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CRITICAL EQUIPMENT SAFEGUARD IN POWER STATIONS USING PLC

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ABSTRACT

This novel will speak about the methods to demonstrate all the protections and interlocks available in the critical equipments of Thermal power station (TPS) and Steam Power Plant (SPP) such as Boiler, Turbine, the Alternator.These critical equipments are to be protected from abnormal conditions and parameters. The failure of any one of these equipments will lead to loss of power generation and also cost of these equipments is huge. Thesafeguard techniques are classified as class a, class b and class c protections. Distributed digital controls and numerical safety relays play a vital role in providing protections to these critical equipments. Conversely, an exertion has been made to demonstrate the operational protections with the aid of a programmable logic controller.

Key Words -Boiler, Turbine, Alternator, Interlocks, Distributed digital control, Programmable logic controller, Thermal Power Plant.

INTRODUCTION

Generation of power becomes challenging task in recent days and an essential requisite large power station are in use for generation of power. It includes various critical equipments like Boilers, Turbines and Alternators in power stations. They are always in activation in Thermal and Steam Power Generation stations(Alamoodi, et al., 2015). Failure of these equipments may lead to starvation of power. This in turn leads to scarcity of electricity. Boiler has got protection against abnormal drum level, abnormal live steam pressure, abnormal live steam temperature, abnormal furnace pressure. Turbine has got protection against abnormal condenser vacuum, abnormal lubricating oil pressure, abnormal axial shift and abnormal turbine speed. Similarly, the generator has also got the following protections 1.10.5kv earth fault, 220kv earth fault, differential protection, incomplete phase condition, rotor earth fault, stator inter turn fault, over current protection, stator overvoltage, rotor overvoltage. So it becomes a necessary job to protect these critical equipments against abnormal conditions and abnormal parameters.

IMPORTANCE OF CRITICAL EQUIPMENTS IN POWER STATIONS

The project illustrates the protection and inter lock schemes for power generating equipments such as boiler, turbine and generator.The protection schemes can be applicable to captive power plants and small scale industries. So the cost of implementation will be little lavish but these protection schemes using PLC is very less and effective in operation (Dragosavac, et al., 2011) The small scale industries and captive power plants are not able to implement the Numerical relays and DCS system because of higher cost. The fact that quotes out with a converter of D.C to A.C in power stations (Dragosavac, et al., 2011). In case of any delinquent happened in the protection schemes then the cost of replacement is economy only. But the replacement of numerical relays is very expensive this is the important significance of our project.

Power generation has been kept as standstill using this protection and interlock schemes (Alamoodi, et al., 2015). This paper plays an important significance role to safeguard the critical equipments asthe usage of PLC is greater advantage, since the number of inputs can be chosen depending upon our requirements (Dragosavac, et al., 2011).The various parameters of the critical equipments and the different types of faults which affect the critical equipments are demonstrated here. By this the abnormal constraints of the critical equipments can be avoided and also the method to rectify the faults which affect the critical equipments are enlightened.

SAFEGUARD OF GENERATOR

Stator Faults: The stator faults mean faults associated with the three phase armature windings of the generator and it is associated with the failure of insulation of the armature windings the main type of stator faults is,

- Phase to earth fault
- Phase to phase fault
- Inter turn faults involving turns of same phase winding.

The most significant fault is phase to earth fault (Fang Yang, et al., 2012)

SAFEGAURD OF TURBINE

Turbine is getting precarious in a power station. Turbine has been provided with certain safety and interlocks in order to save it from anomalous conditions and constraints(Ali, et al., 2015). The following four protections four protection are provided on the turbine side.

- Turbine over speed
- Condenser vacuum +540mmhg
- Axial shift +1.2mm
- Lubricating oil pressure 0.3ksc

SAFEGUARD OF BOILER

Boiler and its auxiliaries play a vital part in steam generation. The steam input at a particular flowrate, pressure and temperature has to be maintained so that the turbine will run and the required output from the generator will be achieved. For example, the steam and input required for generation of hundred megawatts is

- 440/hr steam flow
- Temperature 535 degree Celsius
- Pressure 89 KPa

EXISTING SYSTEM OF PROTECTIONS IN THERMAL POWER PLANT

- Protection system used in TPS is Numerical relays and Distributed control systems which is the latest and the costliest protection system.
- This type of protection system is used only for large capacity power plants.The Plant operate at higher end of Power transmission of Mega-Volts (Chiang Loh, et al., 2009).

CONCEPT OF PROTECTION

- Concept of protection involves the security and safety measures involved against critical equipments in power systems.
- This concept plays a vital role in protection of critical equipments such as boilers, turbines, and generators(Caiyong et al., 2015) consisting various parameters to be observed and certain measures to be taken by suitable protection devices such as relays and circuit breakers. In addition to that the plant undergoes by Voltage distortion by special Snubber circuit method (Shuai et al., 2014).

THEORIES TO MEND THE EXISTING SYSTEM OF PROTECTIONS IN TPS

The existing system of safety and interlock in TPS needs some improvement. In some equipments still old electromagnetic relays are used which has its own drawbacks. Hence in these equipments Numerical protections may be introduced along with Quasi Z-source source(Jong-Hyoung Park, et al., 2014; Yu Tang, et al., 2011).In the present system, the control room engineers are unable to distinguish between the sources of unit tripping. They are unable to identify whether the unit has tripped on boiler cause or turbine cause or generator cause.The effort has been made in this paper by programming a PLC to identify the cause of unit tripping instantly after the unit has tripped.Also it is possible to understand whether the mills have tripped due to interlock or due to any electrical fault. In further the unit exposed beyond out with Improvised Z-source Inverter(Chiang Loh, et al., 2009; Yu Tang, et al., 2011).

INPUT AND OUTPUT:

- I_0- ID / FD Tripping
- I_1- Drum Level Low / High
- I_2- Abnormal Boiler Parameter
- I_3- Mill Tripping Interlocks
- I_4- Turbine Protection
- I_5- Generator Protection
- I_6- Bus Bar Protection
- Q_0- Boiler Protection Operated
- Q_1- Turbine Protection Operated
- Q_2- Generator Protection Operated
- Q_3- Tripping of Mills
- Z- Inverter source

ADVANTAGES OF PROPOSED MODEL

The model is designed as,

- To demonstrate all the critical equipments in power station.
- To demonstrate the various critical parameters controlled in Thermal power station.
- To demonstrate the safety and interlocks in boiler, turbine and generator.
- To demonstrate the non-trip and trip faults on boiler, turbine and generator.
- To demonstrate the consequence when critical equipment parameter goes beyond normal limit and it is deal with switched inductor quasi inversion (Jong-Hyoung, et al., 2014).
- To demonstrate how the critical equipments are safeguarded against abnormal conditions and parameters.
- To demonstrate the importance of all the critical equipments.
- To suggest some ideas to improve the existing safety and interlocking system.
- The Gain support of Tanking circuit enables Inverter source to attain state space (Ali, et al., 2015).

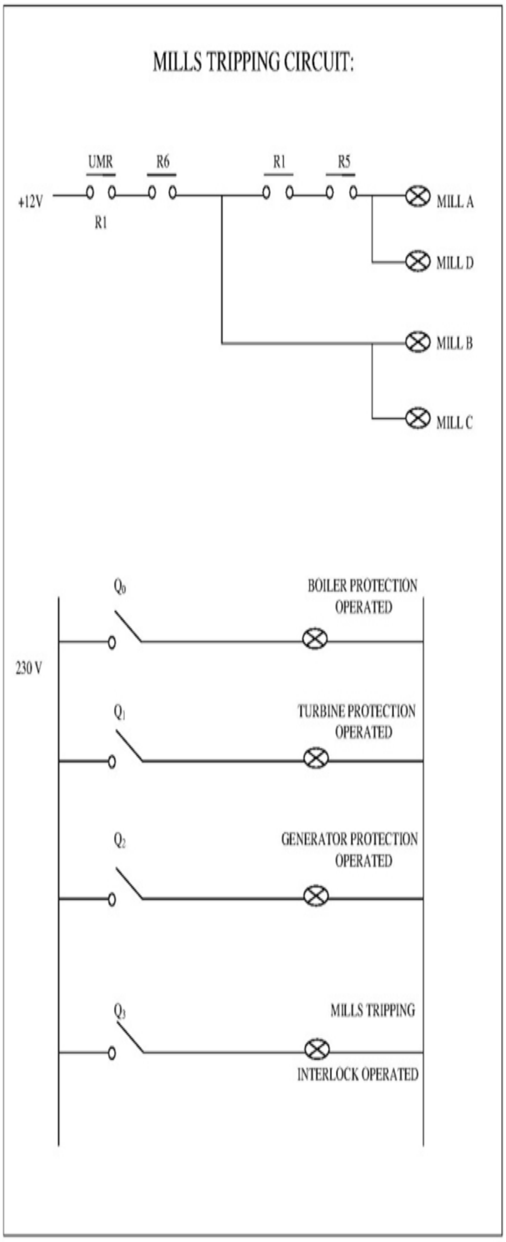

Fig. 1. PLC Program of Mills Tripping Circuit

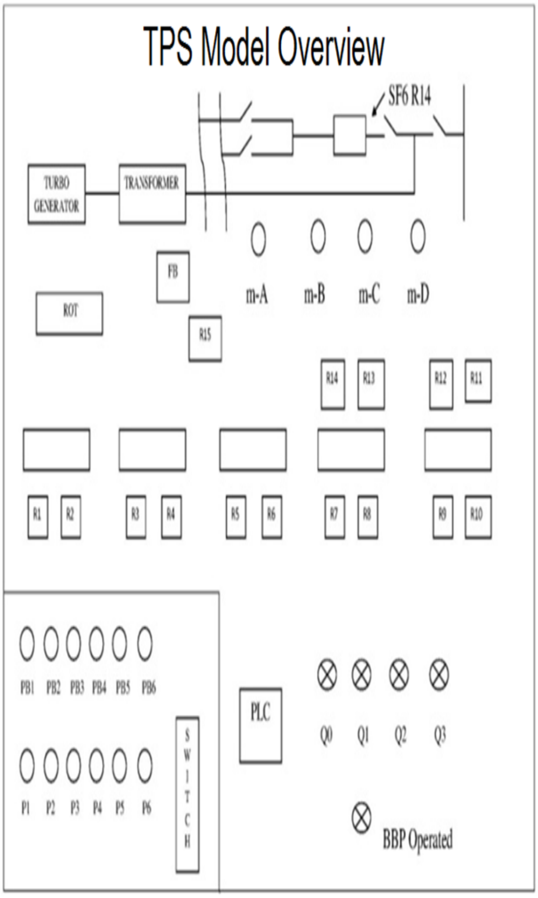

Fig.-2: Proposed TPS Model overview

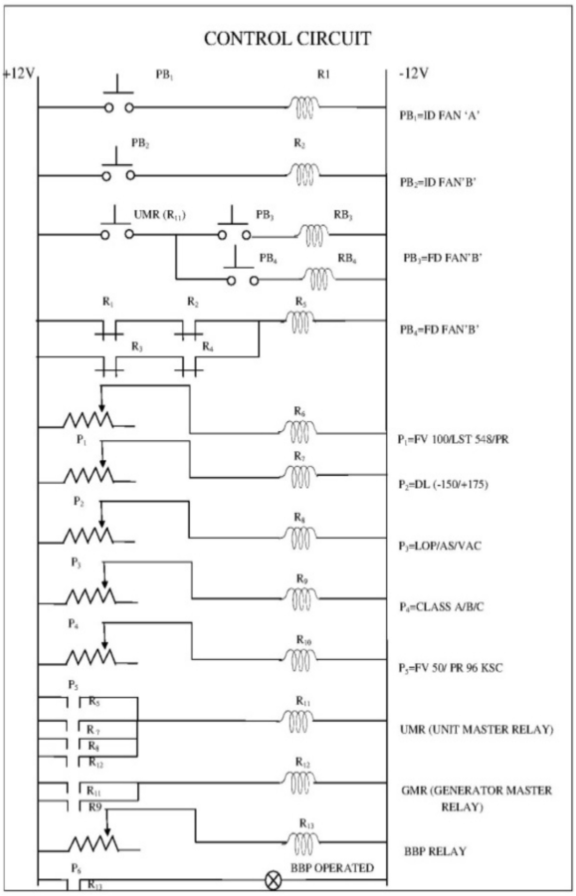

Fig.-3: PLC Program of Control Circuit

CONCLUSION

- Generation of powerbecomes an essential requisite. The three critical equipments in all thermal power station are to be protected(Paulides et al, 2015). Failure of any of these equipments may lead to production power loss. This in turn leads to scarcity of electricity. So it becomes a necessary job to protect these critical equipments against abnormal conditions and abnormal parameters with improvised ZSI (Yu Tang, et al., 2009; Amudhavalli, et al., 2013; Xinping Ding, et al., 2007).
- The interlocks system has been fully commissioned and is operational. Interlocks and Dual Loop Capacitor Voltage control(Yu Tang, et al., 2009; King J.E., et al., 2008) have been in used ever since protective relaying scheme were implemented for three critical devices like boiler, turbine and generator. Interlocks prevent undesired states in electrical equipments.
- A sincere attempt has been made in the project todemonstrate the existing system and how the existingsystem can be improved with PLC.

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