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Effect of Unbalance Current in Phases of 220kV Extra High Voltage Transmission Line of Adani Electricity Mumbai Power System

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***Abstract*—Effect of unbalance current in one of the 220kV Extra High Voltage lines on AEML Power System is discussed in this paper. This 220kV EHV Line is a Tie line connecting one of the EHV Station of AEML & Maharashtra State Electricity Transmission Company Ltd in Mumbai Region. Due to this unbalance current in 220kV Transmission line AEML faced Tripping of one of the important Tie lines on overcurrent protection. Hence Data was collected from both the utilities & study was performed so as to mitigate unbalance current issue.**

***Keywords*— asymmetry, current unbalance, sequence currents, three phase load flow, magnetic field.MSETCL**

INTRODUCTION

Adani Electricity is now India's no. 1 utility company according to Ministry of Power's 11th Annual Integrated Rating and Ranking for Power Distribution Utilities, a report prepared by McKinsey & Company.
At Adani Electricity, we are dedicated to empowering individuals to live a sustainable lifestyle and make a positive impact every day. We aim to contribute to building a cleaner and greener environment with Green Tariffs while creating sustainable value and empowering India through #GrowthWithGoodness, in line with Adani Group's philosophy.
We also believe in providing customer-centric services through our innovative and advanced solutions. Our technology-driven value-added services, such as Smart Meters and Adani Electricity mobile app, have made it easier for customers to manage their accounts and access information about their energy usage digitally.
Established as a fully owned subsidiary of Adani Transmission Ltd, we are Mumbai's leading power distribution utility company. With a distribution network spanning over 400 sq. km, from Bandra to Bhayander on the western side and Sion to Mankhurd on the eastern side of Mumbai, we provide reliable power to over three million households.

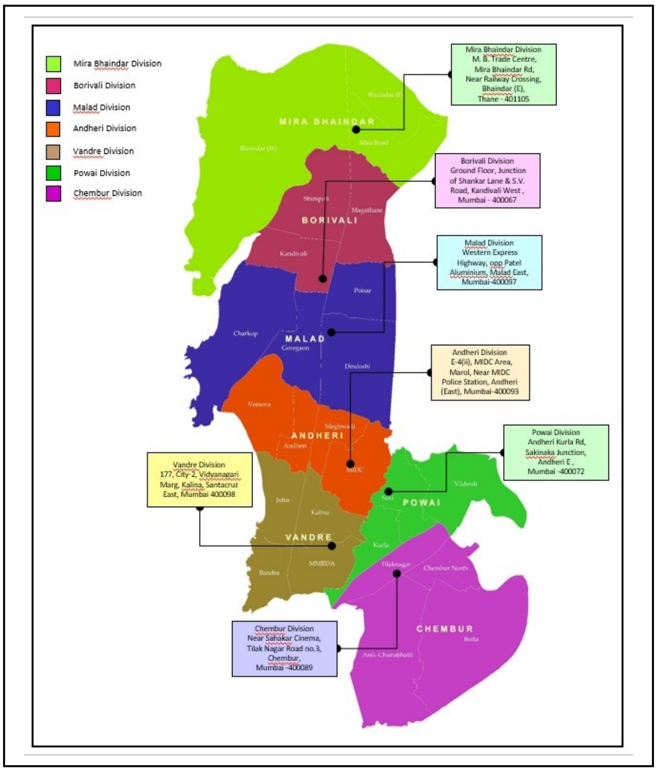

FIG I-ADANI SUPPLY AREA

The area of license to supply the Electricity is measured about 400 sq.km. Presently the maximum demand of AEML Transmission system is around 2161MW.
To meet the increasing demand of power Mumbai area, AEML has erected and commissioned 2 numbers of 250 MW Thermal Generating units at Dahanu, 120 km north of Mumbai in the year 1995.
There are 08 Nos of 220kV Transmission EHV Stations mentioned below.

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1) 220/33kV Aarey EHV Station.
2) 220/33kV Versova EHV Station.
3) 220/33kV Ghodbunder EHV Station.
4) 220/33kV Saki EHV station.
5) 220/33kV Goregaon EHV station.
6) 220/33kV Gorai EHV station.
7) 220/33kV Borivali EHV station.
8) 220/33kV Chembur EHV station.

Connectivity between AEML Transmission network & MSETCL network is achieved by one 220kV Transmission line from 220kV Boisar receiving station of MSETCL to 220kV Versova receiving station, Also MSCTCL Borivali & MSCTCL Boisar stations is connected to Ghodbunder EHV Station by one Transmission line each, Borivali station is connected to MSCTCL Borivali by two lines, Gorai station is connected to MSCTCL Borivali by two lines and Chembur station is connected to MSCTCL Trombay by two lines. AEML Transmission network is also connected to TPC Transmission network by four Transmission lines, one between 220kV Aarey receiving station & 220kV Borivali receiving station, one between Borivali & Tata Borivali receiving stations and two between Saki & TPC Saki Stations. Also, AEML Transmission network is connected to TPC Transmission network by two Transmission cables between 220kV Chembur and 220kV Trombay. 220kV SLD is shown below.

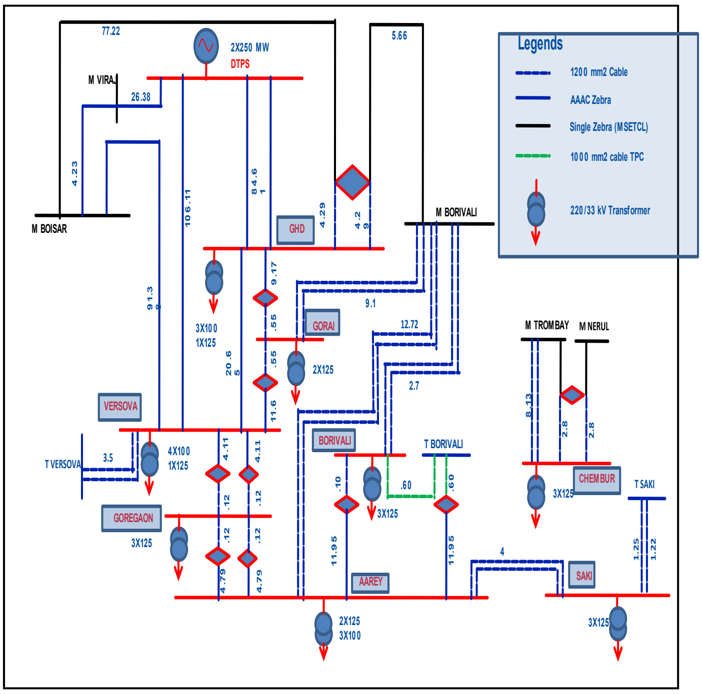

FIG II -220kV SLD

AEML's 220kV Ghodbunder EHV Station is interconnected to following lines.

1. 220kV Versova EHV Station,
2. 220kV Dahanu EHV Station (Generator),
3. 220kV MSETCL Boisar EHV Station,
4. 220kV MSETCL Borivali EHV Station &
5. 220kV Gorai EHV Station.

Normally at 220kV Ghodbunder EHV Station power is imported from Dahanu, MSETCL Boisar & Power is exported to MSETCL Borivali, Versova & Gorai.

We observed current unbalance on R, Y, B Phases of 220kV Ghodbunder-MSETCL Boisar line. Yph was carrying more current as compared to the other two phases.

During peak load conditions due to unbalance effect the Yph was crossing thermal overload limit of 800A & 220kV Ghodbunder-MSETCL Boisar line used to Trip on overcurrent protection.

A. Line parameters.

TABLE-I

Line configuration as below.

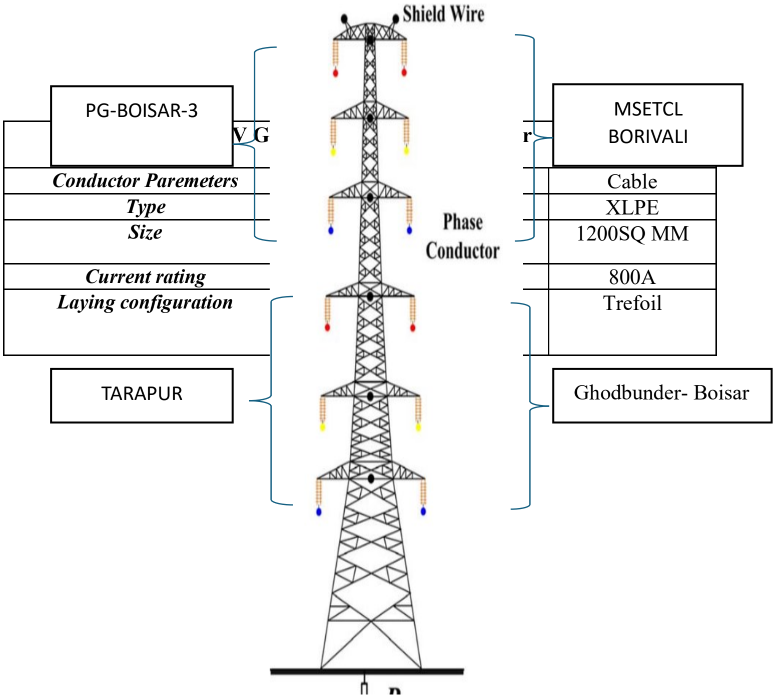

FIG III -Line configuration

Following are the 220kV Ghodbunder-MSETCL Boisar line parameters.

TABLE-II

A	Name of Line	220kV Ghodbunder-MSETCL Boisar	
1	*Type of Conductor*	Overhead	Cable
2	*Line Length (km)*	77.22	4.1
	Line Parameters (Ohms/Per KM/Per Phase/per circuit/ Primary Value)		
1	*R1*	0.02957	0.0203
2	*X1*	0.3072	0.132
3	*Ro*	0.3066	0.059
4	*Xo*	1.0849	0.079

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B. Details of Current unbalance.

1. Current Unbalance during Normal conditions

When the System is in normal condition & all Transmission line elements are in service, the phase current unbalance observed was less. Means when the system is in normal condition the loading on the 220kV lines connecting to MSETCL Boisar is less than 80% of the thermal loading. Hence the Yph was not crossing the thermal overload of 800A.

2. Current Unbalance during System Contingency

From the below table its observed that During Tripping of Dahanu Thermal Power station Unit-2(250MW)

TABLE-III

Sr. No.	Date	Type of System Contingency	Ir (A)	Iy (A)	Ib (A)	Effect on AEML Power System
1	19 April 2023	Dahanu Thermal Power station Unit-2 is Tripped & AEML Peak- 2042 MW @15:15 Hrs	614	722	638	Overloading of Line
2	12 June 2023	At MSETCL Borivali-Tarapur line was under	660	802	720	220kV Ghodbunder-MSETCL Boisar Line Tripped on

Source lines at MSETCL Borivali we observed increased loading on 220kV Ghodbunder-MSETCL Boisar Line.

C.Probable causes of Current imbalance

With the development of grid structure and expansion of load capacity, more and more new plants and substations have been connected to the breaks of long transmission lines, which results in the emerging of short transmission lines. They have also been used as outlets of generators and connecting line between distribution network transformers and different loads. Compared to long power lines, short ones have smaller impedance and distributed capacitance. In terms of the current imbalance, electromagnetic coupling in short lines is relatively smaller than long lines. They are also more easily affected by loads' operation since that short lines are usually.

connected directly to different loads. Consequently, there could be more factors that contribute to the current imbalance in addition to electromagnetic coupling.

electromagnet coupling had less effect on short power lines, so there must be more other factors related to the current imbalance, some of which we consider as constants while vary in the actual grid.

Four possible factors will be discussed in the following part including bundle spacing, phase arrangements, unbalanced load and modes of operation.

1) Bundle Spacing

phase current changes with the adjustments of bundle spacing. And the increasing difference in the bundle spacing between the conductors leads to larger unbalanced current. In some extreme cases previously mentioned, if two conductors adhered to each other than the bundle spacing would drop to a small value, which resulted in an even bigger current imbalance.

2) Phase Arrangements

For untranposed line, conductors' positions are usually asymmetric which result in asymmetry of the mutual inductance. Actually, mutual inductance is an expression of the electromagnetic coupling be- tween conductors and circuits. Since that different phase sequences result in different mutual inductance which leads to asymmetry of parameters.

Phase arrangements were usually divided into three categories including the same sequence for two circuits, the reverse sequence for two circuits and other phase sequence. There is total 21 kinds of phase arrangements, the detail of which was represented in table IV.

1	**2**	**3**	**4**	**5**	**6**	**7**
ABC	ABC	ABC	ABC	ABC	ABC	ABC
cba	acb	cab	bca	bac	cba	abc
8	**9**	**10**	**11**	**12**	**13**	**14**
BAC	BAC	BAC	BAC	BAC	ABC	CBA
cba	cab	acb	bca	bac	abc	acb
15	**16**	**17**	**18**	**19**	**20**	**21**
CBA	CBA	CBA	ACB	ACB	CBA	CAB
cab	bca	cba	cab	bca	acb	cab

The same sequence brings small imbalance. BAC-bca and ACB-cab included in other phase sequence also constrain the imbalance well. But the reverse sequence ABC-cba has the lowest unbalanced current among all 21 ways. Theoretically speaking, it's because this sequence arrangement reduced each other's electromagnetic coupling. And the current imbalance becomes lower consequently. Above all, the arrangements of phase sequence have a huge influence on the current imbalance. So, a good choice of it could reduce the unbalance factor noticeably.

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3) Unbalanced Load

Degree of load imbalance increases the current imbalance becomes more serious simultaneously. So, the load imbalance should be taken into consideration to reduce the unbalance factor because it also affects the current imbalance.

4) Mode of Operation

Operation Mode is a comprehensive concept which is composited by several aspects, including the neutral connections, transformer operations and generator operations, etc. Adjustments of operation mode may lead to changes in power flows and imbalance could probably suffer from it. This paper mainly discusses one kind of operation mode, namely changes in grid structure. All the mentioned lines were shown in Fig.III.

Here are four mod- es of operation and table VIII lists the resultant data:

1.Single-circuit I and Single-circuit II are both under normal operation.

2.Single-circuit line I is disconnected, and Single-circuit line II is under normal operation.

3.Single-circuit line I is disconnected, and Single-circuit line II is under normal operation.

4. Both are disconnected.

D. Conclusion

According to the simulation results and analysis above, the actual grid is not as ideal as the simulation grid, and the unbalanced current in the studied double-circuit line is influenced by all these four factors, including bundle spacing, phase arrangements, unbalanced load and operation mode. So, we offered some corresponding suggestions to eliminate the unbalanced current.

1.Check the bundled conductors' installation of the studied multi-circuit line and reduce the error of bundle spacing. Making sure that the bundle spacing's const- ruction error within the range of +8cm--5cm, and spacers should also be considered to be built for power lines without it. As line in question is a Twin conductor line so this solution could not be considered.

2. Choose the reverse phase sequence of ABC-cba for the studied double-circuit line since that this sequence arrangement reduced each other's electromagnetic coupling effect dramatically. And the current imbalance becomes lower consequently. This phase sequence is also recommended for new transmission lines.

3. Periodic inspections are needed for the three-phase load to ensure that the load imbalance is within the permitted range. If not, restrict the load imbalance as lower as possible.

4. Operation modes also have an influence on the current imbalance. But changes of grid structure are too costly to achieve in actual grid. As a result, the suggestion is when new transmission lines are planned to be constructed, we need to fully consider the impact of this factor.

5. Line may be proposed for HTLS so that unbalanced loading will be catered by High Ampacity conductors & this high value of current may not overload the line. Avoiding the Tripping of line.

REFERENCES.

[1] Jiangyuan Zhou, Dahai You, Shuilin Lu “Analysis of Unbalanced Current in a 220kV Short double-circuit Line “Huazhong University of Science and Technology Wuhan, China 430074.

[2] A. Kalyuzhny, Member, IEEE, and G. Kushnir “Analysis of Current Unbalance in Transmission Systems with Short Lines”
DOI: 10.1109/TPWRD.2006.883011 · Source: IEEE Xplore