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The Short Circuit Grid Level of Karnataka Frame (Till 220kv) Transmission Network for 2017-18 Time Frame and Definite Re-Commendation to Overcome

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ABSTRACT: Short circuit studies is done for calculating the withstanding capability of the switchgears like fuse, circuit breaker during the normal operation (load flow) and abnormal operation (fault conditions).This analysis is internally used for relay coordination. MIPOWER software is used for performing this study. MIPOWER is a highly interactive, user-friendly windows based Power system analysis package. Short circuit studies, transient analysis can be done with very high accuracy and tolerance. When a fault occurs in the system very high level of current flows in the system and it leads to cascading failure of the system, and if adequate protection is not taken at correct time then the system will black out.

The power consumption of any city is difficult to manage and to analyse in order to uncomplicated the issue of the utility, we should use computer simulation to understand the load flow in the network and plan accordingly. Bangalore city is consuming half of the total power being generated in Karnataka. so this has resulted in increasing power network and connected substation. hence, to understand the power flow and line loading as well as congestion in substation use of understanding of Karnataka power transmission network and modelling it using MIPOWER for short circuit analysis methods and field survey is needed, we clearly show the interconnection of the sub stations, power flow from each substations and the power consumptions by loads connected to each substations simulating the details in the software package.

We collected the data about the location of the substation, the transformers and the different conductors used for the transmission lines from KPTCL officers. We were able to draw Karnataka Metropolitan Transmission network map which is not presently available. These data has been updated in the MIPOWER software and simulated for load flow analysis.

KEYWORDS: Short Circuit Analysis, MIPOWER, Load Flow Studies.

I.INTRODUCTION

Karnataka Power Transmission Corporation Ltd. (KPTCL) is the state owned Power Transmission Company which undertakes intra state transmission of power to DISCOMs and to the open access consumers within the state. The transmission system of the state was upgraded to 220KV with Commissioning of the Sharavathi- Shimoga- Peenya line on 25th January 1965 of 361 km. Another three 220KV lines between Sharavathi-Shimoga-Peenya were subsequently energized. The first inter-state 220KV line between Peenya- Singarpet of 162 km route length was commissioned in 1965. The generating capacity of the Shivasamudram Power House gradually increased to 42 MW in stages. To meet the increasing demand for power, the Shimsha Generating Station, with an installed capacity of 17.2 M.W, was commissioned in the year 1938. The power demand was ever on the increase, for industries and rural electrification, and additions to generating became imperative. The 1st stage of 48 MW and 2nd stage of 72 MW of the Mahatma Gandhi Hydro-Electric Station were commissioned during 1948 and 1952, respectively. Subsequently, the Bhadra Project, with an installed capacity of 33.2 MW, and the Thungabhadra Left Bank Power House, with an installed capacity of 27 MW at Munirabad were commissioned during 1964 and 1965, respectively.

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The State of Karnataka, with availability of cheap electric power, and other infrastructure facilities, was conducive for increased tempo of industrial activity. It became necessary therefore, to augment power generating capacity by harnessing the entire potential of the Sharavathi Valley. The first unit of 89.1 MW was commissioned in 1964 and completed in 1977. The demand for power saw a phenomenal increase in the mid sixties and onwards with the setting up of many public sector and private industries in the State.

As power generation in the State was entirely dependent on monsoon and was subject to its vagaries, the State Government set up a coal based power plant at Raichur. The present installed capacity of the power plant at Raichur is 1260 MWs. To augment the energy resources of the State, the Kalinadi Project with an installed capacity of 810MW at Nagjhari Power House and 100 MW at Supa Dam Power House, with an energy potential of 4,112 Mkwh, were set up.

MIPOWER is a highly interactive, user-friendly windows based Power System Analysis package.It includes a set of modules for performing a wide range of power system design and analysis study. MIPOWER features include a top notch Windows GUI with centralized database. Steady state, transient and electro-magnetic transient analysis can be performed with utmost accuracy and tolerance. Designed to assess the risk of Voltage instability and margin of stability during sudden disturbances, under steady state conditions. It ranks the load busses based on the L-index value and the highest L-index indicates the system collapse point. The value of L-index is zero at no load and 1 at the verge of collapsing point. Performs three-phase harmonic load flow to compute harmonic distortion factors. Calculates harmonic transfer and driving point impedances for both transmission and distribution power systems.

The following are the features of MI POWER:

1. Power System Network Editor
2. Database Manager
3. Graph Utility
4. Free Programmable Blocks
5. Load Flow Analysis
6. Short Circuit Analysis
7. Transient Stability Study
8. Relay Co- Ordination
9. Voltage Instability Analysis
10. Harmonic Analysis
11. Network Reduction
12. Sub Synchronous Resonance
13. Electro Magnetic Transient Analysis
14. Line And Cable Parameter Calculation
15. Long Term Load Forecast
16. Three Phase Load Flow Analysis

II LITERATURE SURVEY

The system characteristics during short circuit condition and will act as a path to design the protective scheme for the undertaken circuit. The most severe short circuit condition i.e. 3 phase to ground fault is tested on actual 72 bus system considering a 220 KV Masudpur substation as the test system. During this condition very high current flows through the system which damages the equipment. It also causes the interruption in the supply provided to the customers. Initially load flow analysis is done to obtain the power flow in the complete system which is followed by short circuit studies. In this paper short circuit studies done on the system gives us the maximum fault current and fault MVA rating which helps in relay setting, coordination and setting up the overall protection system.[1].

Increased generation capacity along with entrance of new power plants to the grid has caused increase in the level of short circuit in transmission grid substations. In this paper, methods for decreasing fault current used theoretically and practically are gathered briefly first. Then, short circuit level is studied in transmission substations at Azerbaijan

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regional electricity company region in 2014 to introduce practical methods to decrease fault current. Short circuit level of mentioned transmission grid is analyzed using DIgSILENT and appropriate methods are proposed to decrease fault current [2].

III. OBJECTIVE

- It is observed that short circuit levels are critical at some of the substations especially 220 KV and 400 KV level and it is within the corresponding rated breaking capacity as per CEA planning criteria.
- According to the previous year data of 2016-2017 short circuit analysis since, there was high fault level so we are providing suitable recommendations for 2017-2018 time frames.
- Hence, it is advisable for KPTCL to initiate immediate action for reconfiguring the 220KV and 66KV network in Karnataka or initiate alternate measure to reduce the fault level such as Providing series reactors or bus-split operation or fault limiters and at the same time initiate action for replacing the breaker and other related works with a capacity of 63 KA.

IV. THE SHORT CIRCUIT STUDY

Short-Circuit Currents are currents that introduce large amounts of destructive energy in the forms of heat and magnetic force into a power system. The reliability and safety of electric power distribution systems depend on accurate and thorough knowledge of short-circuit fault currents that can be present, and on the ability of protective devices to satisfactorily interrupt these currents. Knowledge of the computational methods of power system analysis is essential to engineers responsible for planning, design, operation, and troubleshooting of distribution systems.

Risks Associated With Short Circuit Currents: The building/facility may not be properly protected against short-circuit currents. These currents can damage or deteriorate equipment. Improperly protected short-circuit currents can injure or kill maintenance personnel. Recently, new initiatives have been taken to require facilities to properly identify these dangerous points within the power distribution of the facility.

Short Circuit analysis is required to ensure that existing and new equipment ratings are adequate to withstand the available short circuit energy available at each point in the electrical system. A Short Circuit Analysis will help to ensure that personnel and equipment are protected by establishing proper interrupting ratings of protective devices (circuit breaker and fuses). If an electrical fault exceeds the interrupting rating of the protective device, the consequences can be devastating.

It can be a serious threat to human life and is capable of causing injury, extensive equipment damage, and costly downtime. On large systems, short circuit analysis is required to determine both the switchgear ratings and the relay settings. No substation equipment can be installed without knowledge of the complete short circuit values for the entire power distribution system. The short circuit calculations must be maintained and periodically updated to protect the equipment and the lives. It is not safe to assume that new equipment is properly rated.

Short circuit studies are performed for various types of faults (3-phase, phase to phase, double phase to ground, and phase to ground) at different locations throughout the system. However, the most severe of the fault is 3-phase to ground and the system is simulated for these fault conditions. The short circuit study is carried out to:

- Compute the fault current at different voltage class.
- Identify whether the system and the equipments could withstand the prospective fault current.
- Specify the ratings of the equipments for future expansions.
- Ensure that protective equipments are properly coordinated and can isolate faults quickly.
- Design the ground mat in substations.

Benefits of a Short Circuit Analysis Performing a Short Circuit:

1. Reduces the risk a facility could face and help avoid catastrophic losses.
2. Increases the safety and reliability of the power system and related equipment.

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3. Evaluates the application of protective devices and equipment. Identifies problem areas in the system.
4. Identifies recommended solutions to existing problems.

V.STEPS FOR THE ANALYSIS

Studying Karnataka power system using Mi-POWER software package by modeling the transmission network of the entire state. In this study we have considered 4Nos of 400KV stations majorly feeding Bangalore city as in figure 1 and the MW power injected to each bus is shown as generated at that bus for clear understanding to avoid any further modeling of the interconnected lines for simplicity.

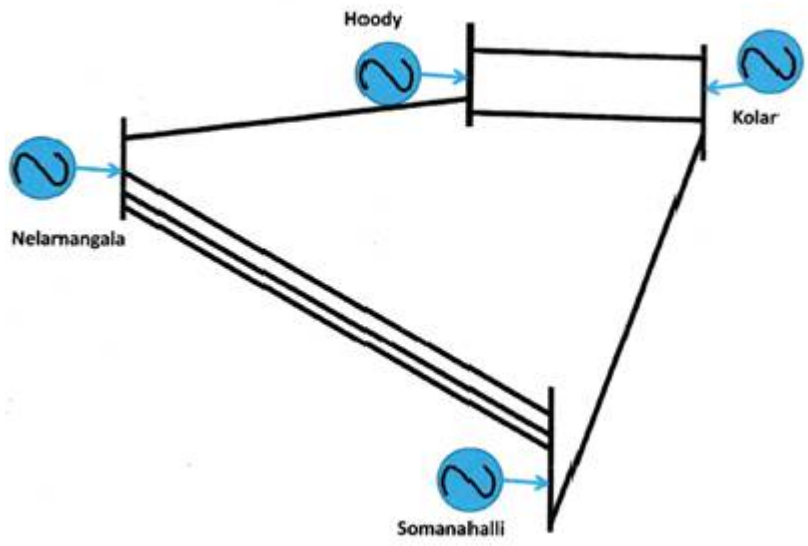

Fig.1 Major 400KVSubstations in Bangalore

A. BUS DATA

- Initially go to the last record option and click add record, the new bus will be created.
- In the next step the bus name is given such that the name should indicate the substation name and the voltage level of the bus and the total description is given.
- For example ,in the above shown SMNHLI21 indicates somanahalli bus of 220 KV
- Then nominal voltages are given as shown above it may be 11, 66,220,400 KV respectively.

B. TWO WINDING TRANSFORMER DATA

- Initially go to the last record option and click add record, the new transformer will be created.
- Then the manufacturer reference number is given, the reference number is selected such that it should indicate the MVA rating and step up or step down voltage of the transformer.
- Then by selecting the manufacturer reference number the De-Rated MVA, Rating I, Rating II values are automatically taken by the MI-POWER software.
- The “FROM” bus number and the “TO” bus numbers are given to connect the transformer between two buses.
- The bus with highest voltage rating is given as control bus number.

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- The number of transformers connected in parallel is given .In order to enter the number of transformers it should satisfy the transformer parallel conditions.
- Then the status service can be changed according to our requirements whether it should be out of service or in service.

C. TWO WINDING TRANSFORMER LIBRARY DATA

- In transformer library we look in for the manufacturer number, MVA rating, primary voltage, secondary voltage.
- The minimum and maximum tap numbers are given such that the controlled voltage is made to flow through the transformer.
- Then select whether on load or off load tap change.
- Then positive sequence impedance, positive sequence X to R ratio, zero sequence impedance, zero sequence X to R ratio values are automatically taken by the MI-POWER software .

D. THREE WINDING TRANSFORMER DATA

- Initially go to last record option and add record the transformer number will be created.
- Then the manufacturer reference number is given, the reference number is selected such that it should indicate the MVA rating and step up or step down voltage of the transformer.
- Then by selecting the manufacturer reference number the De-Rated MVA is automatically taken.
- It is same as that of two winding transformer but with tertiary winding.
- The “FROM” bus number and the “TO” bus numbers are entered to connect the transformer between two buses.
- The bus with highest voltage rating is given as control bus number.
- The number of transformers connected in parallel is entered .In order to enter the number of transformers it should satisfy the transformer parallel conditions.
- Then the status can be changed according to our requirements whether out of service or in service.

E. THREE WINDING TRANSFORMER LIBRARY DATA

- Here we are checking for the reference number, primary MVA rating, secondary MVA rating, tertiary MVA rating and primary, secondary and tertiary voltage.
- Then the status can be changed according to our requirements whether out of service or in service.
- The other parameters are automatically taken by the MI-POWER software.

F. LINE/CABLE DATA

- Initially go to last record option and add record the line/cable number will be created.
- Then select the structure reference number such that it indicates the type of material conductor to be used.
- By selecting the structure reference number the De-Rated MVA, Rating I , Rating II values are automatically taken.
- Then the “FROM” bus number and the “TO” bus numbers are entered to connect the transmission line between two buses.
- Then the status can be changed according to our requirements whether out of service, from end open ,to end open and in service.
- The transmission line length in Km is entered.
- The total number of circuits whether it is single or double circuit is mentioned.

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G. LOAD FLOW STUDIES

- Here the load flow is made to run in fast decoupled method because in this method the number of iterations is less and it was advised by KPTCL.
- slack bus concept of LFA is selected
- According to KPTCL the slack bus is WR765 which is at the western region, The slack bus at west doesn't really exist it ia a ideal bus created by KPTCL if there is increase in demand power will be drawn from slack bus, If the demand is less and excess power is given back to slack bus.

H. LOAD FLOW RESULT

- Click the Load Flow Analysis button on the Mode toolbar to switch to Load Flow Analysis mode.
- To run the load flow study, click on the Run Load Flow button located in the Load Flow toolbar. After running the Load Flow Analysis, the results will be displayed on the one-line diagram.
- Running a Load Flow Analysis will generate an output report. In the Study Case toolbar, you can select the name of an existing output report to overwrite.
- Output reports provide a way to view a more detailed and organized representation of the results. Click on Report Manager in the Load Flow toolbar, and go to the Result page and select Load Flow Report. As different file formats for the output report as shown in Fig 6.9.After running the Load Flow study, analyze the output data for different elements in a very compact and summarized way by using the Load Flow Results Analyzer

I. SHORT CIRCUIT ANALYSIS

- After running the short circuit analysis a box will appear in that select study info.
- After selecting study info the dialog box appears as shown above.
- In the box select the buses for which the short circuit results should be obtained.
- The short circuit results obtained gives complete detail of the selected buses .

J. SHORT CIRCUIT ANALYSIS RESULT

- From the Mode toolbar, select the short circuit mode by clicking on the Short-Circuit Analysis button.
- From the Study Case toolbar, click the Edit Study Case button. This will open the Short Circuit Study Case editor, allowing you to change calculation criteria and options. From the Information page, choose a bus or multiple buses to be faulted.
- The results of the Device Duty Short Circuit calculation are displayed on the one-line. Changing the settings in the short circuit Display Options can modify the results displayed and their format on the one-line.
- To view the output reports click on Report Manager from the Short Circuit toolbar, and go to the Result page and select Short Circuit Report.

VI. RESULT AND DISCUSSION

In this fig 1, we have considered 4Nos of 400KV stations majorly feeding Bangalore city and the MW power injected to each bus is shown as generated at that bus for clear understanding to avoid any further modelling of the interconnected lines for simplicity.

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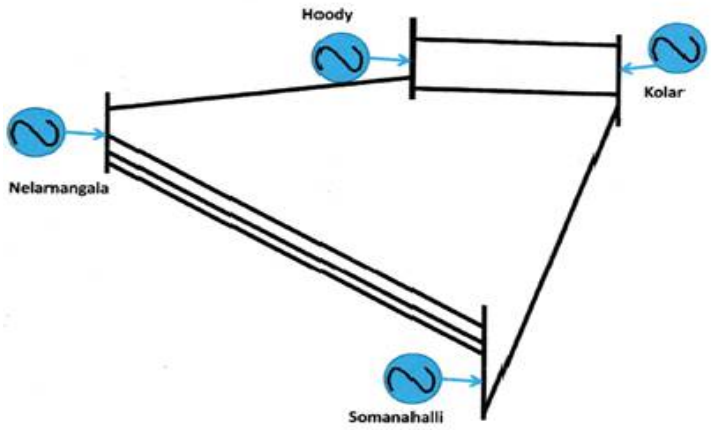

Fig. 1 Major 400KVSubstations in Bangalore

- The following table 1, indicates complete details of three phase fault level of 400 KV substations.

Bus No	Bus Name	Rated Voltage KV	3-Phase MVA	Fault Current kA
32940151	BSPURA41	400.000	9765.360	14.095
32940371	GDHLLI41	400.000	8669.985	12.514
32940491	GUTTUR41	400.000	15842.625	22.868
32940681	HIRYR41	400.000	13977.716	20.176
32940682	CNHALLI4	400.000	13578.545	19.600
32941121	KAIGA41	400.000	11282.280	16.285
32941491	KOLAR41	400.000	18849.586	27.208
32941671	NRNDRA41	400.000	14013.974	20.228
32941881	RCHRNW41	400.000	26722.182	38.571
32941891	KUDGI41	400.000	25175.199	36.338
32941901	KUDGIN41	400.000	24813.068	35.816
32941911	MDGRIN41	400.000	25812.835	37.259
32941921	SURANA41	400.000	16346.134	23.594
32942191	SMNHLI41	400.000	22279.622	32.159
32942401	JGLRNW41	400.000	12651.719	18.262

Table.1 Three Phase Fault Level Of 400KV Substations Result

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VII .CONCLUSION

The load flow analysis shown indicates the load pattern on the different voltages lines which can specify the loadings of the lines as well as the substations. The utility can take necessary steps to tackle the issues of the over loading of the lines and substations with the help of the load flow studies.

The short circuit levels which were critical at some of the substations especially 400 KV and 220 KV level and it is within the corresponding rated breaking capacity as per CEA planning criteria have been rectified.

According to the previous year data of 2016-2017 short circuit analysis there was high fault level so recommendations for 2017-2018 time frame were been provided.

The following are the recommendations been provided:

1. Breaker Replacement
2. Addition of reactance by using fault limiting equipments.
3. Network Reconfiguration by splitting the Bus.

VIII. FUTURE SCOPE

- The load flow study carried out for the entire Karnataka state is expected to decrease the unexpected downtime.
- The short circuit analysis done till today, reduces the risk a facility could face and help avoid catastrophic losses.
- The short circuit analysis evaluates the application of protective devices and equipment, which increases the safety and reliability of the power system and related equipment in the near future.
- The short circuit analysis done till now, have identified the problems associated with the system and hence the recommendations have to be implemented by KPTCL.

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