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Review paper on Fault analysis and its Limiting Techniques.

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ABSTRACT

The main aim of the power system is just provide the continuity of power supply to the consumers and that should be present in the power system anyhow. In this study, a comprehensive review on selection and role of the fault current limiting techniques. An important factor in selection of FCL scheme is the degree of reliability of supply expected during faults with minimum damage to equipment life and properties. The aspects which influence this decision are operational flexibility, system safety, reliability and cost. The role of FCL in the system is to limit the fault current without interrupting the continuity of the power supply.

KEYWORDS:- **Fault current limiter (FCL), substation layout, conventional methods.**

I. INTRODUCTION

Power system is not static but changes during operation (switching on or off of generators and transmission lines) and during planning (addition of generators &transmission lines). Thus fault studies need to be routinely performed by utility engineers. The problem of the Fault current in the Power system increases day by day. Faults usually occur in a power system due to the insulation failure, flashover (Lightning strokes), physical damage and human error. Due to that power system affected and many problems occurs like unstable power system, discontinuity in power supply, Blackout, etc. Hence, it becomes one of the most serious problem in the power system.

For limiting this fault current we studied various conventional methods and devices for it and try to reduce it as possible.

The need for FCLs is driven by rising system fault current levels as energy demand increases and more distributed generation and clean energy sources, such as wind and solar, are added to an already overburdened system. So, we have to limit this abnormal current to save our power system from damage. FCLs are a new type of power equipment that protect power system equipment from excessive large mechanical, magnetic and thermal stresses that can occur. When an electrical fault creates a low impedance path across other power system. Equipment or to ground. The new functionality provided by FCL's is even more critical as capacity increases to serve larger loads. This situation inherently adds to both system-wide and local fault current magnitudes. Due to that power systems ride through periodic faults to provide necessary capacity and functionality during periods of peak demand.

To understand the requirement of limiting the fault current, let us consider a system and do the Fault analysis on that system. Consider that maximum fault current while choosing the Fault current limiting techniques. Generally LLL& LLLG faults are most severe occurs in the power system. so we will consider the value of that fault current while designing of bus bar system and selecting switchgear equipment or limiting techniques.

II. OVERVIEW OF FAULT CURRENT LIMITING TECHNIQUES

A fault current occurs due to the varies causes such as lightning stroke, downed power lines, or crossed power lines cause faults. During a fault, abnormal current flows through the system often resulting in a failure of one section of that system. There are different techniques to limit this fault current and some attributes which are to be taken into consideration while selecting the proper fault current limiting techniques. List of different current limiting techniques are as given below:-

1) Multiple circuit up-gradation
2) Bus splitting
3) Construction of New lines/sub station
4) High impedance transformer
5) Series reactor
6) FCL

The list of attributes that sho55uld be taken into account while selecting the fault limiting techniques.

- Time
- Cost

- Reliability
- losses
- System stability
- Space
- Maintenance
- Flexibility
- Downtime

III. DESCRIPTION

1) Equipment Up-gradation

When a fault duty problem occurs, usually more than one breaker will be affected. Upgrade of these breakers has the disadvantage of not reducing available fault currents and their associated hazards, as well as the often prohibitive expense of replacing the switchgear within a substation.

2) Bus splitting

This entails separation of sources that could possibly feed a fault by the opening of normally closed bus ties, or the splitting of existing busses. This effectively reduces the number of sources that can feed a fault, but also reduces the number of sources that supply load current during normal or contingency operating conditions. This may require additional changes in the Operational philosophy and control methodology.

3) Construction of new lines/sub stations

Fault current over-duty coupled along with other factors may result in a utility selecting this solution, which will correct immediate problems, as well as providing for future growth. However, this is the most expensive of all the conventional solutions. Usually we can't prefer this type of solution due to higher cost.

Fig.1:- Constructing the New Substation.

4) High impedance transformer

Using high impedance transformers may result in the considerable reduction of fault current level. However the undesired effects on transient stability and voltage stability might be significant.

5) Series reactor

Series reactor or current limiting reactor (CLR) is a well-known fault current limiting technique. Compared with many other methods, it is more economical but it required a large space. In addition its effect on the reliability of substation is negligible.

Current limiting reactors limit fault current due to the voltage drop across the terminals, which increase during the fault. However, this reactor also has a voltage drop under normal loading conditions and presents a constant source of losses. They can interact with other system components and cause instability.

Fig.2:- Current Limiting Reactor (CLR)

6) Fault current limiters(FCL)

FCLs are a new type of power equipment that protect power system equipment from excessive large mechanical, magnetic and thermal stresses that can occur. When an electrical fault creates a low impedance path across other power system equipment or to ground. The new functionality provided by FCL's is even more critical as capacity increases to serve larger loads. This situation inherently adds to both system-wide and local fault current magnitudes. Due to that power systems ride through periodic faults to provide necessary capacity and functionality during periods of peak demand.

Types of FCLs

1) Super conducting fault current limiter

Superconducting fault current limiters exploit the extremely rapid loss of superconductivity above a critical combination of temperature, current density, and magnetic field. In normal operation, current flows through the superconductor without resistance and negligible impedance.

Fig.3:-Super conducting fault current limiter (SCFCL)

If a fault develops, the superconductor quenches, its resistance rises sharply, and current is diverted to a parallel circuit with the desired higher impedance.

Advantages

- ✓ Mostly used at transmission side.
- ✓ 66 kV to 230 kV transmission voltage levels
- ✓ Up to 50 % or higher fault current reduction

SFCLs are described as being in one of two major categories :

- Resistive type
- Inductive type

Generally, we used Resistive Type FCL in the practical system due to its more advantages.

1) Resistive type FCL

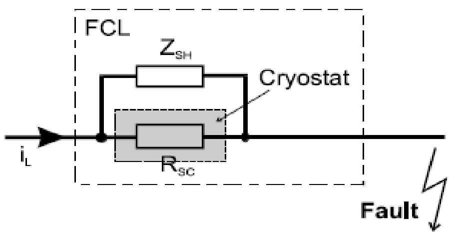

Fig.4:- circuit of Resistive type FCL

The resistive type FCL contains the superconducting material. The quench process in resistive SFCLs results in heat that must be carried away from the superconducting element by the cryogenic cooling system. When a fault occurs, the current increases and causes the superconductor is used to quench there by increasing the resistance exponentially. The current level is determined by the operating temperature, amount and type of superconductor. The rapid increase in resistance produces a voltage across the superconductor and results in the current to transfer to the combination of inductor & Resistor. This combination limits the voltage increase during a quench.

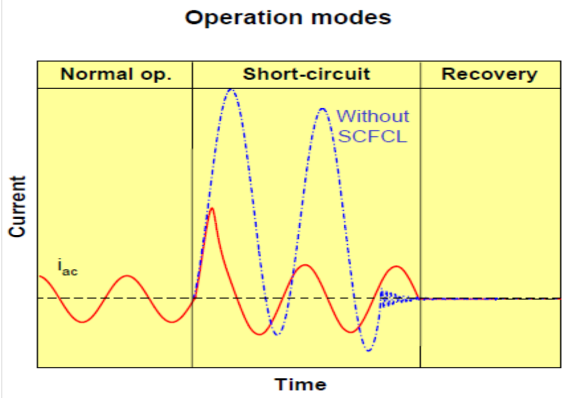

Chart 1:- Characteristic of Resistive type FCL.

2) Solid state Fault Current Limiter (SSFCL)

Solid State Fault Current Limiter (SSFCL) is proposed here consisting of power semiconductor devices consisting of desirable features such as high blocking voltage, low onstage voltage, low conduction loss and thermal management. Power semiconductor devices such as the GTO, IGBT, SCR, and IGCT are the most promising devices used in SSFCL.

Generally SSFCL consists of thyristor controlled reactor and series capacitor where the former reduces the short circuit current and the latter increases the transmitted power.

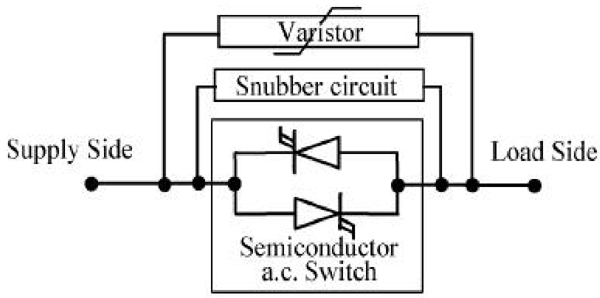

Fig.5:- Circuit arrangement of SSFCL

This consists of both series and parallel resonant circuits that are being tuned to supply frequency. Under normal condition, very low impedance is provided through series resonant circuit and under fault conditions, SSFCL provides high impedance by parallel resonant circuit.
As compared to the limiters described above, SSFCL forms the vital device in R&D.

Advantages

- ✓ Mostly used at Distributed side.
- ✓ Superconducting Fault Current Limiter
- ✓ Up to 45 kV distribution voltage levels

✓ Up to 50 % or higher fault current reduction

IV. EVALUATION OF THE SYSTEM USING ETAP SOFTWARE

For the simulation of fault analysis we are using ETAP software. For that, we have taken a real time system and simulate it. The Single line diagram of that system is as given below:

Fig.6:- Single diagram of the system.

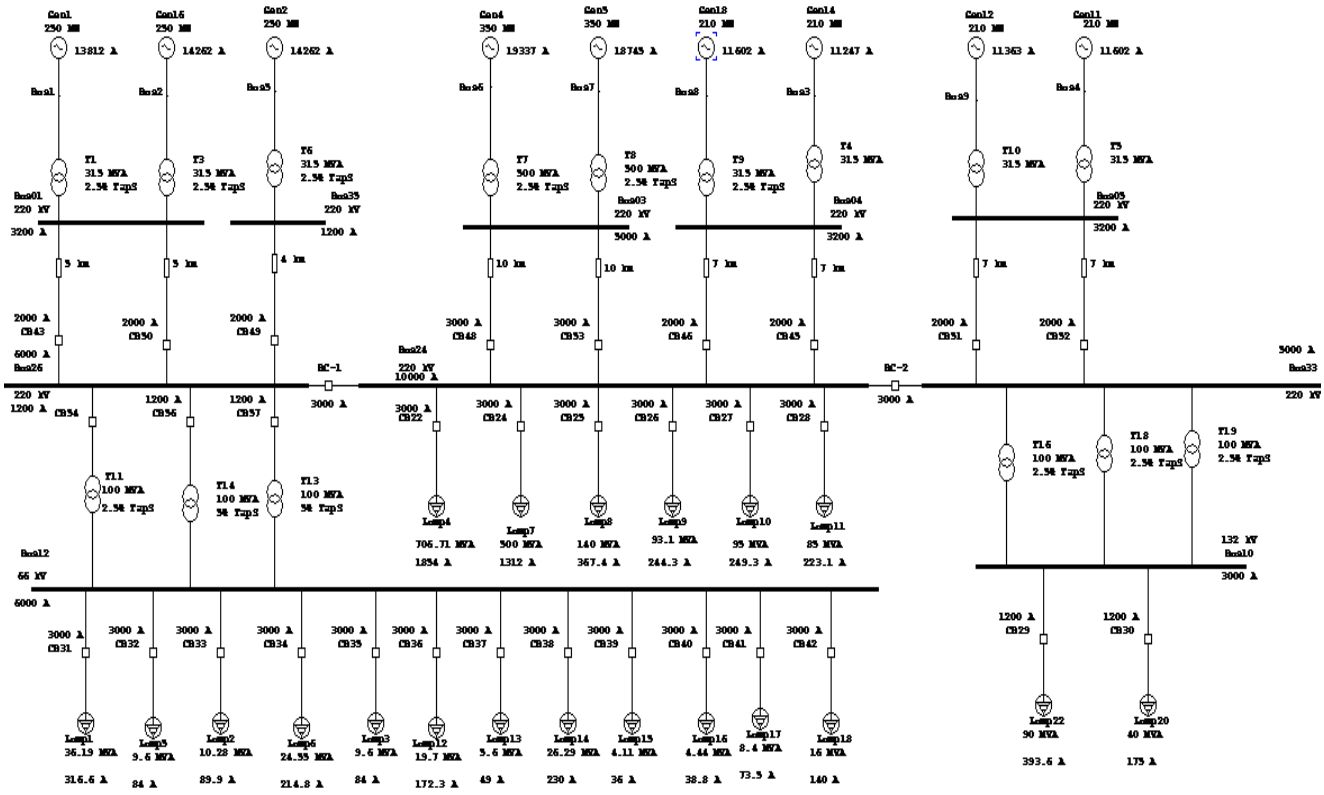

Fig.7:- Load Flow of the system

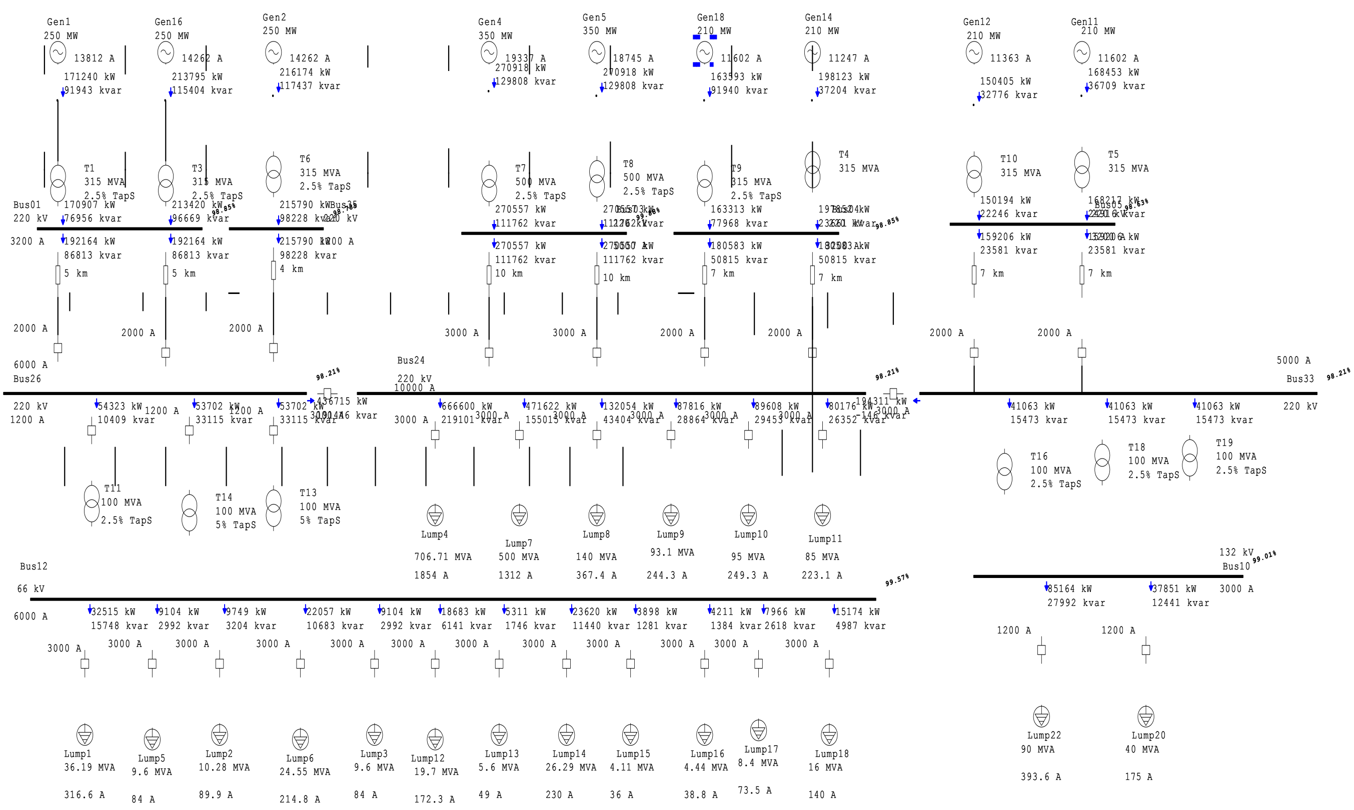

Table 1:- Generation data

ID	MW	MVar
Gen 1	171.240	91.943
Gen 16	213.795	115.404
Gen 2	216.174	117.437
Gen 4	270.918	129.808
Gen 5	270.918	129.808
Gen 18	163.593	91.940
Gen 14	198.123	37.240
Gen 12	150.405	32.776
Gen 11	168.453	36.709
Total generation	1823.619	783.065

Table 2:- Load data

LOAD ID	KV	MVA	Total load
Lump1	66	36.19	174.76
Lump5	66	9.6	
Lump2	66	10.28	
Lump6	66	24.55	
Lump3	66	9.6	
Lump12	66	19.7	
Lump13	66	5.6	
Lump14	66	26.29	
Lump15	66	4.11	
Lump16	66	4.44	
Lump17	66	8.4	
Lump18	66	16	
Lump20	132	40	130
Lump22	132	90	
Lump4	220	706.71	1619.81
Lump7	220	500	
Lump8	220	140	
Lump9	220	93.1	
Lump10	220	95	
Lump11	220	85	

Table 3:- Bus Rating with loading capacity

ID	KV	Amp	% loading
Bus01	220	1119.7	35
Bus03	220	1538.3	30.8
Bus04	220	996.1	31.1
Bus05	220	856.4	26.8
Bus10	132	572	19.1
Bus12	66	1529.3	25.5
Bus24	220	4297.9	43
Bus26	220	1752.3	29.2
Bus33	220	857.5	17.1
Bus35	220	629.9	52.5

- ✓ Here, we perform the short circuit analysis to determine the fault current.
- ✓ We created the fault at BUS24 and we get the **maximum fault current that is 46.68 KA.**

- ✓ If we applied bus splitting method then we can reduce the fault current up to 5-15% but in this method continuity of power supply is reduced.
- ✓ If we connect the current limiting reactor it can reduce the fault current up to 15-20% but it can reduce power transfer capability.

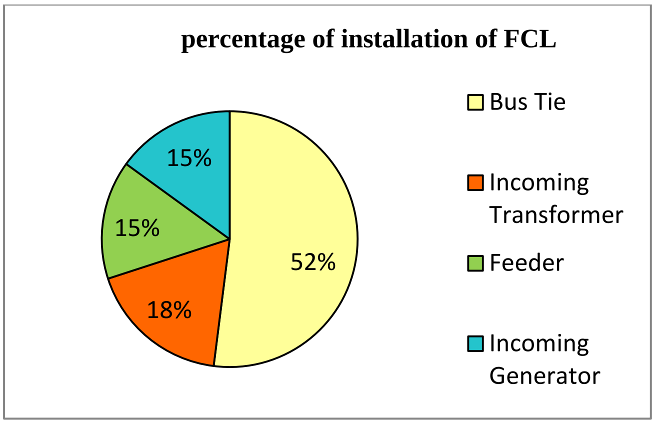

Chart 2:- Percentage Location of FCL

- ✓ If we connect the FCL in the system then it can reduce the fault current as well as it improves the power transfer capability with uninterruptible power supply.

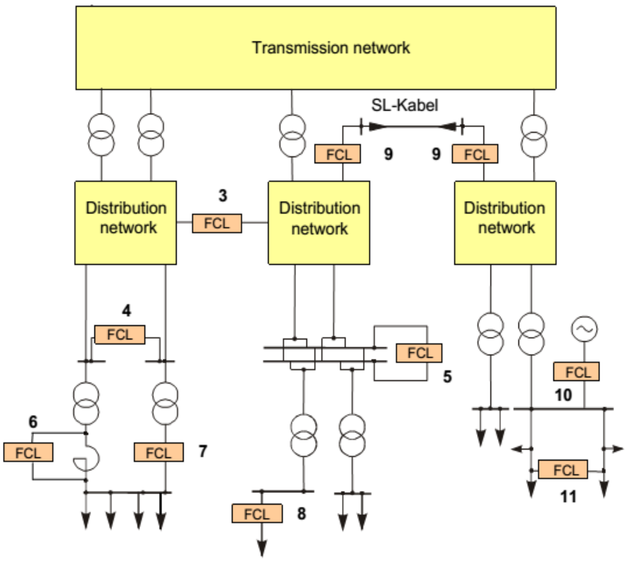

Fig.8:- Different Location of FCL

V. CONCLUSION

We can figuring out that around 15 - 20% of 46.68 KA fault current can be reduced by putting reactor in between 24 and 26 bus of 220KV. In this paper an attempt is made to review of the Fault current limiting techniques and its role in power system networks. In major cases, the location of FCL installation is at bus tie because it gives reliable operation of the system and optimizes fault current to the minimum level.

VI. REFERENCES

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