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Designing a Simulator for Control Panel Examination in Gas Insulated Switchgear

Aishwarya S.Taur
Dept of Electrical, Electronics Engg
Marathwada Institute of Technology
Aurangabad, Maharashtra, India

Dr. Sunita M. Badave
Dept of Electrical, Electronics Engg
Marathwada Institute of Technology
Aurangabad, Maharashtra, India

Abstract: **Because of quick industrialization and expanding populace everywhere throughout the world, the need of proficient and solid power source has turned into the prime request. However, since geographic region has decreased because of expanding populace, production of a minimized however proficient power providing medium is required. Gas Insulated Substation is the answer for such issues. Gas Insulated Substation utilizes Sulfur hexafluoride (SF6) gas which has an unrivaled dielectric properties utilized at direct weight for stage to stage and stage to ground protection. The controlling part mainly enrolled is control panel. This paper presents a simulator that is testing kit to examine all operations done by control panel.**

Keywords: Switchgear; Control panel; Interlocking tools; Harting Connectors

I. INTRODUCTION

All inclusive economy and populace keeps on developing which brings about ascent of electrical power necessities and electrical systems improving day by day from single phase to multiphase systems [1]-[4]. For this reason, substation must be made more effective and solid to adapt up to increment popular, particularly adjusting current power distribution and transmission framework [5]-[6]. Despite the fact that in most recent couple of years an essential improvement has been made by coordination of Smart Metering (AMI) and Smart Grid innovation [7,8] yet this innovation limits itself just in distribution stage as it straightforwardly identified with correspondence amongst customer and request. We as a whole realize that power is delivered, at that point transmitted and after that conveyed through Grid Stations or Sub-stations. For additional proficiency the transmission and circulation division must be enhanced and it is discovered that development of Gas Insulated Substation [GIS] is a further advance for better effectiveness. [5-8]

GIS utilizes Sulfur hexafluoride (SF6) gas which has a predominant dielectric properties utilized at direct weight for line to line and line to ground protection. In this kind of substation, the high-voltage conductors, electrical switch interrupters, switches, current transformers, voltage transformers and lightning arresters are epitomized in SF6 gas inside grounded metal fenced in areas. GIS is utilized when space is to be giving a high position in the huge cities. In instance of Air Insulated Substations (AIS) distance between phase to phase and phase to ground should be vast. For this reason, an expansive space is required in AIS. In any case, as the dielectric quality of SF6 gas is substantially higher in respect to the air, important for stage to stage and ground leeway for all hardware are much lower in GIS which brings about huge decrease of sub-station measure.

GIS is preferable in following places.

- Smart cities, metros, cities and towns
- Under ground stations
- Substations and power plants located off shore
- Hilly areas and valley regions

The history of protection goes back to the end of nineteenth century. The first protection device invented and used was the fuse. Fuses were originally introduced in the North American and European markets almost simultaneously in mid-1880. The Evolution can be separated in to three principle organizes; the primary stage was the time of electromechanical relays, which began once again 100 years back. The following time was portrayed by static or solid state relays, which were presented in 1960s. The present time with microchip based transfers began in the start of the 1980s, where microprocessor played out the logic, however the filtering was analog. Even though prior model frameworks had been actualized, the main economically accessible completely numerical relay was presented in 1984.

Ever, the essential capacity of security has not changed: to appropriately distinguish an unsettling influence in the system and to clear the faulty region. Distinctive advances have been connected to change a type of protective relay as most of the relaying fundamentals are inherited from previous technologies.

The electric panels, widely used in all kind of substations and industrial applications, contain all the secondary devices, such as the measurement elements, control switches, signalling and secondary protection (overcurrent, differential, voltage relays, etc). The manufacturers and panel builders/assemblers must secure proper operation once energized, ensuring the safety of operators and facilities in which they are located. Fig.1 depicts the control panel for a bay in GIS for 245kV.

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In this paper we will go through a control panel testing, need of testing, problem while testing 245kV, 400kV control panel and accordingly design the simulator for easy testing so that to nullify the problem occurred while testing.

Fig.1 Control Panel for every bay in GIS

II. CONTROL PANEL OF GAS INSULATED SWITCHGEAR

Each bay of the gas protected substation (GIS) is furnished with a control cabinet for local control and checking of the individual operation and is for the most part put in front or adjoining their GIS bays relying upon the voltage level. This panel is called as local control cubicle (LCC). The control panel is metal encased, detached, made of sheet steel, and gave a lockable pivoted entryway and door worked lights. The nearby control cabinet has all vital control switches, neighborhood/off/remote lockable selector switches, close and open switches, estimating instruments, all position markers for circuit breakers, separate switches and establishing switches, alerts, mirror graph, AC and DC supply terminals, control and auxiliary relay, et cetera.

The control panel is composed so as to encourage full and free control and checking of the GIS locally. All electronic parts inside the bay control panel are intended to work palatably for the predefined venture necessity. No less than 20% of each extra contacts (NO (Normally open) and NC (normally close)) are provided with an auxiliary relay for future work.

The control cabinet is equipped with a mimic diagram on the front of the cabinet showing:

a. A mimic diagram showing the arrangement of electrical equipment in the bay including bus bar isolating links.

b. Control switches and local/off/remote changeover (lockable) for operation of all circuit breakers, disconnect switches, and grounding switches.

c. Position indicators showing the position of all circuit breakers, disconnect switches and grounding switches.

d. Overriding interlock switch between disconnects and grounding switches associated with circuit breakers (depending on the user's requirements).

e. SF6 gas zones.

f. The color of the mimic bus should be according to the user's requirements.

All control power circuits are protected by miniature circuit breakers in each cabinet. Other circuits supplying loads, such as heaters, receptacles, or lights, have separate overload protection. The cabinet is grounded with a suitable copper bus and the hinged door of the cabinet is grounded by a flexible grounding connection. Fig. 2 gives control panel showing mimic diagram.

Fig.2 Control cabinet showing mimic diagram

III. TESTING OF CONTROL PANEL

During Factory Acceptance Test (FAT), all the operations and logics from LCC are checked by Customer. There are three voltage levels that are 145kV, 245kV and 400kV. 145kV complete module is ready at the factory so testing can be done easily.

But in case of 245kV and 400kV module, some equipments are to be installed at the site because of heavy size and difficulty in complete module transportation. Hence 245kV and 400kV module is not ready at factory, because of that FAT for control panel is become difficult. Looping method is used for testing. Looping can be done only by studying drawings. Fig.3 shows harting connector with looping of wires. For single annunciation checking, number of wirings is needed. This increases complexity as well as some annunciations or function cannot be performed during Factory Acceptance Test.

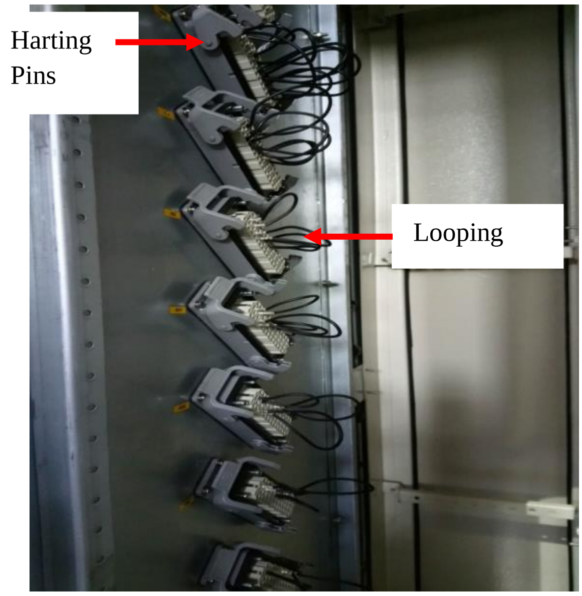

Fig.3 Harting Pins and Looping

IV. SIMULATOR DESIGNING

To check operation of LCC without coupling it to gas insulated switchgear in front of customer during Factory Acceptance Test.

An innovative trolley mounted PLC- HMI based GIS simulator designed to test LCC panels of 145kV, 245kV and 400kV bays. General architecture of kit is shown in fig. 4. This kit will operate with following steps:

1. Simulator will act as GIS model for respective 145kV, 245kV and 400kV bays.
2. The relays present in kit will receive open and close command from LCC. These commands are nothing but equipments (disconnector, earthing switch or CB) open/ close command by using twist switches given by a person who is testing LCC.
3. These commands will lead to close respective relays timers. Closing of these relay timers gives feedback to PLC. Using PLC program, respective relay boards get signal. These relay boards are having NO/ NC status found out from GIS drawing studies.
4. Alarm indication and customer interfaces will be simulated through this kit. To check whether alarms are operating, alarm checking window is designed in HMI.

The main function of kit is to operate like gas insulated switchgear which will have following safety interlock. To follow these interlocks is the purpose of LCC. Hence testing of LCC panel against these interlock is very essential. The interlocks are-

1. No closing of disconnectors onto the load

Closing of disconnector onto the load means line is fully charged and all the devices except disconnectors are closed.

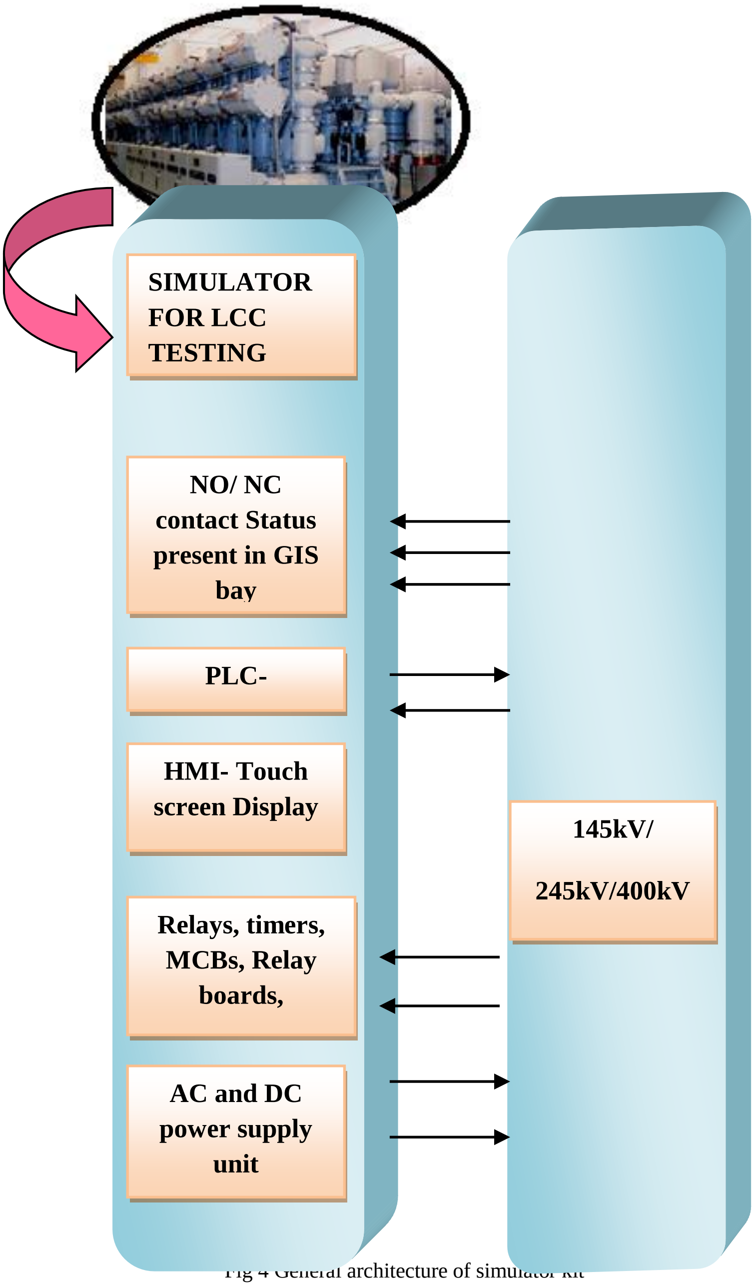

Fig 4 General architecture of simulator kit

In this case if disconnectors are closed, full line current has to be sustained by disconnector contact pins. For 145kV, nearly 3150A current and for 400kV nearly 5000A current flows through line. This much high current may damage the contact pin.

Circuit breaker should be closed while line is charged, instead of disconnector because of high making current capacity of CB. Hence disconnector should never be closed onto the load.

2. No opening of disconnector under the load

Similarly, if the line is charged and now disconnector is to be opened, there will be wear and tear of its contact pin. It has to break maximum current. Hence CB should open first and then disconnector because of high breaking capacity of CB.

3. No closing of disconnectors with earthing switch closed

If disconnector and earthing switch closed simultaneously, complete line current gets path through earthing switch. Because of high line current and low capacity of earthing switch to handle it, its contact pin will damage. This condition can only be satisfied in case of maintenance time, to discharge induced currents.

4. No switching of earthing switch when busbar or equipment is energized

This will surely damage earthing switch as energized line is earthed directly. As explained in earlier interlock, high current from energized line is getting earthed in this case.

5. No closing of Circuit breaker if the associated disconnectors are in intermediate state

If disconnectors are not completely closed and at the same instance CB gets closed, this will lead to high voltage generation as well as create spark in disconnector contact. Hence CB should never close if disconnectors are in their intermediate state.

6. No paralleling of buses by disconnectors when bus coupler is open

Bus coupler is used when there is need to shift load from one bus to other. When bus coupler is closed then only, the load can be shifted. If shifting of load is done using disconnector when coupler is open there will be paralleling of two buses where current gets halved.

7. Circuit breaker can be connected to only one bus at a time

As explained in earlier interlock, two buses may become parallel to each other of CB connected to both of them. To prevent this condition, circuit breaker should connect only to one bus as a time.

Hence, these are the interlocks taking care by LCC. Even though any operation or command goes wrong, that is against these interlocks LCC will not take that command. Hence before installing LCC to site, it has to be tested against all these interlocks.

Fig 5 shows designed simulator for panel examination.

V. CONCLUSION

With this simulation kit, fully functional assessment of LCC panel can be conducted viz panel wiring; interlock wiring, component functioning etc. This way any abnormalities in LCC will be detected in the factory itself resulting in reduced site complains.

With simple plug in harting connection there is no longer need for complex wiring and tiresome setup arrangements for LCC testing. So, considerable amount of man hour is saved in this Process.

In traditional LCC testing methods the test setup had to be changed for different voltage level switchgear. But with inclusion of PLC in our simulation kit it can be easily programmed to respective voltage Level switchgear without changing the hardware connection within stipulated time

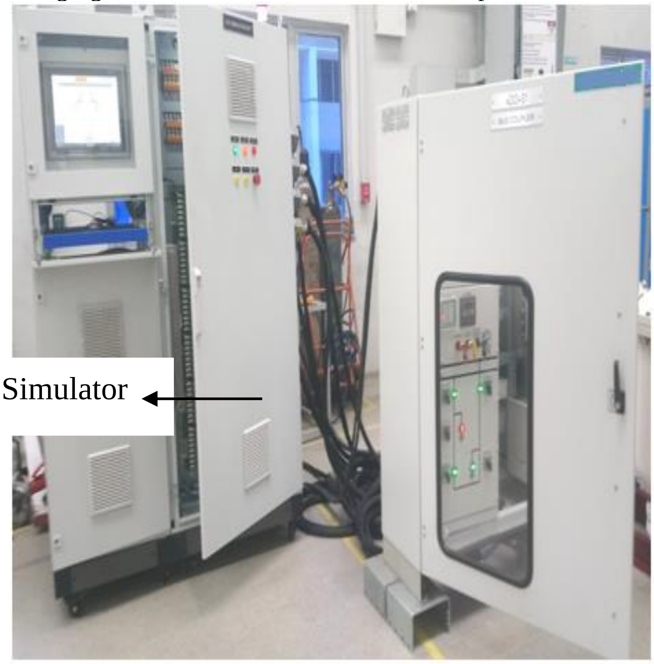

Fig.5 Testing of LCC panel

REREFENCES

[1] C. Kalaivani, P. Sanjeevikumar, K. Rajambal, M. S. Bhaskar, L. Mihet-Popa, “Grid Synchronization of Seven-phase Wind Electric Generator using d-q PLL”, Energies Journal, MDPI AG Publications, Switzerland, vol. 10 (7), 926, pp. 1–21, 4 Jul. 2017.

[2] M. S. Bhaskar, P. Sanjeevikumar, S. Pierluigi, V. Fedák, V. Harshal, T. Aishwarya, “On The Structural Implementation of Magnetic Levitation Windmill”, Conf. Proc. of IEEE 1st Industrial and Commercial Power System Europe, 17th Intl. Conf. on Environment and Electrical Engg., IEEE-I&CPS/IEEE-EEEIC'17, Milan (Italy), p.p 1-5, 6-9 June 2017.

[3] P. Sanjeevikumar, F. Blaabjerg, P. Wheeler, R. Khanna, M.S. Bhaskar, S. Dwivedi “Optimized Carrier Based Five-Level Generated Modified Dual Three-Phase Open-Winding Inverter For Medium Power Application” Conf. Proc. IEEE Transportation Electrification Conf. And Expo Asia-Pacific (IEEE-ITEC'16), Busan (Korea), pp. 40-45, 1-4 Jun. 2016.

[4] P. Sanjeevikumar, M.S. Bhaskar, F. Blaabjerg, M. Pecht, M. Luigi, M. Matteo, “Dual Six-Phase Multilevel AC Drive with Single Carrier Optimized Five-Level PWM for Star-Winding Configuration” Lecture Notes in Electrical Engineering, Advances in System, Control and Automation, Springer, Vol. 442, pp. 733-740, Dec. 2017.

[5] A. S. Tuar, S. M. Badave, P, Sanjeevikumar, M. S. Bhaskar, Z. Leonowicz, P.Saino, “Revista on Design of Simulation Kit For Testing Local Control Cabinet In Gas Insulated Switchgear” Conference: IEEE 2nd Industrial and Commercial Power System Europe, 18th International Conf. on Environment and Electrical Engg., IEEE-I&CPS/IEEE-EEEIC'18, Palermo (Italy), June 2018.

[6] Bilal Latif M.,Abbas W. ,Masood B., “Comparison of Gas Insulated Substation over Air Insulated Substation” IET-CIRED Seminar 2002

[7] Hart, “Using AMI to realize the Smart Grid,” in Proc. IEEE PES Gen. Meet. 2008.

[8] Hoffman M. and Dam T. U., “Building energy efficiency technology road maps: A case of Bonneville Power Administration (BPA),” in Proc. Technol. Manage. Global Future, July, 2006.