

## A STUDY OF SHORT CIRCUIT ANALYSIS AND LOAD FLOW OF 132KV SUBSTATION USING ETAP AT BAHAWALPUR

Muhammad Tanveer

Master Scholar, Department of Electrical Power Engineering, The Islamia University of Bahawalpur, Pakistan.

[engrtanveer28@gmail.com](mailto:engrtanveer28@gmail.com)

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Corresponding Author: \*

Muhammad Tanveer

### Abstract

A short circuit analysis is a crucial for any power grid station because it damages the technical devices that installed on the grid. This research tries that if short circuit and faults occurred, how it will be affected on the whole grid as well as load flow. Generally there are three types of faults occurred in the grid and these are triple line fault, double line to ground fault and single line to ground fault. The load flow method is the tool to analyze the grid system. There are different methods for load flow analysis as Newton Raphson method, Gauss-Siedel method and Fast-Decoupled method. The three load flow methods have been compared on the basis of number of iterations obtained. Newton Raphson method is one of the best relevant methods to this study; hence, Newton Raphson method is applied to analyze the load flow of 132kV grid station in Bahawalpur. The Load flow analysis of grid is carried out through simulation tool ETAP. In proposed system, there are 128 distribution transformers that have a rating from 100KVA to 500KVA. During the load flow analysis, it is observed up to 18% losses in this grid. These losses are the sum of active losses and reactive losses. The active losses are 5.382 KVA and reactive losses are 4.980 KVA. It was seen that many of the distribution transformers and distribution lines are overloaded. There were eight positions where faults occurred, which are located at bus 96, bus 1100, bus 890, bus 1195, bus 1235, bus 1280, and bus 1338. A three types of fault observed that are LLL LG and LLG. Short circuit major reasons are moisture, trees and sudden variation in loads. All the results are calculated by using proposed methodology. Short circuit analysis gives complete information about line to ground fault, double line to ground fault and triple line to ground fault. After installing the accurate rated on protective devices, such as circuit breaker and protective relays. Then the line to ground fault, double line to ground fault and triple line fault are reduced from 18 % to 11%. This will help to overcome losses of transformers.

### INTRODUCTION

Load flow is very important in electrical power system short circuit and voltage stability must be proper installation. Required protective scheme setting, stable and reliable operation for power

plat. If the demand and supply are maintained then the system is stable. Load flow study give the information about magnitude, phase angles of load buses, reactive power of generator buses, flow of

real power and reactive power on transmission lines. The population raises in Pakistan then rise the demand of electricity but generating station not increases according to demand load in country that the reason of short fall of electricity (Siddique et al, 2019, May). The planning and calculating the buses voltages, phase angle, active power reactive power and apparent power passing from system component in normal condition using load flow mathematical tools. Load flow study plays a vital role in steady state solution of power system network. The number of existing generation unit and transmission lines requires the review of traditional method and creation of new concepts. Electrical power system is back bone of the development of a nation (Shaikh et al, 2018, April). The electric power demands increase day by day. Power system stability depends on demand and supply from system. If the voltages is under level the impact on power grid is negative on distribution system (Shambare, Sun and Imoru, 2019, November). If the voltages level is exceeding on normal condition then loads are tripping, system element and transmission line leading to series of outages. The existing transmission lines in power system are not designed to support the control requirement of complex interconnected system. However decreasing the system stability and security if certain buses are overloaded due to these overloaded buses voltage profiles are deteriorating and system efficiency is low (Gomez, 2019). Existing generating station need to redesign and Building more generating station is also necessary to overcome increasing demand.

In the electric power system, the short circuit can occur when the connection between two nodes is damaging and it is introducing a huge amount of harmful energy in the form of heat into the power system. Sometimes the fault is occurred due to a short circuit. In the power system, a short circuit introduced a specific type of energy in a huge amount (Latt, 2019). That type of energy in the

form of specific heats and magnetic force. When the short circuit occurs and no voltage drop across the connection or no resistance there is said to be an ideal short circuit. In this situation, the rest of the circuit current is limited only by the resistance. When the short circuit occur fault current passed in the system within a millisecond and a thousand times greater than the normal operating current of the system (Campanhol et al, 2018).

A short circuit can also occur when a protective device interrupts the excessive current in the power system. Due to the short circuit currents may deteriorate equipment and if the protection against the short circuit is improperly it can kill maintenance personnel. Short circuit current is also caused by the damage or destruction of wiring insulation. When the part of the current-carrying conductor meets with another conductor or touch with another circuit than a short circuit occurs (Ullah et al, 2017, May).

#### Research Methodology

The short circuit analysis of 33/11/0.4 KV distribution system was performed using ETAP software based on EEC 60909 with short current calculation approach. Short circuits are different types of parallel and asymmetric faults in different places. In addition, this article describes the temporary fault current envelope on the network bus level fault current obtained using IEC 61363-1 (Jamil et al, 2019, July). The results of a short circuit analysis can be presented determine the maximum size of safety equipment to satisfy customers with reliable service. The calculation of three-phase asymmetric short-circuit faults is a complex problem. This article provides an overview and analysis of current methods to calculate proportional short-circuit errors in three steps. In this research, only Newton Raphson method is discussed for the calculation of load flow problems.

#### Newton Raphson Solution Method

The different methods are used to solve the nonlinear equation of the system. Newton Raphson's method is the most popular method using for the nonlinear equation. The Newton Raphson method starts with initial guesses of all unknowns (Kapahi, 2017). Newton Raphson method used the Taylor series and ignored the higher-order terms of the power balance equation in the power system.

$$\begin{bmatrix} \Delta\theta \\ \Delta|V| \end{bmatrix} = -J^{-1} \begin{bmatrix} \Delta P \\ \Delta Q \end{bmatrix} \tag{2.1}$$

In equation (i) and are represent the mismatch equations.

$$\Delta P_i = -P_i + \sum_{K=1}^N |V_i| |V_k| (G_{ik} \cos \theta_{ik} + B_{ik} \sin \theta_{ik}) \tag{2.2}$$

$$\Delta Q_i = -Q_i + \sum_{K=1}^N |V_i| |V_k| (G_{ik} \sin \theta_{ik} - B_{ik} \cos \theta_{ik}) \tag{2.3}$$

$J$  Represents the matrix of partial derivatives

$$J = \begin{bmatrix} \frac{\partial \Delta P}{\partial \theta} & \frac{\partial \Delta P}{\partial |V|} \\ \frac{\partial \Delta Q}{\partial \theta} & \frac{\partial \Delta Q}{\partial |V|} \end{bmatrix} \tag{2.4}$$

### Literature Review

In the fault analysis first of all we need the power flow or load flow study that is the flow of electrical power in an interconnected system is numerical. The flow of power normally used simplified notation like as single line diagram and per-unit system, and target on the various facet of AC power parameters, such as real power, reactive power, and AC voltages of the power system. The steady-state operation of the power system is normally analyzed. For the planning of the future expansion of the power system and determining the operation of the existing system, the load flow or power flow studies are very important. The hand solution to commercial power systems is usually too complex (Tang, 2017, December). Short circuit faults analysis, stability studies, unit commitment, economic dispatch, and load flow or power flow studies are performed easily on a computer as compared to hand solution.

The main objective of load flow is to obtain complete information on the voltage angle and magnitude of each bus in a power system (Gana et al, 2017). The flow of real and reactive power on each branch and output of the generator in the form of reactive power can be determined analytically if once this information is known.

The identifying known and unknown variables of the system at the beginning of the power flow problem solution. The identifying variables are dependent on the type of bus. The load bus is not connected with any generator. If the bus is connected with anyone generator is called a Generator bus.

### Results and Discussion

A case study was conducted at the 132 kV grid station at Bahawalpur. Two transformers are used for analysis. Two zones which are Zone A Transformer, Zone B Transformer, all of which have the same 20 MW rating. Short-circuit analysis requires the determination of a steady-state problem solution of any linear network. This analysis supplies the electrical system with current and voltage during the fault condition. This information showed to evaluate the ability of circuit breakers to establish the necessary barrier and to build an effective guardrail system. To have sufficient information, various defects are developed at various locations and the study is many times repeated. Throughout short-circuit analysis, indomitable parameters, such as loading and lime load identification, are typically ignored.

Transport network generator device and Fault By correctly integrating the representations.

Short circuit calculations are needed for the proper use of equipment in compliance with the NEC and ANSI standards. Detail needed to process these calculations can greatly be depending on the size of the utility and the link. Connecting ribbon and cable also face short circuits with restrictions, and an in-depth analysis will investigate equipment, switches, and circuit breakers without interruption.

Short circuit studies are done applying the IEEE power system software. For large systems, these short circuit calculations include both the speed change rating and the relay setting. Knowledge of calculation methods for the analysis of electrical systems is compulsory for engineers responsible for

the design, planning, troubleshooting, and operation of distribution systems.

A short circuit study is an electrical system method that defines the severity of the currents that flow during a power failure. The comparison of these calculated values with the classification of the equipment makes it possible to guarantee the safety of the electrical system. There are two main lines and each mainline consists of four sub-lines. The total number of transformers in every four sub-lines includes the two transformers of 500 KVA, seven transformers of 400 KVA, five transformers of 200 KVA, and two transformers of 100 KVA. The Power factor varies from 0.85 to 0.95. Actual rating of transformer zone A and zone B shown in table 1 and table 2.

Table 4.1: Actual Rating of Transformer and Route Length of Zone A

Name of transformer	Ratings (KVA)	Route length (KM)	voltage at receiving end (kV)	load Power Factor
Chak No 12 BC 1	400	2.1	0.323	90
Chak No 12 BC 2	400	3.2	0.325	87
Chak No 12 BC 3	100	4.5	0.311	85
Chak No 12 BC 4	500	6.2	0.302	80
Chak No 12 BC 5	400	7.5	0.32	88
Chak No 11 BC 1	200	8.75	0.315	86
Chak No 11 BC 2	100	10.2	0.31	85
Chak No 11 BC 3	500	12.5	0.31	88
Chak No 11 BC4	200	13.7	0.309	87
Basti Borana 1	200	12	0.302	88
Basti Borana 2	200	10	0.305	88
Basti Haji Sharif	400	18	0.3	88
Basti Haji Nawaz	400	1.8	0.321	89
Basti Farida Bad	200	5.6	0.297	90
Basti Malik Jahanwar	400	5	0.317	92
Chak No 29 BC 1	400	6.7	0.321	86
Chak No 29 BC 2	100	7.8	0.312	85
Chak No 29 BC 3	400	8.2	0.312	84
Chak No 29 BC 4	100	10	0.312	82
Basti Faiza bad 1	500	11	0.312	87
Basti Faiza bad 2	400	12.6	0.312	88
Basti Mochi	200	13.9	0.312	89
Basti Rashida	200	9	0.312	86
Pull baguchi	500	11	0.312	90
Chak 8BC 1	200	8	0.312	92

Chak 8BC 2	400	1.3	0.312	95
Pathano vala chak 1	200	1.8	0.312	84
Pathano vala chak 2	400	2.54	0.347	87
Pathano vala chak 3	400	5.5	0.32	88
Basti chachran 29 bc	200	6.2	0.34	85
Basti sheikh Majeed 1	400	7.67	0.321	82
Basti sheikh Majeed 2	400	8.81	0.323	90
Basti sheikh Majeed 3	400	9.9	0.321	94
Basti sheikh Musa 1	400	11	0.318	89
Basti sheikh Musa 2	100	12	0.283	91
Basti sheikh Musa 3	500	13.8	0.299	86
Basti sheikh Musa 4	400	18	0.33	87
Basti Zahor Ahmed	200	1.9	0.342	82
Basti Bahg vali	100	2.4	0.342	88
Dera Rashid hayat	500	3	0.342	81
Basti Ahmed Nawaz	200	3.9	0.342	88
Basti qaziayan	200	4.24	0.342	89
Basti akbar ali	200	5.35	0.342	88
Basti dad potra	400	7	0.342	88
Basti mahran	400	8.54	0.342	88
Basti kotana	200	11	0.342	87
Basti sanjar	400	13	0.342	79
BHU 29 bc	400	4	0.342	86
Dera Haji iqbal	400	15.2	0.342	85
Basti basher arin	400	3	0.342	84
Basti Ahmed deen	100	1.8	0.342	87
Dera dr sheer Ali	500	2.7	0.34	93
Basti Chachran	400	3.95	0.324	92
Dera sultan	200	4.6	0.324	89
Chak no 28 bc 1	100	6	0.307	83
Chak no 28 bc 2	500	7.45	0.316	88
Chak no 28 bc 3	200	9.25	0.313	85
Chak no 28 bc 4	200	11	0.31	81
Chak no 25 bc east 1	200	12.3	0.308	88
Chak no 25 bc east 2	400	13	0.298	87
Chak no 25 bc east 3	400	14.23	0.337	83
Chak no 25 bc east 4	200	18	.319	89
Chak no 25 bc west 1	400	3.6	0.33	83
Chak no 25 bc west 2	400	2.1	0.338	86

Table 4.2: Zone B Actual Raring of Transformer and Load Power Factor

Name of transformer	Ratings (KVA)	Route length (KM)	Voltage at receiving end (kV)	Load Power Factor
Hot vala	200	4	0.334	79
Hot vala	100	4.5	0.316	87

Hot vala	500	5.31	0.322	86
Hot vala	200	6.3	0.322	84
Hot vala	200	9	0.313	85
Hot vala	200	11.2	0.311	87
BHU Agha pur	400	13.4	0.315	79
Basti agha pur	400	15	0.305	86
Rahima bad basti	200	17	0.312	85
Basti haji Allah devya	400	5	0.312	84
Sandman town	400	8	0.312	87
Sandman town	400	6.2	0.312	93
Sandman town	400	7.67	0.312	92
Sandman town	200	6	0.312	89
Sandman town	100	9.9	0.312	83
Kumbhari vala	400	11	0.312	88
Darzi vala	400	12	0.312	85
Captain vala	400	13.8	0.312	81
Agra chok	400	18	0.312	88
Agra basti	500	1.9	0.342	87
Basti Ridan	400	2.4	0.342	83
Basti Ridan	200	3	0.342	89
Basti Ridan	400	3.9	0.342	83
Basti Ridan	400	4.24	0.342	86
Basti Ridan	400	5.35	0.342	79
Basti Ridan	400	7	0.342	90
Maloqsaha basti	200	8.54	0.342	87
Maloqsaha basti	500	11	0.342	85
Maloqsaha basti	400	12	0.342	80
Maloqsaha basti	200	10	0.342	88
Waseem bad east	100	18	0.342	86
Waseem bad east	500	1.8	0.342	85
Waseem bad east	200	5.6	0.342	88
Waseem bad east	100	5	0.317	87
Waseem bad east	200	6.7	0.321	88
Waseem bad east	400	7.8	0.312	88
Waseembad west	200	8.2	0.312	88
Waseem badwest	400	10	0.312	89
Waseembad west	400	11	0.312	90
Waseembad west	100	12.6	0.312	92
Jabar colony	400	13.9	0.312	86
Jabar colony	100	15.32	0.312	87
Jabar colony	500	7	0.312	88
Jabar colony	400	3	0.312	89
Jabar colony	200	3.9	0.312	86
Hasmi Garden	200	4.24	0.312	90
Hasmi Garden	500	5.35	0.347	92
Hasmi Garden	200	7	0.32	95

Hasmi Garden	400	8.54	0.34	84
Hasmi Garden	400	11	0.321	87
Khybane Ali housing scheme	200	12	0.323	88
Khybane Ali housing scheme	400	10	0.321	85
Khybane Ali housing scheme	400	18	0.318	82
Khybane Ali housing scheme	400	1.8	0.317	83
Khybane Ali housing scheme	100	5.6	0.321	88
Khybane Ali housing scheme	500	5	0.312	85
Kachi basti	400	6.7	0.312	81
Kachi basti	200	7.8	0.312	88
Kachi basti	100	8.2	0.312	87
Punjab college	500	10	0.312	83
Punjab college	200	11	0.312	89
Alnoor Garden	200	6.7	0.312	83
Rhemat house	200	7.8	0.312	86
Basti Allah yar	400	8.2	0.312	79

To analyze the load flow of two transformers, the implementation of the grid is done on ETAP software. ETAP is good and reliable software for the implementation of load flow. The following assumptions are made for the implementation of the existing system on ETAP software.

Name of parameters	Assumptions for parameter
Type of system	Three phase Ac system
Distribution line type	Over headline conductors
Type of load	Constant load
Standard frequency	50 HZ
Standard voltage	380 V(L-L)
Type of conductors	Aluminum conductor steel reinforce (ASCR)
Voltage limits	Critical over voltage>105%; critical under voltage<95%; marginal over voltage>102%; marginal under voltage<97
Bus1	Reference bus or slack bus

**ETAP simulation of 132 KV grid station new cantt road Bahawalpur**

In this simulation first of all collect all data from 132KV grid station cantt Bahawalpur and then simulate on ETAP computer-based software. For the simulation of this grid, station use in 132KV grid station, two transformers rating of each transformer is 20 MVA, use the two cables in one

transformer and each cable unit is metric, frequency is 50, type of cable is AL. In the existing system, some cables and transformers are overloaded. But when the change these cables through metric unit cable then this issue is solved. Simulation Diagram of 132kv grid station is shown in figure 4.1.

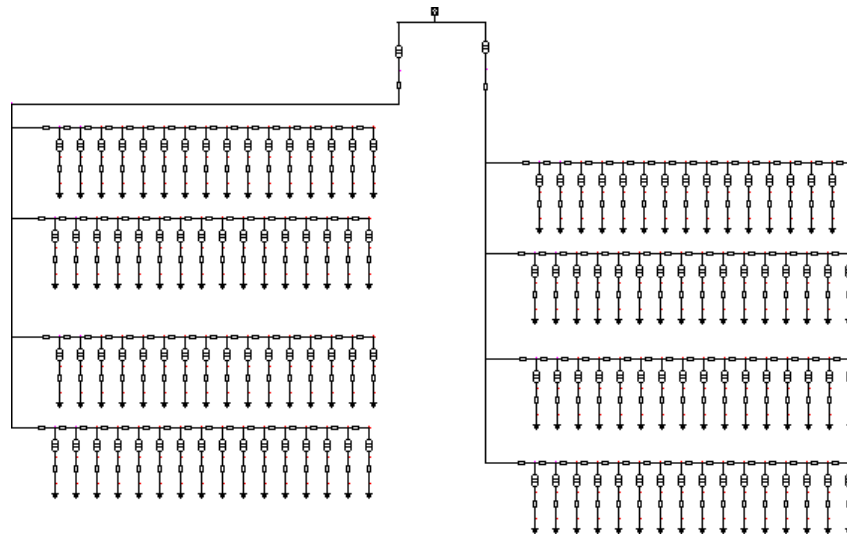


Figure 4-1: Simulation of 132 Kv Grid Station New Cantt Bahawalpur

**Zone A Transformer Power Factor**

The power factor profile is varying in the range of 0.80-0.95. Separate Transformer has different power due to inductive or resistive loads. Resistance has a linear characteristic. When loads are inductive like motor or capacitive power system

has different behavior. The inductor lags the current. Capacitor leads current. The overall system has different behavior on different loads. This design system voltage has different power factors due to different loads behavior as shown in figure 4.2.

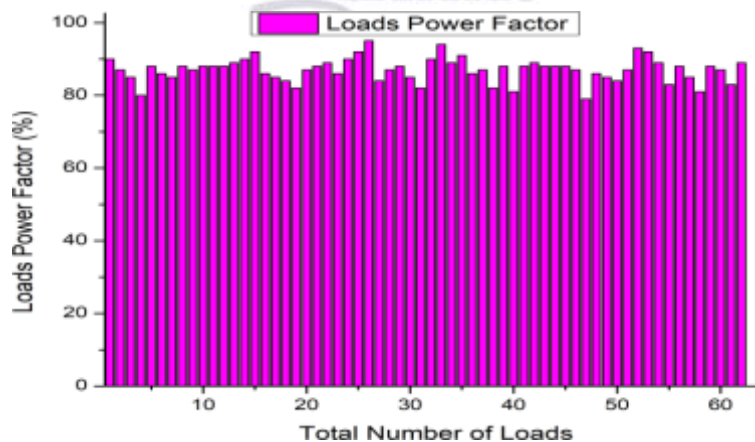


Figure 4-2: Zone A Transformer Load Factor

**Zone A Transformers Losses**

The analysis of the desired system with the help of the graphical representation narrates the Transformer losses that change from 7 kW to 10 kW. Each transformer has different transformer losses; it depends on the loads type like inductive or

capacitive, such as transformer condition and user loads behavior. There are two feeders. Each feeder is 20 MW. Each feeder consists of four lines. In feeder A each line consists of two transformers of 500 kVA, seven transformers are of 400 kVA, five transformers

are of 200 kVA and two transformers are of 100 KVA as shown in figure 4.3

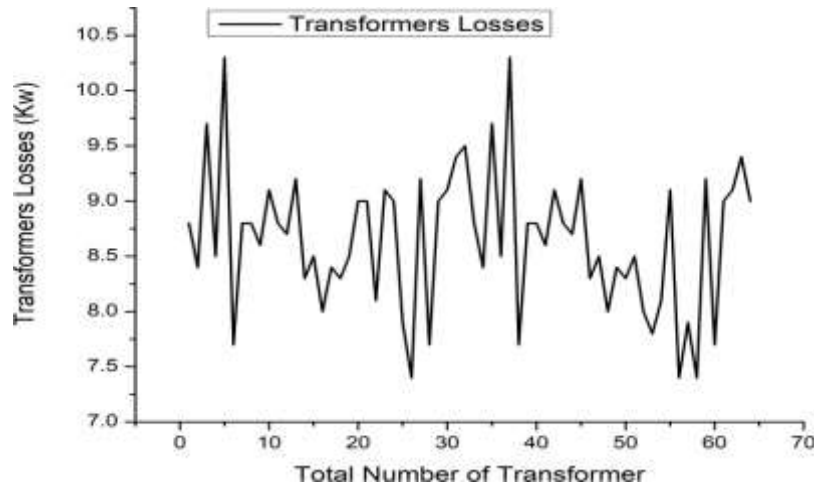


Figure 4-3: Zone A Transformer Losses

**Zone A Lines Losses**

The distribution line's losses vary from 15kw to 19Kw. These losses are due to overloads of a transformer, distribution lines, and low loads of

power factors. In the radial system, each distribution line's losses are shown in the figure as shown in figure 4.4.

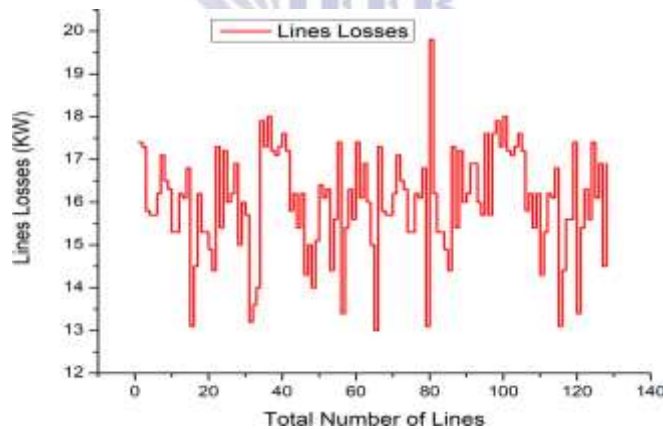


Figure 4-4: Zone A Line Losses

**Zone A Loads Voltages**

64 transformers are linked to 64 loads, and their voltage profile is associated separately with it. Loads are at different distances and have different voltage profile. The voltage profile varies from loads to loads. More distance and loads behavior

are two important parameters. Long-distance loads have more losses and low voltage profile. Overall, the load voltage varies in a range of 340 V to 365 V of all the zones from one to four as shown in figure 4.5.

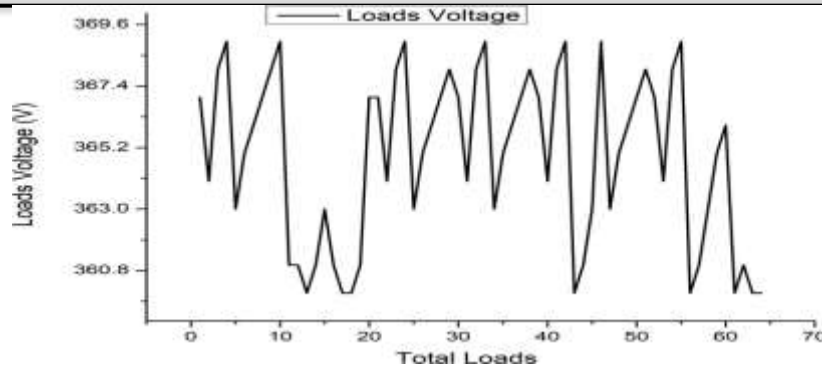


Figure 4-5: Zone A Load Voltages

**Zone A Transformers Rating and Distance**

The transformer rating and distance graph are shown in the figure. This graph predicts how each transformer distance and its rating. Transformers

have a maximum distance of 19.8 km and the maximum rating is 500KVA as shown in figure 4.6.

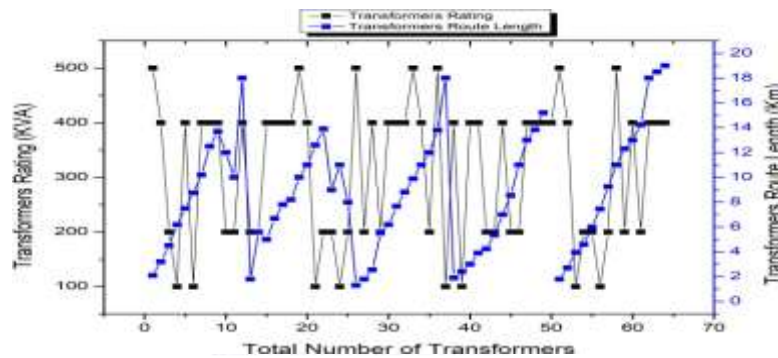


Figure 4-6: Zone A Transformer Rating and Distance

**Zone B Transformer Power Factor**

The power factor profile is varying in the range of 0.83 to 0.95 in all the B zones. The power factor percentages are used for 80 % to 95% separate loads. Resistance has a linear characteristic. When loads are inductive like motor or capacitive power

system has different behavior. The inductor lags the current. Capacitor leads current. The overall system has different behavior on different loads. This design system voltage has different power factors due to different loads behavior as shown in figure 4.7.

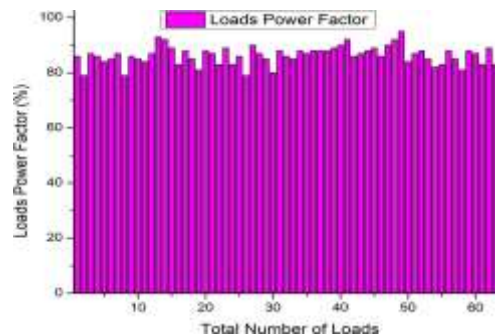


Figure 4-7: Zone B Transformer Load Factor

**Zone B Transformers Losses**

The analysis of the desired system with the help of the graphical representation narrates the Transformer losses that change from 0.1 kW to 1.2 kW. Each transformer has different transformer losses, it depends on the loads type like inductive or capacitive, such as transformer condition and

user loads behavior. There are two zones. Each zone is 20 MW. In the feeder B, each line consists of six transformers are of 200 KVA, four transformers are 400 KVA, two transformers are 100 KVA and four transformers are 400 KVA as shown in figure 4.8.

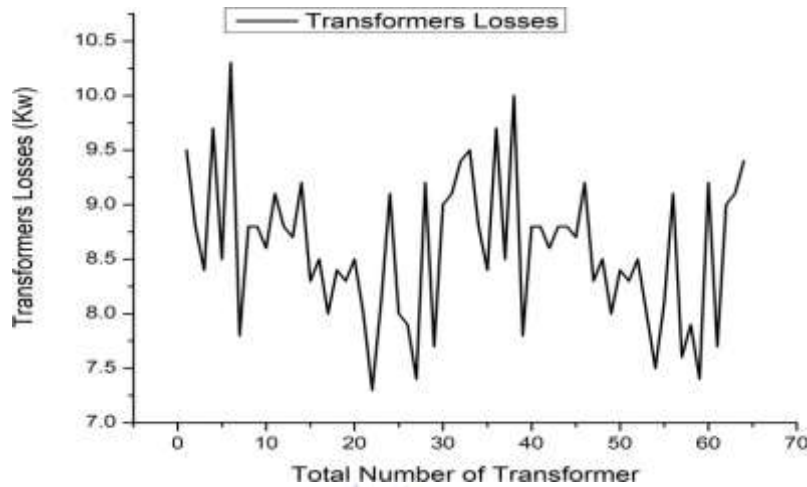


Figure 4-8: Zone B Transformer Losses

**Zone B Lines Losses**

The distribution line's losses vary from 12kw to 19.5Kw. These losses are due to overloads of the

transformer, distribution lines, and low loads of power factors. In the radial system, each distribution line's losses are shown in figure 4.9.

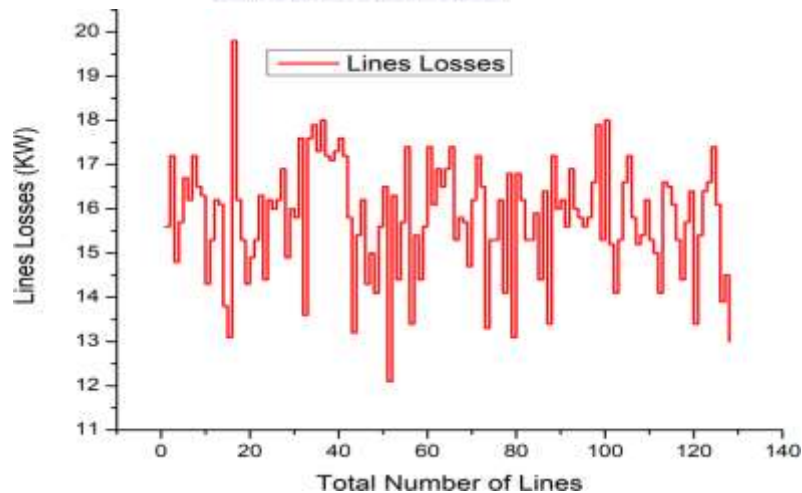


Figure 4-9: Zone B Line Losses

**Zone B Loads Voltages**

64 transformers are linked to 64 loads, and their voltage profile is associated separately with it. Loads are at different distances and have different voltage profile. The voltage profile varies from loads to loads. More distance and loads behavior

are two important parameters. Long-distance loads have more losses and low voltage profile. Overall, the load voltage varies in a range of 340 V to 365 V of all the zones from one to four as shown in figure 4.10.

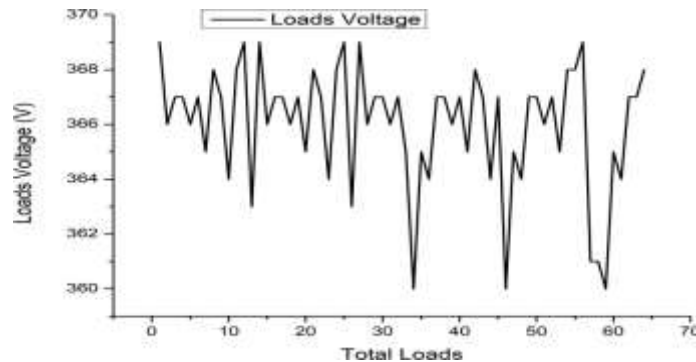


Figure 4-10: Zone B Load Voltages

**Zone B Transformers Rating and Distance**

The transformer rating and distance graph are shown in the figure. This graph predicts how each transformer distance and its rating. Transformers

have a maximum distance of 19km and a maximum rating is 500KVA as shown in figure 4.11.

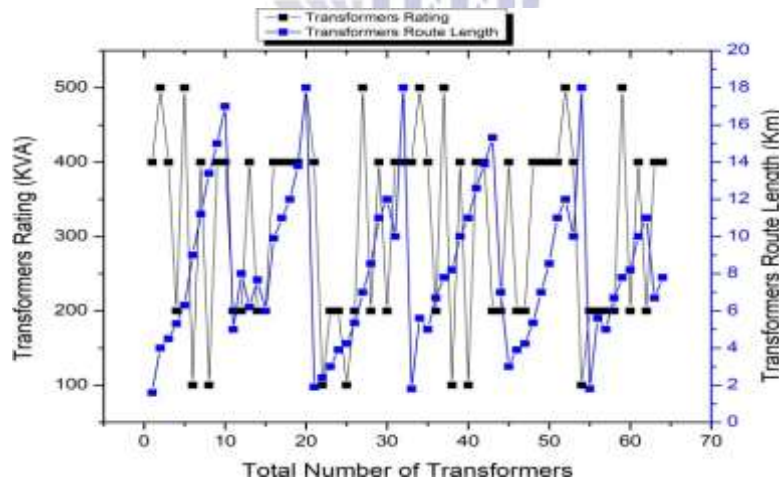


Figure 4-11: Zone B Transformer Rating and Distance

**Graphically Representation of 132kv Bahawalpur grid station load variations from 2013 to 2021**

This graph shows previous power consumed by the different loads. This graph is from 2013 to 2020 as shown in figure. Power vary year to year because

increase of population which directly effects the load consumption. In every year load profile is different which caused the load shedding in power system. A new transformer is installed in 2021 which provide the 20MW.

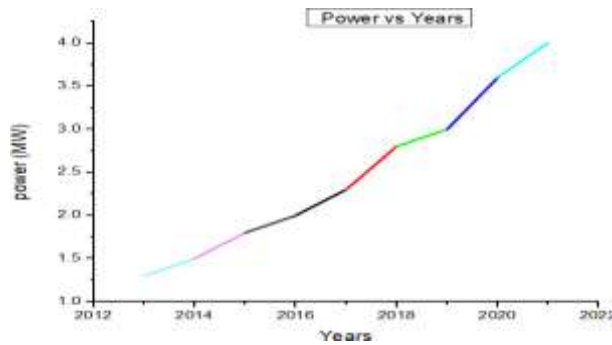


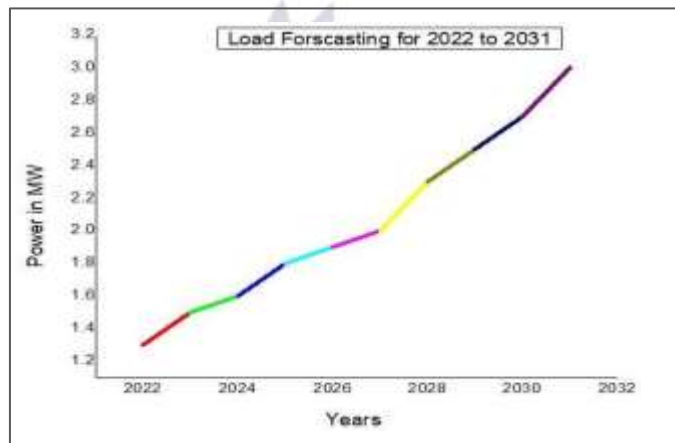
Figure 4-12: Power consumed in 2013 to 2021

**Graphically Representation of 132kv grid station cant Bahawalpur load forecasting for 2022 to 2031**

This graph shows 132kv Bahawalpur Cantt grid station load forecasting 2021 to 2031. This data is

taken from pervious load profile, which shows how to population is increasing year to year? Expected power increase in 2022 is 1.3 MW, in 2023 1.5MW and so on show in figure 5.2.

Figure 4-13: Load forecasting 2022 to 2031



When the short circuit occur at bus 96 the values of fault current of 3-phase, line to ground, double line, and double line to ground fault shown in table 4.3.

Table 4.3: Faults Current When Short Circuit Fault Occurs At Bus 96

Fault current	3-phase	LG	LL	LLG
Initial symmetrical current (KA, rms)	1.841	1.329	1.595	1.855
Peak current (KA)	2.789	2.014	2.416	2.811
Breaking current (KA, rms, symmetrical)	0	1.329	1.595	1.855
Steady state current (KA, rms)	1.841	1.329	1.595	1.855

When the short circuit occur at bus 1100 the values of fault current of 3-phase, line to ground, double line, and double line to ground fault shown in table 4.4.

**Table 4.4: Faults Current When Short Circuit Fault Occurs At Bus 1100**

Fault current	3-phase	L-G	LL	LLG
Initial symmetrical current (KA, rms)	1.540	1.055	1.334	1.516
Peak current (KA)	2.284	1.565	1.978	2.249
Breaking current (KA, rms, symmetrical)	0	1.055	1.334	1.516
Steady state current (KA, rms)	1.540	1.055	1.334	1.516

When the short circuit occur at bus 890 the values of fault current of 3-phase, line to ground, double line, and double line to ground fault shown in table 4.5.

**Table 4.5: Faults Current When Short Circuit Fault Occurs at Bus 890**

Fault current	3-phase	L-G	LL	LLG
Initial symmetrical current (KA, rms)	1.536	1.052	1.33	1.512
Peak current (KA)	2.278	1.56	1.973	2.242
Breaking current (KA, rms, symmetrical)	0	1.052	1.33	1.512
Steady state current (KA, rms)	1.536	1.052	1.33	1.512

When the short circuit occur at bus 933 the values of fault current of 3-phase, line to ground, double line, and double line to ground fault shown in table 4.6.

**Table 4.6: Faults Current When Short Circuit Fault Occurs At Bus 933**

Fault current	3-phase	L-G	LL	LLG
Initial symmetrical current (KA, rms)	0.707	0.437	0.612	0.661
Peak current (KA)	1.023	0.632	0.866	0.956
Breaking current (KA, rms, symmetrical)	0	0.437	0.612	0.661
Steady state current (KA, rms)	0.707	0.437	0.612	0.661

When the short circuit occur at bus 1195 the values of fault current of 3-phase, line to ground, double line, and double line to ground fault shown in table 4.7.

**Table 4.7: Faults Current When Short Circuit Fault Occurs At Bus 1195**

Fault current	3-phase	L-G	LL	LLG
Initial symmetrical current (KA, rms)	0.758	0.471	0.656	0.711
Peak current (KA)	1.097	0.682	0.95	1.028
Breaking current (KA, rms, symmetrical)	0	0.471	0.656	0.711

Steady state current (KA, rms)	0.758	0.471	0.656	0.711
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When the short circuit occur at bus 1235 the values of fault current of 3-phase, line to ground, double line, and double line to ground fault shown in table 4.8.

**Table 4.8: Fault Current When Short Circuit Fault Occurs at Bus 1235**

Fault current	3-phase	L-G	LL	LLG
Initial symmetrical current (KA, rms)	1.360	0.907	1.178	1.322
Peak current (KA)	1.999	1.333	1.731	1.944
Breaking current (KA, rms, symmetrical)	0	0.907	1.178	1.322
Steady state current (KA, rms)	1.360	0.907	1.178	1.322

When the short circuit occur at bus 1280 the values of fault current of 3-phase, line to ground, double line, and double line to ground fault shown in table 4.9.

**Table 4.9: Fault Current When Short Circuit Fault Occurs at Bus 1280**

Fault current	3-phase	3-phase from previous paper	L-G	L-G from previous paper	LL	LL from previous paper	LLG	LLG from previous paper
Initial symmetrical current (KA, rms)	1.841	1.83	1.329	1.313	1.595	1.58	1.855	1.86
Peak current (KA)	2.789	2.80	2.014	2.81	2.416	2.40	2.811	2.80
Breaking current (KA, rms, symmetrical)	0	0	1.329	1.33	1.595	1.58	1.855	2.86
Fault current	3-phase	L-G		LL		LLG		
Initial symmetrical current (KA, rms)	0.261	0.156		0.226		0.239		
Peak current (KA)	0.377	0.225		0.326		0.344		
Breaking current (KA, rms, symmetrical)	0	0.156		0.226		0.239		
Steady state current (KA, rms)	0.261	0.156		0.226		0.239		

When the short circuit occur at bus 1338 the values of fault current of 3-phase, line to ground, double line, and double line to ground fault shown in table 4.10.

Table 4.10: Fault Current When Short Circuit Fault Occurs at Bus 1338

Fault current	3-phase	L-G	LL	LLG
Initial symmetrical current (KA, rms)	0.934	0.591	0.809	0.884
Peak current (KA)	1.356	0.857	1.174	1.284
Breaking current (KA, rms, symmetrical)	0	0.591	0.809	0.884
Steady state current (KA, rms)	0.934	0.591	0.809	0.884

A comparison between previous paper and 132kv grid Bahawalpur

Fault current	3-phase	3-phase from previous paper	L-G	L-G from previous paper	LL	LL from previous paper	LLG	LLG from previous paper
Initial symmetrical current (KA, rms)	1.540	1.534	1.055	1.054	1.334	1.34	1.516	1.517
Peak current (KA)	2.284	2.29	1.565	1.560	1.978	1.98	2.249	2.249
Breaking current (KA, rms, symmetrical)	0	0	1.055	1.056	1.334	1.33	1.516	1.52
Steady state current (KA, rms)	1.540	1.547	1.055	1.055	1.334	1.33	1.516	1.52

Fault current	3-phase	3-phase from previous paper	L-G	L-G from previous paper	LL	LL from previous paper	LLG	LLG from previous paper
Initial symmetrical current (KA, rms)	1.841	1.83	1.329	1.313	1.595	1.58	1.855	1.86
Peak current (KA)	2.789	2.80	2.014	2.81	2.416	2.40	2.811	2.80
Breaking current (KA, rms, symmetrical)	0	0	1.329	1.33	1.595	1.58	1.855	2.86
Steady state current (KA, rms)	1.841	1.83	1.329	1.30	1.595	1.58	1.855	1.86

A comparison showed that all values such as three phases, line to ground, line to line, Double line to ground has almost same results as predicted in this thesis. This research showed fault values are changing with respect to distance and different points. Every point has different values. All observation made in this report already highlighted in previous sections.

Summary

In this chapter draw the table of actual rating of transformer and also draw the graph of loads power factor, transformer losses, line losses, load voltages, transformer rating and distance of both

zone A and zone B. In the zone A rating of transformer is varying 100 KVA to 500 KVA, power factor varying 0.8 to 0.95, losses of transformer varying 7KW to 10KW, line losses of zone A is vary 15KW to 19 KW, load voltages of zone A is varying 340V to 365V and the total distance of zone A is 19.8km. In the zone B rating of transformer is varying 200 KVA to 500 KVA, power factor varying 0.88 to 0.93, losses of transformer varying 8KW to 9KW, line losses of zone A is vary 12KW to 18 KW, load voltages of zone A is varying 345V to 380V and the total distance of zone A is 18km. Draw the table of single line to ground fault current, double line

fault current and double line to ground fault current.

## Discussion

There are two main transformers for analyses each has a rating of 20MVA. There are 128 distribution transformers that have a rating from 100KVA to 500KVA. There are eight places where short-circuit mostly occurred. All protective devices and different equipment are abnormal during short conditions. All bus results observed and grid station behavior highlighted results show a single line to ground faults is more dangerous than other faults. Load flow study plays a vital role in steady state solution of power system network. The number of existing generation unit and transmission lines requires the review of traditional method and creation of new concepts. Electrical power system is back bone of the development of a nation. Due to the short circuit currents may deteriorate equipment and if the protection against the short circuit is improperly it can kill maintenance personnel. Low voltage can cause a serious problem in specific machines. The regulations of transmission lines capture electrical and mechanical strength. In case of weather conditions like wind fallen, temperature and pressure the transmission line should be able to compensate the load. If the voltage is low then the machines run excessively hot the electricity is a very important asset in everybody when the shortfall occurs in the power system then everybody's life feels discomfort. For the precise and reliable results of the load flow and short circuit of 132kv substation, Cantt Bahawalpur can perform on the Electrical Transient Analyzer Program (ETAP). ETAP can give complete tools of electrical design programming consists of link capacity, transfer coordination transient steadiness, and much more. In the field of electrical engineering recently powerful computer- based software is an originated cause of elevated research.

## Conclusion

Contingency in the power system occurs on daily basis. In Pakistan, losses and interruption are common because of a shortage of power. Many systems are overloaded and have not reliable

performance. Due to this consumer side baldly affected. In this article, a case study had taken form 132kv grid Bahawalpur. Detailed analysis performed using the Electrical transient analysis program (ETAP) which is a basic tool for analyzing electrical system behavior. Load flow performed and short circuit analysis done and efficient result obtained. A load flow study plays a vital role in the steady-state solution of the power system network. Load flow study gives information about the magnitude, phase angles of load buses, reactive power of generator buses, the flow of real power, and reactive power on transmission lines. The electrical apparatus of the power system should be the capacity of bearing the heating, thermal and mechanical stresses introduced by this fault current. In the electric power system short circuit analysis provides the necessary protection against the overcurrent flow, human personnel protection, limit the excessive current, improve the duration of interruption during equipment failures, and short circuit.

During load flow analysis there are 5.382 Active losses and 4.980 Reactive losses. These losses and overloaded transformer and distribution lines are observed. Afterload flow, a detailed analysis of the short circuit performed. Short circuit of a single line to ground, doubles line to ground, and line to line attempted. There are eight points in a simulation where faults occurred, these points are bus96, bus1100, bus890, bus933, bus1195, bus1235, bus1280, and bus1338. A three types of fault observed that are LLL LG and LLG. Short circuit major reasons are moisture, trees and sudden variation in loads. Each bus faults current and other parameters carefully examined and required results obtained. Future research on this grid station can be implemented like a hybrid energy system like solar, biomass can be injected. These energy sources are reliable and have not more environmental issues.

## Future Recommendations

In Pakistan agriculture waste and biomass sources are available. These sources are available throughout the year. In summer and winter session different crops are available. In winter sessions cotton waste and sugarcane are available in the

large amount. But in summer session wheat straw is a major source of energy (Cirnu and Badralexi, 2014). These sources every year burns for making bricks and for domestic burning purposes. This area is also rich for agricultural and biomass waste. Agricultural waste can be used for thermal power plants. Biomass can be used for biogas power plants. Animals dung can be used for power generation or it can also be used for making biogas for industrial and commercial purposes. In this area, there are many mini biogas power plants for domestic purposes. On a daily basis, dung can be used for the generation of power. It will reduce the power demand of consumers. The modern age is moving towards electric vehicles. If power is available in excess amount then the Charging point for electric vehicles can be connected to this system (Gongada et al, 2016, March). A short circuit analysis of this system can be performed. The smart metering system can be connected to the new system. Electricity consumption detail will be available at the end of each month or when need report for analysis. Peak hour electricity can be measured and extra charges plenty during peak hours can be enforced on the customers.

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