Project:

**MULTI FUEL CFB BOILER SIMULATOR**

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Document title:

**SYSTEM DESCRIPTION**

**TURBINE CONTROL**

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1. GENERAL

Reference Document:

- Description of TGR system: S1MAY__-BFB2501 (WA56566)
- STG EHG & AVR (TGR) Logic Diagram: S1MAY__-BFF2502 (WA46324)
- Schematic Diagram for TGR System: S1MAY__-BFB2502 (W431187)

1.1 Outline

Turbine control system controls opening of control valves corresponding to demand signals, and steam flow to be come into steam turbine. Further Electro-hydraulic governor (EHG) controls turbine speed at start-up and turbine load at parallel operation continuously and automatically. In addition to the above function, EHG has the quick valve closing function by load shedding relay and automatic valve test function.

1.2 EHG function

Turbine speed control before synchronizing and load control after synchronizing are carried out by controlling inlet steam flow. Turbine speed control, load control, load shedding relay control and emergency control is carried out by open and close action of each main steam stop valve, steam control valve, reheat steam stop valve and intercept valve.

a) Normal operation

In normal operation, inlet steam flow is controlled by changing the steam control valve lift according to the electrical demand.

b) Load shedding relay

When rapid load change more than limit value or load rejection occur, load shading relay detect them in a moment and rapid close both steam control valve and intercept valve to prevent the overspeed of turbine.

c) Emergency control

When turbine speed increase to limit value, electrical emergency governor is actuated to rapid close main stop valve, steam control valve, reheat steam stop valve and intercept valve. Therefore inlet steam flow to turbine is shut off and turbine become stop.

The EHG function consists of mainly following control loops:

1. Speed control loop
2. Power control loop
3. Turbine inlet steam pressure (MSP) control loop
4. Steam pressure Limiter control loop
1.3 Speed Control Loop

Two speed inputs are processed by high selector gate, higher value is used for speed control. The speed control loop only determines control valve position to adjust turbine speed at setting value before the generator is paralleled to the power system. Such the task is transferred to the power control loop or the MSP control loop after synchronization with the system, however, it is put on the position for back-up protection at the same time to prevent from over-speed during parallel operation.

1.4 Power Control Loop

The steam turbine shall be controlled on this MW-control mode normally. In the event of a drop of grid frequency, the governor valves shall open instantaneously to provide frequency support in the form of additional MW. When the main steam pressure (MSP) control mode is operation, this MW-controller is tracking to the main steam pressure (MSP) controller.

1.5 Turbine Inlet Steam Pressure (MSP) Control Loop

Two main steam pressure inputs are processed by high selector gate, higher value is used for MSP control. MSP mode (Turbine Follow mode) of operation results in the governing system modulating the steam flow to regulate the steam pressure at a fixed value. The control system shall switch automatically to this mode when faults occur which prevent normal control of the boiler. MSP mode will take over following a drop in steam pressure of 10% or an increase in pressure of 3%. It shall be possible to manually switch to this mode. When the power control mode is operation, this steam pressure controller is tracking to power controller.

1.6 Steam Pressure Limiter Control Loop

The pressure limiter shall override the governor and progressively reduce the steam flow to the turbine as the steam pressure before the HP steam turbine governing valves drops below a predetermined value in order to limit serve drops in steam temperature.

1.7 Condenser Vacuum Limiter Control Loop

This limiting controller shall override the governor and progressively reduce the steam flow to the turbine as the condenser vacuum falls over a predetermined range in an effort to maintain the condenser vacuum at this value. The setting shall be adjustable. It shall be possible to override the device during vacuum raising and it shall not come into operation below 1000 rpm.

1.8 Control Valve (CV) Position Control Loop
An output from the above loops is given to the CV position control loop as its setting. Consequently, it adjusts CV position in accordance with its characteristic curves respectively.

This portion outputs opening command to the Electro-hydraulic (E/H) converter mounted on each CV separately. Due to each E/H converter having two magnet coils, two separate signal (±10V) lines are connected to them.

1.9 Operation scheme

This system supports following operation stage:

1.9.1 Start-up Operation

a) Before synchronizing

Speed control loop functions during turbine acceleration up to rated speed after steam admission. Around rated speed the setting can be adjusted for synchronizing by manual or automatically from automatic synchronizing system (ASY).

b) After synchronizing

Just after synchronization, an initial load is instantaneously taken by it to avoid the generator reverse power. At the same time, speed setting is fixed at rated speed by interlock action and the speed control loop will function as back-up protection against over speed.

1.9.2 Normal Operation

During normal operation, Power control loop functions under constant pressure. The steam turbine should be capable of operation with a fixed boiler pressure by controlling the governor valves. While operating in this mode the steam turbine should be capable of providing primary operating reserve in the form of addition megawatts by immediately opening of the governor valves in the event of system frequency dips.

1.9.3 Shutdown Operation

Unloading up to the minimum load is conducted by the power control loop.

2. EQUIPMENT DATA
2.1 EHG & AVR panel (TGR)

EHG and AVR function are installed in duplex digital control system named TGR. The TGR system is implemented redundant and hot stand-by system with MPU processing parts and control I/O device installed MPU shelf.

Construction:

a) Power supply:
For control unit: Both AC 230V, 50Hz, 1-ph(UPS) and AC 230V 50Hz, 1-ph(Normal) For relay circuit: DC220V
For others: AC 230V, 50Hz, 1-ph(Miscellaneous)

b) Location: Electronic room
c) Degree of protection: IP31
d) Finish color: For exterior surface: RAL7032 For interior surface: RAL7032

Please see “Description of TGR system” S1MAY__--BFB2501 (WA56566).

2.2 STG DCS Panel  [Out FUJI’s scope, supplied by ABB ]

Plant normal operation, starting, and stopping is performed by DCS (Fuji's out of scope) at the electric room.

This system has following functions:
- Interlocking of STG auxiliary equipment
- Closed loop control
- Process sensor inputs for monitoring on CRT
- ATS (Automatic turbine start/stop)
- TSE (Turbine Stress Evaluator)

2.2.1 Interlocking of STG auxiliary equipment (e.g. pump, fan, heater, solenoid valve, etc.)

Interlock logic of STG auxiliaries are implemented in DCS cubicle.

i. Lube oil system
- Two sets of AC motor driven Main oil pump
- One set of DC motor driven Emergency oil pump (operation interface only)
- One set of AC motor driven Jacking oil pump
- Two set of Lube oil tank heater
- One set of AC motor driven oil tank vapor extractor
ii. Control fluid system
- Two sets of AC motor driven Control fluid pumps
- Two sets of AC motor driven Control fluid radiators
- One set of Heating pump for control fluid

iii. Others
- One set of Gland steam condenser exhauster - Drain valves (motor operated)
- One set of cold reheat steam non-return valve (solenoid operated)
- One set of AC motor driven turning device
- One set of vacuum breaker valve (motor operated)
- One set of LP casing water spray valve (motor operated)

Detail logic will be provided as in document "Interlock block diagram' S1MAY__-BFF2501.

2.2.2 Closed loop control

i. Turbine gland steam pressure control
The purpose of this control is to keep the constant pressure of turbine gland steam, header. Pressure deviation between setpoint and actual process value passes PI function gate in the DCS to move the position of the turbine gland steam control valve.

ii. Turbine lube oil temperature control
The purpose of this control is to keep the constant temperature of turbine tube oil after oil cooler. Temperature deviation between setpoint and actual process value passes PID function gate in the DCS to move the position of the lube oil temperature control valve.

iii. Generator air cooler outlet air temperature control
The purpose of this control is to keep the constant temperature of Generator cooling air. Temperature deviation between setpoint and actual process value passes PID function gate in the DCS to move the position of the temperature control valve. The lowest temperature among three temperature inputs is used to prevent from over air-cooling.

Detail control loops will be provided as in document "Instrument flow diagram" S1CQ___-BFB2501.

2.2.3 Process sensor inputs for monitoring on CRT

- STG operating condition (Steam condition, Generator output)
- STG auxiliary operating condition
- STG annunciation

2.2.4 ATS (Automatic turbine start-up and shut-down)

ATS function covers pre-start check, start-up from turbine reset to load up to minimum load of the unit of the STG. Step sequence logic is used for ATS and proceeding and time over can be monitored on CRT.

Detail logic will be provided as in document "Functional Loop Description for Startup System (ATS)” C0CQ___-BDB2505 and “ATS Logic Diagram” S1MAY__-BFF2506.

2.2.5 TSE (Turbine Stress Evaluator)
The wall temperature monitoring calculator, which will be installed in DCS, provides a function for monitoring the temperature of the turbine wall so the temperature difference between the inner surface wall and the mean point (50%) of each of main stop valve casing and the high pressure turbine casing, and the difference between the surface temperature and the mean temperature of each of the intermediate and high pressure turbine rotors can be monitored (thermal stress monitoring with temperature difference). The output of the stress evaluator shall be used to limit or hold the ramp rates at a large temperature difference.

3. OPERATION

Please see documents “Description of TGR system” S1MAY__-BFB2501 (WA56566), “STG EHG & AVR (TGR) Logic Diagram” S1MAY__-BFF2502 (WA46324) and “Schematic Diagram for TGR System” S1MAY__-BFB2502 (W431187), "Interlock block diagram' S1MAY__-BFF2501, "Instrument flow diagram" S1CQ___-BFB2501, "Functional Loop Description for Startup System (ATS)" C0CQ___-BDB2505 and “ATS Logic Diagram” S1MAY__-BFF2506.