OPEN ACCESS
Saudi Journal of Engineering and Technology
Abbreviated Key Title: Saudi J Eng Technol
ISSN 2415-6272 (Print) |ISSN 2415-6264 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com/sjeat

Review Article

Standardization of Protection Commissioning Testing in Transmission Protection Department

Amna Abdulla*, Sara Almulla

Engineer, Dubai Electricity and Water Authority

DOI: 10.36348/sjet.2020.v05i11.012 | **Received:** 07.11.2020 | **Accepted:** 16.11.2020 | **Published:** 23.11.2020

***Corresponding author:** Amna Abdulla

Abstract

In line with the recent developments and innovations, standardization is a topic that is mainly focused on to ensure an easy flow of operations and reduction in complexity in many different fields. Given the diverse applications of which standardization can be applied to, this paper will focus specifically on the standardization of commissioning tests for protection relays as well as the process and the impact of the implementation of standardization in this particular field. ***Background* :** This paper's focus and origin is from the United Arab Emirates specifically in the electricity sector in Dubai's Water and Electricity Authority (DEWA); Transmission Power Division, Transmission Protection Department (TPD). Direct emphasis is on the commissioning section where various commissioning tests are carried out for many different protection relays in many different applications in Transmission Substations of Voltage Levels 400/132kV and 132/11kV. As of date, Transmission Power substations counts 330 numbers while more are yet to undergo or complete the engineering phase only to enter the commissioning phase and be tested and commissioned. Commissioning tests have been made easier and more efficient by introducing standardization in 2010, where procedures of various commissioning tests involving protection relays have been standardized and applied whenever a new substation comes to light.

Keywords*:* Protection Commissioning Testing, Standardization of Commissioning Testing.

INTRODUCTION

Standardization is a concept that basically creates one common direction for a particular application, which further means that a common set of rules are applicable within the standardized set and shall not be reformed from. In relation to electrical substations, standardization has also been implemented in various electrical areas present in substations nowadays. It is believed that standardization contributes to lower substation cost, proven operating procedures, proven equipment, and simpler spare requirements [1].

According to Twomey it is frequently considered as a risk when new applications, concepts and innovations are introduced in the substation design [1]. This is due to the need for redesigning the systems and the standardized designs in order to accommodate the new changes, which should be thoroughly studied to confirm feasibility and compatibility with the already established standards and designs. Hence, this factor of risk can be considered as a problem to standardization.

One of the biggest current challenges today's protection engineers have to deal with is to master the high complexity of modern protection systems. Multifunctional protection relay is one of the reasons behind this complexity. Even though the multifunctionality is not used to the full extent most of the time, it is still there and thus increasing complexity. As a result, we can see a very high number of parameters available in modern protection devices. Finding strategies to manage all these parameters becomes more and more important [3]. Standardization is a solution to overcome this complexity in electrical utilities. Many utilities have started to create standard test plans in connection with the settings´ standardization process. These standard test plans are handed over to the field engineers together with the standard settings. Henceforth, operational efficiency, reduction of deviations, and ability to scale are aims of every business, regardless of the scope of its work. These are obvious benefits of standardizing any process [4].

Standardization of commissioning tests

Standardization has been an ongoing process in many different fields and for any process to be standardized, there should be some studies performed

on how it can be achieved and categorized based on similarities taking into consideration all the critical requirements. In terms of Standardizing Protection Commissioning Tests, below shall elaborate on how the process was carried out along with applicable examples.

A) Standardization Process

In Transmission Protection Department, Transmission Power Division, a New Protection Philosophy (NPP) has been studied and implemented in all related Single Line Diagrams (SLDs) and Protection Schemes. Within this context, standard SLDs and schemes have been prepared for the different applications available in the transmission protection network such as Line Feeder, Transformer Feeder, Bus bar etc. The new philosophy and the standard SLDs and schemes are first used as a foundation and starting point of the process of standardizing the commissioning tests. Furthermore, there is another element and process that TPD undergoes which has been taken into consideration in the process of standardization of commissioning tests. The pre-qualification process of protection relays allows for a list of approved and rejected relays. When the relay passes and becomes qualified, this particular relay type and make is added to a list of approved relays, which is further used as a reference to all involved stakeholders as to which relays are acceptable and can be chosen to be used. The approved relays are then referred to in creating standard test reports for all existing and expected to come relays.

Therefore, as a starting point in the process of standardization of commissioning tests, first the standard SLDs and schemes are referred to and in line with them related commissioning tests have been segregated into sub-categories and standardized based on similarities. Table 1 below illustrates the different commissioning testing procedures that have been standardized in terms of Protection Device, Scheme and Settings Testing.

Table-1: Standardization of Commissioning Testing Procedures

Category	Standardized Procedures
Feeder Protection Transformer Protection Protection Devices & Scheme & Settings Configuration High Impedance BB Protection	BC/BS Protection Reactor Protection REF Protection

Further breakdown of each Standardized Commissioning Testing Procedure includes the related standardized test reports in each, and test reports have been segregated in terms of Voltage Levels (400kV, 132kV, 11kV, and 0.4kV) and further in terms of Protection Relay Manufacturer, since approved manufacturers are already established and a list of pre-qualified relays is already available. Henceforth, for each category in Table 1, there are applicable standardized test reports that fall under it, which is exemplified in Table 2 below.

Table-2: Standardized Commissioning Test Reports

Protection Relay Test Reports			
400kV Protection Relays	**132kV Protection Relays**	**11kV Protection Relays**	**0.4kV Protection Relays**
Feeder	Feeder	BMP	LVAC Protection Relay
ICT	IDT	CZ	
Feeder Reactor	Feeder Reactor	VSR	
Bus Reactor	Bus Reactor	PFC	
GT	Transformer Feeder	Backup Protection	
BS/BC	BS/BC		
Main-1BB (HV)	Main-2		
Main-2 BB (LV)	Main 2		
Series Reactor	Syncro Check		
Synchro Check	Backup ICT		
	VSR		

An example is demonstrated in Table 3 below showing how standardization has been implemented to commissioning tests of protection relays in terms of Standard SLDs and schemes and pre-approved protection relays. For example, under the standardized commissioning testing procedure of Feeder Protection lies the related 132kV feeder protection relays and for each related protection relay, there are standard test formats for each approved manufacturer.

Table-3: Example of 132kv Standard Test Reports Applicable For Standard Feeder Differential Test

Category	**Protection Device, Scheme & Settings Configuration**			
Standardized Application Procedure	Feeder Protection			
132kV Protection Relays	Feeder(Main-1/Main-2 Relays)			
Relay Manufacturer Based Test Reports	Make 1	Make 2	Make 3	Make 4
	Main-1 Relay	Main-1 Relay	Main-1 Relay	Main-1 Relay
	Main-2 Relay	Main-2 Relay		Main-2 Relay

Thus, standardization in this case is implemented in terms of protection relay manufacturer as the same types of relays are chosen and coming as bulk to test per year. Further due to the fact that there is an already established list of approved relays and so it is expected to receive most, if not all, types or makes of relays. For example, Make-1 Main-2 Feeder Protection relay has an average of 58 numbers per year while Make-3 Main-1 Feeder Protection has an average of 27 numbers per year etc. Table 4 below shows the average substations and relays commissioned per year.

Table-4: Example of 132kv Standard Test Reports Applicable For Standard Feeder Differential Test

Average Total SS Per Year	Average Total Relay Per Year	Make 1	Make 2	Make 3	Make 4
16	534	184	44	172	160

Hence, standardization will ease the testing of the average number of relays received per year, 534 numbers, by creating a common procedure to follow for each type of relay.

ADVANTAGES OF STANDARDIZATION

Standardizing protection commissioning testing has a direct effect on the increase of reliability, security and efficiency of the utility's system. Without test standards, successful test system solutions are not reused or shared between departments [1]. This can lead into data lose and waste of resources. On the other hand, main benefits of commissioning testing standardization can be mentioned as major quality control, collecting standard database, which will contribute in enhancing sustainability in processes, optimizing manpower, reducing time taken for procedures preparation and implementing effective cost optimization.

A) Major quality control

One of the main advantages of standardization of commissioning tests of protection relays is that the quality factor is highly controlled and this is done by having consistent quality testing across all applications and projects. Testing procedures are tested beforehand in the lab and pre-configured accordingly before producing the final standard test reports, given the already established standard SLDs and schemes and pre-approved list of protection relays. This shows that prior to testing, the standard test reports undergo verification, optimization and confirmation, which further demonstrate the quality of the standard test reports and the effect it has on applying the standard commissioning tests of protection relays in all projects.

B) Construction of a standard database

Standard tests will lead to standard results format, equipment and resources. Each time the test department needs to replace an obsolete test system; valuable time and resources must be spent and wasted on developing a new solution [1]. This wasted time can be used instead for collecting standard results format as dependable data sources to reuse in various applications, which will enhance the processes and procedure. Those applications can be mentioned as enhancement of sustainable processes, optimization of manpower, decrease in time taken for procedure preparation and cost effectiveness.

C) Enhancement of sustainable processes

If a company is not reusing test solutions in some way, it is not being as efficient as it should [5]. When the testing system is standardized the journey of a new test will be minimized as the hardware, software and databases can be reused. This will result in a sustainable process by avoiding the purchase of new hardware and equipment. For instance, all protection commissioning testing in DEWA can be done using OMICRON device. This sustainable approach is in line with DEWA's vision, which is also coherent with Dubai's sustainability missionary.

D) Optimization of manpower

One of the main elements of standardization of commissioning testing was standardizing number of the activities for each equipment and man-days required for each of these activities. This approach has dramatically affected the optimization of future resource planning. For instance, in Transmission Protection Department different engineers used to be allocated in the same substation to perform different activities based on their experiences and the daily requirement received by the contractor. However, after standardization of the testing plan and the testing activates, parallel work can be done in substations. In other words, a single engineer can handle more than one activity in the same substation.

E) ***Reduction of time taken for procedure preparation***

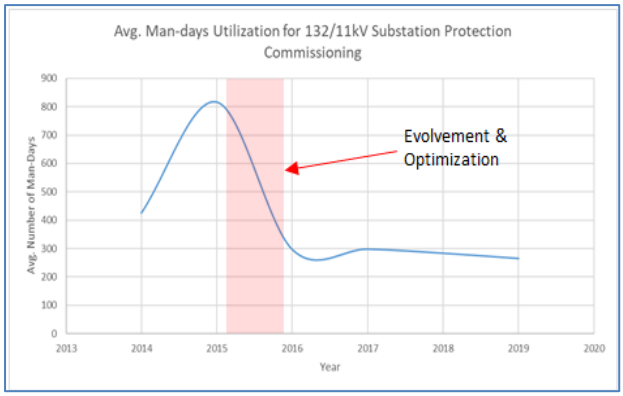

Fig-1: Average Man Days Before and After Standardization

The time taken to prepare different individual procedure for each relay is tremendously high, knowing that the yearly average number of commissioned substations in Transmission Power in DEWA is 16 substations, with an average number of 534 relays to be commissioned. Standardizing tests saves the procedure preparation time and invests it in other slots, which further results in optimizing the manpower within the utility.

F) ***Cost Effectiveness***

Cost effectiveness analysis is a way to examine both the costs and health outcomes of one or more interventions [6]. Therefore, effective cost does not necessarily mean low cost. Standardization of commissioning testing system is an obvious example of being cost effective. Although standardization is a costly process, but the outcome can save the losses, which a non-standardized system will cause. Failure in reusing the hardware, software and resources will lead to spending budget on unnecessary new equipment. Furthermore, not being able to plan the manpower effectively will lead to time waste. Not only that, but also the time taken for preparing different individual procedure for every application and relay every time a new substation arrives will take a lot of time and effort. Henceforth, not only time required will be increasingly high, also more manpower will be required further increases the utilization of resources and increasing costs as a result. Therefore, the cost of standardizing the testing system is a tremendously effective way in managing effective cost.

Results of standardization of commissioning testing

As a result of standardization of commissioning tests, it is evident that there has been a drastic reduction in the manpower required for the commissioning of protection relays in transmission power substations. That, but also with the constant evolvement in design changes, optimization and digitization, the level of standardization has been greatly increased and evolved as well. Figure 1 below displays the average man-days utilized before and after ultimate optimization, where it is evident that the average man-days greatly decreased. This indicates the positive effect of optimization, evolvement and ultimate standardization has on overall operations and efficiency in terms of resource and cost optimization.

Standardization assisted in the reduction of manpower by first putting a standard number of days for each activity, which further assists in the optimization of manpower. Second, by allowing engineers to witness parallel activities at the same time. For instance, before standardization five engineers were sent to the same substation to monitor five different activities. This was considered as five man-days, since it occupied five engineers each of which is considered to utilize one of their working days. As a result, the average manpower required for a substation increases. Therefore, the reduction of manpower plays a role in the optimization of manpower which further improves the cost effectiveness of the utility.

Furthermore, the number of substations commissioned increases every year and with the optimization, evolvement and ultimate standardization, the average man-days required per year decreased. This emphasizes the fact that higher efficiency and overall productivity is achieved as a result given that the number of substations and relays commissioned per year significantly increases, as shown in Table 5 below.

Table-5: Average Man-Days, Substations and Relays Commissioned Per Year

Year	No. of SS commissioned per year	Total No. of commissioned relays per year	Average man-days per year
2014	6	229	425
2015	8	379	817
2016	17	585	296
2017	15	468	298
2018	22	666	283
2019	28	882	265

CONCLUSION

In conclusion, the concept of standardization overall and specifically in Protection Commissioning Tests have showed a clear positive impact in terms of adding value to existing procedures. Major quality control, ease of operations, reduction in complexity, enhancement of sustainable processes, optimization of resources, better utilization of time, and cost effectiveness are all evident benefits and results that further contribute to the enhancement of the overall performance.

REFERENCES

1. Twomey, C. (2019). Innovation and Standardization of Substation Equipment. Springer, Cham.

2. Rahman, T., Hong, Q., & Blair, S. (2013). "Standardization of Power System Protection Settings Using IEC 61850 for Improved Interoperability", IEEE Power & Energy Society General Meeting, [Accessed 18 June 2020].
3. Bastigkeit, B., Schossig, T., & Steinhauser, D. (2009). "Efficient Testing of Modern Protection IEDs", OMICRON electronics. Available: http://www.pacw.org/fileadmin/doc/WinterIssue09/efficient_testing_winter09.pdf.
4. Hannula, E. (2014). "Why standardize operations and why not?", Read Qentinel. [Online]. Available: https://info.qentinel.com/blog/why-standardize-operations-and-why-not. [Accessed: 18- Jun- 2020].
5. Baker, D. (2020). 4 Benefits of Test System Standardization. [online] Gsystems.com. Available at: https://www.gsystems.com/blog/test-standardization> [Accessed 16 June 2020].W.-K. Chen, Linear Networks and Systems. Belmont, CA, USA: Wadsworth. 123–135.
6. Cdc.gov. (2020). Cost-Effectiveness Analysis. [online] Available at:https://www.cdc.gov/policy/polaris/economics/cost-effectiveness.html> [Accessed 16 June 2020].