

Discussions on cultivation mode for inter-disciplinary operation, maintenance and repair talents for substation secondary system

Kai Xue^{1, a}, Shouchen Xu^{2, b}, Xilin Zhang^{3, c}, Xiaojuan Han^{4, d}

1. State Grid Jilin Electric Power Company Limited Training Center, Changchun, Jilin 130022, China

2. State Grid College of Management, Beijing, 100085, China

3. State Grid Jilin Electric Power Company Limited Changchun Power Supply Company, Changchun, Jilin 130021, China

4. Department of Control and Computer Engineering University of North China Electric Power, Beijing, 102206, China

^a381093267@qq.com, ^bshouchen-xu@sohu.com, ^c985222805@qq.com,

^d1747860586@qq.com

Keywords: substation, secondary system, inter-disciplinary talents, in-service employees, on-the-job training

Abstract. In order to cultivate inter-disciplinary operation, maintenance and repair talents for the substation secondary system that meet the requirements of State Grid Corporation of China in its system reform featuring "intensive management in human, financial and material resources, and systemic management in planning, construction, operation, maintenance and production", and in promoting global energy Internet construction, we will discuss in this paper such issues as the status quo of the operation, maintenance and repair of the substation secondary system, necessary knowledge and skills for the operation, maintenance and repair of the substation secondary system, professional knowledge of the operation, maintenance and repair personnel, common course training carried out by the training centers of the provincial and municipal companies, setting up professional chief-expert systems at municipal power supply companies, and cultivation of professional backup experts for the substation secondary system, and propose suggestions on how to set the major of "Electrical Engineering and Automation" at electricity-related universities. The rapid expansion of power grid scale, increased equipment integration of the substation secondary system, high-standard requirements for safety, power distribution reliability, and power quality indicators, decreased size of operation, maintenance and repair personnel indicate the necessity and imperativeness of the methods herein.

1. Introduction

In 2012, State Grid Corporation of China carried out the reform featuring "intensive management in human, financial and material resources, and systemic management in planning, construction, operation, maintenance and production". Promoting the global energy Internet construction^[1] whose major technical features are smart power grid, ultra-high voltage and clean energy has risen to a national strategy. Substations are an important link in a smart power grid, and their stable operation directly concerns the power consumption at thousands of households, economic development and social stability.

Literature [2] - [6] studied on-the-job training of in-service employees. This paper discusses the issue of cultivating inter-disciplinary operation, maintenance and repair talents for the substation secondary system.

2. Status quo of operation, maintenance and repair of substation secondary system

2.1 Scope of operation, maintenance and repair equipment of substation secondary system

The operation, maintenance and repair of the substation secondary system are mainly the responsibility of the relay operation maintenance team of the substation maintenance company. The major equipment and devices subject to operation, maintenance and repair include:

The merging unit and smart terminal for the process level in the control area;

The measuring and control device, protective device, automatic safety device, wide area phasor measurement device PMU for the space level in the control area;

The clock system, monitoring main unit, relay protection management module for the station level in the control area, the communication gateway in the control area;

The electric energy collecting device and fault recording in the non-control area, and the communication gateway in the non-control area;

The lateral isolation and longitudinal encryption identification device for secondary safety protection of the substation; and

The network communication equipment for the process level, space level and station level of the substation

2.2 Status quo of equipment of substation secondary system

A diversity of equipment for the substation secondary system: integrated automation substation, digital substation, first-generation smart substation, new-generation smart substation, substation secondary system equipment with different technical standards in the same region.

Miscellaneous equipment models of substation secondary system: The substation secondary system equipment in the power grid of the same region is provided by different suppliers and the substation secondary system equipment provided by the same supplier may have different versions.

2.3 Connection between substation secondary system and other disciplines

The discipline of the substation secondary system is closely connected with such disciplines as communication, substation primary system, electric energy metering and dispatching automation main station. The substation secondary system receives signals from the substation primary system equipment and electric energy meter, uploads the automation remote signaling and telemetry information to the dispatching automation main station, and sends the remote-control commands from the dispatching automation main station to the corresponding controlled equipment of the substation.

2.4 Complexity of the operation, maintenance and repair discipline of substation secondary system, and existing problems

In conclusion, the operation, maintenance and repair discipline of the substation secondary system is a discipline of high technical complexity of the power supply company, and the engineers engaged in operation, maintenance and repair must be inter-disciplinary talents with professional knowledge. In reality, the operation, maintenance and repair of the substation secondary system relies much on suppliers' technicians, and there are potential hazards that threaten the safe and stable operation of the power grid. It is very necessary and pressing to specifically study how to cultivate inter-disciplinary operation, maintenance and repair talents for the substation secondary system.

3. Analysis of necessary knowledge and skills for operation, maintenance and repair of substation secondary system, and professional knowledge of operation, maintenance and repair personnel

The status quo of the operation, maintenance and repair of the substation secondary system shows that the operation, maintenance and repair personnel for the substation secondary system must possess knowledge in terms of relay protection, automation, computer (including embedded industrial computer), computer network, test instrument, and relevant advanced placement.

The members of the relay operation maintenance team are basically the graduates of the major Electrical Engineering and Automation, and a small number of them are the graduates of computer-related majors.

The substation secondary system is closely connected with such disciplines as communication, equipment of substation primary system, electric energy metering and dispatching automation main station. Therefore, the operation, maintenance and repair personnel of the substation secondary system must also have some understanding of the above related professional knowledge.

According to the curriculum provision for the major Electrical Engineering and Automation at electricity-related universities, embedded industrial computer, computer network and its advanced placement are not necessarily included into the required courses in the teaching program.

The graduates of computer-related majors do not possess knowledge of the electric system.

4. Training centers of provincial and municipal companies carry out common course training

4.1 Questionnaire on professional knowledge possessed by operation, maintenance and repair personnel of substation secondary system and supplier sorting based on equipment archives

A questionnaire on the professional knowledge possessed by the operation, maintenance and repair personnel of the substation secondary system is made according to the knowledge required for the operation, maintenance and repair of the substation secondary system. The HR departments of the provincial companies take the lead, and the HR departments of the municipal companies are responsible for organization and implementation.

According to the equipment archives of the substation secondary system of the operation, maintenance and repair department, a list of suppliers for different kinds of equipment is made.

4.2 Carry out common course training

Whether it is necessary to offer the training course targeting the lack of knowledge of the operation, maintenance and repair personnel of substation secondary system should be determined according to the result of the questionnaire survey. The training centers of the provincial power companies should make detailed plans for common course training. The training centers of the provincial or municipal power companies should be responsible for organization and implementation.

4.3 Carry out equipment-level training

The training centers of the provincial and municipal companies organize the R&D or engineering personnel of the suppliers to come to the training centers and give centralized and systematic lessons, so that more operation, maintenance and repair personnel of the substation secondary system can directly hear the lessons given by the equipment R&D or engineering personnel, have face-to-face exchanges, and solve the difficult issues during operation, maintenance and repair. This will greatly improve the operation, maintenance and repair level.

5. Municipal power supply companies set up a chief expert system for each discipline

The municipal power supply companies set up a chief expert system for each discipline. For

example, the chief expert of the discipline of substation secondary system, chief expert of the discipline of communication, chief expert of the discipline of substation primary system, and chief expert of the discipline of power transmission. The chief experts of these disciplines participate in the construction of important projects, guidance on handling failure and abnormalities, solution of difficult technical problems, and technological innovation in the discipline, as well as answering difficult technical questions of the engineering staff at the company level in the discipline.

The chief expert of a discipline is the chief expert at the company level, not just the chief experts of a work unit or department. The difficult technical and engineering questions related to the experts' discipline at the company level should all get the quick and authoritative answers from the chief experts, which will play an irreplaceable role in abnormality and fault handling, and help the power grid operate in a safe, stable, efficient and high-quality way. In this sense, the chief experts of all disciplines are the public tutors at the company level, and are very favorable to the rapid growth of the operation, maintenance and repair personnel of the substation secondary system.

6. Cultivation of backup experts for substation secondary system

6.1 Trial implementation of multi-tutor system for backup experts for substation secondary system

The disciplinary feature of the substation secondary system is that the differences between skill orientation and technology orientation have become gradually fuzzy. The technology of the substation secondary system is developing rapidly. It is necessary to set up skill-oriented, technology-oriented and innovative tutors for the backup expert cultivation for the substation secondary system.

6.2 Proper increase of the proportion of backup experts for substation secondary system

The discipline of the substation secondary system is featured by a big disciplinary span, a variety of equipment, and miscellaneous and complicated models, and is closely connected with the disciplines of substation primary system, measurement and communication. The computer technology is developing rapidly. The construction standard for substations is updated from time to time, and the professional knowledge requirements for the operation, maintenance and repair personnel of the substation secondary system are constantly increasing. The cycle for cultivating the engineering personnel who are able to carry out the operation, maintenance and repair of the substation secondary system independently has increased. The posts of the engineering staff for the operation, maintenance and repair of the substation secondary system must be relatively stable. The proper increase of the proportion of the backup experts for the substation secondary system is one of the measures to improve the level of expertise of the engineering staff and maintain relatively stable posts of the engineering staff.

6.3 Selection and appraisal conditions for backup experts of substation secondary system are close to those of substation primary system

The weight and proportion of the post technology and skill appraisal should be increased in the selection and appraisal of outstanding expert talents, so as to pick out those personnel who are truly devoted to repair, testing, abnormality and fault handling at their posts, and who have the genuine ability and learning and development potential. The guidance role of the policy on encouraging experts to dig into the professional skills and technologies at their posts should be brought into play. In the expert selection and appraisal conditions, the weight and proportion of the score "working time at grassroots units" (years of working on the frontline) should be increased, the guidance role of the policy on encouraging experts to be engaged in the operation, maintenance and repair on the frontline should be brought into play, and an expert team that are truly devoted to their own work and can stay on the frontline of operation, maintenance and repair for a long time should be set up.

7. Suggestions on how to set the major Electrical Engineering and Automation at electricity-related universities [7]

The concept of the discipline of power secondary system should be built. The discipline of power secondary system is a generic term of the electric system protection, monitoring, control and its required computer communication.

Based on the existing curriculum provision of the major Electrical Engineering and Automation at electricity-related universities, it should be stressed that the discipline of the secondary system should include relay protection, remote automation, computer (including embedded industrial computer), computer network, test instrument, substation primary equipment (voltage transformer, breaker, isolating switch, electromagnetic instrument transformer, electronic instrument transformer and arrester, etc.) and the advanced placement it requires.

Electricity-related universities should, if conditions permit, include the above courses into the required courses in the teaching program for the major Electrical Engineering and Automation, which is most favorable for cultivating inter-disciplinary operation, maintenance and repair talents of the substation secondary system. If it is impossible to include the above courses into the teaching program for required courses, one of the alternatives is to display a list of the professional knowledge required by the secondary discipline and the recommended optional courses in the "Recruitment and Employment" column on the university's website for students to choose from.

8. Conclusions

It is very necessary and imperative to specifically study how to cultivate inter-disciplinary operation, maintenance and repair talents for the substation secondary system. The training centers of the provincial and municipal companies should offer professional training courses for the substation secondary system at different levels. The power supply companies should make more efforts to cultivate inter-disciplinary operation, maintenance and repair talents for the substation secondary system. Electricity-related universities should set the courses for the major Electrical Engineering and Automation based on the actual work needs of the power secondary system. Only after various measures are taken can we successfully cultivate the engineering talents that meet the requirements of the operation, maintenance and repair discipline of the substation secondary system.

References

- [1] Liu Zhenya, Global Energy Internet[M]CHINA ELECTRIC POWER PRESS, 2015, pp.1-376.
- [2] Zhang Xilin, Xu Shouchen, On Research and Practice of Building a Harmo Progr & Pro Team with Technological Innovation as Management Media [C] 2nd International Conference on Management Science and Industrial Engineering, 2013, pp.514-518.
- [3] Zhang Xilin, Xu Shouchen, Innovation Research on Learning from Lv Qingsen Activities by Grass-root Party Organizations [C] 2nd International Conference on Management Science and Industrial Engineering, 2013, pp.510-514.
- [4] Zhang Xilin, Zhang Hui, Contest of Dispatch Departments in Power Supply Enterprises [J], China Electric Power Education, vol. 35, pp.243-244, 2010.
- [5] Zhang Xilin, Xu Shouchen, Research on Innovative Training Methods for Frontline Employees in High-Technology Department of Power Enterprises and the Practices [C] 2nd International Conference on Management Science and Industrial Engineering, 2013, pp.518-521.

- [6] Zhang Xilin, Yang Guiying, Liu Xiaowei. Training Management Experience of Power Dispatching Department of Power Supply Enterprises [J]. China Electric Power Education, vol. 29, pp.48-50, 2010.
- [7] Zhang Xilin, Xu Shouchen, Design on the Curriculum Reform for Experimental Classes of Secondary Majors in Electric Power System [C] 2nd International Conference on Management Science and Industrial Engineering, 2013, pp.506-509.