## Project:

**MULTIFUEL CFB BOILER SIMULATOR**

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<th>Author:</th>
<th>Approved:</th>
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## Document title:

**TURBINE PROTECTION SYSTEM DESCRIPTION**

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<th>Submitted for:</th>
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1. GENERAL

Reference Documents;

- Description of Over Speed Protection System  S1MAY__-BEC2504
- Turbine Protection Logic Diagram     S1MAY__-BFF2503 (WA46326)

Turbine protection device are arrange to actuate trip solenoid valve for main steam stop valve /reheat stop valve, and operate to close these emergency valves.

In case the following faults is occurred in turbine and the around, turbine would be stopped automatically.

1.1 Outline

Turbine protection system consists of sensing parts, turbine protection circuit, and trip solenoid valve. The following figure shows out line of turbine trip flow since sensing parts have been detected, until closing all stop valve and control valve.
1.2 The Function of Turbine Protection

(1) Over speed
(2) Thrust failure
(3) Shaft vibration high
(4) Main steam inlet temp. Low
(5) HP exhaust steam temp. high
(6) LP exhaust steam temp. high
(7) Exhaust steam press. high
(8) Lube oil supply press. Low
(9) Boiler trip (MFT)
(10) Generator trip
(11) EHG heavy fault
(12) Manual trip (TURBINE TRIP PB ON)
(13) Power system frequency low
(14) Reverse power

1.2.1 Over Speed

1.2.1.1 Overall

The turbine shall be provided with duplicated independent over speed protection channels. Over speed protection system is mainly composed of Bentry Nevada 3500/53 over speed system, speed sensor, proximitortor.

The speed signal (pulse signal) detected by 6 pieces of speed sensors is transmitted to 3500/53 system.

In case of over speed, 3500/53 system output-relay operates, and the trip signal is processed by duplex 2 out of 3 voting hardwired circuit.

These devices shall be entirely separate from the regulating governor and shall be capable of effecting immediate closure of both emergency stop and governor valves. The turbine Protection System has both 110% and 105% setting for over speed protections. When the unit is synchronized, the trip setting value shall be set at 110% (3300rpm).

And when the unit is un-synchronized, the trip setting value shall be set at 105% (3150rpm). The above descriptions are presented in attached “Turbine protection system overview”
1.2.1.2 TÜeV approval

Bentry Nevada 3500/53 over speed detection system is available with TÜeV certification, as the system of detection monitor, Proximittor (amplifier), probe (speed pick up).

1.2.1.3 Testing procedures of over speed protection

The 3500 over speed protection module has an on board frequency generator that can generate a test signal for testing the over speed protection function of the monitor.

Test mode is performed by BN Maintenance tool that are connected to rack interface module.

1. Run the Rack Configuration Software on the test computer (Maintenance tool).
2. Enter a Start RPM (400rpm minimum) and an End RPM (limited to the upper full scale range) for the test frequency to sweep through.
3. Choose Verification from the Utilities menu and choose the slot of the Over speed Protection Module to be tested then click the Verify button.
4. Verify that the OK LED is on, that the Channel OK State status on the Over speed Protection Verification screen reads OK, the bar graph indicator for Speed is green, and that the Current Value Field has no alarm indication.
5. Click on the Invoke Test Mode button on the Verification screen. This will initiate the Over speed Test function. The rpm displayed on the bar graph indicator for Speed will begin to ramp from the configured Test Mode Start rpm.

6. As the rpm level exceeds the Over Alert/Alarm1 set point level, verify that the bar graph indicator for Speed changes color from green to yellow and that the Current Value Field indicates an alarm.

7. As the rpm level exceeds the Over Danger/Alarm2 (Over speed) set point level verify that the bar graph indicator for Speed changes color from yellow to red and that the Current Value Field indicates an alarm. If Enable Relays While in Test Mode is enabled, verify that the Over speed relay contacts change state.

8. Click on the Invoke Test Mode button on the Verification screen again to remove the module from Test Mode. The Over speed Protection Module will perform a full self-test before resuming monitoring functions.

Verify that the monitor passed the self-test.

1.2.2 Thrust Failure (Shaft position protection)

Electrical thrust protect device includes 3 non-contact displacement detectors that are installed in standstill side, the opposite of the disk on turbine shaft. The shaft position signals detected by 3 pieces of displacement sensor are transmitted to 3500/45 system.

The alarm will be issued when mean value of 3 shaft position signals over alarm value due to the fault such as wear of thrust bearing. In case of thrust failure, 3500/45-system output-relay operates, and the trip signal is made by 2 out of 3 logic circuit in turbine protection system.

Alarm : ± 0.5 mm
Trip : ± 1.0 mm
1.2.3 Shaft Vibration High

The shaft vibration monitoring 3500/32-systems measure X-Y directions per bearing #1 to #5 of turbine generator.
The alarm will be issued when high-selected value of X-Y direction signals over alarm value.
Turbine trip will be occurred only when more than one probe measures over trip value and the other probe installed at next bearing measures over alarm value.

Alarm : 125micron-meter (peak to peak)
Trip : 250micron-meter (peak to peak)

1.2.4 Main Steam Inlet Temperature Low

Turbine shall be tripped in order to prevent the damage by low temperature steam getting into high-pressure turbine.
The alarm will be issued when mean value of 3 temperature signals over alarm value.
The trip signal is made by 2 out of 3 logic circuit in turbine protection system.

Alarm : ANN setting curve
Trip : TRIP setting curve

1.2.5 HP Exhaust Steam Temperature High

Turbine shall be tripped in order to prevent the overheating of blade by ventilation.
The alarm will be issued when mean value of triple sensor over alarm value.
The trip signal is made by 2 out of 3 logic circuit in turbine protection system.
1.2.6 LP Exhaust Steam Temperature High

Turbine shall be tripped in order to prevent the deformation of low-pressure turbine casing. The alarm will be issued when mean value of triple sensor over alarm value. The trip signal is made by 2 out of 3 logic circuit in turbine protection system.

- Alarm : 90 deg.C
- Trip : 110 deg.C

1.2.7 Exhaust Steam Pressure High

Turbine shall be tripped automatically when a predetermined low condenser vacuum is reached. The alarm will be issued when mean value of triple sensor over alarm value. The trip signal is made by 2 out of 3 logic circuit in turbine protection system.

- Alarm : 0.2 bara
- Trip : 0.3 bara

1.2.8 Lube Oil Supply Pressure Low

The alarm will be issued when monitoring signal of lube oil pressure fall less than alarm value. The trip signal is made by 2 out of 3 logic circuit in turbine protection system.

- Alarm : 1.5 barg
- Trip : 1.4 barg

1.2.9 Boiler Trip (MFT)

In the event of boiler trip, turbine shall be tripped in order to prevent the damage of turbine body by wet steam getting into the turbine.

1.2.10 Generator Trip

In the event of internal fault of generator, generator will be automatically cut-off from power system (generator trip), and turbine will be tripped in order to prevent the expansion of fault.

1.2.11 EHG Heavy Fault

In the event of EHG controller heavy fault such as cut of control power, controller fault and loss of turbine speed signal, the speed control is impossible and then safe operation is impossible, so turbine shall be tripped.
1.2.12 Manual Trip (Turbine trip PB ON)

Turbine shall be tripped by manual operation of turbine emergency stop button installed in the control desk in main control room and machine side of turbine (local).

1.2.13 Power System Frequency Low

In the event of system frequency decrease, turbine shall be tripped in order to prevent the resonance of low-pressure long large blade. There is no limitation to operate steam turbine within frequency range of 47.5 Hz to 51.5Hz. Trip signal is made by generator protection relay. Setting value is as follows:

<table>
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<tr>
<th>Condition</th>
<th>Value</th>
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<tr>
<td>110kV CB OPEN</td>
<td>48.0Hz</td>
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<tr>
<td>Turbine trip, GCB OPEN</td>
<td>47.5 Hz</td>
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1.2.14 Reverse Power

In the event of reverse power of generator because of turbine trip, generator will be automatically cut-off from power system (generator trip) in order to prevent the rotation of turbine because of motoring. This trip circuit is constructed in generator protection relay.

2. EQUIPMENT DATA

2.1 ST Protection and transducer panel (TGP)

This panel contains mainly turbine supervisory instrument (TSI) rack, overspeed hard wired protection system, trip solenoid valves circuit, some industrial transducers for STG supervision.

Construction:

a) Power supply

For protective relay circuit: Both AC 230V, 50Hz, 1-ph(UPS) and DC220V
For transducer circuit: Both AC 230V, 50Hz, 1-ph(UPS) and AC 230V, 50Hz, 1-ph(Normal)

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
Detail instruments flow is shown on "Turbine protection logic diagram" S1MAY__-BFF2503 (WA46326) and "Instrument flow diagram" S1CQ___-BFB2501 (WA46328).

See also O&M Manuals 6, 7, 8, 9, 10, 11, 12, 13.

2.2 ST Programmable protection panel (TPR) Out of FUJI’s scope [supplied by ABB]

Turbine protection system is configured in 2-out-of-3 voting circuit with redundancy programmable controller units, and outputs trip signals for the protection to TGP Panel. The programmable system will cover all other protection criterions except the over speed.

Detail protection logic is shown on "Turbine protection logic diagram" L1MAY__-BFF2503 (WA46326).

See O&M Manual for ABB ST Programmable protection panel (TPR)

3. AUTOMATION AND INSTRUMENTATION

3.1 Automation

See document “Turbine Protection Logic Diagram” L1MAY__-BFF2503 (WA46326).

3.2 Instrumentation

See document "Instrument flow diagram" S1CQ___-BFB2501 (WA46328).

4. OPERATION

See document “Turbine Protection Logic Diagram” L1MAY__-BFF2503 (WA46326)

See document "Instrument flow diagram" S1CQ___-BFB2501 (WA46328).
Turbine Governor and Protection Diagram