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An approach to promote Frequency regulation using Free Governor mode operation method

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Abstract: **As energy consumption as well as reliability based availability of power becomes the main factor to the economic growth. The electrical energy demand in country has been rising at the rate of 15% per annum. Generation capacity has been rising at the rate of 10% per annum. To bridge this gap advanced technologies have been necessary to incorporate in the Indian power sector.. Power system frequency is an important indicator of the quality of power supply. The Indian Electricity Act, the frequency has to be maintained within +/- 3% of the rated frequency, 50Hz. In india the frequency is always low and this causes severe problem to the connected load and power generating equipment. The grid operation in india has undergone a dramatic change in recent years with the introduction of Indian Electricity Grid code(IEGC), Free Governor mode operation(FGMO), Availability Based Triff(ABT). The above factors are gaining importance day by day among all stake holders.**

The area of my research proposes the success of the FGMO of Chandrapur Thermal Power plant (CTPP) respond to the standard frequency rate and this will make the operation more secure.

Index Terms— **Chandrapur Thermal Power plant (CTPP), energy consumption , Free governormode operation (FGMO).**

I. INTRODUCTION

The power system Industry is a field where there are constant changes. Power system are becoming more complex as they become interconnected. Load demand also increases linearly with the increase in users. Since stability phenomena limits the transfer capability of the system, there is a need to ensure stability and reliability of the power system due to economic reasons. Other aspect of stability study is to have proper control. It is used in selection of proper material equipments, device and controlling system in order to enhance the normal operation of power system and avoid the serious consequences seen as failure due to fault etc . Frequency drifts upwards or downwards in a power system is the main indicator of the momentary imbalance between generation and demand. In order to maintain the grid stability the power sector has adopted a new technology FGMO, to overcome the difficulties. Frequency stability in electrical network is essential to the maintenance of supply quality and security. This paper investigates whether a degree of built in frequency stability could be provided by adapting the Free Governor mode operation in the power sector to help the grid to maintain the standard frequency rate. With the disturbances in the region, system stability is becoming an increasingly important issue to governments who are ultimately accountable for maintaining the quality of supply.

II. CONCEPT OF FREE GOVERNOR MODE OPERATION:

Generator is a directly connected with grid after synchronisation & turbine is also directly coupled with generator with couplings. Hence turbine speed is controlled by grid frequency as turbine generator and grid are in synchronisation. Thus turbine speed lower or raises as per lowering or raising of grid frequency in this way turbine speed is as such not in control of operator.

Power produced by turbine $P = \frac{2\pi N}{60}$ Nm/s or watts. Hence power produced by turbine is directly proportional to the torque produced by turbine. Torque depends on quality & quantity of steam input to the turbine. Hence quality of steam means, the stream pressure & temperature (i.e. enthalpy, heat content in steam). And quantity means the amount of flow of steam through turbine. Controlling the steam input to the turbine control the power out of the turbine. Steam input to the turbine is controlled by controlling valves position. More the control valve position, more will be the steam input to turbine & hence more the output . Governing system take care of controlling control valves position (steam input to the turbine) as well as act as a protective device for turbine.

III. DEFINITION OF FREE GOVERNOR MODE OPERATION:

Since load on system is constantly changing there is always a slight mismatch between generation and load. If generation is greater than demand, grid frequency rises and vice-versa. During this input-output mismatch, difference is stored/ dissipated as kinetic energy, till system acquires new equilibrium. As frequency fall, governor acts to admit more steam and increases load on the generator .In doing so governor attempts to arrest falling frequency. Opposite action takes place when generated power is more than demand. This is known as Free Governor mode operation. System settles at some new frequency, depending upon speed load - characteristic of entire system.

IV. DETAIL OF 500MW SET AT CHANDRAPUR THERMAL POWER STATION

The KWU turbine is provided with the mechanical and electro hydraulic governing system.

It works on three Modes :-

1 Speed Controller :- Normally used for rolling synchronization & loading upto 10 %

2 Load Controller :- Load varies from 10 % to 100% by varying load set point.

3 Pressure Controller :- Maintain fixed throttle pressure of turbine by varying load.

EHG DIAGRAM

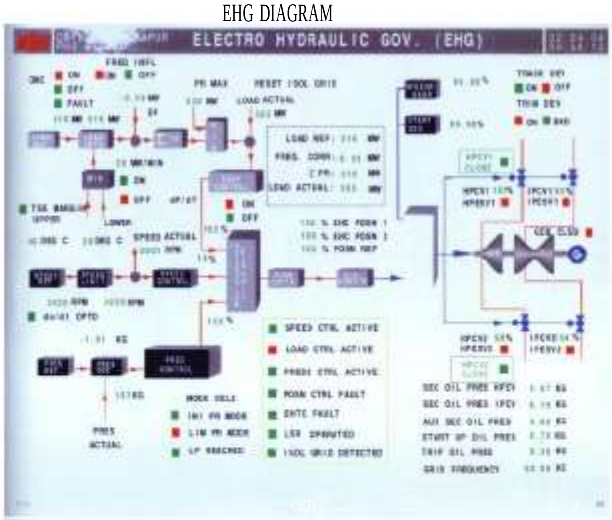


Figure 1.. Electro Hydraulic Governing system

Unit Operation Mode

1. Boiler Follow Mode
2. Turbine Follow Mode
3. Coordinated Master Control (CMC) Mode

1.BOILER FOLLOW MODE :- In this mode of operation, boiler controls (i.e combustion control) are on automatic mode and turbine controls on manual mode. The required load set point in MW can be set from the turbine desk through load reference according to which actual load changes by opening or closing the control valves of turbine. This change in control valve position changes the turbine throttle pressure whose deviation (error signal) with steam flow as feed forward signal will directly acts on boiler controls i.e. boiler master.

2. TURBINE FOLLOW MODE

In this mode of operations turbine control is on auto & boiler control (i.e combustion control) on manual. Turbine tries to maintain throttle pressure by varying the control valves & load changes. It is basically pressure control mode. To maintain load, the fuel & air flow has to be changed manually.

3.COORDINATED MASTER CONTROL (CMC) MODE :-

In this mode boiler control & turbine controls both are on auto mode. It works on load controller with both boiler & turbine on auto coordinating with each other. A common load reference signal it sent to boiler controls & turbine controls.

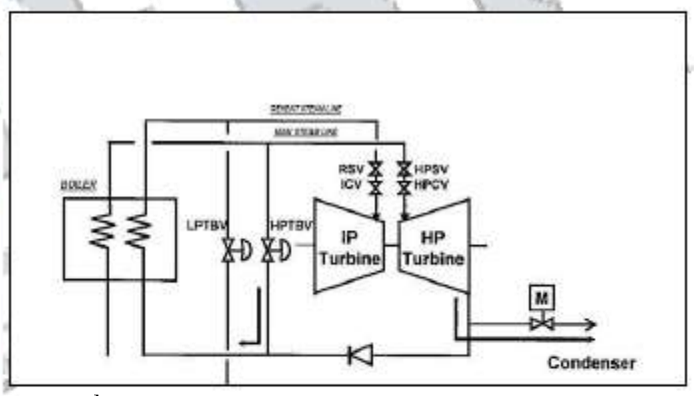


fig.2. Co ordinated Master Control (CMC) Mode

Table No.1. Comparison of different modes.

Mode	Boiler master	Turbine master
Base load	Manual	Manual
Boiler follow	Auto	Manual
Turbine follow	Manual	Auto
Coordinated	Auto	Auto

V. GRID RELATED ASPECTS OF FREE GOVERNOR MODE OPERATION :-

1. At least 50 % of grid capacity should work on FGMO/FI mode, which would help stabilizing grid frequency quickly. TG sets operate more smoothly at constant & rated frequency.
2. Availability based tariff (ABT) also helps keeping grid operation in narrow band frequency because of economical considerations. Free Governor Mode may result in unscheduled interchanges (UI).

Merit order aspect needs to be considered while deciding Free Governor Mode Operation priority order of TG sets.

Area wise load flow & voltage profile considering Free Governor Mode Operation, need to be studied.

VI. Governor Droop Characteristic of FGMO :-

This is percentage change in speed of an isolated turbo- generator when load on turbo- generator is increased from no load to full load (or decreased from full load to no load). This is set at 4 % to 5 % by the manufactures.

$$\%\ \text{Droop} = \frac{\text{Noload Speed} - \text{Fullload Speed}}{\text{Noload speed}} \times 100\%$$

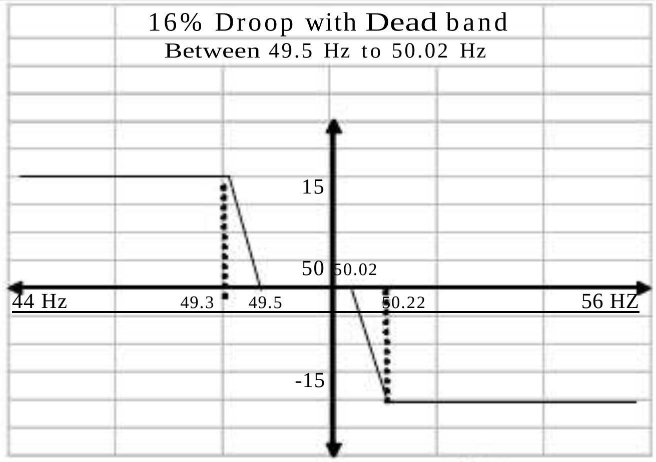
$$= \frac{\text{Change in load}}{\text{Rated load}} \times \frac{\text{Change freq.in}}{50} \times 100\ \%$$

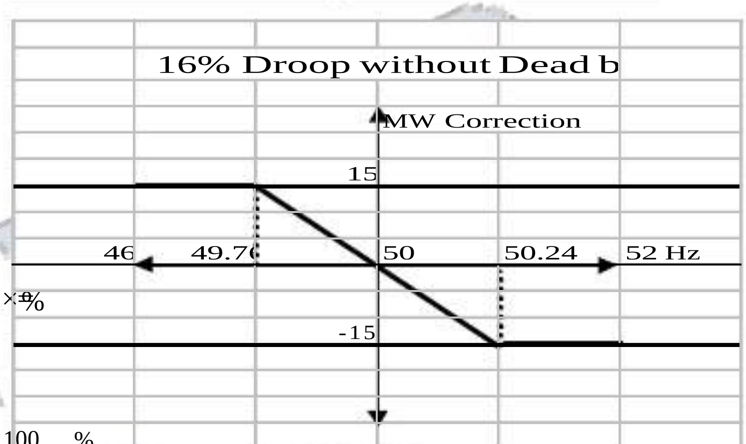
The Indian standard frequency is 50 Hz but $\pm 5\%$ variation in frequency as per load changes is allowed. Thus it is designed for 5 % droop in which turbine full loading to unloading (i.e.500 MW to 0 MW) will vary ± 2.5 change in frequency. This helps in grid discipline.

If the frequency above □ 2.5 % is increased then whole grid will trip out or collapse.

The graph curves with 16% droop characteristics shows that the change in frequency will vary from □ 1.5%, which will be nearer to 50Hz standard frequency.

This is the alternate & better solution of frequency control without any human interference at generating station to avoid any manually loading or unloading of turbine against the grid demand.





Graph 1b. 16% Droop with dead band

CONCULUSION

There is an increase in the size of the generating units, the present maximum size is 500MW and very soon there would be units of 1000MW size. The tripping of a single generating unit of such a large size would create a far more severe contingency and tripping of the entire station is another credible contingency. In these circumstances, there is a need for having a good frequency response for each control area. Free Governor Mode of Operation and provision of reserves by each utility is required.

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