Evaluation Of Voltage Stability Of Transmission Line With Contingency Analysis

S.R.Paveethra, C.Kalavalli, S.Vijayalakshmi, Dr.A.Nazar Ali, D.Shyam

Abstract: The inconstancy present in the transmission line tend to have the cascading collapse and camouflage failure in the transmission power system influence the power transfer capability of the line. Hence, reckoning of transfer capability of the transmission line is the decisive and tricky task. Reckoning of the transfer capability along with the thermal limit violation, bus voltage limit violation and power flow violation should also be considered along with the (N-2) contingency conditions. In this paper, the MATLAB program was developed for IEEE 30 bus system to demonstrate the effectiveness of the proposed system.

Index Terms: Available Transfer Capability (ATC), Total Transfer Capability (TTC), System Operator (SO)

1 INTRODUCTION

Regulated power system operate as a single entity to generate, transmit, distribute and sell electricity to a region or state owing to the government guidelines and government policies. The quality of the power will be affected due to the government policies and guidelines. The customer has been forced to follow the rules and regulation with all restriction. Power is a fundamental prerequisite in the present life. With the developing populace, the utilization and hence request of power is expanding step by step. This issue can be taken care of at two fronts, at the production front and at the transmission front. Coming up to this issue from the generation/production perspective requires age of greater power, which in the present situation isn't a simple choice as large portions of the power producing advancements rely upon non-inexhaustible assets. Electric power transmission lines are regularly working near their most extreme power taking care of capabilities. This high stacking level for broadened time frames builds the likelihood for the lines to outperform their most extreme reasonable conductor temperature or to encounter voltage breakdown. Therefore, exact assurance of the transmission line control move limits is critical. Therefore, the deregulated power system aims at nullifying the monopoly in generation, transmission and distribution sectors thereby, introducing rivalries at various levels. Hence the power generation, transmission and distribution sectors would like to free from customary rules and regulations and become ambitious. Now, the restructured power system will draw the attraction of private sectors thereby improves efficiency of the transmission line, and encourages technical growth and ameliorate the satisfaction of customers at various levels.

- *S.R.Paveethra, Assistant Professor, K.Ramakrsihnan College of Technology, Trichy, India.*
- *C.Kalavalli, Assistant Professor, K.Ramakrsihnan College of Technology, Trichy, India.*
- *S..Vijayalakshmi, Assistant Professor, K.Ramakrsihnan College of Technology, Trichy, India.*
- *Dr.A.Nazar Ali, Associate professor, Rajalakshmi Engineering College, Chennai, India.*
- *D.Shyam, Assistant professor, Rajalakshmi Engineering College, Chennai, India.*

Private parties at various trading level will rival with each other to attract the customer, to win their market share and remain in business. The power system deregulation is expected to offer the benefit of lower electrical price better consumer service, improve the quality of the power and improved system efficiency in such circumstances, the power transfer information, the power transfer capability will be posted on the website Open Access Same Time Information System (OASIS) is also called ATC. ATC is the addition amount of power that can be transferred across the tie lie over the base case flow without exposing the system to any risk. ATC is also defined as Total Transfer Capability (TTC) less than the Transmission Reliability Margin (TRM) less than the sum of Existing Transmission Commitment (ETC) including Capacity Benefit Margin (CBM). Mathematically ATC can be expressed as,

$$ATC=TTC-TRM-ETC-CBM \ldots(1)$$

Total Transfer Capability (TTC) is characterized as the amount of electric power that can be moved over the interconnected transmission network in a unwavering way while meeting the entirety of a predefined set of characterized pre&post-possibility contingency conditions. Transmission Reliability Margin (TRM) is considered as the degree of transmission move capacity important to guarantee that the interconnected transmissions arrange is secure under a sensible scope of weaknesses in the contingency conditions. Capacity Benefit Margin (CBM) is considered as the amount of transmission move ability saved by load serving elements to guarantee access to age from interconnected frameworks to meet age dependability prerequisites.

2 COMPUTATION OF ATC

NERC in 1996 has framed definitions for ATC as a measure of the transfer capability remaining in the physical transmission network for further commercial activity over and above already committed uses. Without considering the TRM and CBM variation, assume both the values as zero. Consider the variation only through the TTC, and then ATC can be computed from the equation mentioned below.

$$ATC=TTC-ETC\ldots (2)$$

At present, there exist a numerous technique to compute ATC and TTC values. Among numerous types, mainly there are two approaches: they are (i) Deterministic approach and (ii) Probabilistic approach. The first approach will not produce efficient value for complex and interconnected system. The second approach can afford surplus information, nearer to the expected data and the probabilistic approach is well suited for the large interconnected system

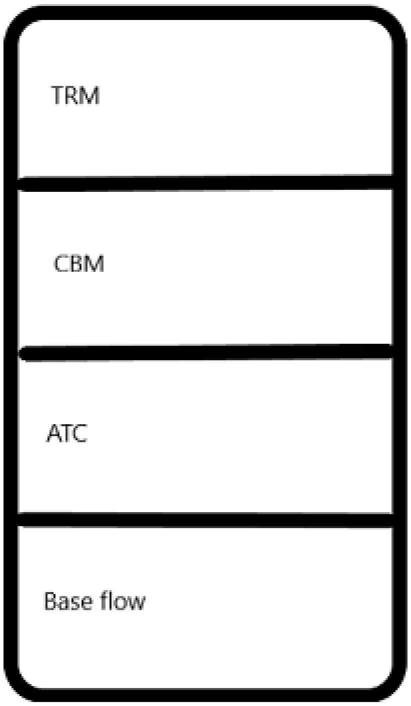

Fig 1. *Basic Definition of ATC*

3 DETERMINATION OF POWER TRANSFER CAPABILITY

In order to augment the Total Transfer Capability along with the diverse constraints and limits has to be included. The steps to calculate the TTC are given below.

1. Load flow analysis.
2. Contingency analysis.
3. Inclusion of line limitation
4. Penalty price calculation

THE AMONG VARIOUS METHODS, THREE POPULAR METHODS WERE USED TO CALCULATE TTC. THEY ARE

1. Continuation power flow method.
2. Repeated power flow method.
3. Security constrained optimal power flow method.

Both CPF and RPF enable transfers by increasing the complex load with uniform power factor at every load bus in the sink area and increasing the injected real power at generator buses in the source area in incremental steps until limits are incurred.

4 STEPS TO BE FOLLOWED

A. Load flow analysis

The power flow analysis will be done by using the fast-decoupled method load flow analysis in order to reduce the number of iteration and memory capacity. The mathematical formulation for computing the load flow analysis can be expressed as follows:

Real power for n bus:

$$P_i^k = |V_i|\sum_{i=1}^{n}|V_i|\left|Y_{ii}\cos(\theta_{ii}+\delta_i-\delta_i)\right| \ldots(3)$$

Reactive power for n bus:

$$Q_i^k = -|V_i|\sum_{i=1}^{n}|V_i|\left|Y_{ii}\sin(\theta_{ii}+\delta_i-\delta_i)\right| \ldots(4)$$

Intensifying the equations (3) and (4) in Taylor's series about the initial estimate and neglecting all higher order terms outcome the subsequent equations. In the above equation, bus 1 is assumed to be slack bus. The Jacobian matrix gives the linearized relationship between small changes in voltage angle and voltage magnitude with the small changes in real and reactive power.

The above equation can also be written as

....(5)

$$\begin{bmatrix}\Delta P\\ \Delta Q\end{bmatrix} = \begin{bmatrix}J_1 & J_2\\ J_3 & J_4\end{bmatrix}\begin{bmatrix}\Delta\delta\\ \Delta|V|\end{bmatrix}$$

The order of Jacobian matrix J_1 is (n-1) X (n-1).
The order of Jacobian matrix J_2 is (n-1) X (n-1-m).
The order of Jacobian matrix J_3 is (n-1-m) X (n-1).
The order of Jacobian matrix J_4 is (n-1-m) X (n-1-m).
Line losses can be calculated based on the below expression:

I --> j

$$I_{ii} = I_L + I_{i0} = y_{ij}(V_i - V_j) + y_{i0}V_i \ldots(6)$$

$$S_{ii} = V_i I_{ii}^* = V_i^2(Y_{ii} + Y_{i0}) - V_i y_{ii}^* V_i^* \ldots(7)$$

Power loss

$$S_{loss\ ij} = S_{ij} + S_{ji} \ldots(8)$$

B. Contingency analysis

Contingency definition includes the arrangement of potential possibilities that may happen in a power framework, it includes the way toward making the contingency list. contingency determination is a procedure of distinguishing the most serious possibilities from the contingency list that prompts limit infringement in the power flow and bus voltage magnitude, along these lines this procedure disposes of the least extreme contingency and abbreviates the seriousness of contingency. There are two variables utilized in this technique:

1. Generation shift sensitivity factor (a_{li})
2. Line outage distribution factor $(d_{l,k})$

The determination of the above factors using the DC load flow is explained below.

a. Formulate the sensitivity matrix [x] using the DC load flow equation

$$\theta = [x][P] \ldots(9)$$

b. Determine the generation shift sensitivity factor Where i corresponds to bus in which the generator is connected, l corresponds to the line under study, i.e. between the buses n and m, $x_l$is the reactance of the line, X_{ni} ,X_{mi} are the corresponding values in the sensitivity matrix.
c. Determine the line outage distribution factor

Where l corresponds to the line under study, i.e. between the buses n and m and k corresponds to the outage of the line which is connected between the buses i and j.

5 RESULTS AND DISCUSSION

Available Transfer Capability has been calculated for Various bilateral transactions for normal as well as with contingency conditions for IEEE 30 bus system. IEEE 30 bus System contains 5 generators, 41 transmission lines. From all these outcomes, we can conclude that the ATC is reduced compared to the normal operating case. It is further detected that for the case of generator outage, ATC values are not far decreased in all transactions. Alike results of ATC

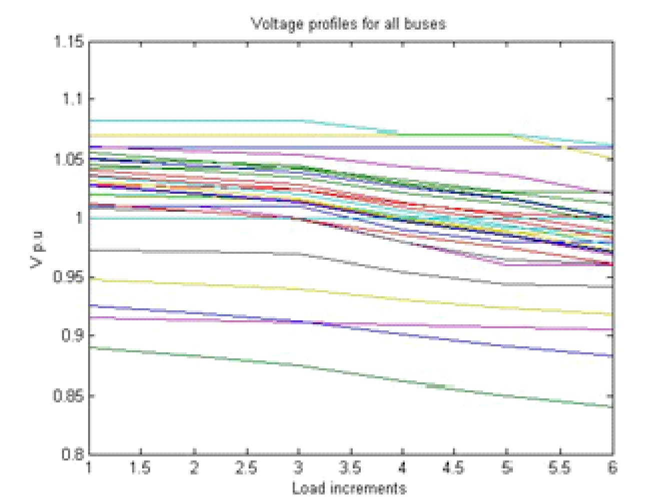

***Fig 2** voltage profile of 30 bus system*

Among the 30 bus system, the bus which has the highest slope is considered to be the weakest bus hence CPF-Predictor corrector method is used to evaluate the system voltage collapse point.

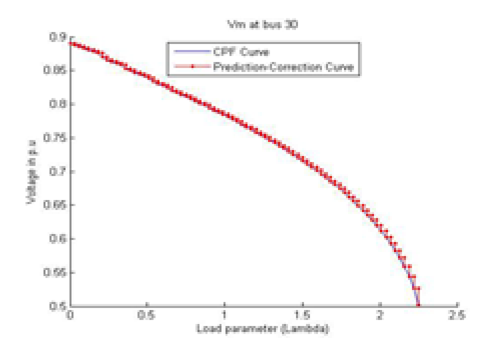

***Fig 3.** Predictor corrector curve for the weakest bus in the system*

From the above results of the Availability Transfer Capability, the transfer value of the transmission line is limited through the various transmission limitations like thermal limits (current carrying capacity), voltage stability, and line flow limits. The voltage value limit violation may lead to the overvoltage and damage the system parameters.

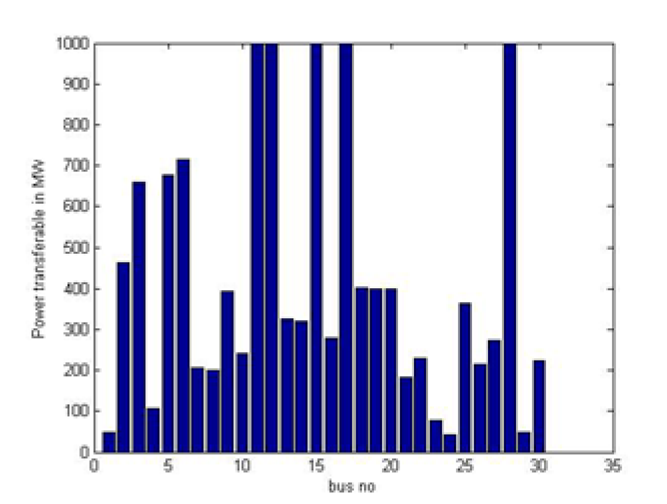

***Fig 4** Power transfer level of each bus.*

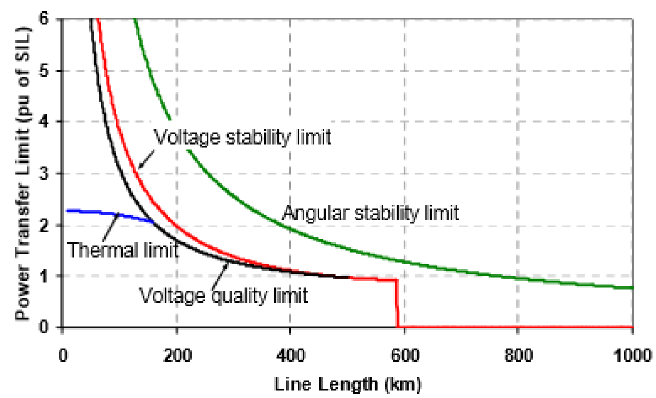

***Fig 5** Load ability curve of transmission line.*

6 CONCLUSION

ATC enrichment is the potential issue in restructured electric power market. This paper has examined traditional PTDF methods including DCPTDF, LOPTDF and GODF for ATC evaluation. This paper would help to improve the ATC results based on various bilateral transactions under normal and contingency conditions. This will aid to diminish extra transmission lines for the structural investments and growth planning issues. The main application for ATC is to provide users an index for finalizing well generation locations and for marketing transactions which will promote the economic benefits in the competitive power markets. The solutions obtained are satisfactory and linear sensitivity factors applied here is of rapid and fewer computation burdens. This system is healthier and suited for real time substation values. As a result, it has been made clear that TTC can be calculated proficiently by using the proposed method.

7 REFRENCES

[1] North American Electricity Reliability Council (NERC) "Available transfer capability- Definitions and determinations," NERCReportJune 1996.

[2] S.R.Paveethra, A.Yamuna, Gabriel

santhoshkumar,Augmented available transfer capability with facts device using ICA algorithm

[3] R.Raghavi, S.R.Paveethra, Modeling of a grid connected new energy vehicle charging station

[4] AT Sankara Subramanian, P Sabarish, A Nazar Ali.(2017)"A power factor correction based canonical switching cell converter for VSI fed BLDC motor by using voltage follower technique"IEEE International Conference on Electrical, Instrumentation and Communication Engineering (ICEICE), pp.1-8

[5] A Nazar Ali, D Sivamani, R Jaiganesh M Pradeep, (2019) "Solar powered air conditioner using BLDC motor," IOP Conference Series: Materials Science and Engineering, vol. 23.

[6] V Venkatesh, A Nazar Ali, R Jaiganesh. V indiragandhi, (2019) "Extraction and conversion of exhaust heat from automobile engine in to electrical energy Energy", IOP Conference Series: Materials Science and Engineering, vol. 23.

[7] Nazar Ali, R. Sagayaraj and R.Jaiganesh. (2018) "Analysis the performance of Embedded ZSI fed Induction motor Under semiconductor failure condition".TAGA JOURNAL VOL 14,pp. 1634-1644.

[8] An Ali Nazar, R Jayabharath, MD Udayakumar (2014) "An ANFIS Based Advanced MPPT Control of a Wind-Solar Hybrid Power Generation_System," international review of modelling and simulations. vol.7, no. 4, pp. 638–643,.

[9] A.Rajkumar and B. Karthikeyan (2014), "fuzzy logic controller for fast transient response dc-dc converter," in American-Eurasian Network for Scientific Information, vol. 8, pp. 65-72.

[10] Sabarish, P., Sankara Subramanian, A.T., Gayathri, A., Anton Amala Praveen, A. C (2019). "A Novel wearable therapeutic aid with intelligent information processing systems" IOP conference series: Materials science and engineering.

[11] Sabarish, P., et al. "Performance Analysis of PV-Based Boost Converter using PI Controller with PSO Algorithm." Journal of Science and Technology (JST) 2.10 (2017): 17-24.

[12] Subramanian, AT Sankara, P. Sabarish, and R. Jai Ganesh. (2017) "An Improved Voltage follower Canonical Switching Cell Converter with PFC for VSI Fed BLDC Motor." Journal of Science and Technology (JST), pp: 01-11.

[13] Udayakumar, M.D., Sabarish, P., Indragandhi, V., Rajkumar, A. (2019) ''An advanced control technique for a Grid-Tied Hybrid Renewable energy system with Reciprocated sinusoidal PWM methodology'' IOP conference series: Materials science and engineering.

[14] Murugesan, S., and C. Kalavalli. "FPGA Based Multilevel Inverter With Reduce Number of Switches for Photovoltaic System." International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Print ISSN (2017): 2395-1990.

[15] Kalavalli C., and K. Parkavi Kathirvelu. "R. Balasubramanian (2013)'Single Phase Bidirectional PWM Converter for Microgrid System ", International Journal of Engineering and Technology (TJET) Vol 5.3.

[16] Raguraman, L., and P. Sabarish. (2013) "Integrated Bridgeless PWM Based Power Converters." International Journal of Advanced Research in Engineering & Technology (IJARET) 4.5 pp: 17-23.

[17] A.Nazar Ali and R. Jayabharath. "Performance Enhancement of

[18] Hybrid Wind/Photo Voltaic System Using Z Source Inverter with

[19] Cuk-sepic Fused Converter." Research Journal of Applied Sciences,

[20] Engineering and Technology7.19 (2014): 3964-3970.

[21] K. Premkumar and B.V. Manikandan, "Stability and Performance Analysis of

[22] ANFIS Tuned PID Based Speed Controller for Brushless DC Motor," in CURR

[23] SIGNAL TRANSD T, vol.13, no.1, 2018, pp. 19-30.

[24] Premkumar et al. (2015), GA-PSO optimized online ANFIS based speed

[25] Control for Brushless DC motor, Journal of Intelligent & Fuzzy Systems, 28,

[26] 6, pages.2839-2850.

[27] K Premkumar et al. (2018), Novel bacterial foraging-based ANFIS for speed

[28] Control of matrix converter-fed industrial BLDC motors operated under low

[29] Speed and high torque, Neural Computing and Applications, 29, 12,

[30] Pages.1411–1434.

[31] J Jegatheesan, A Nazar Ali (2011)' Improvement of Transient Stability

[32] Performance Using Adaptive Neuro-Fuzzy for FACTS Controllers"

[33] African Journal of Scientific Research Vol 6.

[34] A Nazar Ali, R Jeyabharath, MD Udayakumar" Cascaded Multilevel

[35] Inverters for Reduce Harmonic Distortions in Solar PV Applications"

[36] Asian Journal of Research in Social Sciences and Humanities, Vol

[37] 6,pp.703-715.