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# Contingency Analysis of Power System

SHIKHAR SHARMA[1], PROF. VISHAL V. MEHTRE[2]
[1, 2] *Department of Electrical Engineering, Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, India*

***Abstract- Contingency analysis is an important function of power system security. The security assessment is an important task because it offers information regarding the system state in the event of a contingency. The contingency analysis method is being widely used to predict the result of outages like failures of apparatus, conductor, etc, and to require necessary actions to stay the facility system secure and reliable. This paper gives us information on PIDFs and LODFs violations & remedial action to remove violations. Detailed studies have been carried out to work out the contingency plans.***

***Indexed Terms- Contingency analysis, LODFs, PTDFs, generation and transmission planning.***

## I. INTRODUCTION

Contingency analysis is one of the major components in today's modern energy management systems. For the purpose of fast estimating system stability right after outages, the study of contingency analysis involves performing efficient calculations of system performance from a set of simplified system conditions.

Contingency analysis is one of the most important tasks encountered by the planning and operation engineers of the bulk power systems.

The Line Outage Distribution Factor (LODF) is one of the important linear sensitivity factors which play a key role in finding the effect of the critical contingencies and hence suggesting possible preventive and corrective actions to solve the violations in the system.

- LODFs are used to approximate the change in the flow on one line caused by the outage of a second line.
- Typically they are only used to determine the change in the MW flow compared to the pre-contingency flow
- LODFs are approximately independent of flows but do depend on the assumed network topology.
- Power transfer distribution factors (PTDFs) show the linear zed impact of a transfer of power.

## II. CONTINGENCY ANALYSIS

Contingency Analysis (CA) is one of the "security analysis" applications in a power utility control center that differentiates an Energy Management System (EMS) from a less complex SCADA system. Its purpose is to analyze the power system in order to identify the overloads and problems that can occur due to a "contingency".

Contingency analysis is an abnormal condition in the electrical network. It put the whole system or a part of the system under stress. It occurs due to the sudden opening of a transmission line. Generator tripping. Sudden change in a generation. Sudden change in load value. Contingency analysis provides tools for managing, creating, analyzing, and reporting lists of contingencies and associated violations.

CA is used as a study tool for the off-line analysis of contingency events, and as an online tool to show operators what would be the effects of future outages.

- Security is determined by the ability of the system to withstand equipment failure.
- Weak elements are those that present overloads in the contingency conditions (congestion).
- Standard approach is to perform a single (N-1) contingency analysis simulation.
- A ranking method will be demonstrated to prioritize transmission planning.
- CA is therefore a primary tool used for the preparation of the annual maintenance plan and the corresponding outage schedule for the power system.

## III. TYPES OF VIOLATIONS

Line contingency and generator contingency are generally the most common type of contingencies. These contingencies mainly cause two types of violations.

*A. Low Voltage Violations –*

This type of violation occurs on the buses. This suggests that the voltage at the bus is less than the specified value. The operating range of voltage at any bus is generally 0.95-1.05 p.u. Thus if the voltage falls below 0.95 p.u then the bus is said to have low voltage. If the voltage rises above the 1.05 p.u then the bus is said to have a high voltage problem. It is known that in the power system network generally reactive power is the reason for the voltage problems. Hence in the case of low voltage problems reactive power is supplied to the bus to increase the voltage profile at the bus. In the case of the high voltage reactive power is absorbed at the buses to maintain the system' normal voltage.

*B. Line MVA Limits Violations —*

This type of contingency occurs in the system when the MVA rating of the line exceeds the given rating. This is mainly due to the increase in the amplitude of the current flowing in that line. The lines are designed in such a way that they should be able to withstand 125% of their MVA limit. Based on utility practices, if the current crosses 80-90 % of the limit, it is declared as an alarm situation. Different types of remedial actions to solve this problem is explained later in this Paper.

## IV. REMEDIAL ACTION SCHEME

Remedial Action Schemes (RAS) are the key components for any power system utility planning. These are the steps that the utilities need to take in order to get the system back to its normal operation. Remedial Action Scheme (RAS) as the name suggests is the necessary action that need to be taken to solve the violations caused by a contingency. Remedial Action Schemes are also defined as Special Protection Schemes (SPS) or System Integration Schemes (SIS). The RAS is designed to mitigate specific critical contingencies that initiate the actual system problems. There may be a single critical outage or there may be several critical single contingency outages for which remedial action is needed. There may also be credible double or other multiple contingencies for which remedial action is needed. Each critical contingency may require a separate arming level and different remedial actions. The terms SPS and RAS are often used interchangeably, but WECC generally and this document specifically use the term RAS.

Automatic single-phase or three-phase reclosing following temporary faults during stressed operating conditions may avoid the need to take remedial action. Appropriate RAS action may still be required if reclosing is unsuccessful.

## V. TYPES OF REMEDIAL ACTION

i. Shunt capacitor switching
ii. Generation Re-dispatch
iii. Load shedding
iv. Under load tap changing (ULTC)
v. Transformer
vi. Distributed Generation
vii. Islanding

## VI. POWER TRANSFER DISTRIBUTION FACTOR

A source and a sink are specified for each transaction. Active power will then flow from the source to sink in a direction. For each direction, the ATC value is the maximum megawatt source injection that can be transferred to the sink without violating any of the operating limits such as line thermal limits, voltage limits, and system stability limits. In order to investigate how far the system is from an insecure condition, and how a transaction of active power can affect the loading of the transmission system, it is necessary to analyze the sensitivities of line flows with respect to bus injections. These sensitivities are termed as Power Transfer Distribution Factors. Power transfer distribution factors of i-j elements, for the transaction between m-n, will begiven as,

$$PTDF=\Delta f/\Delta P$$

Where,

*PTDF ( )*- Power Transfer Distribution Factors for line i-j for transactions between m-n
*Δf* - Change in the transaction between m and n
*ΔP* - Change in real power flow of line i-j for transaction between m-n,

These values provide a linear zed approximation of how the flow on the transmission lines and interfaces changes in response to the transaction between the seller and buyer. The PTDFs are operating point-dependent.

1. ISLANDING

Islanding is the condition in which a distributed generator continues to power a location even though external electrical grid power is no longer present. Islanding can be dangerous to utility workers, who may not realize that a circuit is still powered, and it may prevent the automatic re-connection of devices.

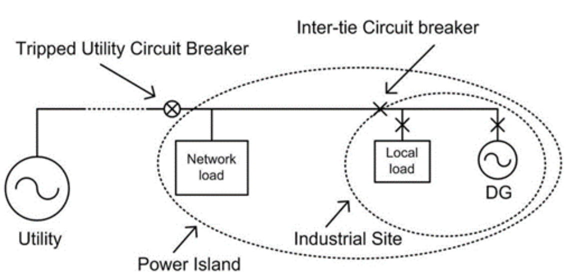



fig.1. Islanding

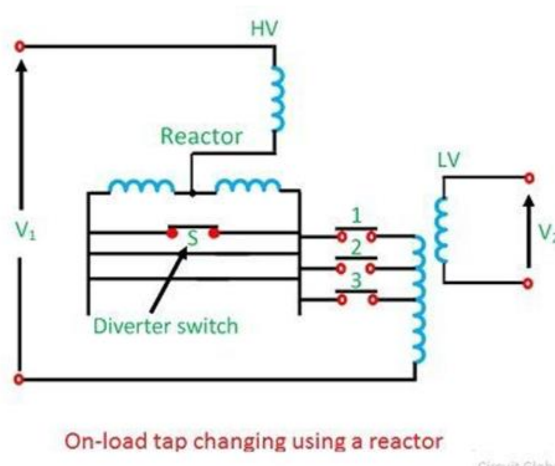
## II. UNDER LOAD TAP CHANGING TRANSFORMER

In order that the supply may not be interrupted, on-load tap changing transformers are used. Such a transformer is known as a tap-changing underload transformer. While tapping, two essential conditions are to be fulfilled

- The load circuit should not be broken to avoid arcing and prevent damage to contacts.
- No parts of the windings should be short-circuited while adjusting the tap.

The tap changing employs a center-tapped reactor R shown in the figure above. Here S is the diverter switch, and 1, 2, and 3 are the selector switch. The transformer is in operation with switches 1 and S closed. To change to tap 2, switch S is opened, and 2 is closed. Switch 1 is then opened, and S is closed to complete the tap change. It is to be noted that the diverter switch operates on load, and no current flows in the selector switches during tap changing. During the tap change, only half of the reactance limits the current.

It is to be noted that the diverter switch operates on load, and no current flows in the selector switches during tap changing. During the tap change, only half of the reactance which limits the current is connected to the circuit.




## CONCLUSION

The corrective actions effectively removed the limit violations in the system. The result that will obtain through the proposed scheme is found to be quite accurate and thus, this work introduces remedial control action for higher-order contingencies. A contingency analysis study helps to strengthen the initial basic plan. It is also helpful to develop system operators to improve their ability to resolve problems. It helps especially the busy power system operators.

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