CHAPTER 6 – SUPERVISION AND CONTROL

CONTENTS

1 General

MAN TURBO will provide the turbine control and monitoring system to perform the control, protection and supervision functions of the turbine-generator set. The offer includes the design/engineering, documentation, manufacturing, erection and commissioning.

The scope of supply for the turbine control system includes the following:

- Analogue / binary signal conditioning
- Turbine governor system
- Turbine-generator supervisory equipment
- Turbine-generator protection equipment
- Control & supervision of auxiliaries
- Vibration measuring system
- Synchronising equipment
- Cabling between turbo-generator set and control panels

2 Turbine Control

2.1 General

The MAN scope of supply includes:

- Complete governing, safety and protection devices, supervisory equipment for reliable operation of the turbo-generator set.
- The turbine governing system based on a one-channel-type programmable logic controller (PLC).
- Start and stop procedures of the turbo-generator set will be automatic.
- The respective supervision signals and alarms will be available, in the control cabinet, for Ethernet / Profibus connection to the plant control system (DCS).
- Turbine control cabinets for installation in the vicinity of the turbo-generator set or in the central control room.

2.2 Accessories/Tasks

The turbine control and protection system consists of:

- Representation of all required measuring values (e. g. temperature, pressure).
- Turbine protection with settings of all limit values.
- Generator protection with settings of all limit values.
- Electronic-hydraulic turbine governor system with following functions:
  - Speed-frequency regulation (start-up/isolated operation)
  - Inlet pressure regulation
  - Extraction pressure regulation
  - Maximum power output limitation
- Electronic vibration measuring system for measuring, indication and supervision with non-contacting displacement sensors installed in the control cabinet with following features:
  - Relative turbine rotor vibrations : Turbine front and rear
  - Absolute casing vibration : Gear
  - Absolute bearing box vibration : Generator front and rear, Turbine front and rear if option BoB24
- Electronic measuring system for measuring, indication and supervision with non-contacting displacement sensors of the axial shaft position.

2.3 Instrumentation

- Measuring : one channel system.
- Quick closing criteria : two channel system.
- Speed trip criteria : 2oo3 channel system.
- Temperatures : PT 100 with transducers to I/O module of PLC.
- Pressures : Transducer without indication (installed at the turbine base frame) to I/O module of the PLC.
- Vibration/shaft position : Directly to I/O module of supervision equipment.

3 Generator Protection

The generator protection is based on a one-channel digital protection system.

The Generator protection includes the following functions:

- Under-voltage protection
- Over-voltage protection
- Over-current time protection
- Differential protection
- Reverse power protection
- Stator earth-fault protection non-directional
- Over-frequency protection
- Under-frequency protection
- Thermal relay
- Short circuit protection

The cable connection between the generator and the bus bar system is excluded.

4 Synchronising Equipment

The synchronising equipment (one channel type) includes the following functions:

- Automatic synchronising device with start/stop from the DCS
- Ammeters for generator current
- Voltmeter
- Cos φ meter (power factor meter)
- Active power meter
- Reactive power meter
- Manual synchronising is possible but instruments are not included (optional price for instruments can be given)

The synchronising switch will manage one generator breaker and one net breaker.

5 Turbine Governor

5.1 Scope of Supply

The control system is based on the electric-hydraulic principle, e.g. its control functions are performed electronically and the actuators of the various valves are actuated hydraulically. The measurement of the actual values is done using measuring transducers which emit standardised electrical signals to the controller.

Our scope of supply includes an electronic-hydraulic turbine governor system with following functions:

- Speed-frequency regulation (start-up/isolated operation)
- Inlet pressure regulation
- load control
- bleed control
- auxiliaries control

5.1.1 Speed Control

The turbine speed is measured electric-magnetically through two electronic speed pickups and fed to the speed governor as a true value. The speed governor (P or PI acting) generates an impulse electronically in accordance with the deviation which sets both control valve groups in the same way. The control valves are closed with rising speed.

5.1.2 Inlet Pressure Control

The value of the inlet pressure is controlled. Turbine speed or output results from the steam quantity of the live steam network. The speed controller acts as limit controller.

The turbine is started with the speed controller. When the rated speed has been reached, the actual value from the live steam pressure transducer is taken. Its control output signal is gradually superimposed upon the manually entered set-point value of the speed controller.

If a fluctuation in the inlet pressure network occurs, it must be compensated by a correspondingly higher or lower steam flow through the turbine. The inlet pressure controller causes this change in steam flow by set-point variations at the speed controller. This, in turn, acts accordingly on the servo cylinder of the steam control valve block.

During independent operation the inlet pressure controller is automatically switched off.

5.1.3 Load Control

The value of the turbine load is controlled. Turbine load results from the steam quantity of the live steam network. The speed controller acts as limit controller.

The turbine is started with the speed controller. When the rated speed has been reached, the actual value of the turbine load is measured. The output of the controller will track as long the controller is switched off to realise a bumbles take over. The load control output signal is gradually superimposed upon the manually entered set-point value of the speed controller.

If a fluctuation of the turbine load occurs, it must be compensated by a correspondingly higher or lower steam flow through the turbine. The load controller causes this change in steam flow by set-point variations at the speed controller. This, in turn, acts accordingly on the servo cylinder of the steam control valve block.

6 Preliminary Instrumentation List

6.1 Turbine

6.1.1 Pressure

Measuring point	Indication			Alarm	Stop	Comment
	Local	Panel	Signal			
Live steam		X	X			
Live steam – high				X	X	1oo2 configuration
Live steam – low				X	X	1oo2 configuration
Wheel chamber		X	x			
Exhaust I		X	X			
Exhaust I – high				X		1oo2 configuration
Lubrication oil		X	X			
Lubrication oil - low				X	X	1oo2 configuration
Control oil		X	X			
Control oil - low				X	X	1oo2 configuration
Oil behind auxiliary oil pump						

6.1.2 Temperature

Measuring Point	Indication			Alarm	Stop	Comment
	Local	Panel	Signal			
Live steam		X	X			
Live steam – low				X	X	1oo2 configuration
Live steam – high				X	X	1oo2 configuration
Inlet chest		X	X			
Exhaust		X	X			
Exhaust – high				X	X	1oo2 configuration
Turbine thrust bearing - load		X	X	X		1o2 configuration
Turbine thrust bearing - unload		X	X	X		1oo2 configuration
Turbine journal bearing - front		X	X	X		1oo2 configuration
Turbine journal bearing - rear		X	X	X		1oo2 configuration
Gearing bearing		X	X	X		
Generator bearing - front		X	X	X		1oo2 configuration
Generator bearing - rear		X	X	X		1oo2 configuration
Oil behind cooler		X	X	X		
Generator-Winding L1 - L3		X	X	X		2oo3 configuration (over 3 windings)
Generator cooling air - cold		X	X	X		
Generator cooling air - warm		X	X	X		

6.1.3 Various

Measuring point	Indication			Alarm	Stop	Comment
	Local	Panel	Signal			
Speed		X	X		X	2oo3 configuration
Rotor position – MIN		X	X	X	X	1oo1 configuration
Rotor position – MAX		X	X	X	X	1oo1 configuration
Control valves; Position 0-100%		X	X			
Lub. oil: level oil tank	X			X		
Lub. oil: oil filter	X			X		
Control oil: level oil tank	X			X		
Control oil: oil filter	X			X		
Generator cooling water leakage detector				X		
Vibration turbine relative. – front		X	X	X		1oo1 configuration
Vibration turbine relative - rear		X	X	X		1oo1 configuration
Vibration gearing absolute		X	X	X		1oo1 configuration
Vibration Generator abs. - front		X	X	X		1oo1 configuration
Vibration Generator abs. - rear		X	X	X		1oo1 configuration

6.2 Generator

6.2.1 Instrumentation

Measuring Point	**Indication**			**Alarm**	**Stop**	**Comment**
	Local	Panel	Signal			
Frequency Net/Generator		X	X			
Voltage Net/Generator		X	X			
Generator current		X	X			
Power factor		X	X			
Active power		X	X			
Reactive power		X	X			

6.2.2 Protection

Measuring Point	Indication		Protection Matrix (Event handling)			
	Local	Panel	Alarm	De-excitation	Breaker	Turbine trip
Differential protection (I)	X	X	X			
Differential protection (II)	X	X	X	X	X	X
Voltage controlled overc. (I)	X	X	X			
Voltage controlled overc. (II)	X	X	X	X	X	
Negative sequence (I)	X	X	X			
Negative sequence (II)	X	X	X	X	X	
Over-voltage step 1	X	X	X			
Over-voltage step 2	X	X	X	X	X	
Under-voltage step 1	X	X	X			
Under-voltage step 2	X	X	X		X	
Over-frequency step 1	X	X	X			
Over-frequency step 2	X	X	X			X
Under-frequency step 1	X	X	X			
Under-frequency step 2	X	X	X		X	
Reverse power step 1	X	X	X			
Reverse power step 2	X	X	X	X	X	X
Field Failure	X	X	X		X	
Stator earth fault protection	X	X	X	X	X	