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Mitigation of Power Interruption in Radial and Grid Feeder Schemes and Safety of Equipment's

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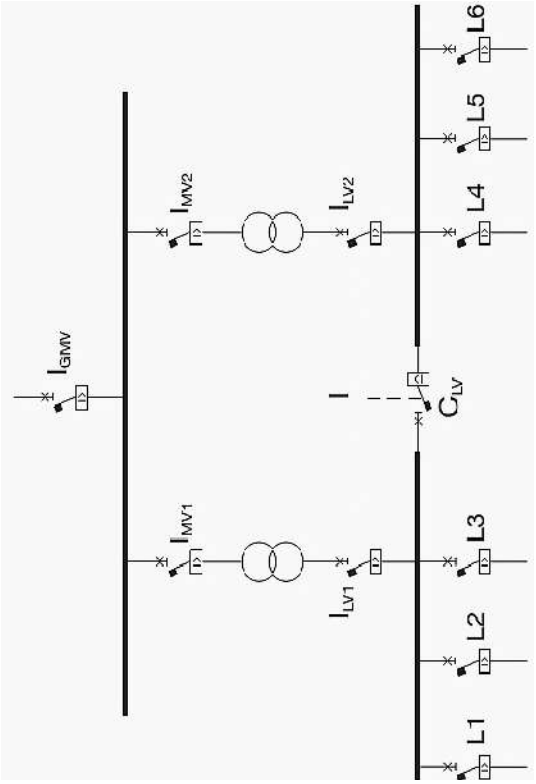
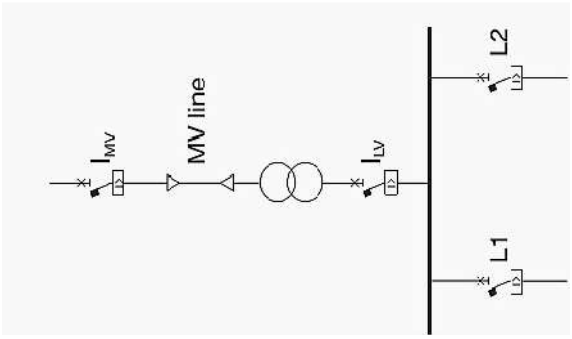
Abstract:

The Continuity of power supply that is reliability of power supply is highly essential for the development of the country. The electric power is distributed to the consumers through electrical network. The study involves the analysis of various obstacles for reliable power supply, interruption in electric power distribution due to defects in relays and circuit. Cost benefit by the prevention and reliability in power supply.

Keywords — **Reliability of power, Mitigation of Interruption, Radial feeders, power transformer and grid feeders.**



Single line diagram of 110kv sub station



Single line diagram of 33kv sub station

1. INTRODUCTION

The power generated at the generating station should reach the consumers, for which Transmission and Distribution network is used. Since electrical equipment's are involved in the Transmission and Distribution network the electric power supply does not reach the consumer without interruption. The interruptions of power supply distributions are caused either intentionally or unintentionally. Intentional

interruptions are the load shedding done to match the demand and supply that is Demand Side Management (DSM). The unintentional interruptions are caused by the defects developed in the Transmission and Distribution network and equipment's associated with them. This research is involved in the area of unintentional interruptions. This study is focused on the interruption in power distribution due to the various defects developed in the relays and its circuits.

II. DEFECT DESCRIPTION

The study is focused on the interruptions in radial feeders. Hence the 110KV and 33KV sub stations have been selected for the study. The study was conducted during 2014-2016 on the causes of interruptions in the utility.

The defect which affects reliability in power supply is categorized as under.

A. Power Transformer

1. Actuation of Oil Surge Relay (OSR) due to internal defect development in Power Transformer during failure of Lightning Arrester (IAS)
2. Operation of differential relay due to improper harmonic range selection.
3. Actuation of oil temperature relay due to Mercury switch defect.
4. Actuation of Bucholz relay due to shorting of leads by entry of rain water and foreign material in the relay junction box.
5. Actuation of winding temperature trip due to shorting of leads at Terminal Block (TB) by insects.
6. Actuation of tripping due to differential relay defect
7. Actuation of Bucholz relay due to low oil level by oil leakage.
8. High winding temperature due to wrong selection of winding current Transformer ratio
9. Actuation of pressure relief valve due to DC supply leakage & shorting of leads by rain water and birds nest.
10. Actuation of high winding temperature due to air looking in power Transformer.
11. Operation on differential relay due to entry of rain watershorting of bushing CT Secondary leads
12. Actuation of Oil Surge Relay (OSR) due to rain water and low oil level due to oil leakage
13. Operation of Power transformer Protection for Power transformer internal fault.

B. Current Transformer

1. Early pickup of relay due to collapse of Current Transformer (CT) ratio
2. Failure of molded type Current Transformer due to entry of rain water inside the Current Transformer (CT) through the crack developed in the molding.
3. Simultaneous tripping of adjacent feeders due to low insulation resistance value of Current Transformer in healthy feeders.
4. Failure of Current Transformer due open circuiting of secondary.

C. Circuit Breaker

1. Non tripping of breaker due to broken spring
2. Non opening of one of the poles in the circuit breaker due to mechanism defect.
3. Non closing of circuit breaker due to low air pressure because of failure of AC supply to compressor motor.
4. Non operation of circuit breaker due to auxiliary switch defect.
5. Burning of trip coil in the breaker due to continuous DC supply due to mechanism defect and shorting DC leads by foreign material.
6. Flash over of breaker due to low insulation resistance value.
7. Non opening of one of the Poles due to broken operating rod.

D. Relays

1. Not opening of breaker due to defect in the miniature relay.
2. Failure of relay due to mixing of AC & DC supply due to failure of control cables during Bus fault.

3. Early pickup of relay due to relay defect.
4. Operation of relay in the healthy feeder due to loose connection in the protection wiring 'L' point during fault in the other feeder.
5. Non operation of relay due to relay fixing mechanical arrangement defect.
6. Backup relay pickup due to non-coordination of relay timings.
7. Non operation of relay when the fault current exceeds the current rating programmed in the relay.

E. Battery

1. Non clearing of fault by circuit breaker due to weak battery because of failure of charger fuse.
2. Not tripping of circuit breaker due to weak battery.
3. Non opening of one of the Poles due to broken operating rod.

F. Lightning Arresters

1. Failure of Lightning Arresters (LAS) leading to On Load Tap Changer (OLTC) defect in Power Transformer.
2. Failure of Lightning Arrester (LAS) causing tripping of breaker.
3. Low insulation resistance value of Lightning Arrester (LAS) causes tripping of circuit breaker.

G. Sub Station Earthing

Weak earthing causes failure of control cables during bus fault.

H. Bus Fault

1. Failure of bus insulator causes tripping of circuit breaker.
2. Bus fault causes damage of Current Transformer (CT) cable at junction box and control cable due to high fault current spreading in the SS equipments.

I. Line

Crossing of different voltage rating lines with insufficient clearance causes tripping of healthy line due to mutual induction.

III. DEFECT PREVENTING TECHNIQUES

The preventing techniques for the defects described above are narrated below.

A. Power Transformer

The actuation of oil Surge relay and Bucholz relay due to entry of rain water and foreign material can be prevented by arresting the entry of water and foreign material by closing the junction box cover with good quality gasket and by providing the proper size gland for the cable. The gaps in the cable entry point should be closed by using M seal. The side entry of the Cable in the junction box to be shifted to the bottom in order to avoid the rain water entry through cable.

The actuation of Oil Surge Relay (OSR) and Bucholz relay due to oil leakage can be prevented by periodically checking the oil level in the Power Transformer and topping up if required to the correct level.

The actuation of oil Surge relay due to the defect developed in the On Load Tap Changer (OLTC) by the failure of lightning arrester can be prevented by periodically testing the lightning arrester for its healthiness and by replacing the lightning arrester if found weak.

The entry of rain water in the secondary side junction box of bushing Current Transformers can be prevented by providing good quality gasket and fixing the covers firmly without any gaps. There by the shorting of secondary leads of Bushing Current Transformer by rain water and the mal operation of differential relay can be prevented.

The harmonic setting in the differential relay should be selected based on the harmonics

generated in the area of use to prevent the mal operation of differential relay. Further, the differential relay should be tested periodically to confirm its healthiness. If found defective, it should be replaced to prevent mal operation of differential relay.

The Thermometers should be tested periodically to confirm its healthiness and if any one of the components found defective, it should be replaced to prevent unnecessary tripping.

The leads at the terminal blocks (TB) should be covered to prevent the shorting of leads by insects and the consequent mal operation of winding temperature trip.

The correct winding temperature Current Transformer (CT) ratio should be selected to avoid the false tripping of high winding temperature.

The power Transformer should be periodically checked for uniformity of temperature in the Transformer. If any not uniformity is found, the air locking in the Transformer should be released to avoid high winding temperature.

The DC leads in the protection wiring of the power transformer pressure relief valve (PRV) should be properly insulated to prevent shorting of leads by DC supply leakage. The rain water entry should be arrested by using good quality gaskets for the cover and proper size gland for the cable and there by the mal operation of PRV can be prevented. The PRV should be provided with cover to avoid the operation of PRV by birds.

The Power Transformer breather, oil condition and IR values should be checked periodically and maintained in good condition and the Power Transformer over loading should be avoided to prevent the development of internal fault in Power Transformer.

B. Current Transformer

The Current Transformer (CT) should be tested periodically to confirm its healthiness. If the CT is found weak or defective, it should be replaced to prevent early pick up of relay due to collapse of CT ratio, simultaneous tripping of adjacent feeders due to low insulation resistance (IR) value of CT and failure of CT due to open circuiting of secondary side.

Incase of moulded case Current Transformer, it should be examined periodically to find out if there is any cracks. If any crack is developed either it should be closed with M seal or the CT should be replaced depending upon the condition of crack to avoid entry of rain water and subsequent failure of CT.

C. Circuit Breaker

The breaker should be periodically checked for its correct operation and its healthiness. If any part is found defective, it should be replaced and mechanism defect should be attended and lubricated for its free operation to prevent the mal functioning of breaker. Incase of pneumatic breaker the compressor operation and AC supply availability to motor should be checked and if any defect is noticed it should be attended immediately to avoid non operation of breaker due to low air pressure.

D. Relay

The relay and its wiring should be periodically tested to confirm its correct operation and if any defect is found it should be rectified to prevent mal operation of relay.

The AC and DC cables should be laid separately to avoid mixing of AC and DC supply and to prevent relay failure.

The delay timings of the relay should be selected properly to avoid backup tripping. The relay current rating should be selected according to the fault level of the area to prevent the

programme locking of relay due to over current during fault.

E. Battery

The battery should be maintained periodically and its charging condition should be monitored continuously and the defect if any found should be attended immediately to prevent the non tripping of breaker during fault due to weak battery.

F. Lightning Arrester

The Lightning Arrester (LAS) should be tested periodically to confirm its healthiness and its correct operation. If any defect is noticed during test, it should be attended or if required LAS should be replaced to prevent development of defect in Power Transformer OLTC during failure of LAS, tripping of breakers due to failure of LAS.

G. Substation Earthing

The Substation earthing should be periodically measured to confirm its healthiness. If any of the earth pit resistance value is more, it should be attended immediately and all the earth pit resistance should be maintained low by proper watering to prevent spreading fault current in the SS equipment and to prevent control cable from damage.

H. Bus Fault

The insulation resistance of all the supporting insulators in the substation should be measured periodically for confirming its healthiness. If any of the insulators is found defective, it should be replaced immediately by healthy one avoid unnecessary tripping of circuit breaker and supply interruption and to prevent control cable from damage during failure of insulator.

I. Line Crosing

The crossing of line should be erected with clearance as per standard to avoid simultaneous tripping of breakers due to mutual induction.

110KV SIDE DEFACTS CAUSE AND REMEDY

110KV CIRCUIT BRAKER WAS NOT CHARGED DUE TO THE FOLLOWING DEFECTS

1. Air pressure operating mechanism air leakage
2. Low air indication i.e. Below 14kgf/cm2
3. Gas leakage
4. Low gas alarm and lockout condition
5. Single phase supply instead of and phase supply
6. Closing and tripping coil worn out
7. DC supply less than recommended DC Voltage
8. 110KV breaker clamps, jumpers are loosen condition
9. Heavy glow ideal charging
10. Pole Discrepancies occur during close
11. Breaker mechanism auxiliary contacts making problem
12. Lighting one the breaker insulator pet coat broken condition
13. Low IR values of Insulators
14. Breaker T&C Switch was not working properly
15. Mal operation of charging of breaker without removing earth rods provided

CIRUIT BREAKER REMEDY

1. Air pressure pipe line, leakage completely avoid. Every weakly with soap solution air leakage checked
2. Air pressure increased by running of compressor motor and maintaining air pressure above 14kgf/cm2

3. SF6 Gas pressure maintain 6.5kgf/cm2 if low tapping of sf6 gas done
4. Gas leakage checked and arrested
5. Single phase preventer contactor and maintain 3 phase supply
6. Closing and tripping coil changed by new one
7. 110 volts DC supply maintained in trip and close coil of breaker
8. Clamps and 110KV Jumpers in Tightness condition
9. Clamp tightness and providing hot-zip zinc coated bolt & nuts
10. Sequence closing of breaker poles maintained with removing dust etc.
11. Proper lubrication done in auxiliary contacts of breaker
12. Lighting spike provided
13. Changing of low IR values Insulator
14. New T&C switch provided
15. Proper authorization experience operators with conduction safety glass

33KV BRAKER DEFECTS AND REMEDY

1. Spring charging motor problem
2. Motor charging limit switch problem
3. Dummy closing of breaker
4. SF6 gas leakage, low gas
5. Vacuum interrupter damaged
6. Circuit breaker during open condition 1no of breaker phase not opening
7. Protection cable damaged due to rats
8. Relay closing and tripping problems
9. Burst breaker insulator
10. Trip and close coil plunger adjustment problem

33KV BRAKER CLOSING REMEDY

1. Damaged spring changed
2. Limit switch changed by new one
3. Adjusting of travel time
4. SF6 gas tapped, gas leakage arrested
5. New vacuum interrupter provided
6. Ammeter loading checked and again open the breaker
7. Cable duct maintained neatly and clean eaten waste not through inside control room.
8. Relay calibrated every year periodically
9. Lighting spike provided
10. Plunger adjustment done

110 KV & 33KV CURRENT TRANSFORMER DEFECTS AND REMEDY

1. Current Transformer secondary saturates
2. Current transformer busted
3. Oil leakage
4. Low IR value
5. Insulator broken
6. Proper measuring CT erected
7. Loose connection of cables
8. Secondary side of loading improper rods provided. Minimum loading transformer
9. Glow in current transformer clamps
10. Current transformer firing

REMEDY

1. Current transformer secondary short circuited
2. Limit the loading amps
3. Gasket provided newly and oil leakage arrested.
4. Improve the IR value
5. Correct ration of C.T. Erected
6. Quality Insulator provided
7. Tightness of cable with duct.
8. Ct rods provided according of loading
9. Clamps changed and provide new bolt & nuts with zinc coated
10. Tree clearance, periodical oil changing done.

IV. TESTING AND MAINTENANCE STANDARDS

The following Standards are to be adapted for preventing the defect in the power apparatus and relays

A. Power Transformer

1. IS 2026,
2. IS 2026 (Part I, II) – 1977
3. IS 2026 (Part III) – 1981,
4. IS 2026 (Part IV) – 1999
5. IS 335-1993,
6. IS 9434 – 1979
7. IS 10593 -1983

B. Current Transformer

1. IS 2705 – 1992

C. Circuit Breaker

1. IS 13118 – 1991
2. IEC 56 - 1987
3. IEC 71 - 1972

D. Relay

1. IS 3842 (Part I) – 1967,
2. IS 3842 (Part XII) – 1976

E. Battery

IS 8320 – 1976

F. Lighting Arrester

IS 3070 (Part I)

G. Earthing

IS 3042 – 1966

H. Insulators

IS 2544-1973

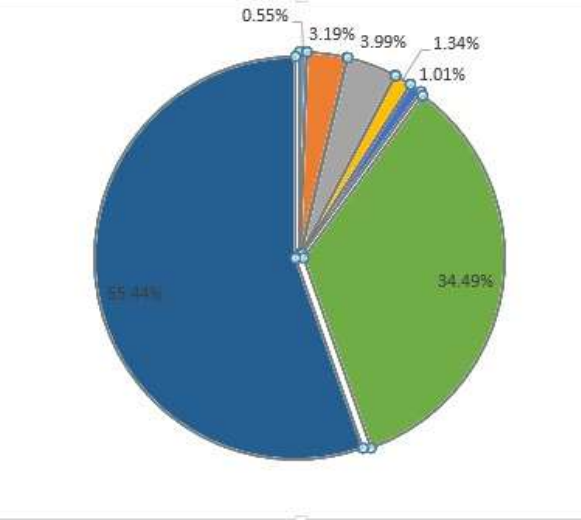
I. Line crossing

IE Rule 77 & 78 – 1956

V. NUMERICAL AND GRAPHICAL RESULTS

The study was conducted in utility during 2014-2016. The interruptions due to the various causes detailed above were analyzed. The techniques for the prevention of above defects were also analyzed. The units due to unwanted interruption and its cost were arrived. Similarly the costs of preventive techniques were also arrived based on the standard material cost & labour cost. The saving due to the adaptation of preventive techniques are furnished in the following table

Single chart for cost of Energy lost in %



Equipment's preventive techniques

Defects in Equipment

1. Power Transformer
2. Current Transformer
3. Circuit Breaker
4. Relays
5. Battery
6. Lightning Arrester
7. Sub Station Earthing
8. Bus Fault
9. Line Crossing

Nature of Defect

1. Miniature Relay Defect
2. Mixing of AC & DC Supply in Relay
3. Early pickup due to Relay defect
4. Protection Wiring Defect
5. Relay fixing Defect
6. Non Coordination of Relay Timings
7. Relay Programmer Error

UTILITY SPECIFICATION

(1). Number of Substations

110/11KV : 13Nos

33/11 KV : 18Nos.

VI. CONCLUSION

Various factors attribute to the defect in power system. The proper research involves the study of various cause and obstacles for the reliable and continuous power supply. The preventive methods improve the performance of the equipment's. In turn it avoids the defect in the equipment's. The prevention of defects would give reliability of power supply and would give cost benefit to the utility.

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