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Procedia Engineering 170 (2017) 496 – 502

Procedia Engineering

www.elsevier.com/locate/procedia

Engineering Physics International Conference, EPIC 2016

The New Method to Determine the Value of Speed Droop for Subcritical Coal Fire Power Plant in order to Contribute to Primary Frequency Control of Power System

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Abstract

Frequency is the controlled variable in balancing electricity supply and demand of power system. Frequency control needs power plants contributions by changing the output power of the corresponding generator until balance condition between electrical supply and demand gets reestablished. The contribution of each power plant is determined by some parameters speed droop and dead band. The Indonesian government regulation for speed droop is a maximum of 5 % with dead band 0.03 Hz but not all power plants can set that value. This paper present new method to determine the optimal speed droop by analyzed the energy storage at Suralaya Power Plant unit 5, 6 and 7.

Peer-review under responsibility of the organizing committee of the Engineering Physics International Conference 2016
Keywords: speed droop; dead band; subcritical power plant; primary frequency control; energy storage

1. Introduction

Frequency is one of the parameters that must be controlled on the electrical grid frequency. Frequency set point in Indonesia is 50 Hz. Primary Frequency Control or free governor is one important means to ensure the stability of the electricity system [8,11]. Primary Frequency Control or free governor is done by the Governor response of each power plant which can contribute to reduce or to increase its generator output power when there is a change load or frequency abruptly [4]

Based on 2009 statistics, there are 214 times system frequency excursion happened and 205 of it caused only by load fluctuation [5]. Figure 1 shows that loss of 380 MW load caused one subcritical power plant trip on the electrical system in the Java - Bali which has total installed capacity of over 24,000 MW can cause a decrease in the frequency of up to 0.8 Hz.

In Grid Frequency Control, subcritical steam power plant of concern because of its large capacity. Subcritical steam power plant is coal fire power plant that using steam operation in subcritical state to drive a turbine as shown in Figure 1.

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Peer-review under responsibility of the organizing committee of the Engineering Physics International Conference 2016
doi:10.1016/j.proeng.2017.03.079

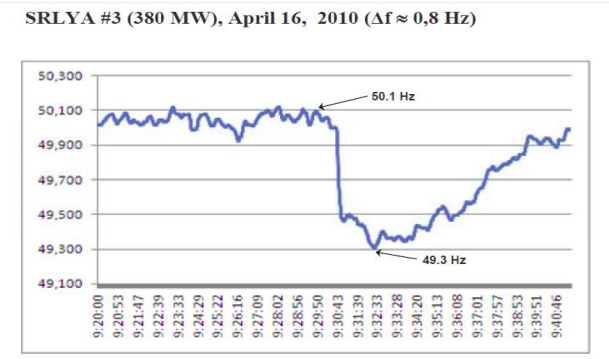


Figure 1. Loss of 380 MW load cause frequency of up to 0.8 Hz [1]

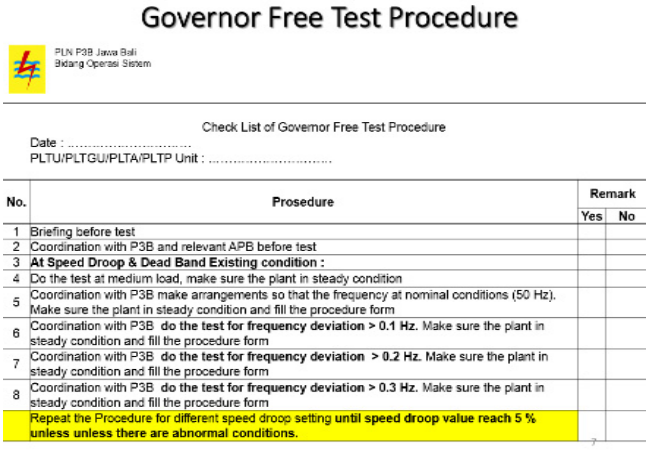
Base on regulation minister of energy mineral resources number 03 in 2007 about Grid code of Jawa Bali power system clause cc 3.2.1 stated that large plants above 50 MW , must operate with a governor that is not blocked (Governor Free) unless otherwise permitted by the Load Control Center and clause OC 3.3 state that All generating units must set a governor droop characteristics at 5 % unless otherwise permitted by the Load Control Center and set at an other level that other.

Speed Droop (SD) is defined as governor change the output of a power plant in direct proportional to the change in the frequency [7] or Percentage of frequency changes that equivalent to the opeaning of 100% fuel valve [5] or defined by the Equation 1 [9].

$$SD\ (\%) = \frac{\%\ Frequency\ Deviation}{\%\ Generator\ Power\ Output}\ x\ 100 \qquad (1)$$

The current value of power plant speed droop implemented through several step as shown in Figure 2 [5]. In this implementation tested to power plant by providing a frequency deviation gradually while watching the stability of power plants. Speed droop value being set until closer to regulation that is 5%.

This value is determined regardless of generation capacity although it has been conducted in stages, testing done in real time, because at the time of testing, the plant has been conditioned to carry out the test while the real frequency deviation happened power plant response can be different. For example Suralaya unit 6 is able to contribute to the incidence of under frequency dated January 13, 2016 up to 649.2 MW of operating power of 600 MW, but only lasts for one second (Figure 3). This shows that not all power plants can contribute in the primary frequency control in accordance with the specified settings because of internal condition. That is why to set the value of speed droop beside implement external test by providing a frequency deviation gradually, it must be analyze its internal capacity.



Governor Free Test Procedure

PLN P3B Jawa Bali
Bidang Operasi Sistem

Check List of Governor Free Test Procedure

Date : .....
PLTU/PLTGU/PLTA/PLTP Unit : .....

No.	Prosedure	Remark	
		Yes	No
1	Briefing before test		
2	Coordination with P3B and relevant APB before test		
3	**At Speed Droop & Dead Band Existing condition :**		
4	Do the test at medium load, make sure the plant in steady condition		
5	Coordination with P3B make arrangements so that the frequency at nominal conditions (50 Hz). Make sure the plant in steady condition and fill the procedure form		
6	Coordination with P3B **do the test for frequency deviation > 0.1 Hz.** Make sure the plant in steady condition and fill the procedure form		
7	Coordination with P3B **do the test for frequency deviation > 0.2 Hz.** Make sure the plant in steady condition and fill the procedure form		
8	Coordination with P3B **do the test for frequency deviation > 0.3 Hz.** Make sure the plant in steady condition and fill the procedure form		
	Repeat the Procedure for different speed droop setting until speed droop value reach 5 % unless unless there are abnormal conditions.		

Figure 2. Free Governor Activation Procedure