SYSTEM DESCRIPTION MKA GENERATOR SYSTEM	Respons. dept GPEL	Date 040216	Reg. E DB 101
	Prepared T.Cota		YAMAMA CEMENT

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Purpose of the system

The purpose of the generator system is to transform mechanical shaft power into electrical 3-phase power which is adopted to voltage and frequency levels of the receiving power system.

General description of the system

The ABB AC generator is a 4-pole synchronous AC generator of salient pole type manufactured by ABB in Sweden.

The generator is of a compact welded steel design. The design concept makes very efficient use of active material employed, resulting in optimal performance with good economy and an exceptionally low total weight.

Special emphasis has been placed on designing an electrical machine with good mechanical stability. The box shaped machine base design allows the stator core with windings to rest directly on the foundations, thus ensuring that all static and dynamic forces are transmitted directly into the foundation.

A combination of short distance between the bearing centres and rigid bearing supports placed under the centre of each bearing, minimises the level of vibration. Traditional sleeve bearings of split type design are employed. The bearing liners are easily replaceable.

The rotor is of salient pole design running below the first lateral critical speed with a safe margin. A very high thermal capacity is characteristic for this rotor design.
The shaft can be designed for double end drive, an often cost effective solution in combined cycles where the gas turbine can drive the generator from one end and the steam turbine from the other.

Brushless excitation is achieved by a rotating exciter mounted on the main shaft outside the bearing at the non driven end. The excitation power is taken from a permanent magnet generator driven by the main generator shaft. The equipment is easy accessible for inspection.
The AC generator is tested according to a standard inspection plan issued by ABB. For further information concerning tests, please refer to the generator specification.
The generator terminal enclosure is a steel structure fitted to the side of the generator. It houses the generator terminals, busbars as well as neutral and line side equipment as specified.
For more information and technical data, please refer to the generator documentation “MV terminal enclosure”, data sheets and brochures.

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Main components

- Generator
  MKA10
  The generator comprise following main components:
  - Stator
  - Rotor

- Exciter
  MKC10
  The exciter comprise following main components:
  - Exciter with rotating diodes
  - Pilot exciter
  - Stand still heater element

  For more detailed information see system description MKC, MKY draw. no 1CS28920.

- Generator terminal box
  +MKA10GA001
  The following equipment is installed in the terminal box:
  - Current transformers for line respective neutral side, see below.
  - Voltage transformers, see below.
  - Stand still heater element, see below.
  - Grounding resistor, see below.
  - Heater element, see below.

- Voltage transformer
  +MKA10GA001.T1
  +MKA10GA001.T2
  +MKA10GA001.T3
  The transformer measures generator voltage for AVR, metering, synchronisation and protection.

- Current transformer, generator line side
  +MKA10GA001.T4
  +MKA10GA001.T5
  +MKA10GA001.T6
  The transformer measures current on the generator line side. Each transformer measures in one phase and has three cores, all cores are used for protection.

- Current transformer, generator neutral side
  +MKA10GA001.T7
  +MKA10GA001.T8
  +MKA10GA001.T9
  The transformer measures current on the generator neutral side. Each transformer measures in one phase and has three cores, one core is used for the AVR, two for protection.

- Surge arrester
  +MKA10GA001.F1
  +MKA10GA001.F2
  +MKA10GA001.F3

- Heater element
  +MKA10GA001.R04

- Grounding resistor
  +MKA10GA001.R21

- MCB terminal box
  +MKA10GA002
  The following equipment is installed in the terminal box:
  - MCB:s for AVR, protection/measuring, see below.
  - Terminals for current transformers, line respective neutral side.

- MCB, AVR
  +MKA10GA002.F1
  The Miniature Circuit Breaker protects the AVR measuring circuit from overload/overcurrent. Tripped MCB gives an alarm and transfers the voltage regulation to FCR (Field Current Regulator). For more information see system description for MKC, MKY draw no 1CS28920.

- MCB's, protection/measuring

+MKA10GA002.F2	MCB, generator protection sub.1
+MKA10GA002.F3	MCB, generator protection sub.2
+MKA10GA002.F4	MCB, measurement for synchronising
+MKA10GA002.F5	MCB, spare
+MKA10GA002.F6	MCB, open delta/earth fault

  The Miniature Circuit Breakers protects the generator protection respective measuring circuits from overload/overcurrent. An alarm is given if any of the MCB's is tripped (excluding spare MCB).

- Exciter terminal box
  +MKA10GA003
  The following equipment is installed in the terminal box:
  - Excitation field breaker.
  - Excitation thyristor convertor.
  - Rotating diode protection.
  For more detailed information see system description MKC, MKY draw. no 1CS28920.
  - Measuring converters for voltage, current, active and reactive power, see below.

- Measuring converters
  +MKA10GA003.E1.A03
  +MKA10GA003.E1.U04
  +MKA10GA003.E1.U05
  +MKA10GA003.E1.U06

- Field instruments terminal box
  +MKA10GA004
  The following equipment is installed in the terminal box:
  - Terminals for field instruments on generator, see below.

- Heater elements terminal box
  +MKA10GA006
  The following equipment is installed in the terminal box:
  - Terminals for stator heater elements, see below.

- PMG terminal box
  +MKA10GA007
  The following equipment is installed in the terminal box:
  - MCB:s for the excitation system PMG, see below.

- MCB, PMG
  +MKA10GA007.F01
  The Miniature Circuit Breaker protects the PMG circuit from overload/overcurrent. Tripped MCB gives an alarm and trips the generator circuit breaker. For more information see system description for MKC, MKY draw no 1CS28920.

- AC injection unit rotor earth fault
  +MKA10GA008

- Generator heater
  MKA10AH005
  The generator is equipped with following anti-condensation stand still heater elements,
  MKA10AH005.R01
  Heater element, generator stator
  MKA10AH005.R02
  Heater element, generator stator
  MKA10AH005.R03
  Heater element, generator stator
  MKC10AH005.R01
  Heater element, exciter
  The heater elements are connected so that they form one 3-phase power consumer.

- Temperature transmitter, bearing metal DE
  MKA10CT005
  The Pt100 sensor measures the drive end bearing metal temperature.
  High metal temperature (H1) gives an alarm and if the second alarm level (H2) is reached manual shutdown is required.

- Temperature transmitter, bearing metal NDE
  MKA10CT010
  The Pt100 sensor measures the non drive end bearing metal temperature.
  High metal temperature (H1) gives an alarm and if the second alarm level (H2) is reached manual shutdown is required.

- Temperature transmitter, incoming air DE
  MKA10CT015
  The Pt100 sensor measures temperature of the cooling air coming to the generator in the drive end.
  Cooling air temperature above (H1) gives an alarm and unloads the turbine.

- Temperature transmitter, outgoing air
  MKA10CT020
  The Pt100 sensor measures temperature of the cooling air leaving the generator.
  High outgoing cooling air temperature (H1) gives an alarm.

- Temperature transmitter, incoming air NDE
  MKA10CT025
  The Pt100 sensor measures temperature of the cooling air coming to the generator in the non drive end.
  The signal is used for indication and also in the AVR for biasing of the Field current limiter.

- Temperature transmitter, stator winding phase L1
  MKA10CT030
  The Pt100 sensor measures the temperature at the phase L1 stator winding.
  Winding temperature above (H1) gives event, high winding temperature (H2) gives an alarm and high temperature (H3) initiates alarm and after 5 min. unloads the turbine.

- Temperature transmitter, stator winding phase L2
  MKA10CT035
  The Pt100 sensor measures the temperature at the phase L2 stator winding.
  Winding temperature above (H1) gives event, high winding temperature (H2) gives an alarm and high temperature (H3) initiates alarm and after 5 min. also unloads the turbine.

- Temperature transmitter, stator winding phase L3
  MKA10CT040
  The Pt100 sensor measures the temperature at the phase L3 stator winding.
  Winding temperature above (H1) gives event, high winding temperature (H2) gives an alarm and high temperature (H3) initiates alarm and after 5 min. also unloads the turbine.

- Vibration transducer, DE
  MKA10CY005
  The accelerometer sensor measures vibration on the generator drive end bearing casing.
  High vibration (H1) gives an alarm and high vibration (H2) gives turbine trip.

- Vibration transducer, NDE
  MKA10CY010
  The accelerometer sensor measures vibration on the generator non drive end bearing casing.
  High vibration (H1) gives an alarm and high vibration (H2) gives turbine trip.

Function

Start up

The generator voltage is controlled by the voltage regulator and the generator speed is determined by the turbine during start up.

Continuos operation

The reactive power produced by the generator is determined by the voltage regulator and the active power is determined by the turbine.

During continuous turbine operation the anti-condensation heaters in the stator, exciter and the MV terminal box is switched off.

Turbine stop

The generator coasts down with the gear and power turbine.

Stand still

The generator, gear and power turbine is at stand still, also during the gas turbine cooling down period.

During standstill the anti-condensation heaters shall be switched on.

Disturbances

Gas turbine trip

After a gas turbine trip the generator coasts down with the power turbine and gear. The lube oil supply to the generator is ensured by the gas turbine lube oil system.

Generator breaker trip

The load throw off from the generator will give an overspeed. The turbine controller will control the turbine and return it to synchronous speed. The turbine controller will then keep the generator at synchronous speed. The voltage regulator will control the generator voltage at nominal voltage. Decision has then to be taken whether the unit should be shut down or synchronised and loaded again.

Loss of power supply

Loss of power supply does not directly affect the system. The lube oil supply to the generator is ensured by the gas turbine lube oil system. The generator can be without lube oil when the rotor is at standstill.

System faults

If there are any damages on the generator the gas turbine unit may not be started or has to be shut down.

- Electrical faults

The generator protection system protects the generator at internal electrical faults by tripping the generator circuit breaker and if necessary also the turbine and the excitation circuit breaker.

The measuring/protection circuits are protected by an MCB on respective circuit, which will trip on overcurrent/overloading.

The PMG circuit is protected by an MCB which will trip on overcurrent/overloading.

The stator winding temperature in each phase is monitored and alarm is given if any of them goes high. Should the temperature continue to increase then an unloading turbine trip is initiated.

- Bearings

Wear or damage to the bearings gives high vibration or/and high bearing metal temperature. Generator vibration respective bearing metal temperature is monitored and alarm is given if any of them goes high.

Other faults

Fault in connecting systems:

- Electrical faults
The relay protection system protects the generator at external electrical faults by tripping the generator circuit breaker and if necessary also the turbine and excitation circuit breaker.

- Lube oil system
Fault in the lube oil system may result in incorrect incoming lube oil temperature and/or pressure to the generator. These parameters are monitored in the lube oil system and the turbine is tripped at too low pressure respective at too high temperature.

Technical specification

Design criteria and standards

EN, IEC, NEMA, IEEE

Dimensioning data

The generator is designed to match the turbine output curve. The turbine output at base load operation (TBO 40000h) shall be generated with a PF of 0.8 with temperature rise as per class B at nominal voltage and frequency.

Peak load (TBO 4000h) shall be handled with temperature rise acc. to class F.

The generator shaft/flange is designed for 5 x nominal torque in order to withstand a 2 phase short circuit.

Emergency power supply

The generator requires lube oil during operation and coast down, but can be without lube oil when the rotor is at standstill.

Installation

A protective cover for the shaft/coupling shall be installed.

Materials

-

Component data

-

Testing and service

A grounding ball is available at each phase on generator line side, for safety grounding during maintenance on generator.

Testing during normal operation

No testing during normal operation is required.

Accessibility during normal operation

Terminal boxes and protection MCB's may be accessed during normal operation.

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