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SIL LEVEL ENHANCEMENT OF EHV AC DOUBLE CIRCUIT CONSIDERING CORONA LOSS

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Abstract: The purpose of transmission network is to transfer electrical energy from generating stations at various locations to the distribution system which ultimately supplies the load. Due to increase in demand for power we moved towards EHVAC transmission lines. The amount of power that a given EHV AC transmission line can transmit safely depends on various limits. These limits can be categorised into two types viz. Thermal and stability/SIL limits. In case of long EHV AC lines the efficiency of transmission is below its thermal limit and restricted by angular and voltage stability limits which restricts line load ability up to its SIL level. For long transmission lines the capacity is limited by its SIL level only which is much below its thermal capacity due to large inductance. Also Decrease in line inductance and surge impedance shall increase the SIL and transmission capacity. There are various factors on which SIL depends on such as spacing between conductors, bundle spacing, diameter of conductor, No. of Sub-conductors per phase, configuration of conductors as well as sub-conductors. With the help of mathematical programming model in MATLAB software and designing software in Graphical User Interface to calculate the major parameters related to SIL and corona loss the results are obtained. This report also compares various Single circuits, double circuit transmission line configurations considering various aspects regarding R.O.W. (Right of way), transmission cost, etc. This report will evaluate which configuration is best and effective for transmission of power for different circuits considering other major aspects for transmission.

I. INTRODUCTION

The According to most updated statistics the Gujarat power system is facing a load growth of approx. 8% per year. It is also known that in last 5 years the load demand has increased about 31.34% and comparative to that our Gujarat I.C. has been raised 68.8% in last 5 years. So we have enough surplus power Talking about India's power system, It facing a load growth of approx. 8.62 % per year. It is also known that in last 7 years the load demand has increased approx. 62.2% and comparative to that our India's I.C. has raised approx. 77.11% from March 2008 to Aug 2014 [1]. In India there is large demand of power in the western and southern region compared to other. Gujarat is a power surplus state. Among all other states. The most power deficit states in India are Andhra Pradesh, Tamil Nadu, Uttar Pradesh, Maharashtra, Bihar and Assam. So to transfer large amount of power from power surplus state or region to power deficit states or region requires long EHV AC transmission lines. However long EHV AC transmission lines are limited by SIL (Surge Impedance Loading) / Stability limits due to large inductance of the lines. The power transfer over an transmission lines are limited by Voltage constraints, Operating related constraints and Thermal constraints.

A. Techniques to Increase SIL level

Considering Corona Loss

The following methods are been discussed for 400kV Double circuit transmission line and there result tables and graphs showing its effect on SIL and Foul weather Corona loss is shown. The parameters used to obtain the results have been shown in the graph itself.

Bun6.2.1 Bundle Spacing (B)

dle spacing is the spacing between sub-conductors, as the B increases Bundle radius R increases and GMReq of bundled conductor increases, which leads to reduction in self inductance of the line and we can have reduction in line inductance and increase in SIL level as the B increases. However the corona loss would slightly increase with

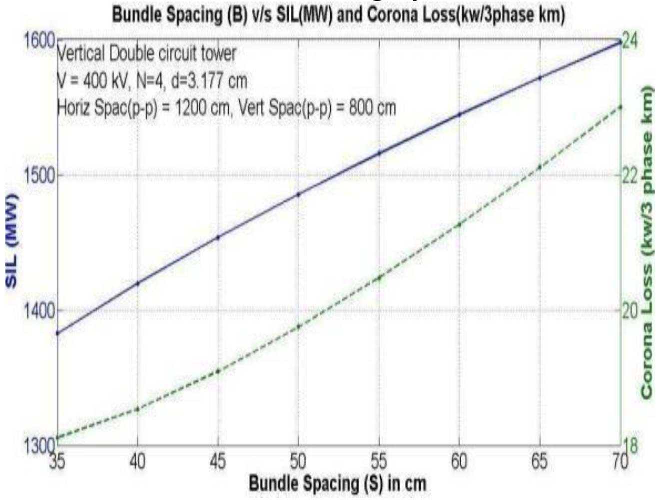

Fig. 1 Bundle Spacing (B) v/s SIL and Corona.

B. Diameter of Conductor (d)

The diameter of the conductor is the size of conductor, with the increase in diameter of conductor the GMReq of the conductor increases and self inductance of the line increase in bundle spacing but comparative to that there is large increment in SIL level is obtained. The Table 2 and Figure 3 show the effect of change in bundle spacing on SIL and corona loss.

B(cm)	L(mH/km)	C(nF/km)	SIL(MW)	Fair Weather Corona Loss P	Corona Loss (kw/3phase km)
35	0.390	29.05	1382.65	0.595	18.11
40	0.379	29.84	1419.48	0.624	18.53
45	0.37	30.56	1453.63	0.651	19.09
50	0.362	31.24	1485.0	0.678	19.74
55	0.355	31.88	1515.77	0.703	20.47
60	0.349	32.48	1544.39	0.727	21.26
65	0.343	33.06	1571.70	0.750	22.11

Table 1 Bundle Spacing (cm) v/s SIL (MW) and Corona (kw/3phase km

reduces, hence there is reduction in inductance of the line and there is increase in SIL level. There would also be more reduction in the corona loss is obtained with increase in diameter of conductor. The Table 3 and Figure 4 show the effect of change in diameter of conductor on SIL and corona loss.

d (cm)	L (mH/km)	C (nF/km)	SIL (MW)	Fair weather Corona Loss P (kw/3phase km)	Corona loss (kw/3phase km)
2	0.381	29.62	1409.2	1.74	42.664
2.5	0.376	30.06	1430.2	0.79	28.137
3	0.371	30.44	1447.9	0.64	20.823
3.5	0.367	30.76	1463.2	0.49	16.644
4	0.364	31.05	1476.8	0.33	14.036
4.5	0.361	31.31	1488.9	0.17	12.299

Table 2 Diameter of conductor (cm) v/s SIL (MW) and Corona (kw/3phase km)

N	ACSR Conductor Diameter (cm)	Weight (kg/km)	Approx. Cost of cond. (Rs./m)	SIL (MW)	Difference in MW	Fair Weather Corona Loss P (kw/3phase km)	Foul weather Corona Loss Pc (kw/3phase km)
2	Moose 3.177	2004	300	1153.9	0	1.80	105.993
4	Zebra 2.862	1621	260	1443.4	290.5	0.64	22.424

Table 3 N v/s SIL and Corona (including weight and cost of conductor)

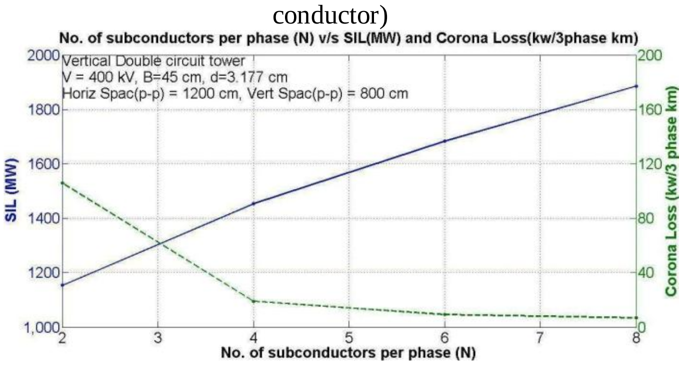

Fig. 2 No. of Sub conductors per phase (N) v/s SIL and Coronaa

C. Horizontal Spacing

The phase to phase spacing is a factor of GMD (Geometric Mean Distance), i.e. if the spacing between conductors is reduced GMD will decrease and there will be increase in mutual inductance of the line which leads to reduction in line inductance and increase in SIL level. However there is limit on the spacing between conductors due to sag of the conductors. This is due to the fact that more the sag more is the swing of the conductor and there are chances of p-p faults, but if we use V string insulators or conductor is replaced with HTLS (high temperature low sag conductors) eg. ACSS (Aluminium Conductor Steel Supported) either both the swinging of conductor is reduced and the spacing of conductors can be reduced. In table Xl indicates line reactance. The Table 1 and Figure 2 show the effect of change in spacing between the bundles on SIL.

Table 4 Horizontal Spacing (p-p) v/s SIL (MW) and Corona (kw/3phase km)

p-p spacing (m)	L (mH/km)	C (nF/km)	SIL (MW)	Fair Weather Corona Loss P (kw/3phase km)	Pc (kw/3phase km)
10	0.366	30.90	1469.80	0.676	20.276
11	0.368	30.72	1461.32	0.663	19.619
12	0.37	30.56	1453.63	0.651	19.094
13	0.372	30.41	1446.69	0.641	18.668
14	0.374	30.28	1440.43	0.631	18.319
15	0.375	30.16	1434.81	0.621	18.03

The No. of sub-conductors in a bundle increases there would be rise in the GMReq of the conductor which would reduce self inductance of the line, and reduction in inductance of the line, therefore there will be increment in SIL level. There is a large increment in SIL level is obtained and current carrying capacity also increases. Also corona loss would reduce drastically with increase in N. However increase in N the loading on existing transmission tower increases so to reduce the weight we can shift from twin ASCR moose conductor to quad ACSR zebra conductor having reduced diameter and weight, but still the overall weight on tower increases, so it is possible only when from the tower is designed to carry increases weight so that we can fulfil the requirement of future increase in power demand. The following table and Figure 5 shows the effect of change in No. of sub-conductors per phase on SIL

II. CONCLUSION

Delta and L configuration shows increased SIL level compared to horizontal configuration. The delta and L configuration offers other benefits like reduction in R.O.W. (Right of Way) requirements, possible to convert single circuit tower to double circuit tower to meet the future increase in connected load. Also the height of the tower could be reduced for Delta and Expanded Hexa tower and so it can be used where there is constraint in the height of the tower. Increase in diameter of conductor and converting twin moose tower to quad zebra or using any other conductor which has reduced diameter of conductor large increment in SIL as well as large reduction in corona loss is obtained. However the existing transmission tower could be

transformed from twin to quad if the tower is designed to carry increased weight. Increase in Bundle Spacing shows large increment in SIL level, however corona loss increases but which is much small increment and voltage gradient is within limits. mize the use of existing right-of-ways. In recent
years great public conc.

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