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Scada Based Auto Part Loading Scheme for Generators

Lini Varghese[1], Remya K.V.[2], Anandu V. S[3].
[1, 2]*Electrical & Electronics Engineering Department, Al-Ameen Engineering College, Kulapully, Palakad, Kerala*
[3]*Electrical Engineer, BPCL, Kochi Refinery, Ambalamugal, Ernakulam, Kerala*

Abstract*: Power system automation enables rapid diagnosis and precise solutions to specific grid disruptions or outages. Load management is very much difficult in the generating side. All generators are operated in parallel for its advantages. But if any fault/voltage fluctuations etc. occurred in one or more generators, load compensation would become tough. This really affect captive power plants for the industrial applications like Process Plants, Steel & Aluminum Industries, Petrochemical & Chemical Industries and Cement Plant etc. which are involved in critical operation during manufacturing or production process which need reliable & quality power. Interruption of Grid power or disturbance in power supply due to voltage & frequency variation may cause severe damage and loss in production as well as revenue. Most of these industries have installed Captive Power Plant (CPP) and it operates in parallel to State Electricity Board's (SEB) supply system. Part loading is a load management/compensation scheme in industries to manage their loads when any generator supply is interrupted due to disturbances. This paper describes how part loading mode of operation can be beneficial during problems arising due to Grid Disturbances while CPP operates parallel with SEB / Grid Supply System and how this can be done using SCADA system.
Keywords: Part Loading, SCADA, Automation, Power System Reliability, Islanding, Generators, Captive Power Plant, Control System, Power System, Grid Disturbance, Critical Loads.

I. INTRODUCTION

A captive power plant is a power generation facility used and managed by an industrial or commercial energy user for their own energy consumption. Captive power plants (CPPs) are generally used by power intensive industries where continuity and quality of energy supply are crucial, such as aluminum smelters, steel plants, and chemical industries. The plants may operate in grid parallel mode with the ability to export surplus power to the local electricity distribution network. They may be operated in island mode that is independent of local electricity distribution system. CPPs are a form of distributed generation, generating power close to the source of use. Distributed generation facilitates the high fuel efficiency along with minimizing losses associated with the transmission of electricity from centralized power plants. Gas engines make ideal captive power plants where there is a localized supply of gas. The main benefit of CPPs is Security of power supply through self-generation. For reasons of reliability, distributed generation resources would be interconnected to the same transmission grid as central stations. Various technical and economic issues occur in the integration of these resources into a grid. Technical problems arise in the areas of power quality, voltage stability, harmonics, reliability, protection, and control.

In this paper section 2 explains about part loading of generators, section 3 explains how it can be done using SCADA-the logical idea, and the paper concludes the advantages of the scheme in the last section, section 4.

II. PART LOADING OF GENERATORS

Power blackout is a short-term or a long-term loss of the electric power to a particular area. There are many causes of power failures in an electricity network. Examples of these causes include faults at power stations, damage to electric transmission lines, substations or other parts of the distribution system, a short circuit, or the overloading of electricity mains. Power failures are particularly critical at sites where the environment and public safety are at risk.in order to eliminate power blackout during any type of power supply failure, part loading is used to compensate the electrical loads mostly in industries which are involved in critical operation during manufacturing or production process which need reliable & quality power. Most of these industries have installed Captive Power Plant (CPP) and it operates in parallel to State Electricity Board's (SEB) supply system. Gas turbine generators are most widely used in such industries due to many advantages. Interruption of Grid power or disturbance in power supply due to voltage & frequency variation may cause severe damage and loss in production as well as revenue. Part loading is a load management/compensation scheme in industries to manage their loads when any generator supply/grid power is interrupted due to

any disturbances. During intentional or automatic islanding of SEB supply, the generators in the CPP should be brought to Part loading mode to take up the variations of the industry load and also to compensate the load which are supplied by the SEB grid bus that is parallel to CPP bus. SEB load is compensated by the CPP of the industry, in order to prevent unnecessary under frequency load shedding. Under frequency load shedding occurs when any increase in load is not compensated properly and the system tries to compensate the load by decreasing its speed and thus frequency.

III. METHODOLOGY FOR AUTO-PART LOADING SCHEME - THE ALGORITHM

Part loading mode of operation can be beneficial during problems arising due to Grid Disturbances while CPP operates parallel with SEB / Grid Supply System and this can be done using SCADA system. Hence power quality can be maintained and system will become more reliable. For that the generator mode should be changed from 'pre select load' mode to 'part load' mode. If any grid disturbances are found the generator changes from pre select mode to part load mode by initiating a frequency raise/lower pulse. Hence the load is transferred from grid to generator. The frequency has to be increased to an acceptable level. If there occurs any delay or if the load to be compensated by the CPP is beyond the capacity of the CPP generator, then the system will go to under frequency load shedding. So that CPP generators can feed the most critical loads of the industry only. The solution to avoid this type of unnecessary load shedding is that to remove the manual intervention and making an automated system. In large industries the CPP generators are running in their half loaded condition. This is done for load compensation in unexpected failures to avoid power blackout through part loading option. In the pre select mode of operation the generator will be pre selected in its half load or half rating .i,e, a machine with 30MW will be operated only for generating 15MW.when it goes to part load mode the generation will increase according to the load compensation needed as it is indicated or monitored by the frequency change. The algorithm is developed by using two generators and SEB bus. The gas turbine generators in CPP are named as GT3, GT5. In normal operating conditions, the generators are parallel with each other and Kerala state electricity board. The automation algorithm starts by checking the relay conditions. If all the relays seem to be healthy, then the system checks for the circuit breaker status if they are ON/OFF. From this point the algorithm will split into 3 cases. Each of them is explained below. The algorithm of automation of the part loading scheme for generators is developed by considering these cases.

Case 1- All the generators and SEB bus connected in parallel: When all the generators and SEB bus are connected in parallel with each other then the automated system will monitor the load status of each generator and also system monitors the load that is compensated by grid. There exists a fact that every CPP is paralleled to the SEB grid under a minimum load dispatch condition. Also if there is any need of CPP load compensation for the grid due to maintenance or any other known condition, the CPP should compensate it. In this case, if there is any trip/fault occurs in CPP generators, it will be compensated by the SEB grid and industrial operations will be done smoothly. Thus avoiding economical loss by preventing power blackout. If any grid disturbances occur, then the CPP generators will compensate the grid connected load along with their own industry load. This is done by part loading the generators of CPP. May be one of them will be part loaded or may be other one too according to the grid load to be compensated. When a machine is changing to pre select mode to part load mode, its APFC should be off in order to maintain power factor. Frequency should be checked out after part loading the generator and should keep within limits in order to avoid under frequency load shedding. In some cases may the load cannot be compensated where the speed decreases as the load is large, the system will be base loaded and will go to under frequency load shedding.

Case 2- One of the generator and SEB bus connected in parallel: When one of the generator and SEB bus connected in parallel, if there is any trip/fault occurs in CPP generator, it will be compensated by the SEB grid. If any grid disturbances occur, then the CPP generator will compensate the grid connected load as it changes to part load mode. In this case also if load cannot be compensated, the speed decreases as the load is large, the system will be base loaded and will go to under frequency load shedding and feeds only critical loads of the industry so as to avoid economical loss of the industry.

Case 3- Independent case: If CPP is not parallel with the SEB under any circumstances and also the generators in the CPP are independent of each other, the load can be compensated up to a limit only. It is done only by the generator which is feeding the load by part loading the generator up to its rated capacity. If the load is beyond the rated capacity, then the system will go to under frequency load shedding by feeding t he most critical loads of the industry.

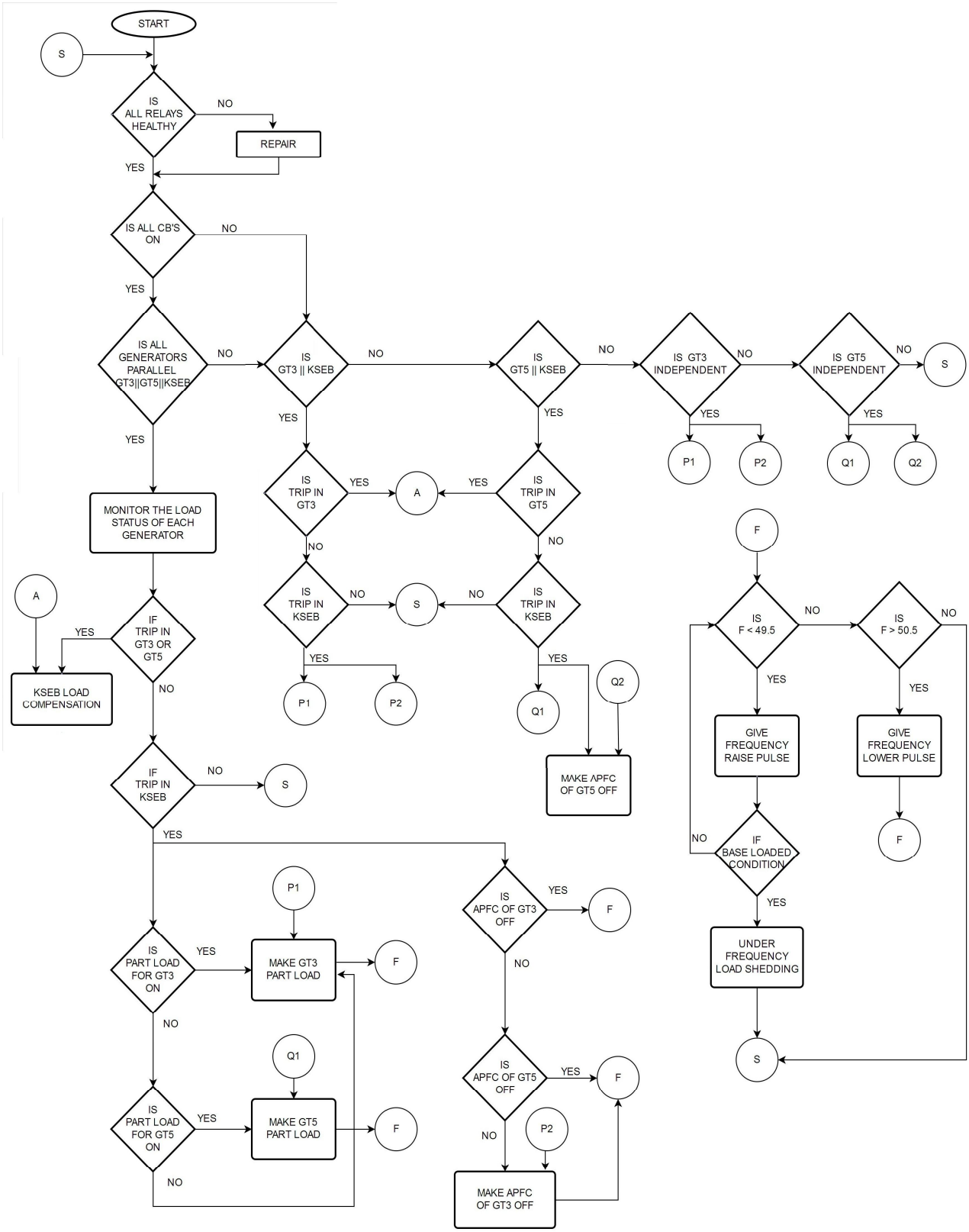

Fig.1 Flowchart of the scheme.

IV. CONCLUSIONS

Interruption of Grid power or disturbance in power supply due to voltage & frequency variation may cause severe damage and loss in production as well as revenue. We can avoid complete blackout situation in the plant and subsequent black start of the power plant. This will help to save the production loss, to reduce severe damages of equipment & process as well as to improve the life of plant machineries. This is done by Switching off the excess load and keeps the part loads on healthy units, during part CPP operation. Also Segregation of essential/critical (i.e. Frequency sensitive) and non-essential (i.e. less frequency sensitive) loads of the plant can be done along with part loading. The essential loads are fed from CPP and the non-essential loads can be catered by grid supply. In this area Automation helps fast action without any personnel risk. Controlling windows can be extended as required– if any new machines or components added to the circuit. Wide variety of power system components can be easily operated & controlled through control panel created using SCADA.SCADA improves the reliability of the power system.

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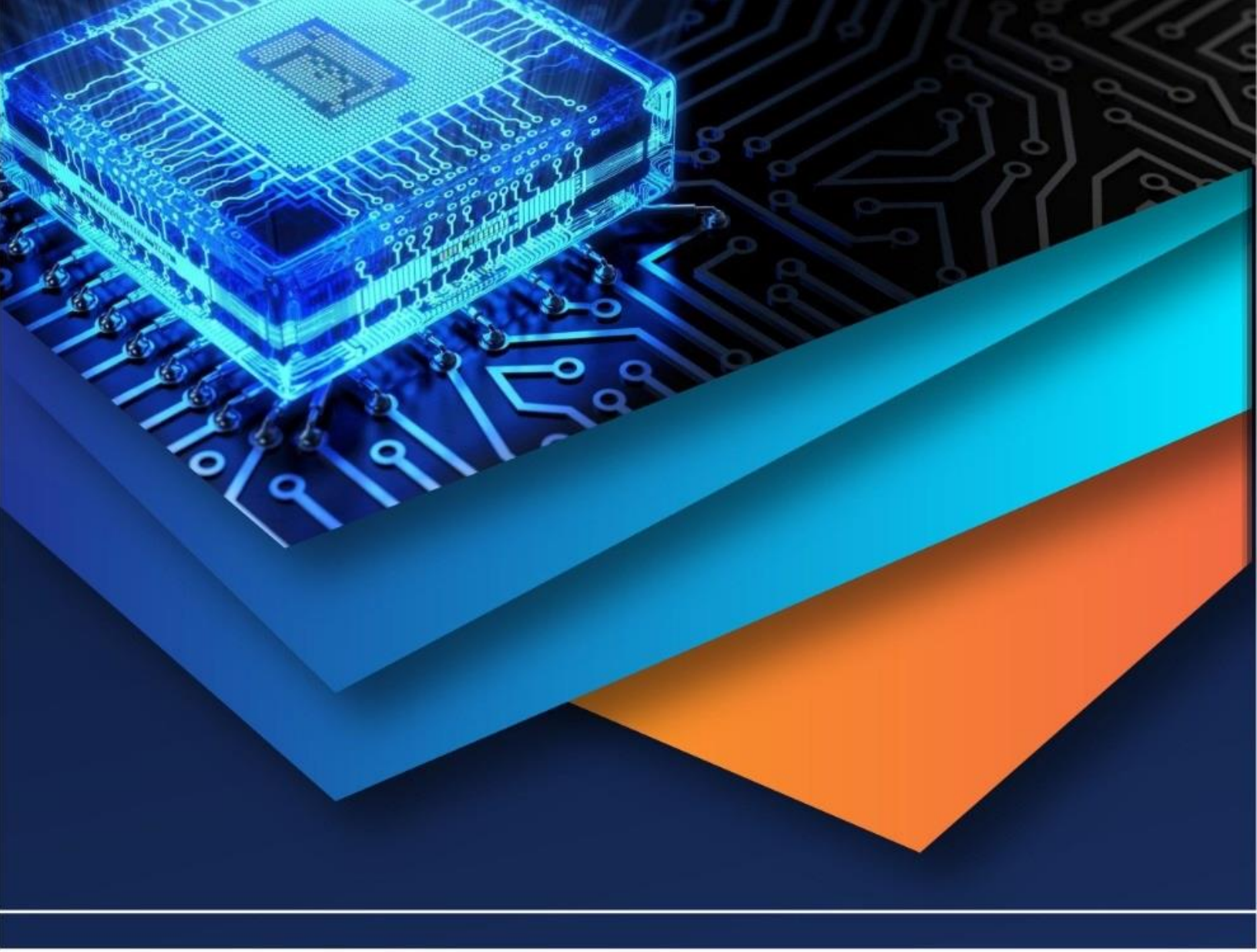

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