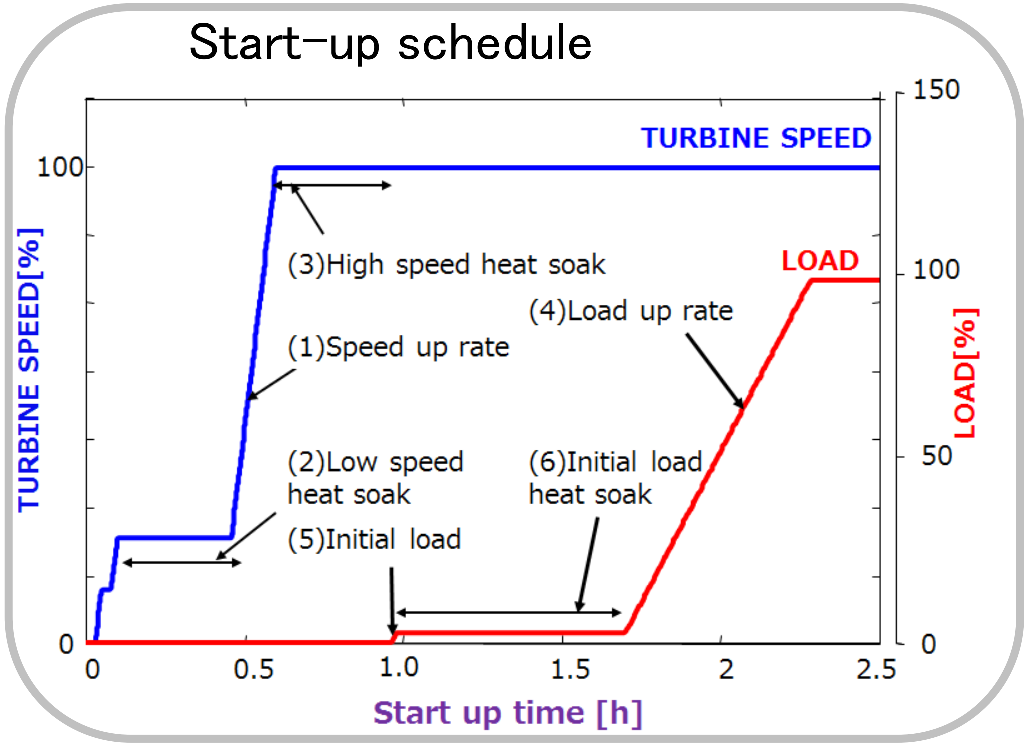
1. Start-up Control for Steam Turbine

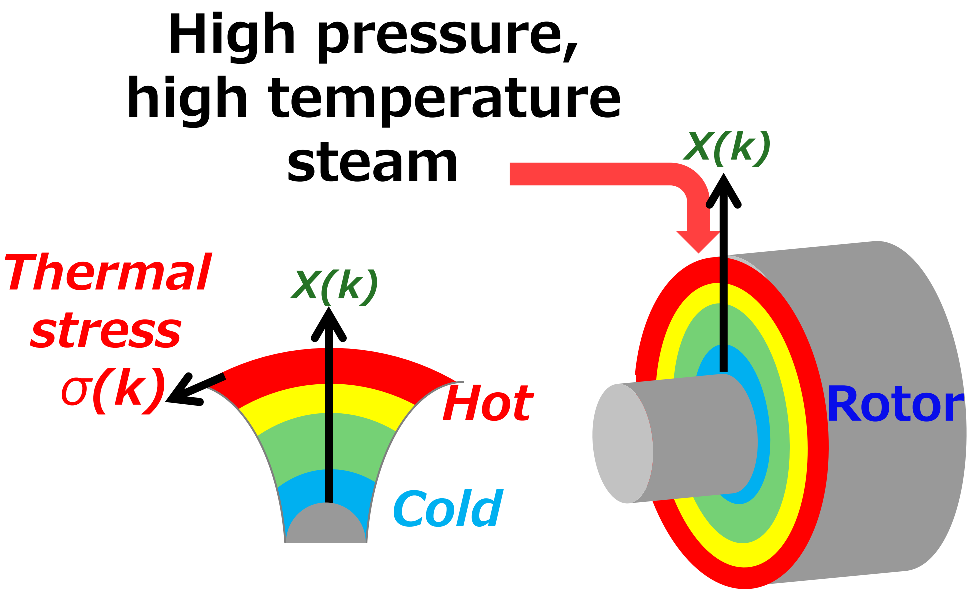


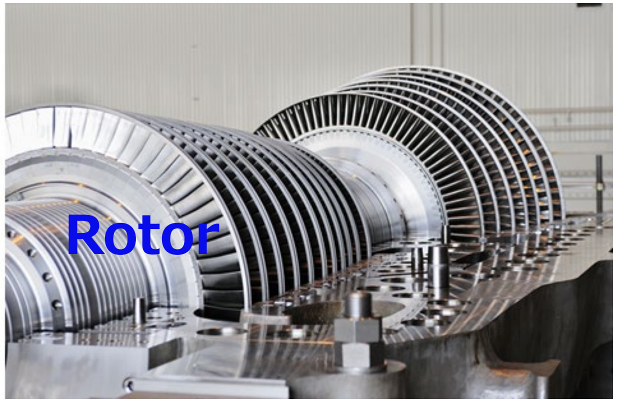


Note :

- Rotor thermal stress
- Differential expansion of rotor

2. Rotor Thermal Stress



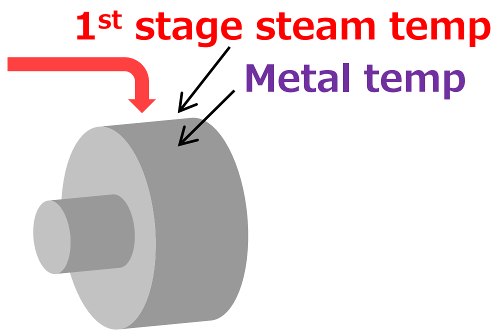


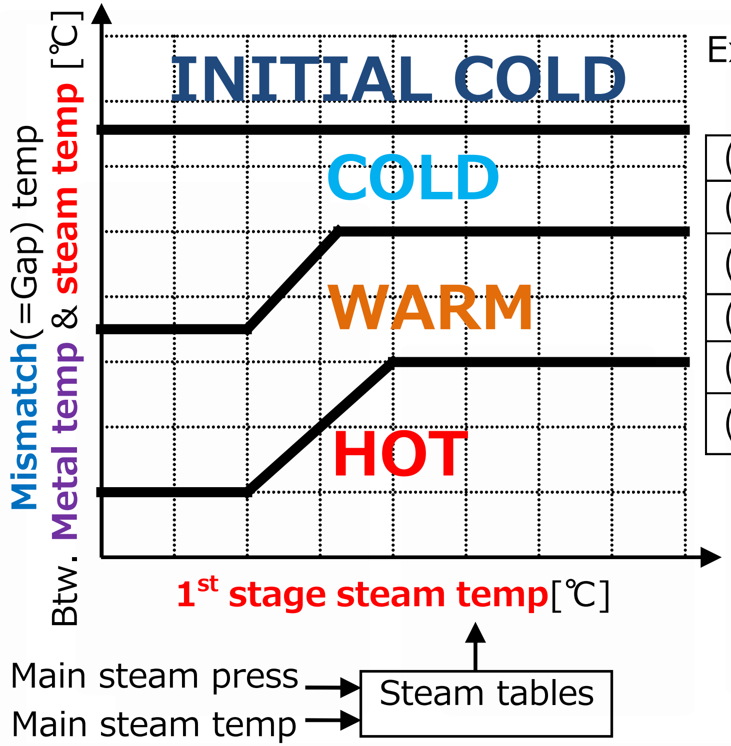
Note：

- Thermal stress ≦ Threshold

(To prevent reduction of turbine life span)

3. Mismatch Chart Explanation



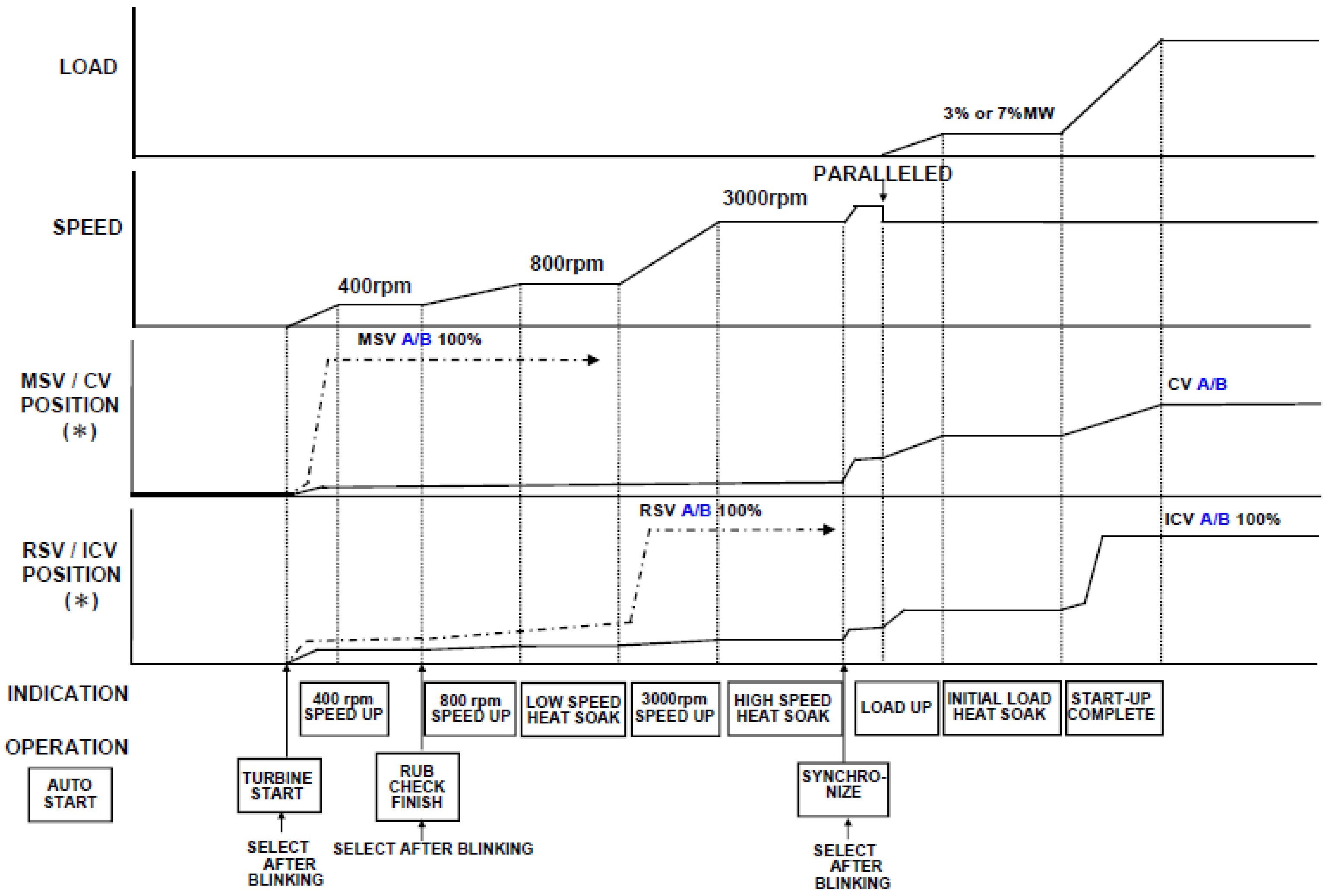


Ex.) **WARM** mode's start-up parameters

(1)Speed up rate	150 (rpm/min)
(2)Low speed heat soak time	0 (min)
(3)High speed heat soak time	5 (min)
(4)Load up rate	1 (%/min)
(5)Initial load	5 (%)
(6)Initial load heat soak time	5 (min)

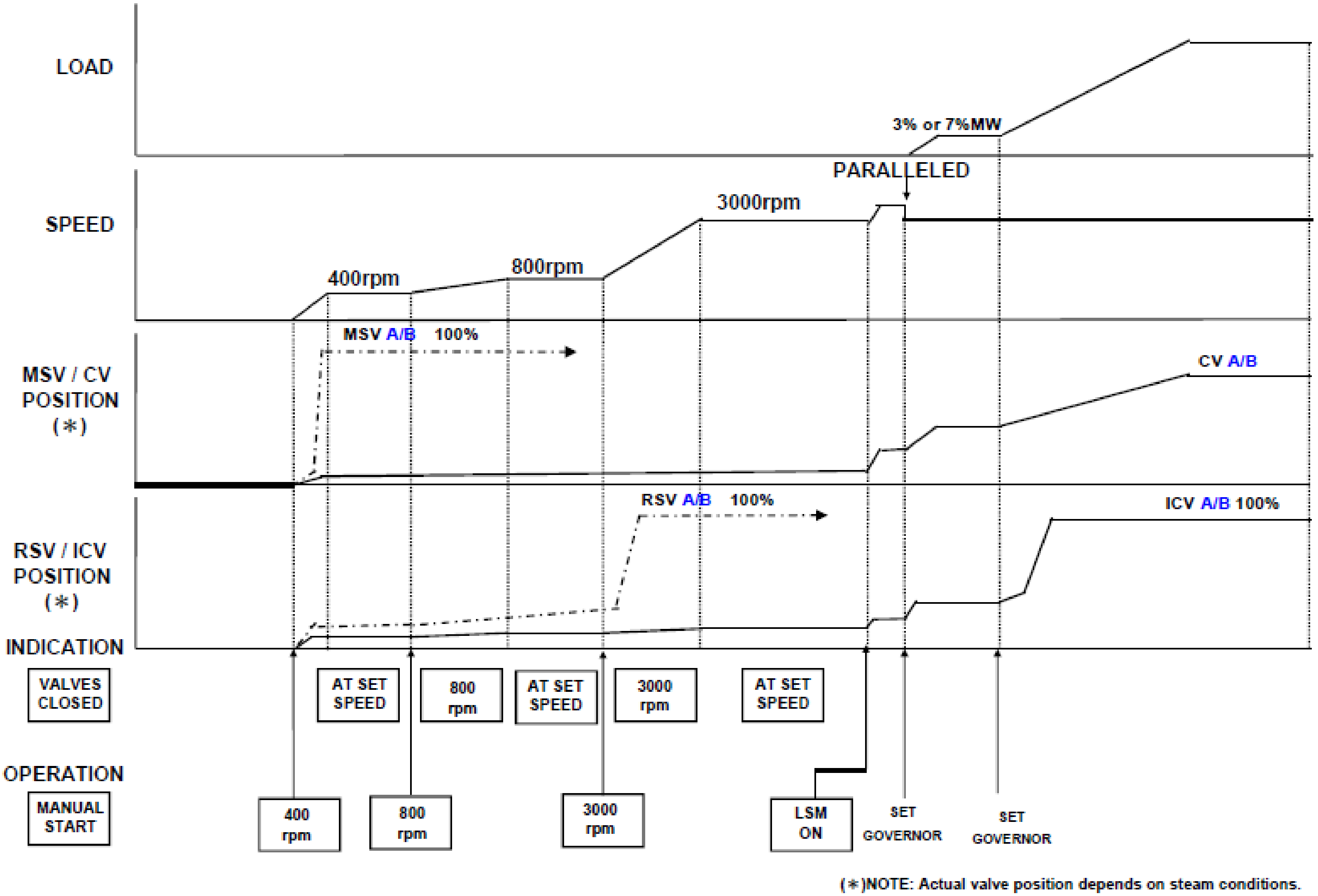
The start-up schedule is decided by the steam condition and the metal temperature before start-up
→ Enough time margin is included

4. Start-up Control – Automatic Mode



(＊)NOTE: Actual valve position depends on steam conditions.

5. Start-up Control – Manual Mode



6. Start-up Parameter

Example

Start up mode	Shutdown Time	ST 1st Metal Temp *(deg.C)*	MS Temp *(deg.C)*	MS Press *(bara)*
Initial Cold Start	>72 hours	150-295	350	85
Cold Start	56 - 72 hours	296-319	400	85
Warm Start	8 - 56 hours	320-444	440	85
Hot Start	<8 hours	>445	500	85

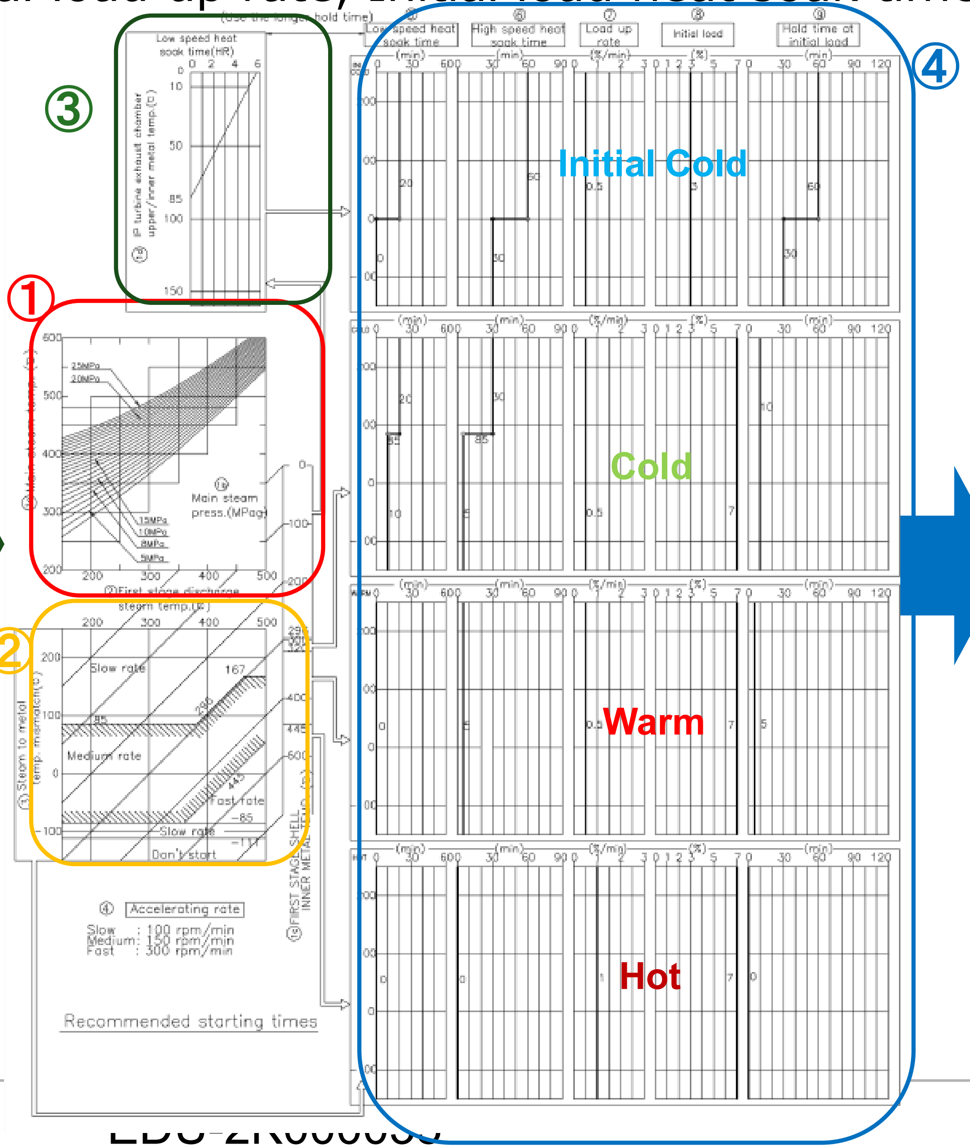
7. Mismatch Chart

Mismatch chart is chart used to determine **Proper start-up schedule** (Turbine acceleration, heat soak time, initial load value, initial load up rate, Initial load heat soak time) , in order to control Thermal Stress at the Turbine.

Input

(measurable field parameter)

1. Main Steam Temp
2. Main Steam Pressure
3. First Stage Shell Inner Metal Temp
4. IP Turbine Exhaust Chamber Upper/Inner Metal Temp (*for Init Cold start only)*



Mismatch chart

Output

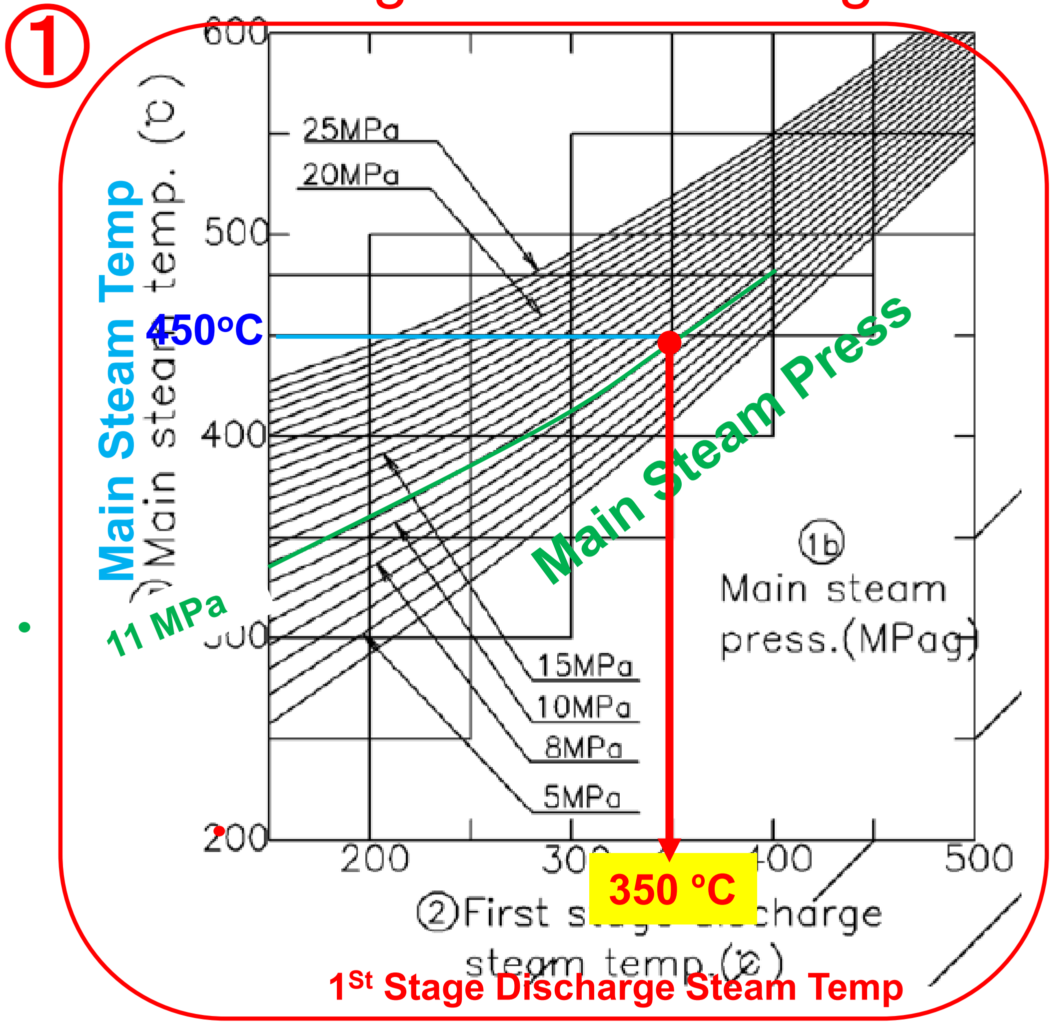
(calculation result)

1. Turbine Acceleration rate
2. Heat Soak Time
3. Initial Load Value
4. Load up rate
5. Initial Load Heat Soak Time

7. Mismatch Chart - ①

Step 1:

Determine First Stage Shell Discharge Steam Temperature by following chart.



Example:

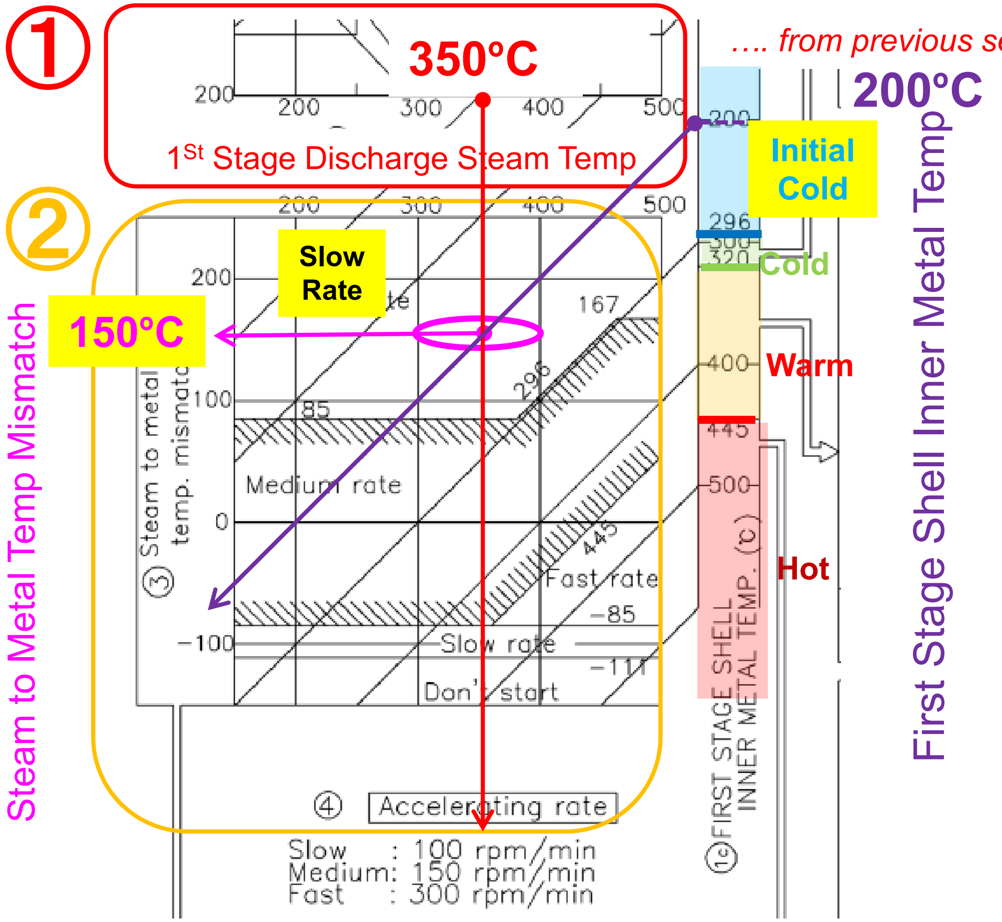
1. Main Steam Temp : 450°C
2. Main Steam Press : 11 MPag

1St Stage Discharge Steam Temp
= 350°C

7. Mismatch Chart - ②

Step 2:

Determine (1) Acceleration rate, (2) Steam to Metal Temp Mismatch and (3) Start up Mode by 1st Stage Discharge Steam Temp and First Stage Shell Inner Metal Temp.



Example:

3. First Stage Shell Inner Metal Temp= 200°C

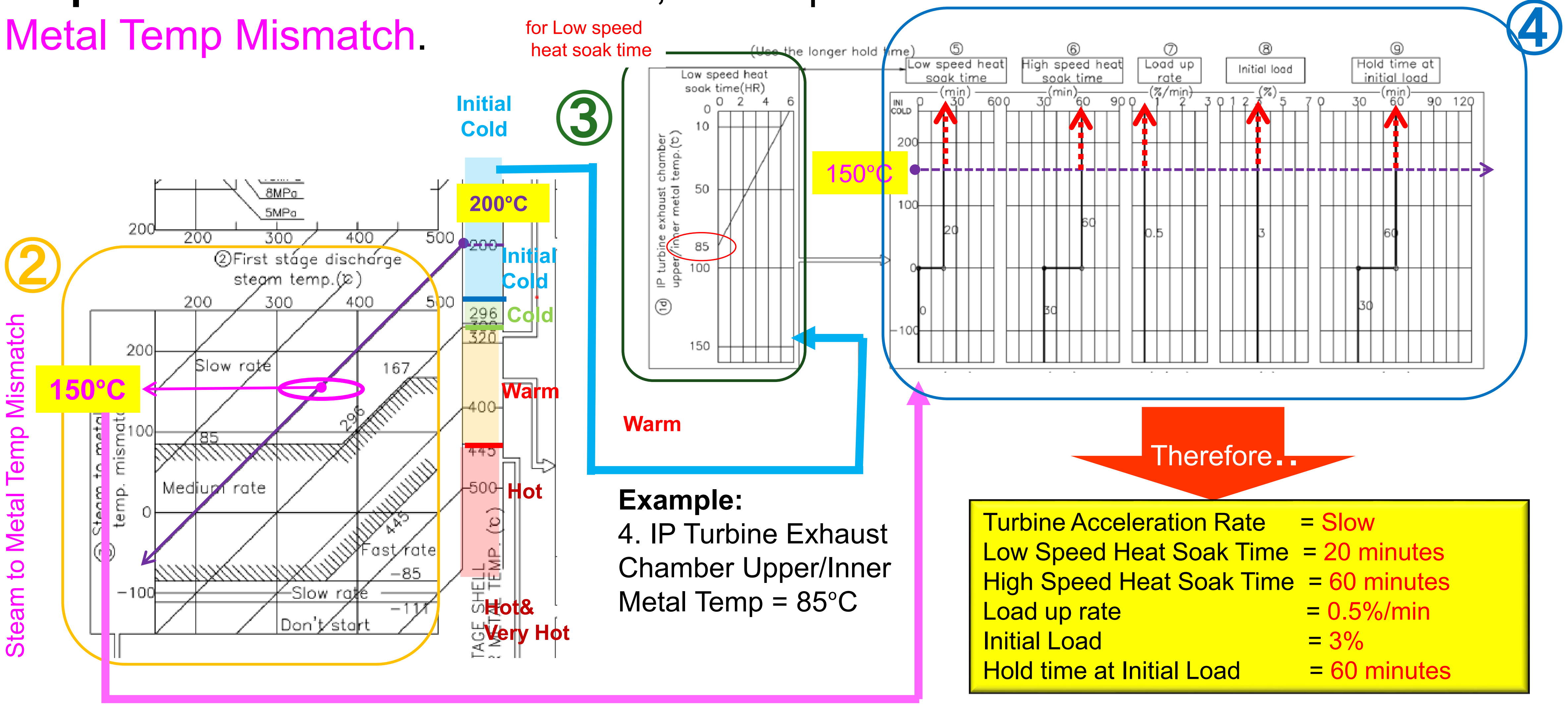
(1) Acceleration rate = Slow Rate

(2) Steam to Metal Temp Mismatch = 150 °C

(3) Start up Mode = Initial Cold Start

7. Mismatch Chart - ③④

Step 3: Determine Heat Soak time, Load up rate and Initial load from Steam to Metal Temp Mismatch.



Example:
4. IP Turbine Exhaust Chamber Upper/Inner Metal Temp = 85°C

Therefore. .

Turbine Acceleration Rate	= Slow
Low Speed Heat Soak Time	= 20 minutes
High Speed Heat Soak Time	= 60 minutes
Load up rate	= 0.5%/min
Initial Load	= 3%
Hold time at Initial Load	= 60 minutes

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Training for D-EHC System
7. BFPT D-EHC Overview

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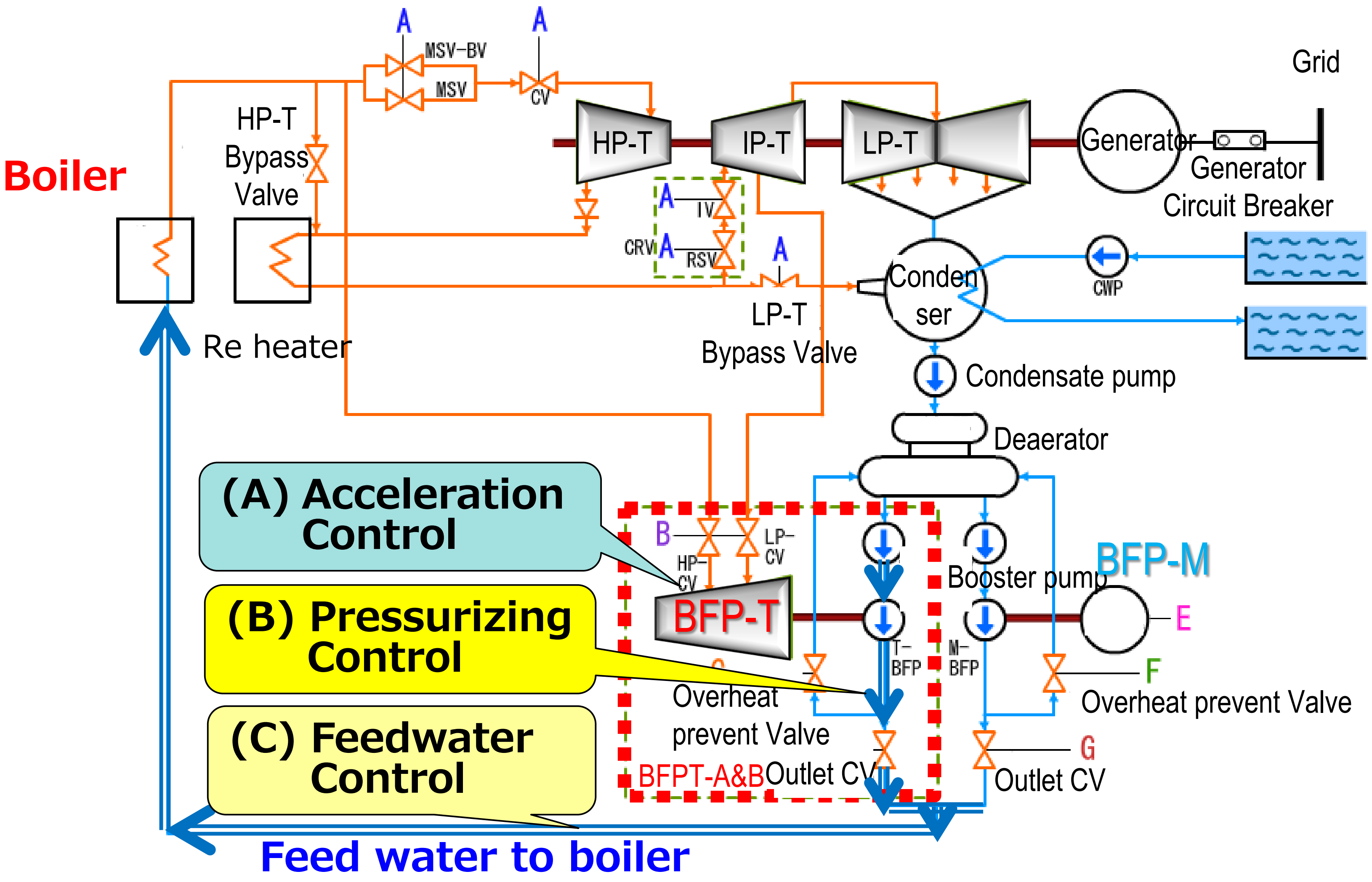
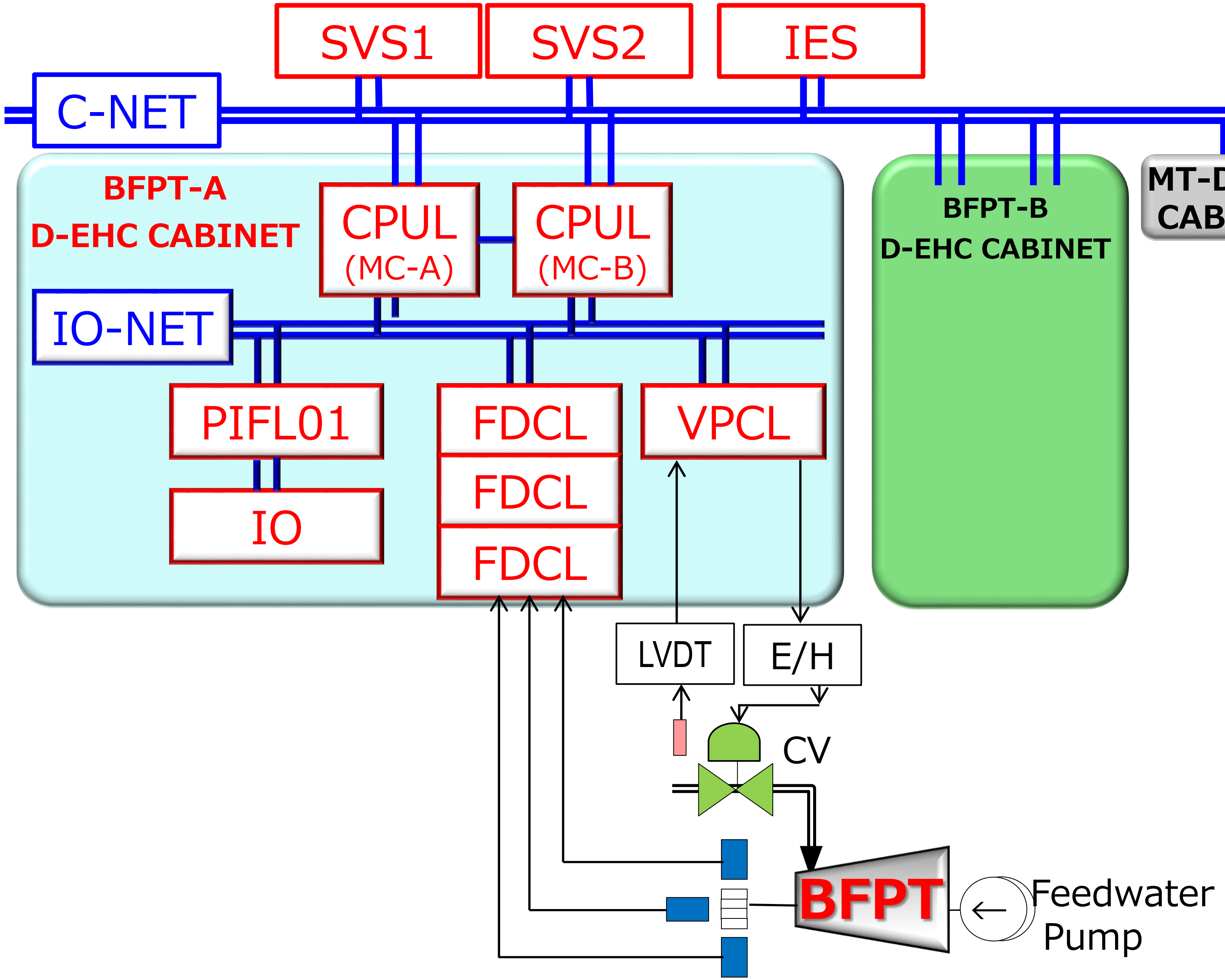
Contents of this lecture

1. Outline of the BFPT D-EHC
1.1 Plant configuration

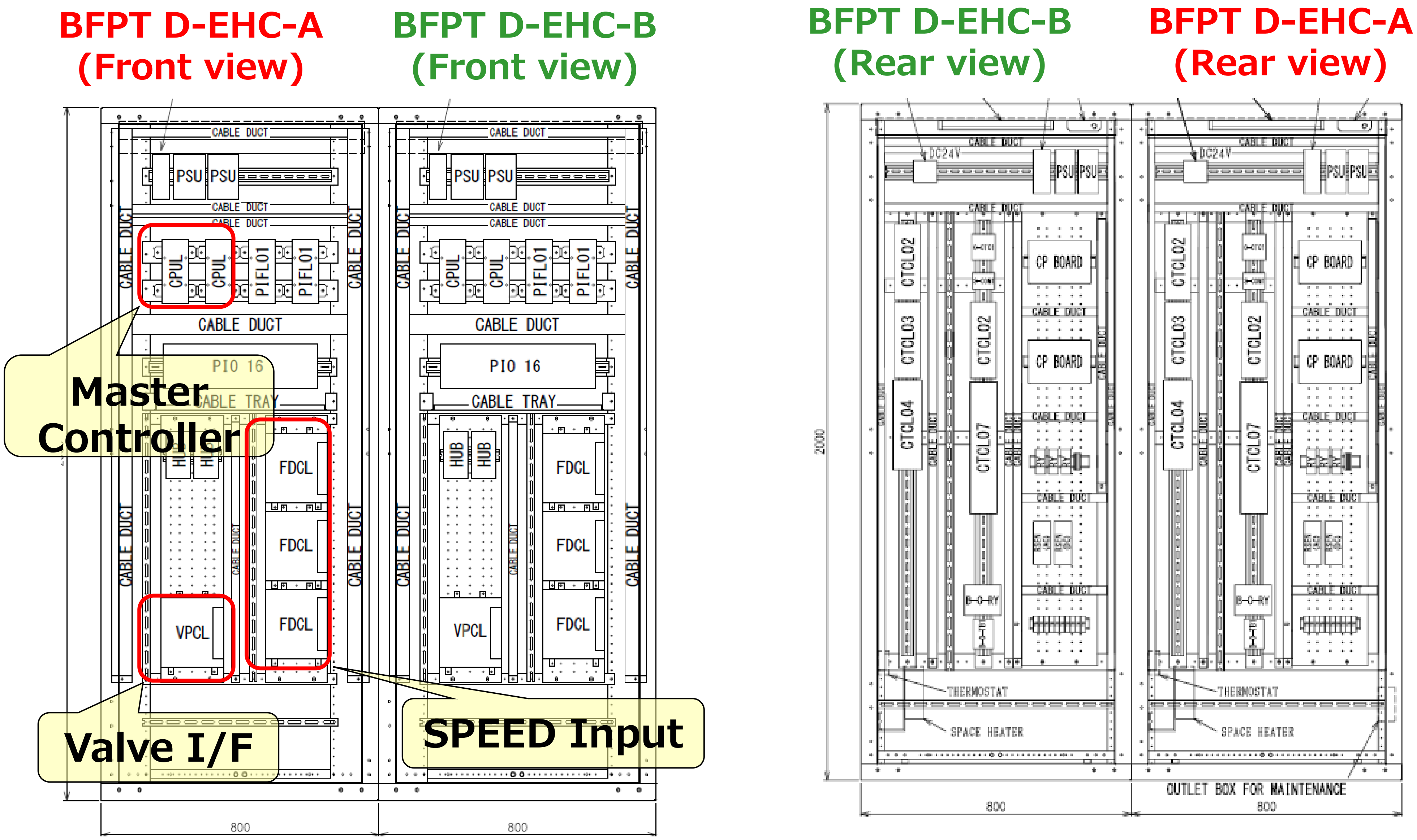
BFPT=Boiler Feedwater Pump Turbine



1. Outline of the BFPT D-EHC
1.2 System Configuration



1. Outline of the BFPT D-EHC
1.3 Arrangement of BFPT D-EHC Cabinet



1. Outline of the BFPT D-EHC
1.4 Power supply configuration

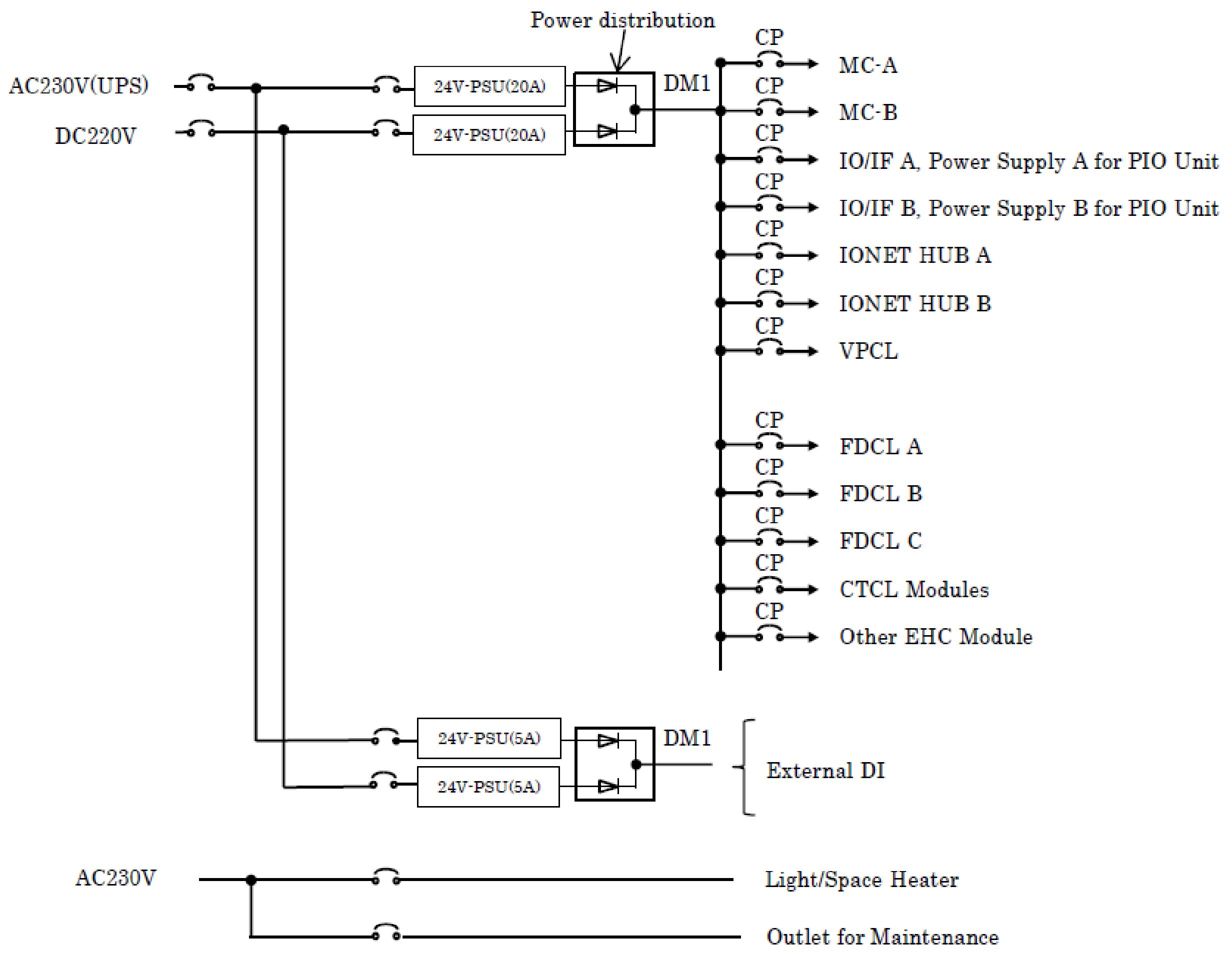
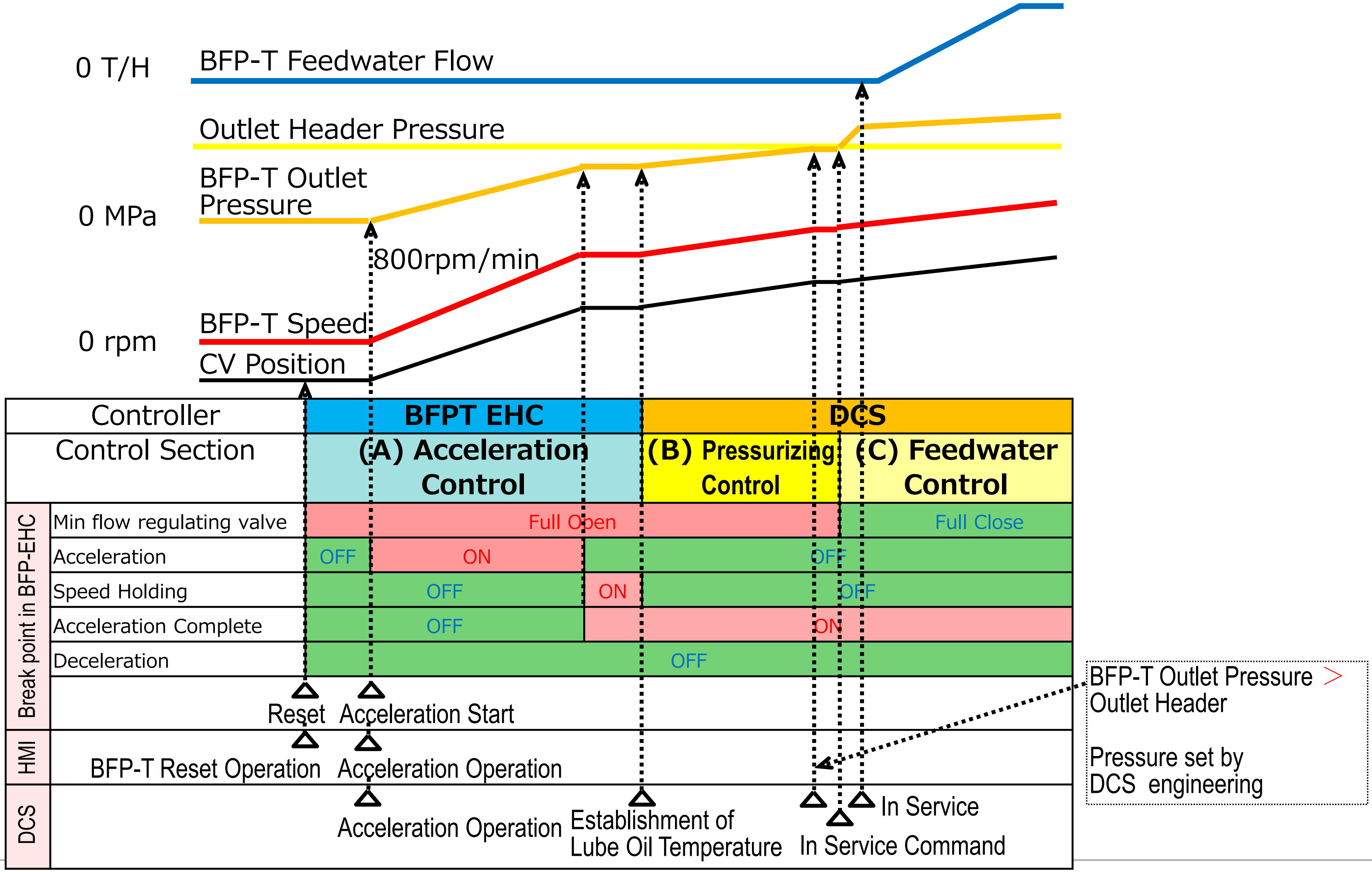


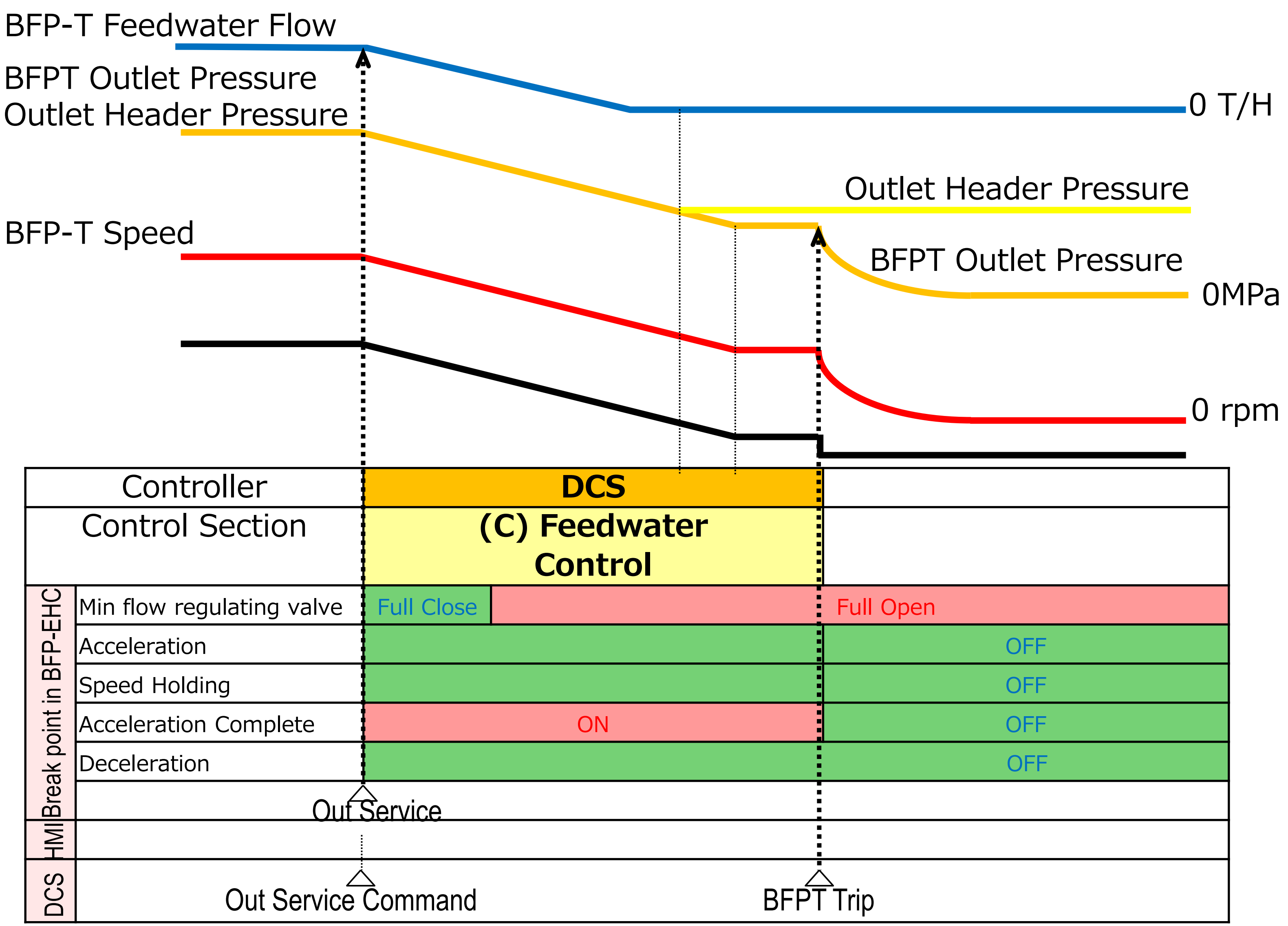
Table Control Function of BFPT-EHC

BFPT D-EHC	1. Acceleration Control 2. Speed holding 3. Deceleration Control 4. Overspeed Trip Test 5. BFP TURBINE Speed Control 6. CV Position Control
DCS	1. Pressurizing Control until Start of Feedwater 2. Feedwater Flow Control
HMI	1. Plant Monitoring 2. Acceleration and Deceleration Operation 3. Overspeed Trip Test Operation

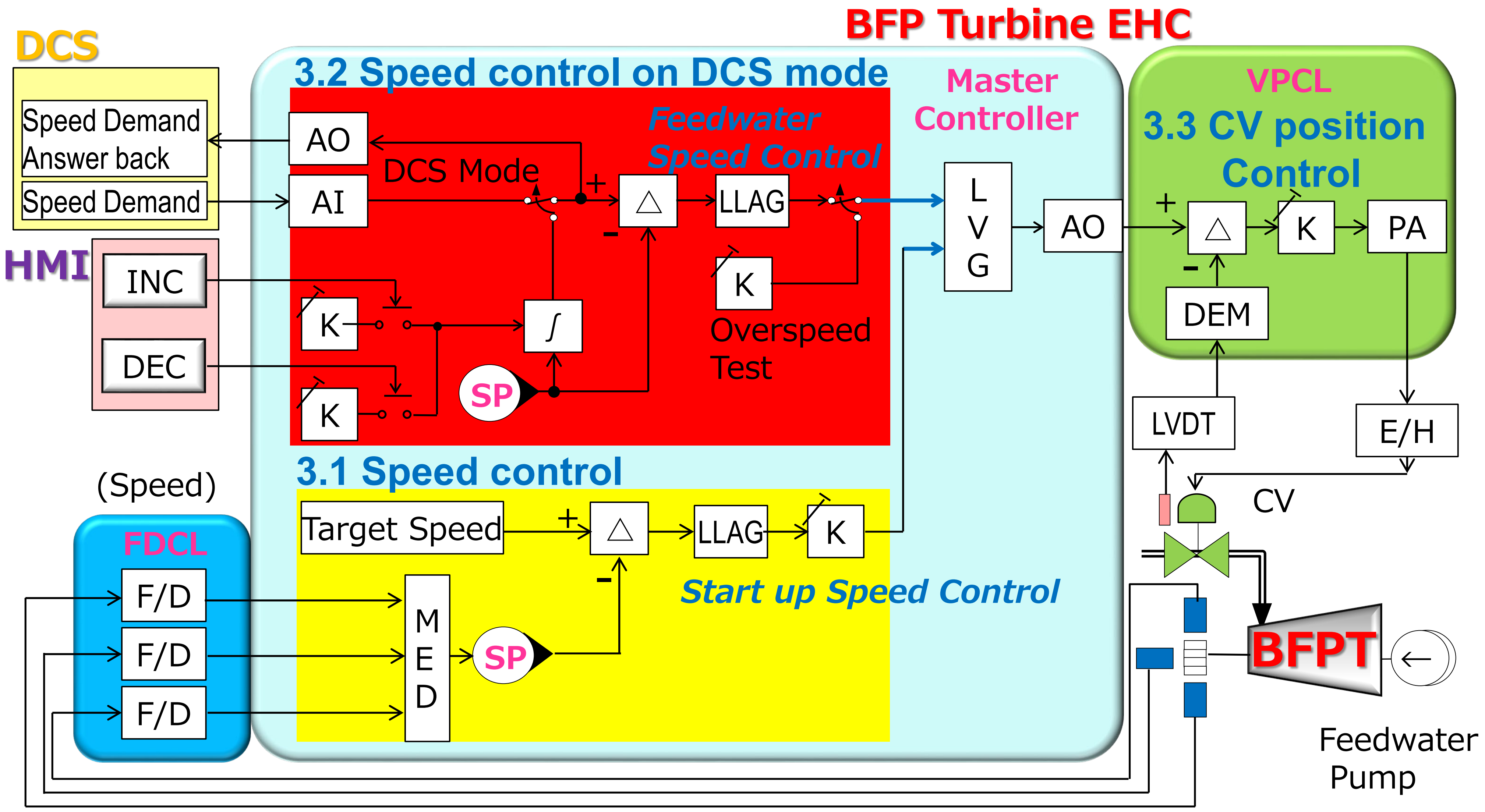
2. BFPT D-EHC Operation
2.2 BFP Turbine Start



2. BFPT D-EHC Operation
2.3 BFP Turbine Shutdown

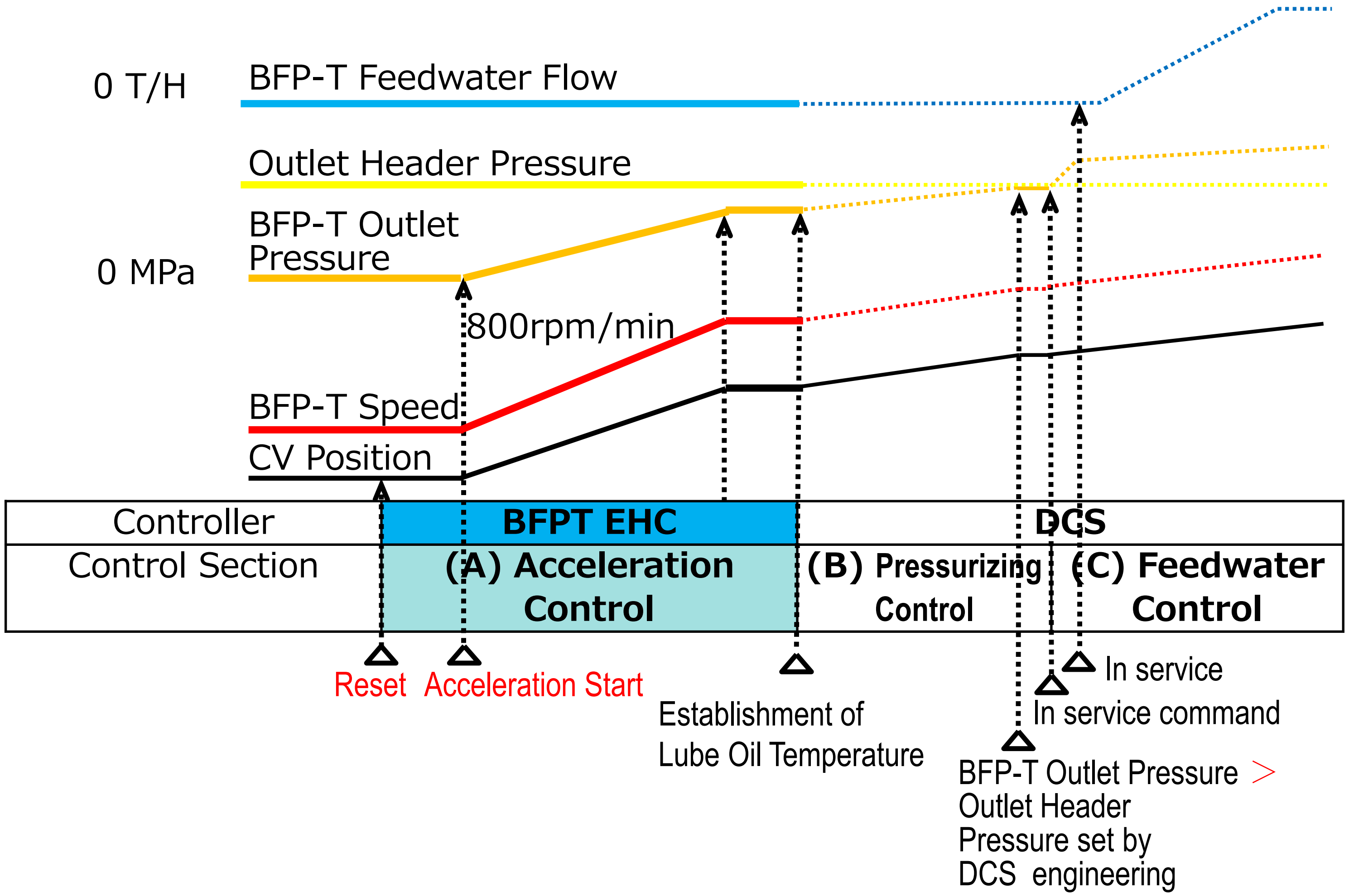


3.Detailed explanation of the BFPT D-EHC Control Block

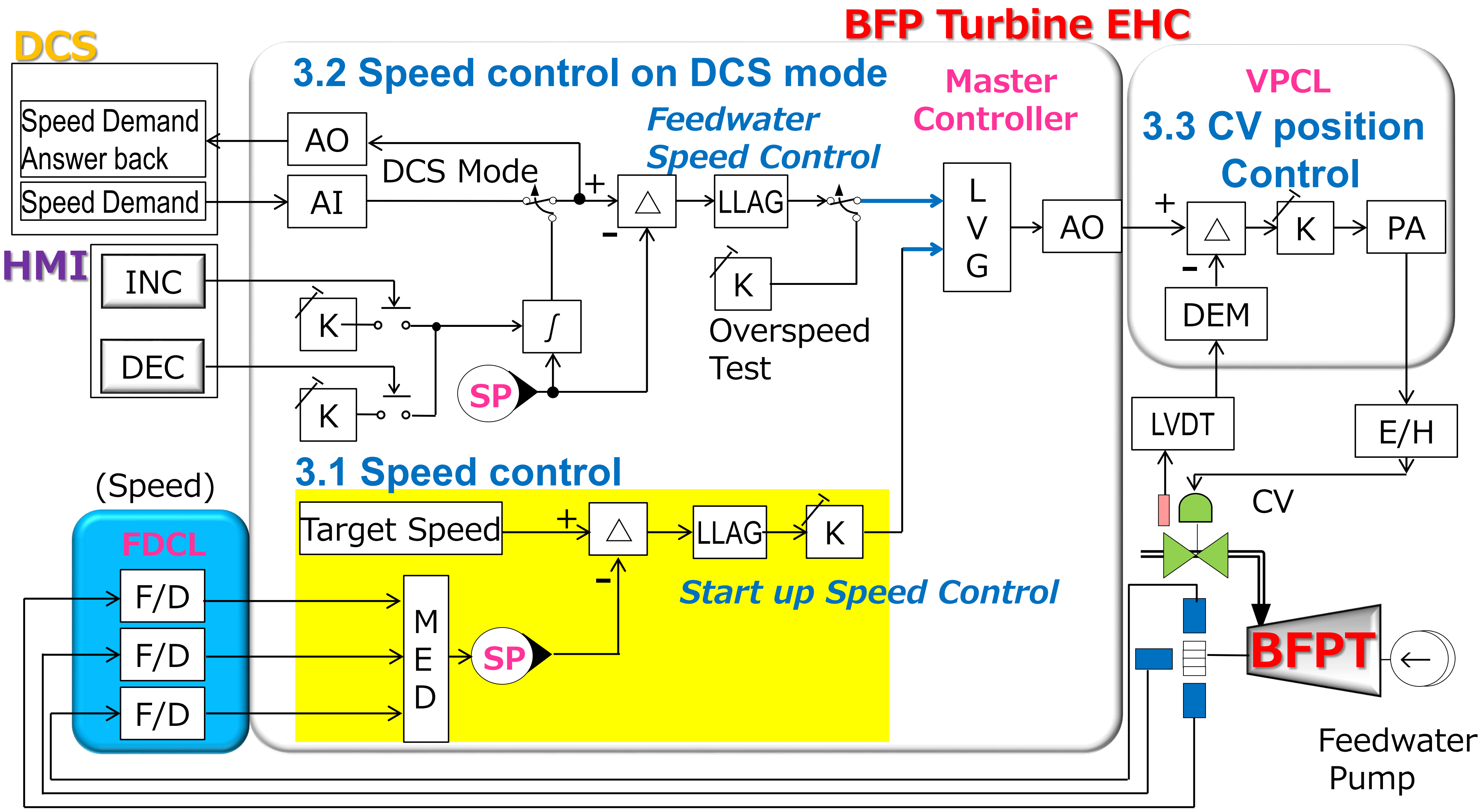


3.1 Speed control

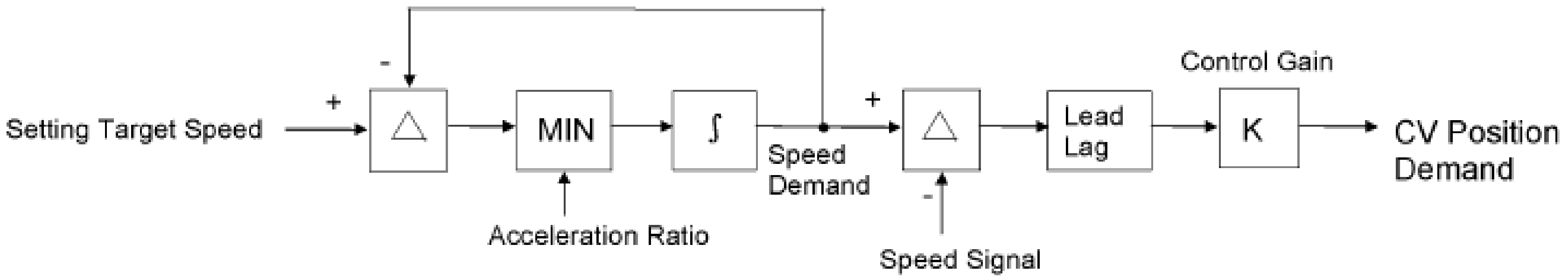
(A) Acceleration Control

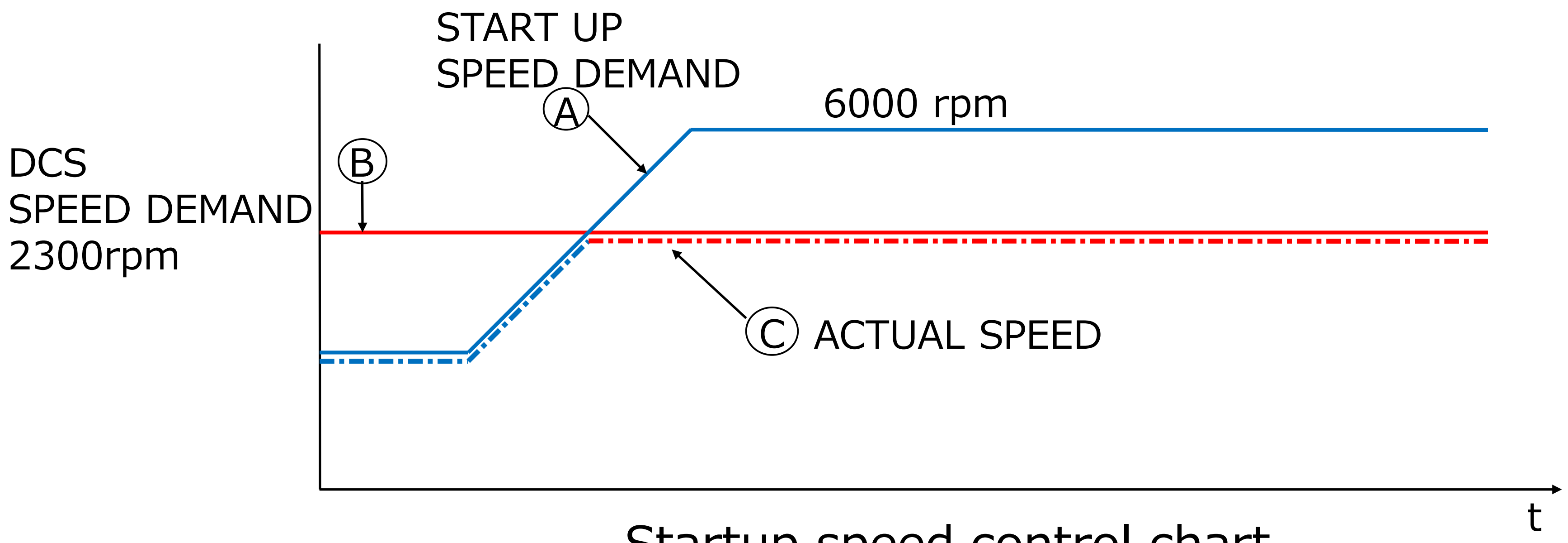


3.1 Speed control



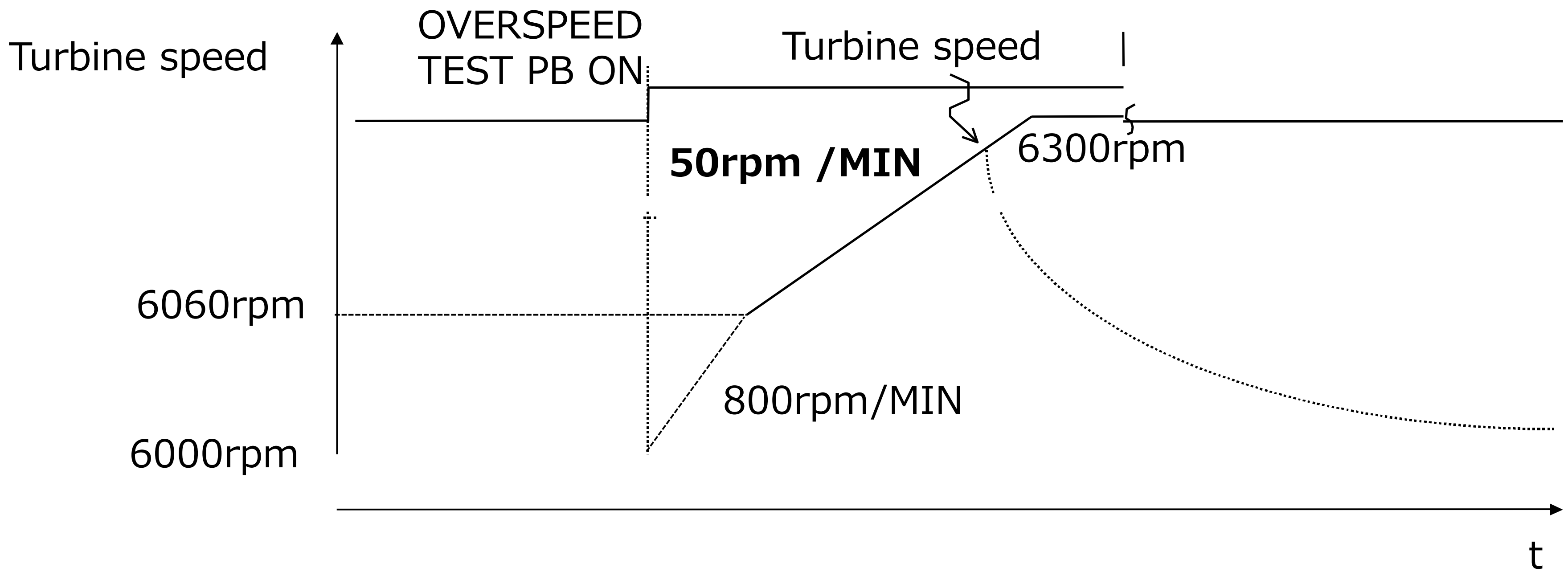
3.1 Speed control
(1) Startup speed control





Startup speed control chart

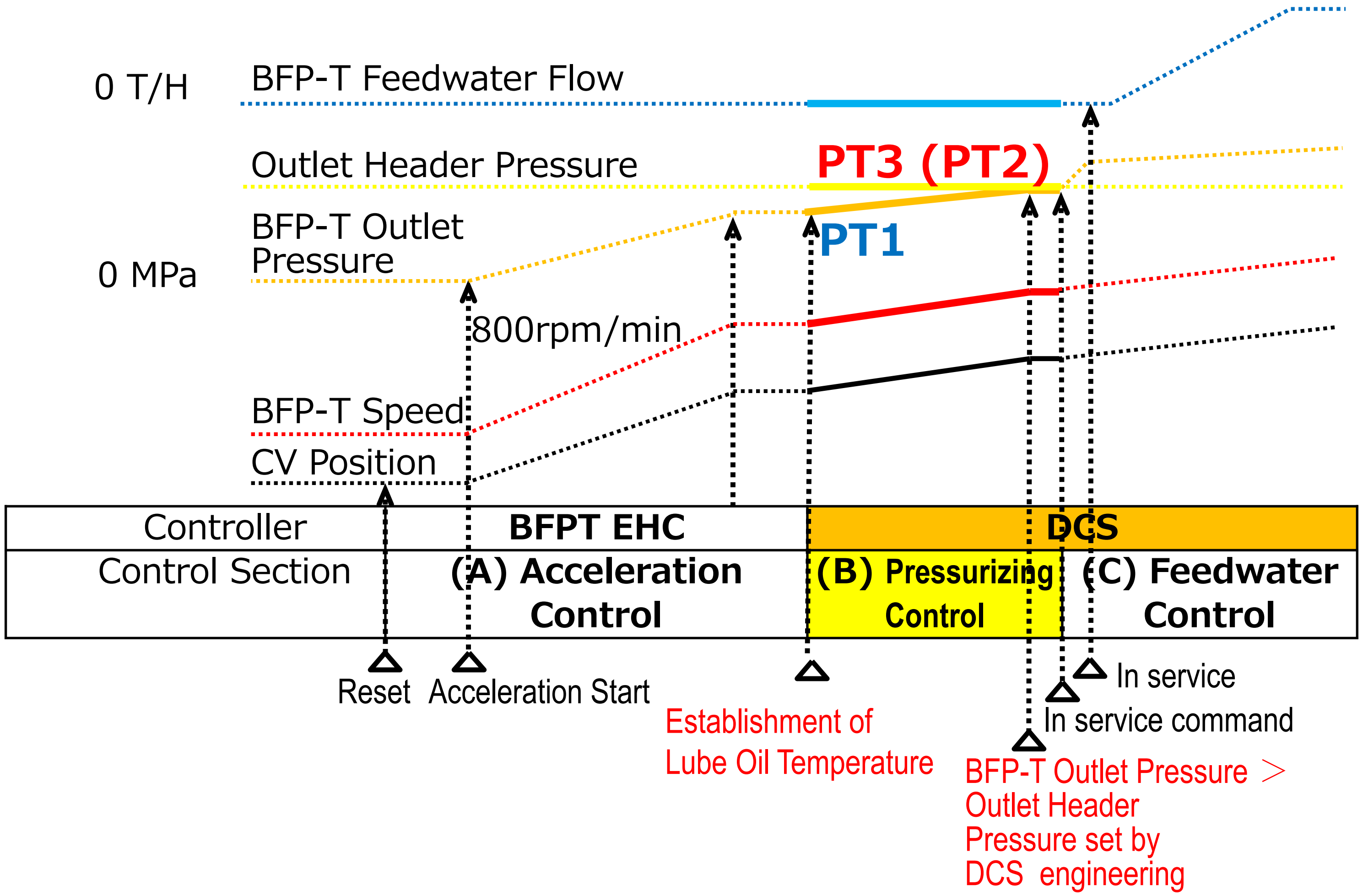
3.1 Speed control
(2) Over Speed Trip test



Over Speed Test Speed Control Chart

3.1 Speed control

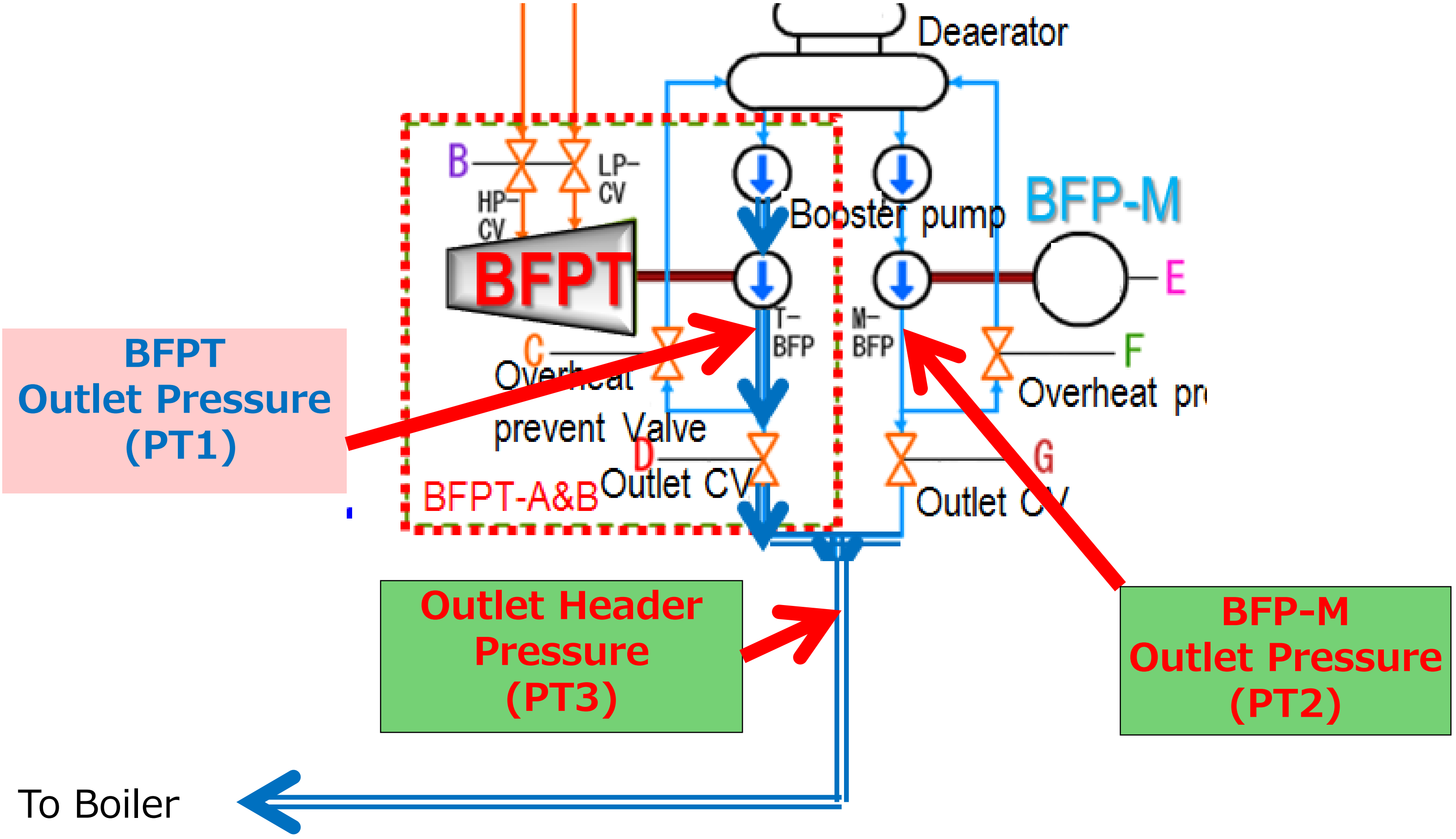
(B) Pressurizing Control



3.1 Speed control
(3) Pressurizing Control until Start of Feedwater Control (DCS)

Before starting BFPT, the pressure relation is as follows.

PT3 = PT2 > PT1



(3) Pressurizing Control until Start of Feedwater Control (DCS)

DCS controls different pressure between PT3 and PT1, and send the speed demand to BFPT-EHC.

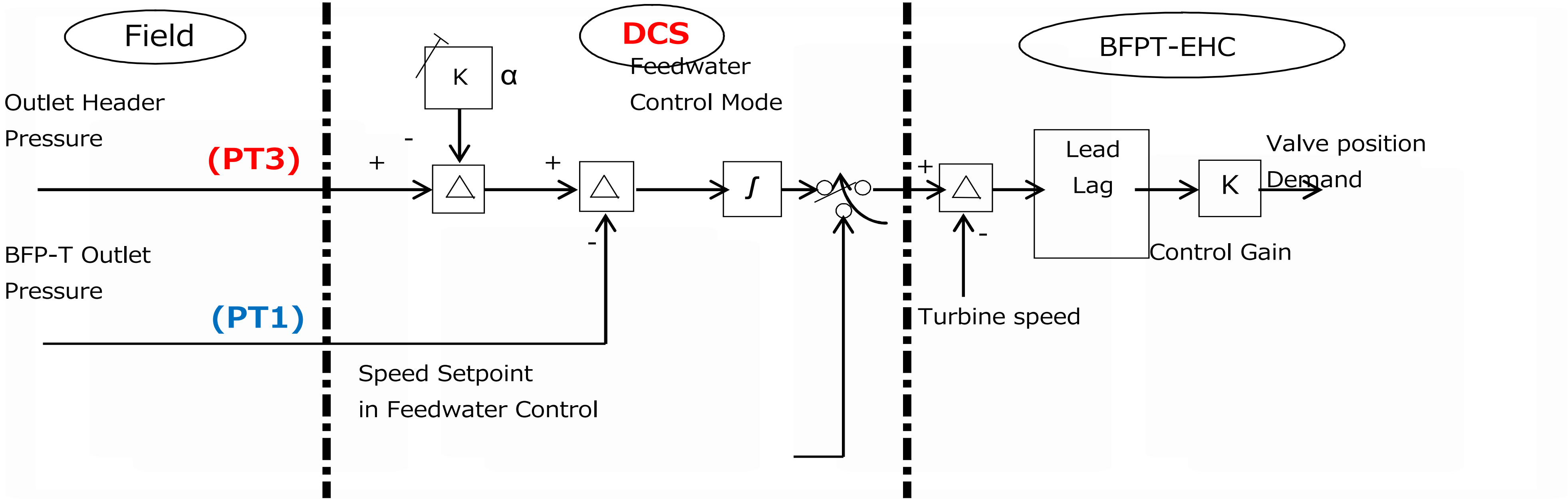
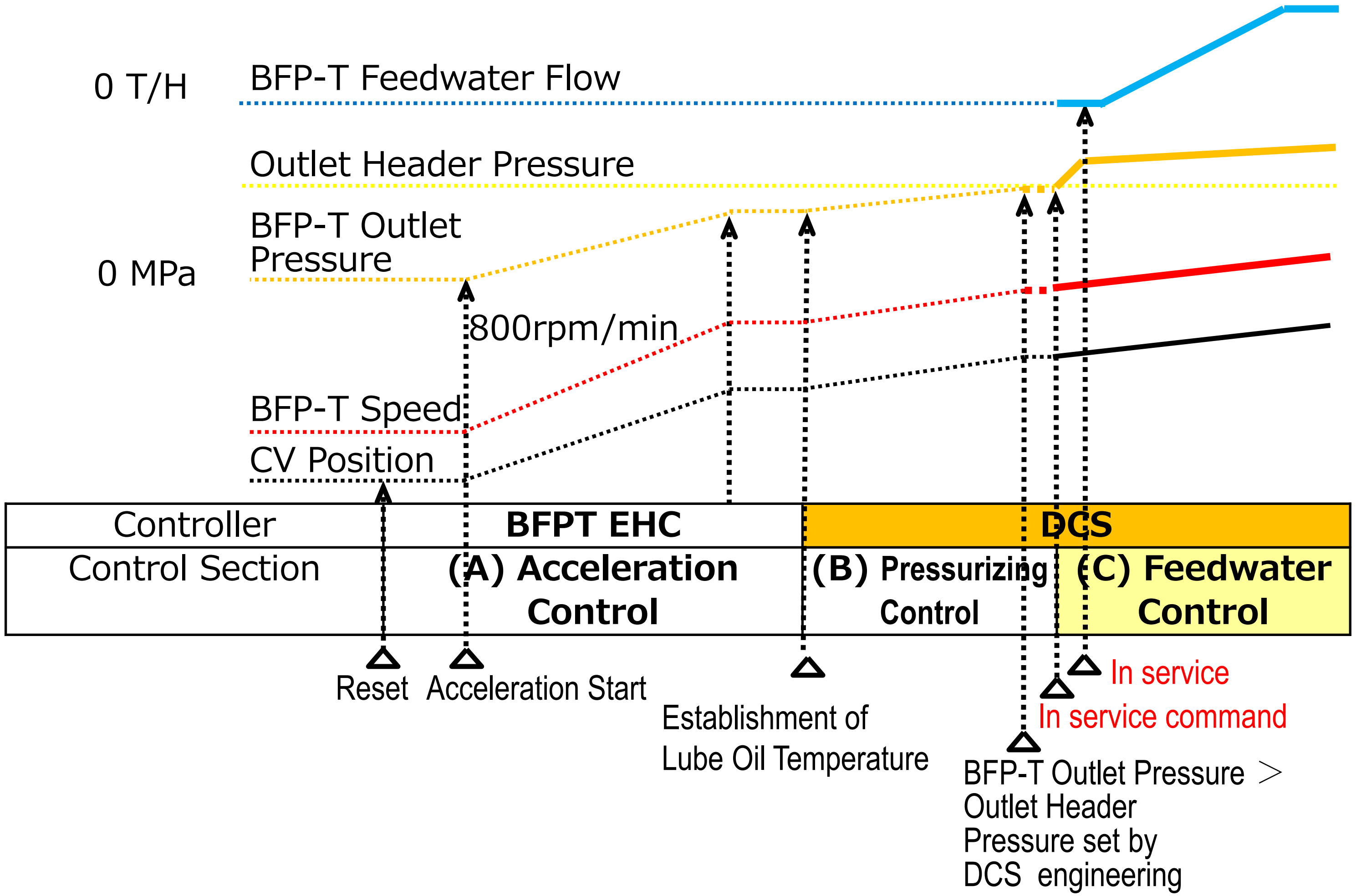


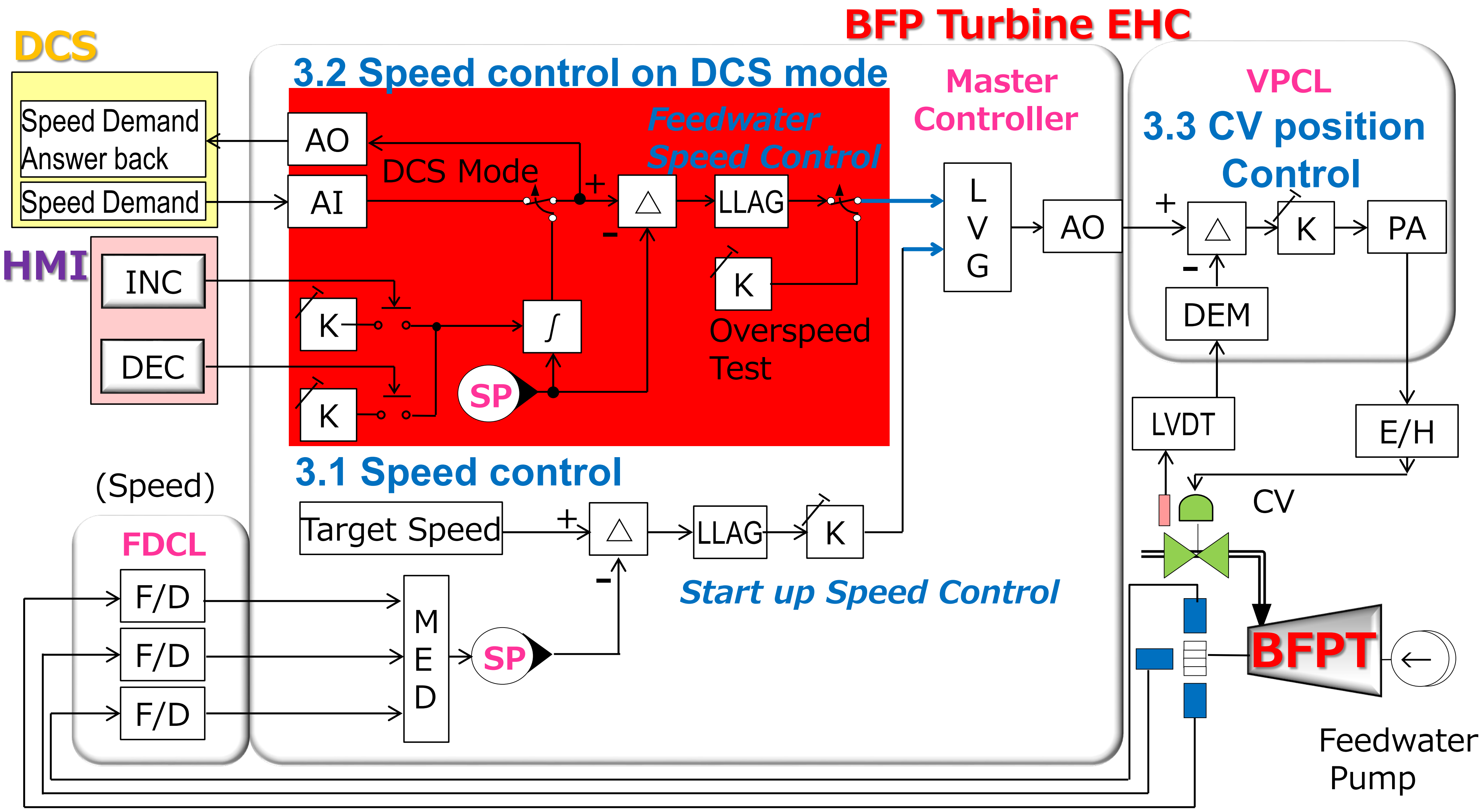
Fig. Block Diagram of Pressurizing Control Mode in DCS

3.2 Speed Control at DCS mode

(C) Feedwater Control



3.2 Speed Control at DCS mode



3.2 Speed Control at DCS mode
(1) Speed Control at DCS mode

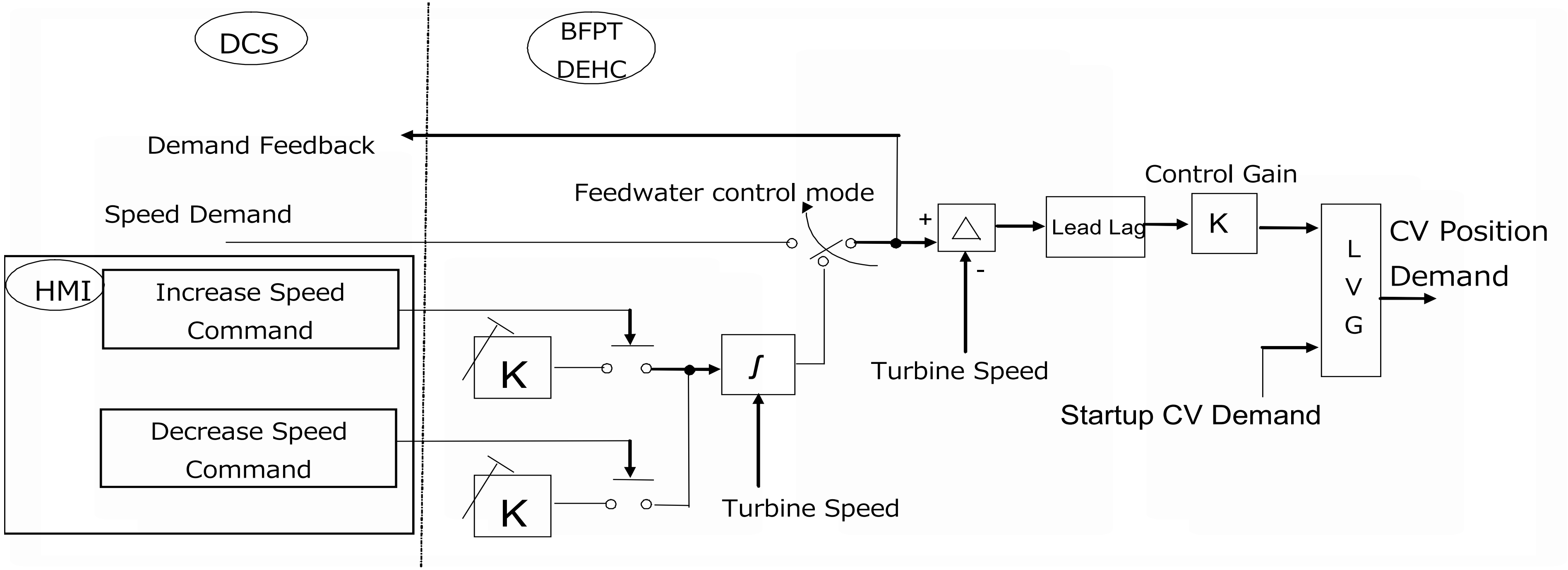
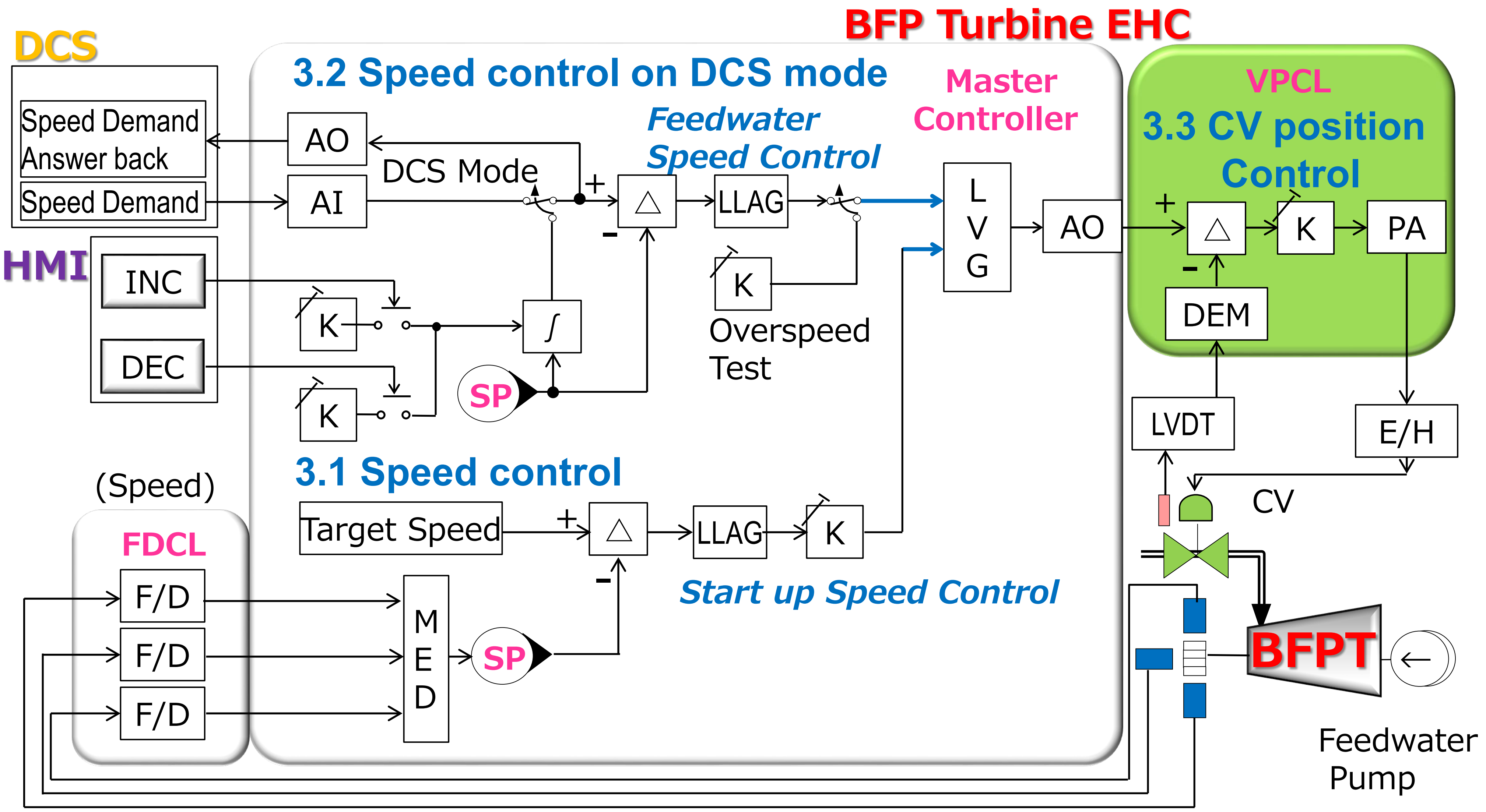
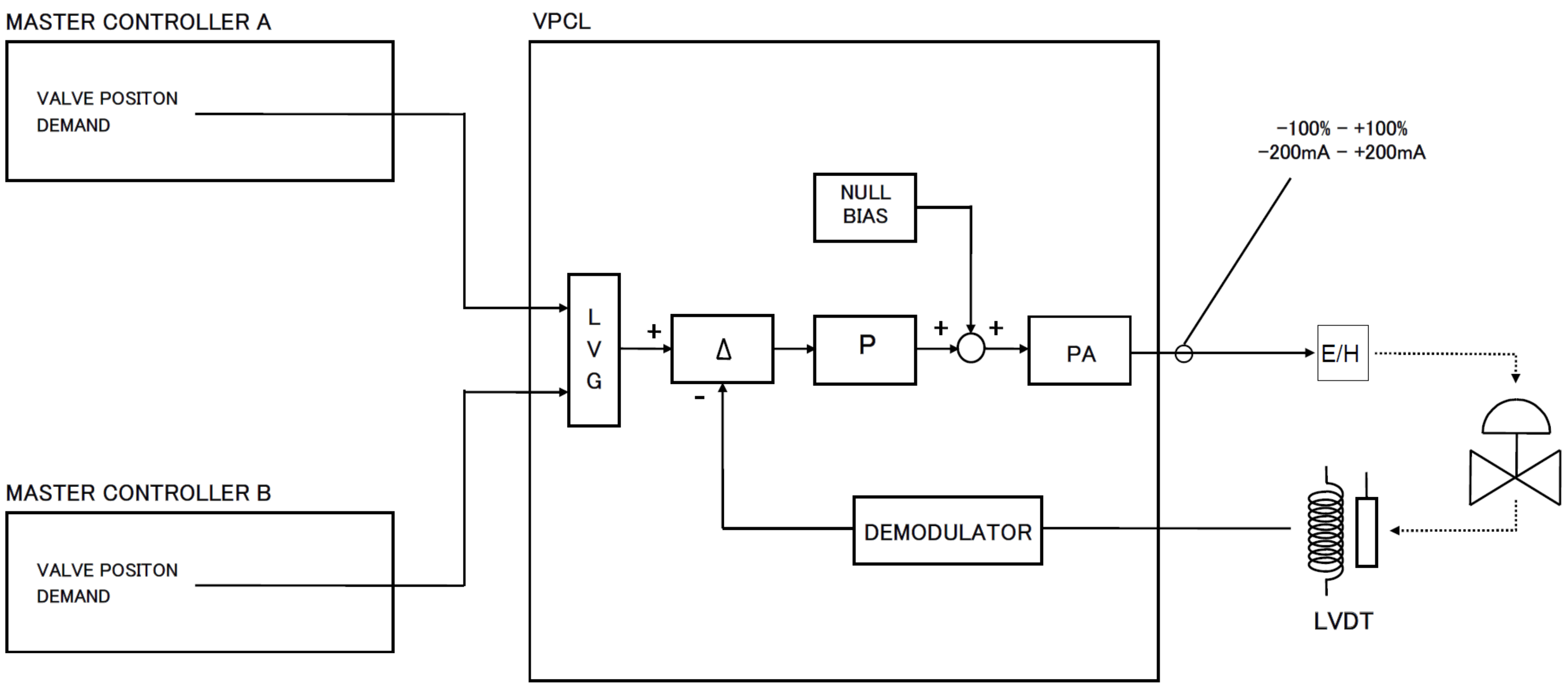


Fig. Block Diagram of Feedwater Control mode

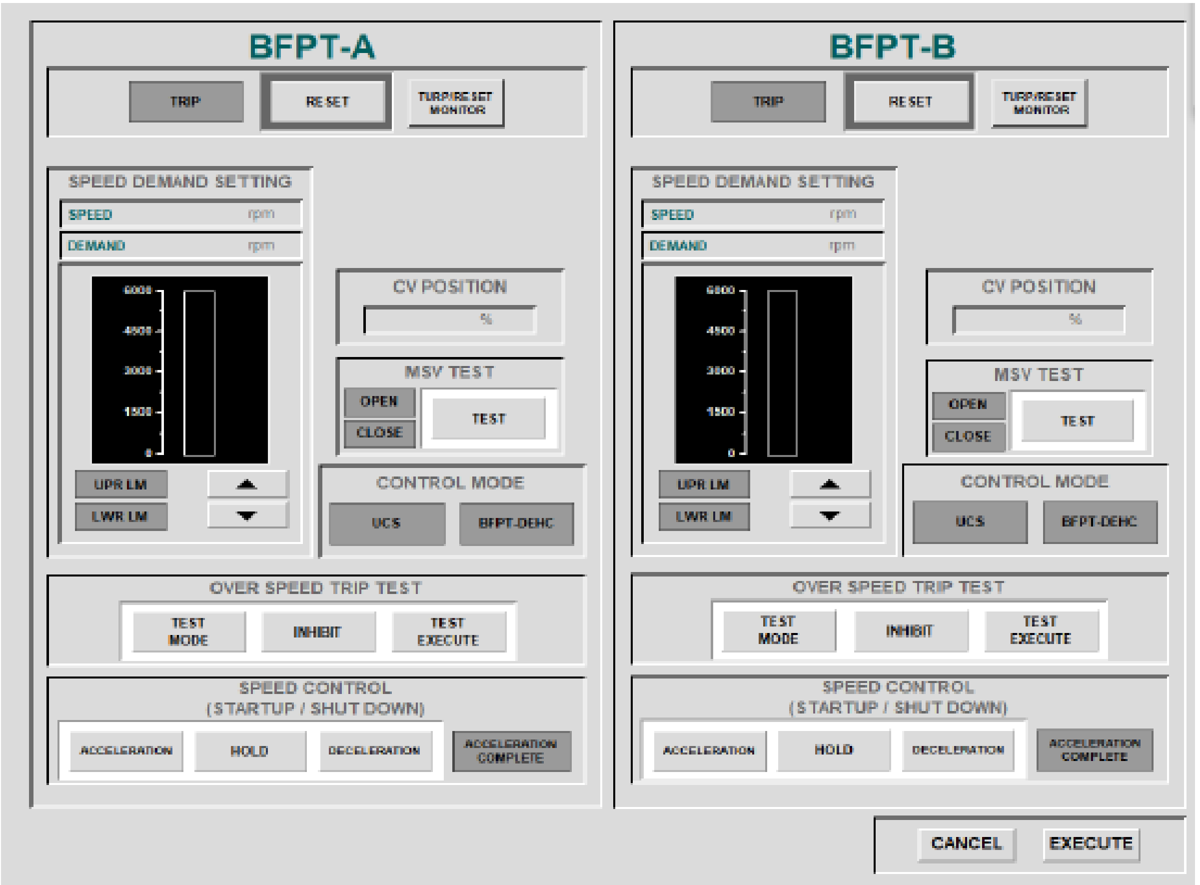

BFP Turbine EHC
DCS
Speed Demand
Answer back
Speed Demand
HMI
INC
DEC
3.2 Speed control on DCS mode
AO
AI
DCS Mode
+
-
△
Feedwater
Speed Control
LLAG
K
Overspeed
Test
K
K
∫
SP
Master
Controller
L
V
G
AO
VPCL
3.3 CV position
Control
+
-
△
K
PA
DEM
LVDT
E/H
CV
(Speed)
FDCL
F/D
F/D
F/D
M
E
D
SP
3.1 Speed control
Target Speed
+
-
△
LLAG
K
Start up Speed Control
BFPT
Feedwater
Pump

3.3 CV Position Control

(1) CV Position Control



4. Operation of the BFPT D-EHC
(1) Graphic Display



Reference Documents

➢ VP1-C-L2-I-CJJ-00003	Hardware Specification for DEHC
➢ VP1-C-L2-I-CJJ-00004	Arrangement Drawing for MT DEHC Cabinet (Front View)
➢ VP1-C-L2-I-CJJ-00005	Arrangement Drawing for MT DEHC Cabinet (Rear View)
➢ VP1-C-L2-I-CJJ-00006	Arrangement Drawing for BFPT DEHC Cabinet (Front View)
➢ VP1-C-L2-I-CJJ-00007	Arrangement Drawing for BFPT DEHC Cabinet (Rear View)
➢ VP1-C-L2-I-CJJ-00008	Outline Drawing for MT DEHC Cabinet
➢ VP1-C-L2-I-CJJ-00010	Outline Drawing for BFPT DEHC Cabinet
➢ VP1-C-L2-I-CJJ-00012	Main Turbine DEHC Control Block Diagram
➢ VP1-C-L2-I-CJJ-00013	BFP Turbine DEHC Control Block Diagram
➢ VP1-C-L2-I-CJJ-00014	Schematic Diagrams for Main Turbine DEHC
➢ VP1-C-L2-I-CJJ-00015	Schematic Diagrams for BFP Turbine DEHC
➢ VP1-C-L2-I-CJJ-00016	System Design Description for MT DEHC
➢ VP1-C-L2-I-CJJ-00017	System Design Description for BFPT DEHC
➢ 6F2K0826	Instruction Manual for MT DEHC Functions
➢ 6F2K0827	Instruction Manual for BFPT DEHC Functions

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Thank you