ISSN 2616-7433 Vol. 2, Issue 4: 46-49, DOI: 10.25236/FSST.2020.020412

Optimization of Water Head Processing Logic for Governor Control System of a Power Station

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Abstract. *A hydropower station is an axial-flow propeller turbine unit with a installed capacity of 4 * 150MW and a rated head of 20m. The treatment of head sampling and the improvement of fault judgment will directly affect the stability and reliability of the load adjustment of the unit. By analyzing the load fluctuation event caused by a certain head failure, the water head processing logic of the governor control system was modified and improved, and relevant verification tests were carried out to achieve the expected purpose and effect, hoping to provide reference for peers.*

KEYWORDS: *Urbine governor; Head treatment; Perfect logic; Load fluctuation*

1. Introduction

A hydropower station is located in Yanbian County, Panzhihua City, Sichuan Province. The power station is mainly for power generation tasks, and it also has downstream comprehensive water requirements. The reservoir has daily regulating performance. The total installed capacity of the power station is 600,000 kilowatts (4x150,000 kilowatts). It is an axial-flow propeller-type hydroelectric generating unit with a rated head of 20.0m. The average output during the dry season is 227,000 kW, and the average annual power generation is 2.975 billion kW.h the annual utilization hours are 4958h.

Although the governor control system runs stably after being put into production, in view of the occurrence of load fluctuations due to incomplete water head processing logic and fault judgment, the water head processing related logic in the control system needs to be optimized and improved to ensure the unit Stable operation.

2. Analysis of Load Fluctuation Events of a Unit

2.1 Overview

At 16:13:12 on November 22, 2017, the # 3 unit of the power station was connected to the grid with a fixed load of 100.4MW, and the operating water head measured by the governor control system of the # 3 unit dropped from 21.5m to less than 11.48m. The speed controller control system A and B sets report “Fault of the downstream water level sensor 3, downstream water level feedback failure, head feedback failure, general failure”. The active control function of the monitoring system is exited, and the speed controller control system is switched from A to B. Set the operation, the operating head is cut from automatic head to artificial head (minimum head 11.48m), the opening of the guide vane remains unchanged at 47.4%, the opening of the paddle is closed from 44.4% to 13.4%, and the unit load is reduced from 100.4MW To 50.2MW, causing a large fluctuation in load.

2.2 Event Analysis

As shown in Figure 1, on November 22, 2017 at 16:13:12, the # 3 machine governor control system reported a head failure, and the # 3 machine's running water head quickly dropped from 21.5m to 11.48m within 1s. The governor control system is switched from A set of main to B set. The active control function of the monitoring system is withdrawn. The governor is no longer controlled and the guide vane opening remains unchanged because the governor control system operation head changes. The blade opening degree was closed from 44.4% to 13.4% under the association relationship, and the unit load was reduced from 100.4MW to 50.2MW.

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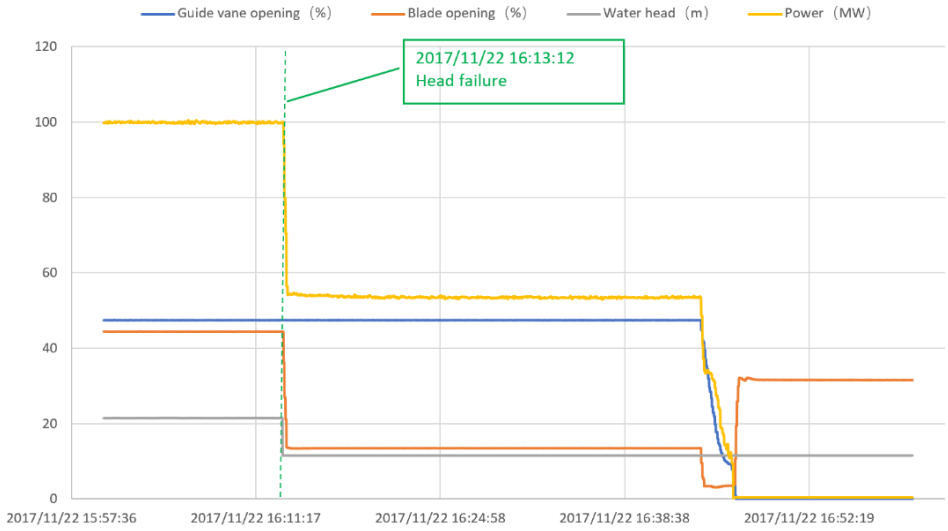

Figure.1 #3 Unit Waveform Diagram of Head Slipping Load

1.3 Event Conclusion

The direct trigger of this event was the failure of the water head sensor, and the root cause was a loophole in the water head switching mechanism in the governor control system: the imperfect artificial head program segment caused the 20 m artificial head value set in the human-machine interface to fail. Instantly, it was not correctly retrieved by the program segment. Instead, the dead head value was abnormally issued, which caused the water head to change from 21.5m to 11.48m in an instant, which caused the subsequent blade association and the load to slip.

Simultaneously check the water head processing related logic of the governor control system. In order to ensure that the water head is worthy of stability and reliability, further optimization is needed in the following areas: perfect water head fault cut artificial water head logic, increase water head change rate judgment, modify the water head sensor alarm cross line value .

2. Optimize the head logic

2.1 Perfect Automatic and Artificial Head Switching Mechanism

In the governor program, “When the automatic water head cuts the artificial head, the governor program calls the artificial head value set in the governor touch screen setting window as the running head value (the 20m rated head value is written by default, only in the artificial head mode) After setting the artificial water head value, click the parameter setting button to actually write the setting value.) “Was changed to” When the artificial water head is cut manually by an artificial head or the automatic water head is cut by an artificial head due to a head feedback failure, the speed is adjusted The water head value before switching is called as the running water head value in the regulator program. In the artificial water head mode, the artificial water head value setting can still be performed in the governor touch screen setting window “to ensure that the automatic water head cuts the artificial water head. During operation, the head value remains unchanged to avoid causing unit load fluctuations.

2.2 Self-Increasing Head Change Rate Judgment Logic

In view of the fact that the water head measurement mechanism of the governor control system is based on the principle of calculating the difference between the pressure values of the volute and the draft tube, the rapid and large changes in the flow rate of the unit will cause a large sudden change in the pressure of the volute and draft tube to affect the head Calculated values, extracting the relevant data under the extreme working conditions

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of 100% load dump of the unit found that: # 1 machine head maximum change value is 0.8m, # 2 machine head maximum change value is 1m, # 3 machine head maximum change value 0.6m, # 4 machine head maximum change value is 0.8m.

According to the maximum head jump data of each unit extracted above, a “head jump over limit” fault is reported in the governor control system when the head change rate exceeds 1.5 m every 30 seconds, and the head value of the governor is still selected. The previously calculated average head value will not be selected by the governor until the difference between the latest calculated head value and the current running head value falls within 1.5m. In this way, the jump head value is eliminated, and the accuracy of the head value of the governor control system is improved.

2.3 Correct the Upper Limit Alarm Setting of the Downstream Water Level Sensor

At present, the pressure measurement points of the upstream and downstream water level sensors of the governor are based on the sensor range of 0-600KPa, which has exceeded the limit alarm. 600KPa corresponds to a water level of 60m. See the following table 1:

Table 1 Power Station Tail Water Level Statistics Table

No.	Time	Lowest tailwater level(m)	Tailwater level(m)	Tail water level change(m)
1	1 月	989.4	992.8	3.4
2	2 月	989.8	992.9	3.1
3	3 月	990	992.4	2.4
4	4 月	989.1	992.3	3.2
5	5 月	989	992.4	3.4
6	6 月	989	994.6	5.6
7	7 月	989.1	995.9	6.8
8	8 月	988	996.4	8.4
9	9 月	989.4	996.7	7.4
10	10 月	989.2	995.4	6.2
11	11 月	986.6	994.3	7.7
12	12 月	987.9	991.5	3.6

As can be seen from table 1, the range of the tailwater level of the power station in 2017 was 986.6-996.7m (the lowest and highest tailwater levels were taken as the highest values of the year), and the maximum change in the water level was about 10.1m, which is related to the downstream water level sensor of the governor By comparing the measured values, it can be concluded that when the tail water level is highest, the measured water level of the downstream water level sensor is about 20m, and the upper limit alarm setting of the downstream water level sensor of the governor is changed from 60m to 30m, so that the water level sensor can be reported in a more timely and accurate manner. Failure to ensure more accurate head measurement of the governor.

2.4 Improve the Alarm Function of Water Level Sensor Disconnection, over Limit, Deviation Delay

The sampled value of the current water head sensor changes for a short time due to external interference or pressure pulsation, which leads to the occurrence of sensor disconnection, limit violation or deviation fault. At the same time, the peak duration of the pressure pulsation of # 3 machine is about 4 ~ 5s. Therefore, the alarm time of the water level sensor disconnection, limit violation and deviation fault judgment is modified to 10s to avoid the short-term jump of the sampling value. Frequent alarms occur.

3. Conclusion

According to the analysis of load fluctuation caused by head failure of a power station, this paper finds some logic loopholes in the governor control system, and proposes some methods and treatments to improve the head logic. The tests have been verified and the expected results have been achieved. . At the same time, the amount of head is of great importance to the governor of a dual-gear turbine. If it is not handled properly, it will easily cause an abnormality of the active output. It must be paid great attention. It is hoped that the optimization of the

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head logic will provide reference for peers.

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