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A SURVEY ON POWER SYSTEM BLACKOUT AND DIFFERENT SCHEMES TO AVOID BLACK-OUT IN THE INTERCONNECTED GRID

Basudeb Dey, Avishek Roy, Ritwik Basak, Sandeep Basak
Assistant professor, Student B.tech in Electrical Engineering
Department of Electrical Engineering
JIS College of Engineering
Kalyani,India
basudeb.dey@jiscollege.ac.in

Abstract: This paper gives the idea about the defence mechanism of Indian Grid systems. Utilities should take prudent actions in the design of power system to avoid cascading outages and power system blackouts. Power-swing protection should be the last recourse in preserving system transient stability. Methods that can improve the transient stability are briefly discussed in this paper.

Keywords: Loadshedding,Islanding,WAMS,URTDSM,Isolator.

I. Introduction

Outage planning of inter-State and inter-regional transmission elements should be carried out in a coordinated manner at RPC fora (say Operation Co-ordination sub- committee of RPCs) in accordance with regulation 5 of Central Electricity Authority (Grid Standards) Regulation, 2010 and Section 5.7.1 of Indian-Electricity-Grid-Code. In case need for emergency maintenances arise in between two meeting of Operation Co-ordination sub-committee, NLDC and RLDCs should allow such maintenance after carefully looking at prevailing system conditions under intimation to RPC Secretariat.

II. DEFENCE MECHANISM

Two types of load shedding schemes based on system frequency and bus voltage magnitudes are used.

Under frequency load shedding: This is widely used to preserve the security of both the generation and transmission system during disturbances. When reduction in system frequency fall below 49Hz Under frequency relays would be activated and after a short time delay TD without recovering a tripping signal would be issued to trip a circuit breaker with a specific load disconnected from supply. Such schemes are essential if a utility intends to minimize the risk of total system Collapse .This schemes maximize the reliability of the overall network and protect system equipment from damage.

Under voltage load shedding: This is required when voltage magnitude continues to decay but the System frequency is within acceptable tolerance band. Use is made of under voltage relay fed from the bus/feeder voltage transformers to monitor, detect and disconnect some load when all other solutions have failed to preserve system stability and for mitigation against voltage collapse. The under voltage relay will operate and trip a feeder circuit breaker when the input level falls below a pre-set threshold for more than a few seconds.

III. ISLANDING SCHEMES

After occurrence of acute system disturbances, the system may split into parts, which may or may not survive depending on the load generation balance. The part of the system containing the generation sources and certain loads which are planned to be separated from the main grids during system disturbance at preconceived points either through under frequency and / or directional power relays are called as Islands. Due to wide fluctuations in the frequency during restoration, it becomes very difficult to maintain the load-generation balance. A failure to control the frequency may lead to unsuccessful restoration. Repeated collapse of the system islands due to tripping of generators either due to over frequency or under frequency creates delay in getting normalcy. The restorative procedure is the operation of the power system equipments but with portions of the load not being served and / or with loss of system integrity. Proper Islanding of the Grid in times of grid disturbance helps in restoration of the system in least possible time by preventing generators from tripping and maintaining sources of energy within the system that can be used to extend start up power to the rest of the system and the grid is re-built.

Islanding Schemes in Eastern Region: Many Captive Power Producers in Eastern Such as Bokaro Steel Limited, Durgapur Steel Limited, NALCO, RSP, etc. The production is protected by the islanding scheme of the above companies when disturbances

occurs in grid. Also many small CPPs are having Islanding schemes. The July 2012 Grid disturbance has added a sense of urgency in identifying more possible islanding schemes. Some of the Islanding Schemes under discussion in Eastern Region are:

1. Chandrapura TPS of DVC
2. Bandel TPS of WBPDCL
3. Bakreswar TPS of WBPDCL
4. Farakka STPS of NTPC

Special Protection Schemes: Special protection Scheme is defined as a protection scheme that is designed to detect a particular system condition. It causes unusual stress to the power system and to take some kind of predetermined action to counteract the observed condition in a controlled manner. In some cases, SPSs are designed to detect a system condition (instability, overload, or voltage collapse). The prescribed action may require the opening of one or more lines, tripping of generators, ramping of HVDC power transfers, intentional shedding of load, or other measures that will reduce the concerned problem. For example, Special Protection Schemes or SPS prevents the overloading of the transmission system in case of tripping of one line by tripping generators so that other lines are not overloaded. Also the SPS may be programmed to take up other corrective actions for a stressed system condition. As a means of improving power system security and reliability defense plans that utilize the emerging technology such as synchronous phasor measurement systems and reliable digital communication systems are described in the literature.

Among the widely used SPS applicable to voltage instability are:

- Under frequency controlled load shedding.
- Under voltage controlled load shedding scheme.
- Automatic switching (ON/OFF) of shunt reactors and capacitors.
- Over voltage control
- Under voltage control
- Generation rejection
- Remote load shedding.

IV. SYNCHROPHASOR TECHNOLOGY

Synchrophasors are monitoring devices that take high-speed measurements of electrical waves (voltage and current) at a location. The measurement, typically taken 30 times a second, are time-stamped with signals from global positioning system satellites, enabling PMU data from different locations and utilities to be time synchronized and combined to create the broader system's details and its comprehensive view. Synchrophasors, also known as phasor measurement units (PMUs), can provide system operators with feedback about the state of the power system with much higher accuracy than the conventional Supervisory Control and Data Acquisition (SCADA) systems used in the industry, which typically take measurements every 4sec. The frequency of the PMU measurements can show system changes that would not be evident with SCADA data. Because they provide more precise data at a much faster rate, the synchrophasors allow more finitely calibrated measurements of power flows on the grid and a more accurate determination of operating limits in real time. They enable operators to evaluate system measurements rather than use mathematical estimates, giving them the ability to proactively take action to prevent problems rather than react after the fact. In addition to its current role in wide-area monitoring, power system planning and the analysis of grid disturbances, the technology is expected to offer significant benefits for integrating renewable and intermittent resources, automating controls for transmission and demand response, managing transmission congestion and improve in system modelling.

V. WIDE AREA MONITORING SYSTEMS

Recognizing the need of WAMS application in Indian Power System, it is proposed to follow the same philosophy i.e. installation of PMUs on substations of 400kV and above in the State & Central grids, all generating stations at 220kV level and more than 220kV HVDC terminals, important inter-regional connection points, inter-national connection points, provision of PDC at all SLDCs, RLDCs and NLDC along with visualization aids .This shall simplify an unified Real-time Dynamic State Measurements (URTDSM) towards improved system operation. The development of software based analytic functions is to be undertaken in the subsequent phases.

VI. PROPOSED URTDSM IN INDIAN POWER SYSTEM

List of PMU and PDCs to be installed at various substations in Central & State utilities as part of URTDSM is follows as:

Region	Sub-stations		No of feeders		PMU		NODAL PDC	MPDC	SPDC	Main & Back-up NLDC
	ISTS	STU	ISTS	STU	ISTS	STU				
NR	83	96	434	435	227	231	6	9	1	
WR	60	76	520	425	267	216	11	11	1	
ER	51	44	395	199	202	105	4	4	1	
SR	60	71	348	289	183	152	6	6	1	
NER	18	22	95	69	50	36	0	0	1	
TOTAL	272	309	1792	1407	929	740	27	27	5	
	581		3199		1669		57			2

VII. HVDC AS A DISTURBANCE ISOLATOR

Major black-outs in recent years have shown how relatively minor malfunctions in interconnected grids can have repercussions over wide areas. As one link overloads it is tripped, increasing the strain on neighbouring links which in turn disconnect, cascading black-outs over vast areas and causing huge productivity losses for the economy. The solution is a 'firewall' permitting the interchange of power but preventing the spread of disturbance. This can be accomplished using an HVDC link since it can fully control transmission but does not overload or propagate fault currents. When a temporary fault occurs in the AC system connected to the rectifier (AC to DC), the HVDC transmission may suffer a power loss. Even in the case of close single-phase faults, the link may transmit up to 30 per cent of the pre-fault power. As soon as the fault is cleared, power is restored to the pre-fault values. When a temporary fault occurs in the AC system connected to the inverter (DC to AC), a commutation failure can occur interrupting power flow. Power is restored when fault is cleared. A distant fault with little effect on the converter station voltage (less than around 10 per cent) does not normally lead to a commutation failure. A Capacitor Commutated Converter HVDC converter can tolerate about twice this voltage drop before there is a risk of commutation failure. The main reason why a fault condition spreads to a wide area is often that AC transmission links become overloaded. This leads to their disconnection which in turn overload other lines. An HVDC transmission link is easily engineered to take

VIII. CONCLUSION

For long the spotlight in the Indian Power Scenario has been on the Generation sector, whereas the significance of the Transmission was overlooked. However, one of the major reasons for the Indian Grid Collapse was depleted transmission network. During the 31st July disturbance the path between NR and WR was already depleted due to multiple line outages, the reasons varying from over voltage to planned cut offs. Tripping of the 400 kV Bina-Gwalior line under such circumstances led to the grid collapse. Therefore, in future the planned outage of transmission elements needs to be carefully checked by multiple load flow studies and identify probable scenarios of grid disturbance and by taking corrective action prevent them..

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