Discussing about a no-load Governor Judgment and unit Load Shedding Safety

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Abstract: According to the major safety hazards such as overspeed protection actions and disappearance of plant power in the hydro-generator unit during the load shedding process of the Jinkang Power Station after a single outgoing trip, a reconciliation was proposed for the major safety hazards. Modify and adjust the no-load judgment conditions of the governor to ensure that the governor enters the no-load adjustment in a timely and accurate manner to meet the load shedding requirements of the unit, ensure the unit's safe, stable, and reliable operation, and ensure that the plant power is not interrupted and completely eliminated. Security risks.

1. Introduction

For high-head, high-speed hydropower stations, during load shedding, it is difficult to control the speed and the pressure rise rate of the steel pipe during the excessive process. The load shedding test of the switch was successful, but in the case of actual single outgoing trip and load shedding, it often caused the unit's speed to run out of control and the overspeed protection action, which caused the entire plant's overspeed shutdown and the entire plant to lose power. This is the case at Jinkang Power Station. The above phenomenon occurs every time the load is dropped, and the safety situation is alarming.

2. Governor Load Shedding Control (principle description)

The governor in China has developed from the earliest mechanical governor, experienced mechanical governor, electric governor, to the current microcomputer governor, and it is still the PLC, PCC, PAC as the controller's PID regulation rule. Speed device.

General governor manufacturers set the unit to three states: no-load, grid-connected, and isolated network; the general judgment conditions are:

2.1 No-load: the unit Exit Switch is in the Open Position

Grid connection: The unit's outlet switch is in the closed position, and the frequency is in the range of 50 ± 0.4HZ (the value range of general manufacturers: 0.4 ~ 2HZ);

Isolated network: The unit's outlet switch is in the closed position, and the frequency exceeds the range of 50 ± 0.4HZ (the value range of general manufacturers: 0.4 ~ 2HZ);

In terms of control parameters, the no-load parameter adjustment is the most sensitive, the governor adjusts frequently, and the adjustment effect is the best. The isolated network adjustment parameter considers that the unit operates independently with a small network and is completely separated from the system's large network. Adapt to small grid (or isolated grid) load fluctuation adjustment requirements. Generally, the governor parameter settings are the same as or similar to the no-load adjustment parameters. At this time, the governor adjustment is also frequent and the adjustment effect is very good. Considering that the current power grid capacity is very large, the sensitive adjustment performance of general units in the system is not very obvious, so it is not necessary to have very sensitive adjustment performance. At this time, in order to reduce the

number of adjustments and extend the governor use Lifetime, intentionally set the adjustment parameters that are not sensitive to the grid.

Unit load shedding test is generally performed when the unit is under load, and the outlet switch of the unit is manually switched on. The governor immediately determines that the unit is in the no-load state and simultaneously takes two measures. The first is to immediately change the electrical opening limit to no-load. Opening degree (the actual opening degree of the unit is increased by 5-8%), the second is to immediately adjust the adjustment parameter to the no-load parameter; under the above two measures, the general unit load rejection test results are very good, and can reach the relevant adjustment Requirements, that is, the rate of increase of the unit speed does not exceed 135% of the rated speed, and the rate of increase of the hydraulic pressure of the unit's pressure steel pipe does not exceed 140% of the rated pressure. After the calculation of the adjustment and guarantee, there are other requirements that are not included in this example.

In actual hydropower stations, when the load is dumped, the unit's exit switches (such as outlet switches, high-voltage side switches of the main transformer, etc.) are often not skipped. At this time, the governor generally waits until the frequency rises more than 50.4HZ. Manufacturers, enter the isolated network to determine the conditions, the minimum is ± 0.4HZ, the maximum is ± 2HZ), the adjustment parameters are changed to the isolated network parameters for adjustment; most manufacturers in order to ensure the accuracy of the isolated network, to avoid the normal operation of the unit and large network When the frequency measurement signal interferes with the isolated network by mistake, the governor has a two-second delay after the frequency reaches the isolated network judgment condition. Due to the above situation, the unit is very easy to overspeed when the unit is tripped under load without tripping the outlet switch.

3. Cause Analysis and Countermeasures

3.1 Causes of Overload Rejection and Loss of Plant Power

The framework of the Sichuan power grid is relatively fragile, especially for small and medium-sized hydropower stations. There are often Sichuan power stations, and then Sichuan power stations ... and then sent to power grid substations. Therefore, the power station is basically the only transmission line, and once tripped, all units will load off. However, the unit's exit switch did not trip, and the governor still considered that it was in the state of grid connection, and adjusted it with grid connection parameters. When the frequency rose more than 50.4HZ (investigating the relevant manufacturers, it was found that domestic speed regulator manufacturers entered the isolated network judgment conditions. The minimum value is ± 0.4HZ, and the maximum value is ± 2HZ). The adjustment parameter is changed to the isolated network parameter for adjustment. In order to ensure the accuracy of entering the isolated network, the governor manufacturer avoids interference due to frequency measurement signals when the unit is operating normally and on the large network. By mistake, the speed regulator has a two-second delay after the frequency reaches the isolated network judgment condition. Jinkang Power Station originally had high speed and high pressure, and it was difficult to meet load shedding stability. With the above objective situation, the opportunity for load shedding adjustment was lost, and the unit ’s overspeed protection action had to stop and lose power at the same time.

In the later period, although the safety control device was used to protect the action, it only played a role in that the unit did not overspeed and did not solve the problem fundamentally. The unit must be shut down and the plant power still disappeared.

3.2 The reasons for the overspeed of the unit are:

3.2.1 The unit has dropped the load and should enter the no-load state. However, because the unit's exit switch has not tripped, the governor still considers the unit to be in a grid-connected state and adjust it with insensitive parameters. Parameters set at that time), and then use sensitive isolated network parameter adjustment.

3.2.2In order to ensure the accuracy of entering the isolated network, and to prevent the unit from

entering the isolated network due to the interference of the frequency measurement signal during normal and large network operation, the governor has a delay of 2 seconds after the frequency reaches the isolated network judgment condition, which is a delay. The opportunity for adjustment.

The reason for the disappearance of plant power is very clear. After the line trips, the unit cannot maintain the no-load state, the unit's exit switch trips, and the plant power disappears.

In order to solve the problem of the disappearance of plant power and the problem of excessive load shedding, it is necessary for the governor to correctly determine the state of the unit and keep the load shedding stable to the normal no-load state. So basically we have to solve the governor problem.

3.3 Countermeasures

When the unit rejects load, if the governor can ensure that the unit enters the no-load state in time and adopts no-load parameter adjustment, while limiting the guide vanes below the no-load opening, it can certainly ensure the unit's normal load shedding and ensure that the unit is stable. The no-load state also ensures the normal use of plant power without disappearing.

The no-load state of the unit should actually be a state in which the unit maintains the rated speed and voltage without sending active and reactive loads to the system; therefore, it can be considered that the unit only has a main transformer (only no-load loss) and plant power. The unit is also under no load.

For this reason, it is recommended to adjust the no-load state judgment of the unit with the manufacturer. The actual load of the unit in the no-load state is at most only the no-load loss of the main transformer and some plant electrical loads. At this time, the load is small, which is relative to the unit's guaranteed output. (The general load of the unit is above the guaranteed output). It is very small. Change the unit’s no-load judgment condition to a case where the unit load is less than 5-7% of the rated load. All are determined to be no-load and run with no-load parameters. In this way, when the line load shedding (that is, the unit's actual load shedding) is ensured, the governor can immediately determine that the unit is in the no-load state, and switch the parameter to the no-load parameter, thereby ensuring good regulation performance, and the unit's load shedding is controllable and safe. Corresponding requirements.

We refer to the unit's 5-7% rated load as the no-load load. When the unit load is greater than the no-load load, the unit is determined to be connected to the grid; when the unit load is less than or equal to the no-load load, the unit is determined to be in the no-load state. Of course, it is also possible to use the unit's exit switch in combination with the unit's no-load load, that is, the unit's exit switch is in the open position or the unit's exit switch is in the closed position, but the unit is no-load when the unit load is less than or equal to the no-load load. On the contrary, when the unit's exit switch is in the closed position and the unit load is greater than the no-load load, the unit is in the state of grid connection.

Generally, the governor is connected to the power signal of the unit, which is not difficult to realize; of course, it is better to change the power judgment to the unit current judgment.

3.4 In response to these situations, countermeasures are taken as follows:

3.4.1 The position signal of the outgoing line switch and the unit's exit switch (or other related switches) is jointly introduced into the governor, and the closed state is confirmed as the closed state. As long as any switch is in the open position, it is judged as the unit is in a no-load state.

3.4.2 The no-load load (or no-load current) of the unit is used as the condition for the governor to judge the no-load state of the unit. When the unit load (or current) is less than or equal to the no-load load (or no-load current), the unit is judged to be in no-load Load state, the adjustment parameters are adjusted to no-load parameters, and the electrical opening is immediately limited to the no-load opening.

3.4.3For the connection mode of a unit corresponding to a main transformer, to communicate with the power grid company, it is recommended that the trip signal of the safety control device to trip the high-side switch of the main transformer, and not to exit the unit's exit switch, and to achieve high cycle cutting The purpose of the power grid meets the requirements of the power grid;

because the plant-use transformer is on the low-voltage side of the main transformer, the unit is also kept running with no-load plant electricity.

3.4.5 Cancel or reduce the delay judgment of the isolated network of the governor. In order to ensure the accuracy of the access to the isolated network, and to avoid the accidental entry into the isolated network due to the interference of the frequency measurement signal during the normal operation of the unit and the large network, the governor has a 2 second delay. Due to this 2-second delay, the unit is extremely prone to over speed when the line is dumped. The discussion held that there is no need for a delay. At most, the governor should adjust more. If a delay is required, it is recommended that the time be reduced to 0.1 second.

3.4.6 In view of the current very stable power grid, the system cycle generally fluctuates between 49.95 ~ 50.05. Adjust the frequency range of the unit entering the isolated network. When the unit frequency is less than 49.9HZ or exceeds 50.1Hz, the unit is considered to be in an isolated network state. The governor immediately enters isolated network mode for frequency modulation.

4. Conclusion

As long as the above measures are taken, the unit will be able to avoid the phenomenon of overspeed or overpressure of the pressure steel pipe during load shedding. Of course, the realization of the above five measures will actually be limited by some conditions and cannot be achieved individually, but these measures will play a certain positive role, especially using the unit load (or current) as the judgment condition for the unit to enter the no-load state It will fundamentally correctly judge that the unit enters the no-load state, which will ensure the stability of the unit's normal load shedding and ensure that the power consumption of the entire plant will not disappear.

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