



## Reliability and Redundancy - are you ready for Simplicity?

Changes in technology are forcing protection, automation and control specialists to look at **how they can apply well established protection principles and philosophies** that were proven in the XXth century to communications based systems, **while maintaining or even improving their reliability.**

That was the reason to focus this issue of the magazine on the subjects of reliability and redundancy and invite experts from different countries to discuss them. One of the key requirements for any protection and control system is to ensure that any short circuit fault or other abnormal system condition will be cleared in a way that will minimize its effect on utilities' or customers' equipment. In many cases people focus on the reliability of the protection and control system. This is very important, but not sufficient. We should always keep in mind that the protection cannot clear the fault by itself. It needs to interface with the process in order to detect an abnormal system condition and execute an action to clear it. That is why we need to think about the reliability of the fault clearing system.

If we look at the definition of reliability in the IEC 60050 International Electrotechnical Vocabulary, it is "*the ability of an item to perform a required function under given conditions for a given time interval.*" One of the most common methods of improving the reliability of the fault clearing system is through redundancy. If someone tells us that we need to use a redundant system, we need to first ask the question "Redundancy of what?". The fault clearing system includes current and voltage instrument transformers, analog and control circuits, relays, batteries

and breakers. Which of these should be redundant?

To answer this question, we need to think about the importance of the substation to the electric power system; the maximum fault clearing time that is not going to endanger the stability of the system; the protection philosophy and how much money we can spend. However, this is not the complete picture.

If redundant relays are required, we need to decide if they should be identical or different, and this raises the issue of common mode failure because simple duplication of two devices does not mean that the protection system will never fail. The common mode failure can be a hardware or operating principle issue. That is why many utilities apply the principle two relays with different operating principles and from different manufacturers. This solves many of the issues discussed earlier but like everything in life it has a price:

- Utility personnel need to be trained in using different devices and software tools
- Devices of different types need to be kept in stock in case of failure
- The engineering process is more complicated

That is why some utilities accept the practice of using protection devices with different operating principles, but from the same manufacturer and family of products. This eliminates the

common mode failure problem of the operating principle and the need for using different software tools. However, common mode failure of the hardware is still a possibility. If we use two identical relays, we need to deal with the possibility of common mode failure of both operating principle and hardware. To decide if this is acceptable, we need to determine what would be the consequences of the failure of both relays to clear the fault.

Today things get even more interesting. IEC 61850 is shifting protection systems from hard wired to communications based solutions. The protection and control engineers need to consider the reliability of a fault clearing system that also includes merging units and Ethernet switches. We need to think about the reliability of the different possible communications architectures and the impact of their failure on the performance of the system.

Moreover, this is not all we have to consider. Time synchronization within the substation and between substations also plays an important role that needs to be evaluated. We must decide if we need redundant clocks and what they should be. We need to think about what happens if the GPS system fails due to a sun storm or any other reason. Nevertheless this is what makes our lives so interesting. This is why we always need to think, we need to learn, we need to innovate - all to avoid the sleepless nights. Of course, when the fault occurs and everything works as we designed it to work, we experience the feeling of satisfaction that money cannot buy. ■

**"Simplicity is prerequisite for reliability."**

*Edsger Dijkstra (1930 - 2002)*