A COMBINED MAINTENANCE METHOD FOR COMPLICATED CONDITIONS

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ABSTRACT

With the fast expansion of Shanghai's power grid and downsizing policy for efficiency, the existing maintenance method is no longer suitable. Present equipment conditions and maintenance methods of Shanghai are discussed, after that this paper analyses pros and cons of the existing maintenance method. Then a new method - combined maintenance method is proposed, which can serve the conflict efficiently. Finally, this paper analyses the potential problems and solutions in the new method, and put forward some advices for the future.

I. INTRODUCTION

With the development of modern technology and fast expansion of power grid, the purpose of maintenance is not only to keep or restore the equipment's function, but also to improve reliability and reduce cost. It is becoming a decisive element which affects the economic benefit [1]-[2].

There are mainly four maintenance methods as following: (1) Break-down Maintenance (BM), which means that the equipment is only repaired after it has broken down. (2) Time-Base Maintenance (TBM), which means that the maintenance period is fixed depending on statistic data and experience. (3) Corrective Maintenance (CM), which is to eliminate initial fault and frequent malfunction. (4) Condition-Based Maintenance (CBM), this method is relatively new and the maintenance period is based on regular check, online condition monitoring and fault diagnosis [3]-[6].

Among those methods CBM is very popular lately for improving efficiency and reliability. It can arrange maintenance period more reasonably, reduce unnecessary maintenance cost, decrease outage time and find potential fault in time [7].

But CBM is more suitable in developed areas like America or Europe. Developing countries like China have their own characteristics. Although State Grid in China has launched a lot of research work on CBM recently [8]-[10], CBM is still not very mature for the complexity of equipment and lack of maintenance experience. So a reasonable and practical maintenance method is needed to be proposed to deal with this problem.

II. PRESENT MAITENANCE SITUATION

Unlike developed countries, the power grid in China has developed very fast in recent years. There are different kinds of equipments ranging from very old type to newest ones. Take equipment in Shanghai for example, the oldest 35kV transformer in service was put in 1992, and the nearest 35kV transformer in service was put in 2008, although the type of both transformers is the same, but their performance may be very different. Likewise, there are different kinds of breakers range from domestic product to oversea product, from less oil type to SF6 type. But the development of maintenance does not catch up with the fast growing of the power grid. Most area is still using TBM nowadays.

For example, CBM is only used on some extra high voltage equipment like transformer, breaker and transmission line in Shanghai nowadays. For the rest extra high voltage equipment and other lower voltage distribution equipment, TBM is the main maintenance method.

So there exist several conflicts under this condition. With the fast growth of the quantity of substation and downsizing policy, it is hard to cover so many equipments using the former maintenance method. Moreover, this strategy will lead to a waste of man power and material resources. Take 35kV line-transformer unit as an example, the maintenance of breaker, lightning arrester and current transformer are always dealt with at the same time. Because the maintenance period of those equipments is different, there is obvious conflict under TBM. Then the minimum maintenance period is always taken, which can lead to waste of resource and low reliability.

There are several characteristics in nowadays power grid: (1) Power grid structure is becoming more and more stable, which means even some fault is neglected, there will be few ill effect to the power system. (2) The equipment quality is getting better and better, which means the fault rate is very small compared with before. (3) Online monitoring devices like Partial Discharge Monitoring and Infrared Imaging are widely used in Shanghai to find potential problems, which is also a fundamental element. (4) The CBM is going very well for ultra high voltage equipment and achieved some experience.

So, there should be some new maintenance method to replace the existing one.

III. THE COMBINED MAINTENANCE METHOD

From the last section, we can see that the existing maintenance method is no longer suitable for the

development of Shanghai's power grid, so it is necessary to find a new way.

Although there are many merits of using CBM, it is not very suitable to use CBM for all equipment at the transition period. And it will be more proper to use the combined maintenance method as following for the complicated conditions in Shanghai.

(1) For the equipment that has low failure rate and needs high reliability requirement, it is recommended to use CBM. Like 35kV HD4 SF6 breaker and 35kV 3AJ breaker.

(2) For the equipment which has used for a lot of years and needs high reliability requirements, it is hard to set CBM rules properly now, so for safety, TBM should be used for the transition period to keep the equipment healthy, like 35kv SW2-35IV less oil breaker and 10kv SN10-10 less oil breaker.

(3) For some equipment which reliability requirement is not that high and has slighter effect to the whole power grid, which is especially in 10kv and lower voltage grade, simplified CBM or Break-down Maintenance should be implemented. Which means the fault is allowable and acceptable for this kind of equipment, like lightning arrester, reactor and capacitor.

So, we get a combined maintenance method which combine CBM, TBM and BM together.

IV. POTENTIAL PROBLEMS

Although the combined maintenance method has its merits, there are several potential problems when implemented.

(1) Lack of accumulated data: When using the Combined Maintenance method, a lot of data and information about the conditions of the equipment are needed. Because TBM is used before, there are little information accumulated, which will lead to an adverse effect to the implementation of Combined Maintenance. Furthermore, some original data of the early equipment is hard to get.

(2) Unified standard is needed: Although there are specific rules about how to judge the condition of equipment, there will be divergence when implementing.

(3) Devoid of online monitoring methods: The online monitoring methods are not very diversified in Shanghai today. Only Partial Discharge Monitoring and Infrared Imaging are widely used. So it is hard to find some potential faults like in transformer.

(4) Existing assessment method goes against the development of Combined Maintenance: The responsibility is specified before, but it is vague after Combined Maintenance is used, for the error could happen in all steps from data acquisition, operation inspection, online monitoring to conclusion analysis.

To deal with those problems, methods like unifying standards and judging rules, enriching online monitoring technology, improving operation database and enhancing training of relevant staff are needed to be taken.

But even there will be some problem when implementing the Combined Maintenance method, the advantage still overweighed the disadvantage. In fact, accident is hard to affect the grid because of the improvement of the equipment quality and the stability of the power grid.

V. CONCLUSION

Because of the conflict between the development of power grid and the existing maintenance methods, a new maintenance method is needed to improve reliability and save cost. This paper introduces several old maintenance methods, and discusses the condition of equipment and maintenance method in nowadays Shanghai. Then a new maintenance method - Combined Maintenance method is proposed which is suitable for the complicated equipment conditions and immature maintenance experience like Shanghai and other developing area.

In the end, this paper discusses the potential problems in Combined Maintenance and gives the corresponding solutions, which is useful to who has the similar condition.

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