



## Wide Area Protection System for Stability

Along with the growth of loads, the increase of transmission distance and the composited structure of HVAC and HVDC system, the stability characteristics of modern power system are getting more complicated. NR has established unique three-defense-line to protect the power system from blackout. It can significantly improve the stability of the power grid.

### **Fault Clearing (The first defense line)**

The first defense line consists of accurate and fast protective relays to ensure the fault can be quickly cleared to ensure the system keeping the stability. NR provides reliable and high-speed protection products with innovative DPFC protection elements which can significantly reduce the pickup time to trip the fault. It ensures that the fault is quickly cleared before the system loses the stability.

#### **Relevant Products:**

- Numerical protective relays: RCS-900 series

### **Load Shedding and Generator Shut-Down (The second defense line)**

The second defense line is emergency control for severe contingencies. If the unbalance between generation and load is arisen, the wide area protection will take some measurements, such as generator shut-down, load-shedding, to ensure the stability.

While the stability of the power system is lost after the serious fault is cleared, NR's unique wide area protection and control system will calculate the power flow and generate corresponding control strategies. Then the control commands are sent to the executing device to take some measurements to keep the stability of the system.

#### **Relevant Products:**

- On-line Wide Area Protection for Power Stability: RCS-990/RCS-992
- Off-line Wide Area Protection for Power Stability: RCS-990/RCS-992

### **Out-of-step Islanding (The third defense line)**

The third defense line is local corrective control such as out-of-step islanding and load-shedding for extremely severe contingencies. If the second defense line can not rescue the stability, the third defense line will operated to avoid the collapse and minimize the loss of load. NR provides out-of-step protection and frequency/voltage control devices to keep the system stability if the second defense line can't make the system to normal operating state.

#### **Relevant Products:**

- Out-of-Step Protection: RCS-993
- Frequency and Voltage Control for Power Stability: RCS-994



## The On-line Wide Area Protection System for Stability of Fujian Province Grid

### On-line Wide Area Protection for Stability

The “on-line pre-decision, real-time match”, which is the innovative technology of power system stability control, has been actually used in the Wide Area Protection (WAP) system in Fujian Power Grid. The on-line decision making technology can satisfy the requirements of “On-line pre-decision” for power stability and that the decision-making will be provided in 5 minutes. By this system, not only will the decision table be calculated and formed online, but also the operation instruction and necessary suggestion will be given to the grid dispatching operators.

As shown in Fig.2, The on-line Wide Area Protection system in Fujian power grid consists of the Houshi power plant, nine 500kV substations, six 220kV executed substations, and the fiber communication are adopted between each substation and the dispatching center.

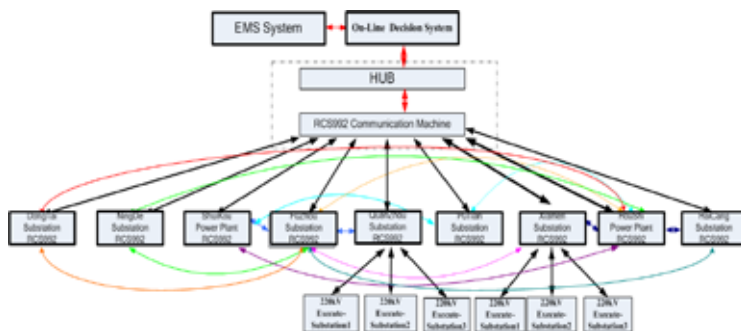


Fig.2 On-line Wide Area Protection System in Fujian Power Grid

### Decision-Making Strategy

The dual-server solution is adopted for the decision-making servers. When the system works in a normal state, one decision-making server is on duty, and the other will remain as hot-backup redundancy. If a fault occurred on the orderly server, the backup server will be upgraded to be on duty automatically. Besides, each decision-making server works in dual network communication mode.

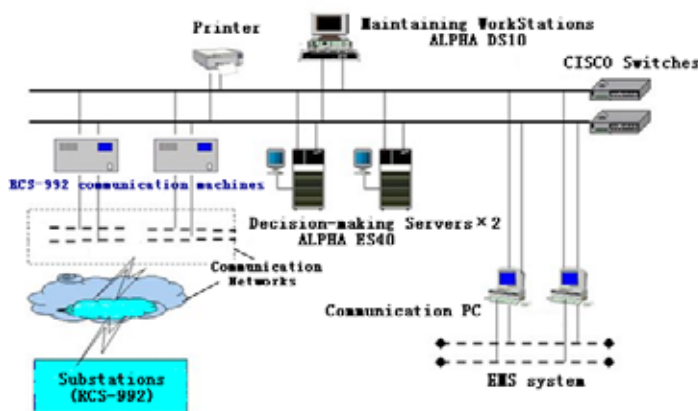


Fig.3 The Communication Mode of On-line Wide Area Protection System



### Operation Performance

The Wide Area Protection system in Fujian power grid has gained the significant operation performance since it had been successfully put into service. The system executed and operated correctly every time when a fault occurred in the power grid. Among all these occurred faults, the system tripping command was really sent twice while the faults may cause the out-of-step of the power grid without control measurement, and it both operated correctly as shown below:

- At 13:31:01 On Jul 11, 2006, the double-circuit tie-line between Fujian grid and East-China grid were both tripped when power flow on the tie-line was 1,059MW. The WAP system accurately calculated the control strategy based on stability analysis, and the control command of the shutdown of 759MW generation was sent to Houshi power plant. After 26ms, the IEDs in Houshi power plant received this command, and 581ms later, the #2 and #3 generators were shut down when the IEDs detected that the system frequency had increased to more than 0.2Hz.
- On Nov 25, 2006, Fuzhou-Putian double-circuit line was tripped which was caused by a fault. The system also operated correctly.