International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 12 | Dec 2023 www.irjet.net p-ISSN: 2395-0072

Introduction of LVAC Auto Change Over Scheme in DEWA Transmission System

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Abstract- Dubai's transmission power system plays a vital role in delivering optimum reliability and uninterrupted power. We therefore need to maintain the highest levels of technology, operational and best design practices for all digital systems.

This paper aims to provide the conceptual design overview and benefits of the innovative design of LVAC Auto Changeover Scheme in DEWA Transmission Substations (132kV).

The existing design of LVAC switchboards (400V AC supply for substation equipment's) used in 132/11 KV substations under DEWA transmission network have three buses powered through three earthing transformers and has two bus sections. During normal operation, all three buses in LVAC switchboard are independently supplied by each earthing transformer (incomer) respectively and bus sections are in open condition. To maintain uninterruptable LVAC supply to substation equipment's, a PLC is used and programmed to execute automatic switching operation of concerned bus section / incomer breakers in case of any of the incomer supply fails. LVAC switchboard has an Auto/ Manual switch and PLC is operational if the switch is on Auto mode. The existing scheme has mainly two issues as below:

A) In case of outage required on any of the IDT's, operator intervention is required to execute switching by shifting Auto/ Manual switch in Manual mode. Manual switching results in loss of LVAC supply as well as generation of several alarms through SCMS.

B) In case of switching off any IDT during LVAC in Auto mode, switching through PLC will affect only with a time delay results in momentary interruptions to downstream LV circuits which generates large number of undesired alarms in SCMS.

With an objective to eliminate momentary supply interruptions and unwanted alarms due to that, the team has developed new logic diagrams to facilitate high speed Automatic changeover of LVAC supplies with minimum allowable paralleling time for the IDT's after study on the risks involved during momentary paralleling. In place of PLC, Bay Control Units (BCU) from approved OEM's are utilized which are in use at higher voltage levels in DEWA system. BCU's are having major advantages over PLC in terms of ease and flexibility in logic buildings, programming of the device and speed of operation.

This paper aims to provide the conceptual overview and benefits of LVAC High speed Auto Change Over scheme developed in house by DEWA specialists in conjunction with specialists from the original equipment manufacturers. The new scheme involves use of Bay Control Units in place of PLC's in LVAC switchgear design. The BCU's and overall scheme is engineered, configured and extensively laboratory tested to ensure perfect functionality of High-Speed Auto Change Overs in LVAC board. Utilizing the capabilities of modern IED's to build large numbers of user defined logic and implementing these in innovative new ways has produced new unique LVAC changeover scheme that enhance functionality and reliability by eliminating discreet components and circuitry whilst maximizing overall efficiency by reducing supply interruptions and unwarranted alarms during supply changeover.

This innovative initiative will ensure that DEWA will have arguably the most advanced LVAC switchboards in its transmission systems both regionally and globally by introducing the latest digital technologies, optimized designs in line with the industry leading best practices.

I. INTRODUCTION

Dubai Electricity & Water Authority (DEWA) was established in 1992 by His Excellency Sheikh Maktoum bin Rashid Al Maktoum with the objective to provide reliable power to residents of the Emirate of Dubai. Since its inception, DEWA has continuously invested in maintaining and upgrading the power delivery infrastructure to meet the increasing demands of the growing Emirate of Dubai.

Dubai Electricity & Water Authority (DEWA) Power System includes Generation, Transmission and Distribution networks. The transmission network operates at 400kV and 132kV voltage levels with over 350 transmission substations consisting of 400/132kV, 132/33kV and 132/11kV sites. LVAC switchgears are installed in all types of transmission substations and are used to supply station loads (station auxiliaries, air conditioning, heating, and lighting etc.). LVAC supplies to various equipment's and related systems are continuously monitored by connecting the alarms through SCMS to DEWA control center. As per existing design, during supply changeover in LVAC, many unwanted alarms are received. Moreover, if the LVAC operational switch is kept in manual mode, manual intervention is required to execute supply changeovers.

In order to overcome the above-mentioned constraints, DEWA team has developed a high speed LVAC auto changeover scheme which allows momentary paralleling of transformers without any side effect thus to avoid supply interruption. The innovative LVAC scheme under discussions is approved for implementation in DEWA's all future 132/11 KV substations.

The major concerns while finalizing the scheme were as follows:

1) 1) During any one of the IDT Switching, paralleling of secondary side may involve circulating currents. In order to overcome the same it is ensured that the primary of the concerned IDT's are already parallel and maximum paralleling time is set as 500 msec and to eliminate any adverse effect such as IDT circulating currents. Moreover the LVAC busbar fault levels are within the limits for paralleling the two LVAC incomers (LVAC fault levels are shown in figure 1).

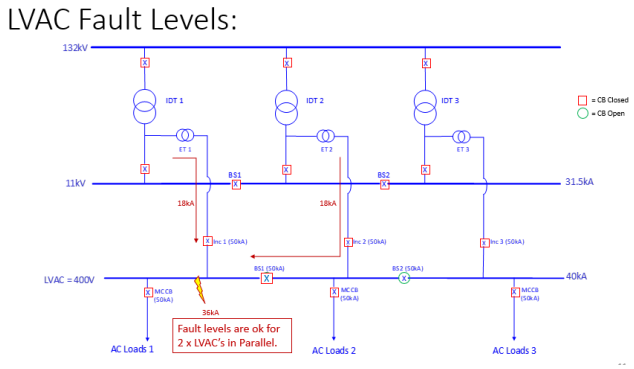


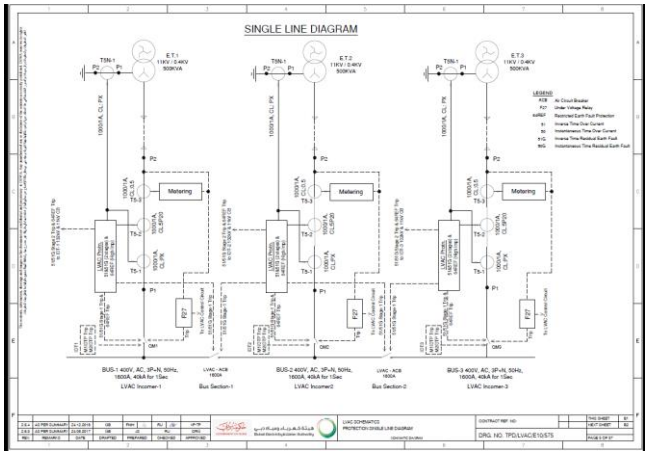
Figure-1: LVAC Fault Levels

2) The complications of switching LVAC breakers from control center would have been challenging with existing PLC, however use of Bay Control Units having IEC 61850 communication facility found as a suitable solution to achieve remote switching.

3) High speed changeover in case of tripping of any one IDT was considered as a risk to other healthy IDT's for momentary paralleling. Hence a hybrid solution was adapted. High speed paralleling was configured for planned switching and low speed LVAC changeover with 10 sec time delay was maintained for IDT protection tripping scenarios without paralleling the IDT's.

II.PROBLEMS WITH EXISTING LVAC SCHEME

Existing LVAC Single Line Diagram



The salient features specified for the existing LVAC scheme related to supply changeover scheme are as below:

1) The substation shall be provided with three auxiliary supplies derived from the three earthing transformers
2) Normally three sections (Bus 1, 2, 3) of the main LVAC switchboard shall be supplied via the associated main incoming circuit breakers with both the bus section breakers in open condition.
3) Electrical interlock shall be provided such that it shall not be possible to parallel any two transformers both on Auto and Manual mode of operations.
4) Only one Auto/Manual switch common to all 5 ACBs shall be provided, and operation logic shall be submitted for DEWA approval.
5) If a fault occurs on a section of the busbars the relevant circuit breaker shall open to isolate the faulty section and any auto-changeover on to a faulty section shall be inhibited.
6) When selected on manual mode no automatic changeover shall occur.

7) SCADA alarms are hardwired since the existing PLC devices are not capable to send alarms directly to SCMS system.

It is evident from the above-mentioned specification clauses that paralleling of transformers was not permitted and manual operations are required for supply changeover during planned outages on any one of the IDT's.

Moreover, momentary supply interruption will results in several unwanted alarms from associated LVAC circuits to SCMS.

III. High Speed Auto Changeover Scheme

The high-speed auto changeover (ACO) scheme is implemented by redesigning the LVAC control system as follows:

1. Auto Changeover (ACO) can be enabled or disabled using the existing auto/ manual switch.
2. The ACO is completely autonomous requiring no action from TCC or HMI.
3. Detection of IDT1 switching out: (the same is applicable for IDT2 & IDT3)
   a) Detect IDT1 132kV CB Open command (switching out IDT1).
   b) Initiate auto changeover of LVAC Bus 1.
   c) Close BS1 and Open Incomer 1 (Aux contact of BS1 Opens IC1 to achieve coordinated high speed switching).
4. Detection of IDT1 switching back into service:
   a) 132kV CB Closed and LVAC supply healthy for 5 seconds.
   b) Initiates restore of LVAC Bus 1 to normal supply.
   c) Close Incomer 1 and then open BS1 (Aux contact of IC1 opens BS1 to achieve coordinated high-speed switching).
5. Duration of paralleling is kept to minimum (milliseconds) therefore no overload concerns.

IDT1 Switching – ACO Scenario is shown in Figure-2.

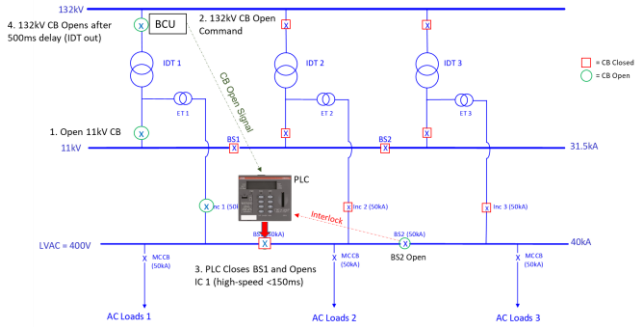
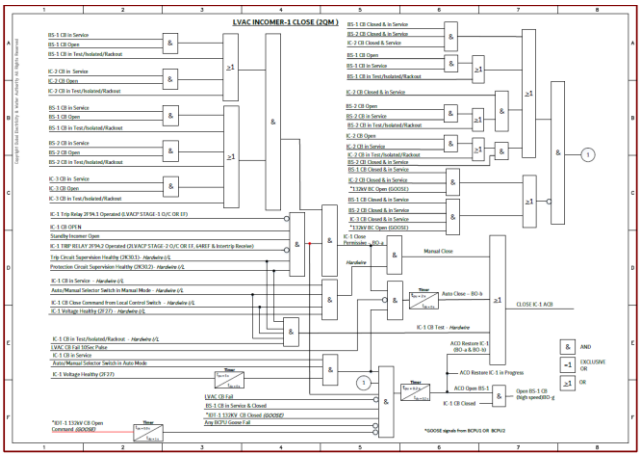


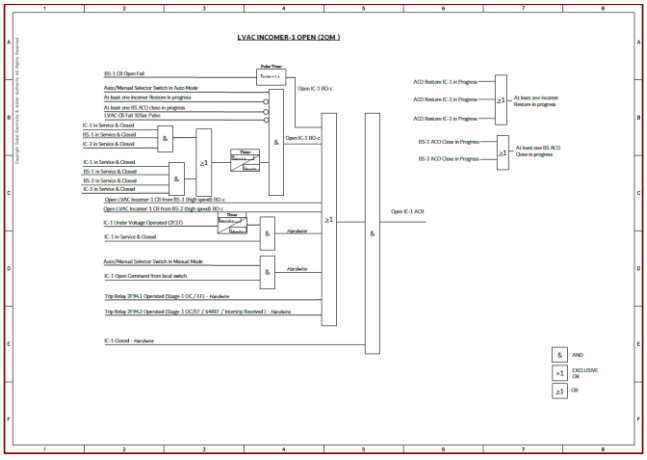
Figure-2: IDT1 Switching

A. ACO Logic

Sample logic – LVAC Incomer CB close



Sample logic – LVAC Incomer CB Open



B. **Methodology:** The steps undertaken for implementing the LVAC changeover scheme are as explained below:

1) Existing LVAC logic and schematic diagrams are thoroughly studied by the team and based on it, new logics are prepared to incorporate hybrid changeover scheme. One high speed logic for routing switching of IDT's and other slow logic for IDT tripping cases.
2) PLC was proposed to be replaced with modern and sophisticated BCU's.
3) The proposal was presented to DEWA Transmission Power Technical Committee and approval was received.
4) BCU input /output requirements were finalized and accordingly, Generic wiring diagrams were prepared.
5) DEWA approved OEM's (SEL, Hitachi, GE and Siemens) were approached to finalize suitable BCU device.
6) M/s Hitachi REC 670 and SEL451 BCU's found most suitable for this application.
7) Extensive laboratory testing was performed on these BCU's considering all network conditions in presence of DEWA stakeholder departments and BCU settings and configurations were finalized.
8) Based on successful evaluation of the BCU's, tender documents were updated to include High Speed Automatic changeover.

C. Advantages of the High-Speed Auto Changeover Scheme

The new innovative LVAC design provides significant benefits to DEWA as a utility. The new design for 132/11kV substations includes the following advantages:

- Eliminate momentary interruption of LVAC supply during IDT outage or switching
- The Scheme is completely autonomous.
- Fast switching avoids exposure to circulating currents.
- It is a cost-effective design improvement due to less number of components and wiring.
- Eliminate unwanted alarms during IDT outage.
- Increased digitization due to elimination of hard wiring (BCU option). BCU is directly connected to SCADA system and all LVAC related alarms are send to SCADA via IEC61850 protocol.
- BCU's are having major advantages over PLC in terms of ease and flexibility in logic buildings, programming of the device and speed of operation.

IV. CONCLUSION

Implementing a high-speed auto changeover (ACO) will avoid interruption of LVAC supply in the event of switching IDT's in and out of service. This will in turn avoid unnecessary supply interruption, associated alarms and improve reliability of equipment.

The high speed ACO avoids the need for operator intervention and avoids exposure to overload since paralleling is extremely short in duration.

The proposed ACO scheme was configured and tested with different OEM BCU. All the test scenario was simulated and passed. Hence the same concept can be implemented wherever applicable.

BCU is the preferred option rather than the PLC.

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