In this thesis, the studies are carried out on AP Power Grid. The studies are mainly focused on alleviating different disturbances in Power Systems especially the blackout condition. The various critical instances lead to blackout in Power Systems all over the globe including Indian scene are studied, the remedial actions for the major disturbances are analyzed. Keeping this as a background, to mitigate such drastic disturbances, and proper preventive measures for saving the power systems to largest extent possible are suggested.

As a first step in this study, various power system disturbances are reviewed and analyzed. The modeling aspects related to blackouts and the concepts related to critical failures are addressed. A Matlab program is developed to compute the effect of the power system failures leading to blackout.

The thesis mainly focused on two aspects which can serve as the preventive measures, when the power system is subjected to critical failures leading to blackouts.

(1) Design and implementation of SPS

(2) Design and implementation of Island Scheme

6.1 DESIGN OF SPS

The traditional protection schemes which are adopted in power systems include line protection, over current protection, differential protection, bus bar protection and generator protection. These protections are designed on the protection philosophy of immediate isolation of the power system equipment from the faults. While the protection schemes presented in this thesis is of special type which is used to protect the power system against the partial or total collapse. The need of the power system in the scenario of deregulation managing the large inter-connected grids, demands the new role of protection philosophy apart from the fault isolation. This means, the protection feature should be clubbed with control action. The role of protection and control system is to timely predict the system instabilities, and to perform the actions to restore the system to a normal state and minimize the impact of the disturbance. To obtain this objective, the protection measures are taken, when abnormal conditions are identified, for the instances where no traditional faults situation is present, but, the system itself may be in transition to dangerous situation such as wide area disturbance or complete system blackout. Accordingly, the protection measures are used to counteract this transition, and bring the system back to safe operating conditions. Thus, the special protection scheme is designed to detect the abnormal condition and to take the predetermined corrective action, to provide the acceptable system performance.

In this thesis, the SPS is designed to prevent the total power plant blackout in the event of the critical failures of the associated evacuation transmission system.

The simulations are carried out for the various cases and the details are discussed.

Case I: The simulations for the base case consisting of the RTPP power plant with all the evacuation lines in service with the total power generation by all the units.

Case II: The simulations with the contingency event application. In this scenario, the effect of the contingency event application on the evacuation lines of the RTPP power plant, when the power plant is in its full generation capacity.

Case III: The simulations with the contingency event application and the actuation of SPS with two units of generation rejection.

Case IV: The simulations with the contingency event application and the actuation of SPS with one unit of generation rejection.

The efficacy of the proposed SPS scheme is analyzed based on the simulated results and the impact of SPS action to mitigate the abnormal overloadings on the critical evacuation lines of the power plant was observed. The comparative power flow results of the system with and without SPS action, are presented in the Table 6.1.

Table 6.1: Comparative study of the Power Flows on the Critical lines with and without the application of SPS

Sl. No	Name of the Feeder	Base Case	Application of Contingency Event without SPS action	Application of Contingency Event and actuation of SPS with two units generation rejection (with SPS Action)	Application of Contingency Event and with one unit out of service at RTPP Power Plant
1	220kV RTPP (Bus no 256) to CNP (Bus no 206) DC line	2 x 248MW	0 MW	0 MW	0 MW
2	220kV RTPP (Bus no 256) to ATP (Bus no 258) DC line	2 x 89.96MW	**2 x 337MW**	2 x 147MW	**2 x 242MW**

From the above table the following observations can be made:

1. In the event of Contingency, the criticality was observed on the evacuation lines emanating from bus no 256 to 258 when the power plant was with full generation.
2. This needs the application of the SPS to bring back the system from emergency to alert state.
3. The application of SPS with generation rejection methodology could avert the criticality with two units generation rejection.
4. Controlling of the generation rejection scheme to the extent of the requirement in case of the power plant not running to its full capacity due to some unit outage emphasizing the need of one unit generation rejection.

6.2 DESIGN OF ISLAND SCHEME

In the present scenario, most of the utilities are equipped with defense mechanism of load shedding, based on the frequency stability criteria, as a preventive step of the propagation of the cascade outages. When this corrective action is inadequate, the system integration will be lost, resulting into the formation of unintentional islands. This sort of disturbance mode of island formation are found experiencing the generation load demand mismatches and hence could not survive, this may lead to blackouts.

The need for the design and implementation of intentional island design scheme is found to be very essential remedial measure to mitigate the blackouts, when the system security is in transition from emergency state to in extremes state.

This thesis proposed a new adaptive technique of designing, modeling and formation of island for a frequency, below the conventional action of regular defense mechanism, as a last resort for preventing the total blackout, with the probability of accelerating the restoration process. The proposed island development is done in three stages.

Stage I: The modeling of the integrated system and determining the power flows

Stage II:

(i) Proposed island scheme consisting of, the major power plant to feed the essential loads of the state power utility, is modeled and simulated.

(ii) The simulated island scheme is investigated for its survival. In this stage, the main design criteria for its implementation in the real time system is tested with the simulations of the integrated system and the proposed Island schemes for its survival by analyzing the power flows for ensuring any abnormalities in the event of the formation of island apart from ensuring the load generation balance. In this context, the needed reactive compensation which was the main pre-requisite for the survival of island is also addressed. From the study results it was observed that there are some buses which were experiencing very low voltages. To avoid the voltage collapse the required reactive compensation was found needed . With suitable compensation the voltages at the respective buses was improved and the same is shown in the Table 5.7. The comparative Table 6.2 illustrates the results with and without compensation.It is observed that the voltage profile at the identified buses which were experiencing low voltages got improved, and were within the permissible limits.

Table 6.2: Comparative study of the voltages incident at low voltages buses after the formation of island with and without compenstion

Name of the Bus/Sub-station	**Voltages in the newly formed island without compensation**		**Voltages in the newly formed island with compensation**	
	PU	**KV**	**PU**	**KV**
1027CHG	0.8770	115.766	0.917	121.066
1042GHP	0.8988	118.640	0.930	122.724
1138SHN	0.8831	116.564	0.919	121.336
1147SVRP	0.8795	118.634	0.915	120.734
1189GBL	0.8962	116.094	0.933	123.150
1474MLK	0.8987	118.293	0.986	130.217

Stage III:

The designed island scheme is validated with the online simulated model of the SCADA system. It is observed that the designed island power flows are in accordance with the real-time power flows. Thus, the scheme is ensured for its load generation balance.

6.3 FUTURE SCOPE

The structural reforms in power sector around the world are taking place in the new era of deregulation and newly introduced electricity reforms acts. Most of the developing and developed countries are looking at the new adaptive techniques for enhancing the reliability and security of the power system. The grids are expanding into larger volumes. Maintaining of the major grids needs more protective schemes to prevent and mitigate the wide spread disturbances leading to blackouts. Most of the utilities are in the stage of developing and implementation of the remedial action schemes suitable to their requirements. Hence, the scope for these applications is unlimited. The suggested schemes are developed based on the available infrastructure and data capture capabilities for the immediate applications with the existing power system conditions. However, as the grids are expanding, more sophisticated protective relays and wide area measurement systems (WAMS) are in the process of implementation, using the best possible communication facilities, by providing the optic fiber network to all the sub-stations and power stations, for the extension of the control signals, from the centralized control centres. With these available facilities, many control schemes can be focused for mitigating the disturbances leading to blackouts.