Some Common Practical issues of Operation of Power Station Units in India

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ABSTRACT
India's growth in Power generation has been spectacular over the past several years. Apart from conventional Hydro and Thermal Power, the non-conventional Solar and wind Power have greatly contributed to this upsurge. There is however some technical issues related to the practices generally being followed or otherwise, in the operation of these plants particularly for hydro which need attention. This paper attempts to bring out and discuss these issues. While doing so, concepts involved are also touched to enable the Power Station engineers to fully appreciate these issues for implementation to reap maximum benefits of the asset they have been entrusted with for operation.

Key words: Operation of power station, droop characteristics, reactive power, operation at no load, operation in manual mode

I DROOP CHARACTERISTICS OF MACHINE

Every generating set has a governor to start/stop it and to control its speed rise during load throw offs so as to bring it back to normal speed, ready for next synchronization. An additional feature of droop is also invariably provided for stabilization of speed in NO LOAD (Temporary droop) and load sharing when operating in the Grid (Permanent droop).

Permanent droop setting selectable in the range of 0 to 10% of 50 Hz, decides load change with change in frequency of the grid. For example a 5% setting would cause 100% change in load on the machine when change in frequency by 2.5 Hz would occur, with no operator intervention. It follows that units at lower setting would pick up more load with fall is frequency, thereby contributing more for maintenance of grid frequency. Thus, it is important for operating engineers to know this setting and be able to change it as per the requirement for base load or peaking operation.

Figure No. 1 shows the variation in real time load with frequency of a 60 MW hydro set plotted while running the unit without operator's intervention.

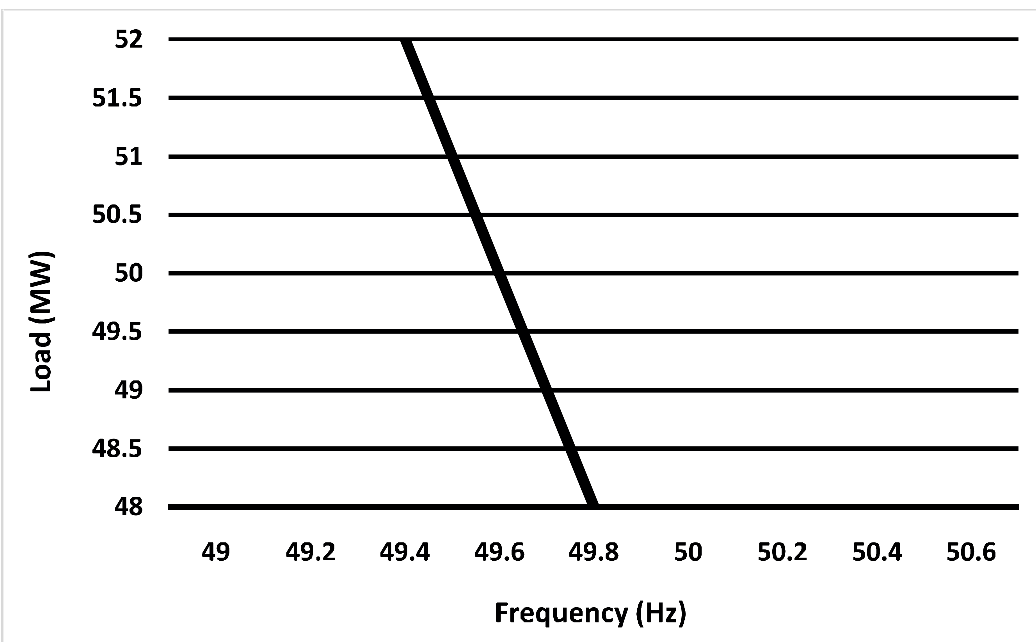

Fig. 1: Variation in real time load with frequency

The calculation of droop from the observed values gives droop of 10% which matched with actual droop setting of 10% as given in Table No. 1.

Table 1
Calculation of droop

S.No.	Machine speed (Hz)	Load on machine (MW)
1	49.0	51.7
2	49.65	48.7
3	∇f = 49.65-49.4 = 0.25	∇P=51.7-48.7=3
4	Change in frequency = (0.25/50)100 = 0.5%	Change in load = (3/60)100 = 5%
5	For 5% load change, the change is frequency = 0.5%. Hence, for 100% load change, the change in frequency = (0.5/5)100 = 10%	

Note: Synchronous generator is used in this case and in almost all large rated generating units. In a synchronous generator, the speed of revolution is directly proportional to the frequency as can be seen from following formula of synchronous speed.

$$\text{Synchronous speed} = (120\ f/P) \qquad (1)$$

where, f = frequency (Hz)
P = no. of poles in generator

II REACTIVE POWER GENERATION

All generating units are designed for producing both active (P) and reactive (Q) powers. The grid needs both these powers to sustain itself as a stable source of power to meet the requirement of inductive loads connected to it. The active power is generated by further opening of guide vanes of reaction turbine (Francis/Kaplan) and nozzles of an impulse i.e. Pelton turbine. The reactive power is generated by giving more excitation in the rotor winding, after synchronization.

The issue here is that either the reactive power is not being generated (operation at unity pf) or is not generated fully as per the capability of the machine which in fact is much more than name plate specifications if operating below rated load, subject to limit of rotor current (and –stator current/voltage). For example, a 105 MW, 11 kV, 0.9 pf generator would deliver 50.93 MVAR at 105 MW, but at 30 MW, it can give 60 MVAR at 0.26 pf, with all parameters remaining within limits. It follows that maintaining rated pf at all loads should not be the aim during operation.

III OPERATION AT NO LOAD

For any generating unit to produce power it has to pass through "No Load" run where efficiency is zero (efficiency = output / input). It is obvious that duration of this run should be kept minimum. The issue here is that power house authorities at different levels are generally found not giving due importance to it, with the result that sizable energy goes waste.

Below are given some practical tips to curtail the duration of no load run.

(a) Avoid unnecessary long duration of no load run for dry out/complex testing before commissioning or re-commissioning after flooding of a machine.
(b) Make use of a function generator for setting speed relays rather than doing it by running the machine.
(c) Tripping logics of machine should not unnecessarily cause stoppage of the unit on occurrence of system faults or after load throw-offs.
(d) After Commissioning, go for full auto start up to auto-synchronization sooner than later. In manual synchronization, the settings of the synchronizing relay should not be too tight.

IV OPERATION IN MANUAL MODE

Normally though machines are operated in Auto Mode- Governor/AVR both in auto – yet at times, due to some or other reason, manual governor or manual AVR operation becomes inevitable. The issue here is that operator must keep in mind inherent risks to the machine in manual mode and therefore remain vigilant. The risks are summarized below.

(a) Operation with Governor in manual mode- Here, strong support of automatic speed control being unavailable, reliance solely on speed relays against over speeds is what we are left with. Cases are known when due to failure of DC control supply, machine broke-down due to the resulting runway speed.

(b) Operation with AVR in manual mode – Like above, automatic voltage control being unavailable, Stator overvoltage protection alone will guard against over voltage.

Other disadvantages of manual mode are that Machine gets tripped in manual governor, requiring restart involving no load run and consequential energy loss as mentioned above under Section III (Operation at no load).

V CONCLUSION

Hydropower plants play very important role in the stable operation of power system mainly due to the quick start/stop feature of hydrogenating units and their capability to supply/absorb reactive power. It is necessary to make optimum use of our natural resource, water in this case. The water management is at top of the agenda of the Government of India in view of its challenging 'Jal Jeevan Mission' of providing tap connection to supply water to every household in the country by 2024. The hydropower projects are multipurpose and power generation may be one of the benefits which may be derived wherever feasible. There is however some technical issues related to the practices generally being followed or otherwise, in the operation of power plants which need attention. This paper has presented some operational issues of a power plant based on vast practical experience of the author for the benefit of power plant operators.