A Review: Voltage Stability Indices for Determination of Voltage Instability Condition in Power System Network

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***Abstract*- Voltage stability assessment is a crucial aspect of monitoring power system stability. It involves evaluating the ability of a power system to maintain acceptable voltage levels under various operating conditions. To assess voltage stability, different voltage stability indices (VSIs) have been proposed in the literature. These indices serve various purposes, including the placement and sizing of distributed generation (DG), Static VAR compensator device, detection of weak lines and buses, and triggering countermeasures against voltage instability.**

This paper aims to provide a comprehensive review of VSIs, considering various aspects such as concepts, assumptions, critical values, and equations. Each VSI offers a unique perspective on voltage stability assessment and has its own set of assumptions, equations, and critical values. By analyzing these aspects, the paper aims to compare and contrast different VSIs to identify their strengths and weaknesses.

The paper also discusses the design and optimal placement of FACTS devices capable of controlling various parameters in power systems, including voltage. By strategically placing these devices and employing optimization algorithms, such as genetic algorithms or particle swarm optimization, the voltage stability of the system can be improved by compensating for reactive power variations.

By reviewing these methods and techniques, the paper provides insights into the advancements made in voltage stability control. It highlights the advantages and limitations of each approach, enabling researchers and practitioners to understand the suitability and applicability of these techniques in different scenarios.

***Index Terms*- SVC, VSIs, FACTS device, voltage stability**

I. INTRODUCTION

The definition of voltage stability provided by the IEEE power system engineering committee states that voltage stability refers to the ability of a system to maintain voltage in such a way that when the load admittance is increased, the load power will also increase, and both power and voltage can be controlled. This definition highlights the importance of maintaining a stable voltage level in the power system to ensure reliable and controllable operation. This control over power and voltage is crucial for the smooth operation of the power system and to avoid voltage instability or collapse[1].

By emphasizing the controllability of power and voltage, this definition recognizes the need for active control measures and appropriate system design to maintain voltage stability. It highlights the importance of ensuring that the power system can respond to changes in load conditions and adjust voltage levels as necessary to meet the demand while avoiding voltage instability

Voltage instability can arise from two main causes: a failure of reactive power sources to provide sufficient reactive power or a failure of power system lines to transmit the required Reactive power[2].This is necessary for voltage control, can be supplied by generators and reactive power compensators such as shunt capacitors. If the reactive power sources are unable to generate or supply enough reactive power to meet the system's demand, voltage instability can occur.

Additionally, voltage instability can be triggered by various incidents in the power system. Some of the primary causes includes[3]:

1.Load Increase: A significant increase in load demand can lead to a surge in reactive power requirements. If the system is unable to meet this increased demand, voltage levels can decline, potentially leading to instability.

2.Tripping of Power System Equipment: The sudden tripping or failure of critical power system equipment, such as transmission lines, power transformers, and generators, can disrupt the balance between reactive power generation and consumption. This imbalance can result in voltage instability.

3.Exceeding Generator Reactive Power Limits: Generators have limits on their ability to provide reactive power. If the reactive power demanded by the system exceeds these limits, it can lead to voltage instability.

4.Malfunction of On-load Tap Changing (OLTC) Transformers: OLTC transformers are used to regulate voltage levels by adjusting tap positions. If these transformers malfunction or fail to respond correctly to voltage variations, it can contribute to voltage instability.

To address and mitigate voltage instability, it is crucial to ensure an adequate supply of reactive power, maintain the stability of power system equipment, and implement proper voltage control measures. This includes appropriate coordination of reactive power sources, efficient reactive power compensation, and effective monitoring and control systems to detect and respond to voltage instability incidents in a timely manner. voltage stability indices helps to investigate voltage instability

Indeed, one of the significant applications of voltage stability indices (VSIs) is identifying weak lines and buses in power systems[5-9]. Weak lines and buses refer to components of the power system that are more susceptible to voltage instability or have limited capability to maintain voltage levels within acceptable limits under changing conditions.

VSIs provide a quantitative measure to assess the voltage stability of different components within the power system. These indices consider various factors such as voltage magnitudes, reactive power flows, and system topology to evaluate the proximity to voltage instability.

Identifying weak lines and buses is crucial for system operators and planners as it enables them to focus their efforts and resources on strengthening these vulnerable components. By reinforcing weak lines and buses, such as through equipment upgrades, reactive power compensation, or topology reconfiguration, the voltage stability and overall reliability of the power system can be improved. Moreover, knowing the locations of weak lines and buses assists in determining optimal placement and sizing of mitigation measures such as FACTS devices, reactive power compensators, or distributed generation (DG) units. These measures can be strategically deployed to enhance the voltage stability of the identified weak components.

This application of VSIs has several practical uses in power system planning and operation. Some of the notable cases include:

1. Placement and Sizing of Distributed Generation (DG) Units: VSIs can assist in determining the optimal locations and sizes of DG units within the power system. By identifying weak lines and buses using VSIs, DG units can be strategically placed in these locations to provide localized reactive power support and voltage control, thus strengthening the overall voltage stability of the system.
2. Capacitor Allocation: Capacitors are commonly used for reactive power compensation in power systems. By employing VSIs, weak buses or lines with low voltage magnitudes or high reactive power demands can be identified. Capacitors can then be allocated to these locations to enhance the reactive power supply and voltage stability, thereby improving system performance.
3. Power System Planning: VSIs play a vital role in power system planning, particularly in long-term expansion planning. By identifying weak lines and buses using VSIs, planners can prioritize the reinforcement of these components in their expansion plans. This could involve upgrading transmission lines, increasing the capacity of transformers, or implementing other measures to enhance voltage stability.

The application of VSIs in these cases enables more informed decision-making, allowing system operators and planners to target their resources and investments where they are most needed. By addressing the vulnerabilities identified through VSIs, power system reliability, efficiency, and resilience can be significantly improved.

It is important to note that while VSIs provide valuable information for identifying weak lines and buses, their application should be complemented by comprehensive system analysis, including dynamic simulations and contingency analysis, to ensure accurate and reliable results.

In the literature, various voltage stability indices (VSIs) have been proposed to assess the voltage stability of power systems. These indices can be categorized into two types: those that are functions of power system impedance and those that only require voltage and current measurements at buses, independent of the power system impedance.

Indices that are functions of power system impedance can provide more accurate assessments of voltage stability. However, in practice, determining power system impedance with high precision is challenging due to atmospheric effects and limited information about the power system. Consequently, VSIs based on power system impedance are prone to errors.

To compare and evaluate the performance of different VSIs, several papers have conducted comparative studies. However, a comprehensive investigation into the overall characteristics, classifications, and differences among the VSIs has not been conducted to date. To address this gap, the reviewed paper aims to provide a thorough analysis of VSIs from various aspects, such as assumptions, concepts, equations, and critical values (CVs). By considering these aspects, the review aims to provide a comprehensive background for understanding the current state of research and identifying future directions in the field of voltage stability assessment.

The outcomes of the review can be utilized in several applications, including the placement and sizing of distributed generation (DG) units, svc device, voltage stability assessment, ranking of buses and lines based on voltage stability, and activation of countermeasures to prevent voltage collapse.

The comparison of voltage stability indices (VSIs) is an important topic in voltage stability research, as it helps in understanding their characteristics, classifications, and differences. Review papers that examine various VSIs can provide valuable insights into their performance and applicability. By considering different aspects and views such as assumptions, concept, equations, and critical values (CVs), these reviews aim to provide a comprehensive understanding of the VSIs.

In such review papers, researchers typically analyze and compare the different VSIs based on several criteria, including:

Conceptual framework: They examine the underlying principles and theoretical foundations of each VSI, exploring the specific concepts and methodologies used in their formulation.

Assumptions: They identify the key assumptions made in each VSI, such as simplifications in system modeling, neglecting certain parameters, or considering specific operating conditions.

Equations and calculations: They provide a detailed analysis of the mathematical equations and calculations involved in each VSI, including the variables and parameters used, as well as any simplifications or approximations employed.

Critical values: They investigate the critical values or thresholds associated with each VSI that indicate the proximity to voltage instability or collapse. These critical values serve as reference points for evaluating system stability.

By reviewing and comparing the VSIs based on these aspects, researchers aim to highlight their strengths, limitations, and applicability in different scenarios. This information can assist in selecting the most suitable VSI for specific applications such as distributed generation placement, voltage stability assessment, ranking buses and lines, and activating countermeasures to control voltage collapse.

Overall, these review papers contribute to the understanding of VSIs and provide a basis for future research and development in the field of voltage stability assessment.

II. VOLTAGE STABILITY INDICES

A voltage stability index (VSI) is a quantitative measure or indicator used to assess the voltage stability of a power system. VSIs are mathematical expressions or formulas that consider various system parameters and measurements to evaluate the proximity to voltage instability.There are numerous VSIs proposed in the literature, and they may vary in terms of their formulation, complexity, and underlying assumptions. Some common types of VSIs include:

1. Voltage Stability Margin (VSM): VSM measures the distance between the current operating point and the point of voltage collapse or instability. It is typically expressed as a percentage or a ratio.	**2. Voltage Collapse Point (VCP): VCP refers to the specific operating condition or point at which the power system experiences a voltage collapse or instability. It can be determined by certain threshold values or critical conditions.**	**3. L-index: The L-index is a measure of voltage stability based on the loadability limit of the system. It quantifies the maximum load that can be supported by the system before voltage instability occurs.**
4. Modal Analysis-Based Indices: These indices utilize eigen value analysis or mode shapes of the power system to assess voltage stability. They consider the interaction between system modes and voltage dynamics to evaluate stability.	5. Sensitivity-Based Indices: Sensitivity-based indices measure the sensitivity of system variables, such as voltage magnitudes or angles, to changes in system parameters or operating conditions. They assess the system's response to disturbances and provide indications of voltage stability.	6. Energy-Based Indices: Energy-based indices assess the energy available in the system to sustain voltage levels. They consider the balance between reactive power generation and consumption, incorporating factors such as generator capabilities and load demand.

The selection and application of a specific VSI depend on the desired objective, available data, system characteristics, and analysis requirements. It is important to note that each VSI has its own advantages, limitations, and underlying assumptions, and their performance can vary depending on the specific power system scenario. Researchers and practitioners often compare and evaluate different VSIs to understand their strengths, weaknesses, and suitability for specific applications. This helps in making informed decisions and implementing appropriate voltage stability assessment and control measures in power systems

Overall, voltage stability indices play a crucial role in voltage stability assessment, monitoring, and control, assisting system operators in maintaining secure and reliable power system operation.

III. VOLTAGE STABILITY INDEX CLASSIFICATION

Voltage stability indices (VSIs) can be classified based on various criteria, including their mathematical formulation, application area, and underlying concept. Here are some common classifications of voltage stability indices:

- **Mathematical Formulation:**

a. Analytical Indices: These indices are derived based on analytical formulations and mathematical equations. Examples include Fast Voltage Stability Index (FVSI) and Line Stability Index (Lmn).
b. Numerical Indices: These indices utilize numerical algorithms and computational techniques to assess voltage stability. They often involve simulation or optimization methods. Examples include Modal Analysis-based Indices and Optimization-based Indices.

- **Application Area:**

a. Bus Voltage Indices: These indices focus on individual buses or nodes in the power system and evaluate their voltage stability. Examples include Bus Voltage Stability Index (VSIbus) and Novel Bus Voltage Stability Index (NVSI).
b. Line Voltage Indices: These indices assess the voltage stability of transmission lines or branches in the power system. Examples include Line Stability Index (Lmn) and Novel Line Stability Index (NLSI).
c. Overall or System-wide Indices: These indices provide an overall measure of voltage stability for the entire power system. They consider the collective behavior of buses, lines, and other system components. Examples include Overall Voltage Stability Index (OVSI) and Composite Voltage Stability Index (CVSI).

- **Conceptual Basis:**

a. Impedance-based Indices: These indices use the impedance or admittance parameters of the power system to assess voltage stability. They consider the reactive power flow and impedance characteristics of buses or lines.
b. Eigen value-based Indices: These indices analyze the eigen values of the power system Jacobian matrix to determine voltage stability. They examine the eigen values' location and properties to identify potential stability issues.
c. Sensitivity-based Indices: These indices rely on sensitivity analysis techniques to evaluate the impact of changes in system parameters on voltage stability. They measure the sensitivity of voltage magnitudes and angles with respect to various system variables.

It is important to note that these classifications are not mutually exclusive, and some indices may fall into multiple categories. The choice of VSI depends on the specific application, available data, computational resources, and desired level of accuracy in voltage stability assessment.on the application area,here we display the various VSIs,there characteristics,area of application,errors etc

Bus VSI (Voltage Stability Index), Line VSI, and Overall VSI are three different indices used for voltage stability assessment in power systems. Let's compare them based on their key characteristics:

- **Scope:**

Bus VSI: Focuses on assessing the voltage stability of individual buses or nodes in the power system.

Line VSI: Evaluates the voltage stability of transmission lines in the power system.

Overall VSI: Provides a comprehensive assessment of the overall voltage stability of the entire power system, considering the collective effects of buses and lines.

- **Analysis Level:**

Bus VSI: Analyzes the voltage stability conditions at each individual bus, providing detailed insights into the stability of specific buses.

Line VSI: Examines the voltage stability of specific transmission lines, assessing their ability to maintain acceptable voltage levels during disturbances.

Overall VSI: Takes a holistic view of the power system, considering the combined effects of buses and lines to assess the overall voltage stability of the system.

- **Purpose:**

Bus VSI: Identifies weak buses or nodes in the power system, guiding voltage control actions and reactive power management at individual buses.

Line VSI: Identifies transmission lines that are approaching stability limits or are vulnerable to voltage collapse, aiding in line reinforcement planning and contingency analysis.

Overall VSI: Provides a system-wide assessment of voltage stability, guiding system-level voltage control measures, and helping to prevent system-wide voltage collapse.

- **Granularity:**

Bus VSI: Provides a more detailed assessment at the individual bus level, allowing for localized voltage stability analysis.

Line VSI: Focuses on specific transmission lines, providing insights into their stability conditions.

Overall VSI: Provides a broad overview of the voltage stability of the entire power system, considering the interactions between buses and lines.

It's important to note that the specific formulas, calculation methods, and applicability of these indices may vary based on different research papers, methodologies, or industry standards. The choice of which index to use depends on the analysis objectives, system characteristics, and the level of detail required in assessing voltage stability at different levels of the power system.

LINE VOLTAGE STABILITY INDICES

Line voltage stability indices are specific voltage stability indices that focus on assessing the voltage stability of transmission lines in a power system. These indices provide a measure of the proximity to voltage instability or collapse specifically for individual transmission lines. They help identify lines that may be more vulnerable to voltage stability issues and require attention in terms of reinforcement or control measures.

- **Fast voltage stability index (FVSI**)

The Fast Voltage Stability Index (FVSI) is a voltage stability index that provides a rapid assessment of voltage stability conditions in a power system. It is designed to quickly evaluate the proximity to voltage collapse based on readily available measurements and system parameters.

$$FVSI = \frac{4Z^2Q_r}{V_S^2X} \text{ ....(1)}$$

The FVSI must be below 1 for a stable transmission line. If FVSI goes beyond 1.00, one of the buses that is connected to the line will experience a sudden voltage drop leading to system collapse[4].

- **Line Stability Index (Lmn)**

This index was formulated based on a power transmission concept in a single line. The line stability index Lmn

$$L_{mn} = \frac{4Z^2Q_rX}{(V_S\sin(\theta-\delta)^2}\text{............(2)}$$

same concept as FVSI in which the discriminant of the voltage quadratic equation is set to be greater than or equal to zero

As long as the Lmn remains less than 1, the system is stable and when this index exceeds the value 1, the system loses its stability and the voltage collapses[10].

- **The Line Stability Factor (LQP)**

It is typically calculated based on the reactive power flow, voltage magnitudes, and line parameters

For the transmission line to be stable, it should be LQ Po1.

$$LQP = 4\left(\frac{X}{V_S^2}\right)\left(Q_r + \frac{P_S^2X}{V_S^2}\right)\text{...............(3)}$$

In this index, the lines are assumed to be lossless (R=Xo o1) and the shunt admittance of lines is neglected.

- **Line Stability Index(Lp)**

This index is formulated by Moghavvemi et al..Lp[11].for power system network the line stability index on transmission line end side is depicted as;

$$L_p = \frac{4RP_r}{(V_s\cos(\theta-\delta))^2}\text{....................(4)}$$

Here stability index is dependent only on active power .for suitable calculation reactive power & shut admittance of line is considered negligible.

- **Novel line stability index (NLSI)**

The Novel Line Stability Index (NLSI) is a voltage stability index proposed by Yazdanpanah-Goharrizi et al. It is derived based on a similar concept as the Line Stability Factor (Lp) and is used to assess the stability of a power transmission line.

$$NLSI = \frac{P_r R + Q_r X}{0.25 V_S^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

The NLSI provides an indication of the proximity of the line to its stability limit. the NLSI value gets closer to unity, it suggests that the line is experiencing high reactive power flows (Qr) and/or high real power flows (Pr) relative to the voltage magnitude (V) and line parameters (R and X)[12]. This indicates that the line is operating at or close to its maximum capability, and any further increase in power flows may lead to voltage instability.

- **New Voltage Stability Index (NVSI)**

The NVSI representated by Kanimozhi et al. based upon the similar conceptualization as of Lp [13]. The NVSI is a numerical index that quantifies the proximity of a power system to voltage collapse. It takes into account various system parameters, such as voltage magnitudes, and reactive power flows, and calculates a single value that represents the system's voltage stability condition. The specific formula and calculation method for the NVSI can vary depending on the approach or methodology used by researchers or power system engineers.

This index is defined for a transmission line as follows:

$$NVSI = \frac{2X\sqrt{P_r^2 + Q_r^2}}{2Q_r X - V_S^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

For the transmission line to be stable NVSIo1. In this index, the line resistance as well as the line shunt admittance are neglected

BUS VOLTAGE STABILITY INDEX

- **Voltage Collapse Prediction Index (VCPIbus)**

it is an index used to assess the vulnerability of individual buses or nodes in a power system to voltage collapse. It aims to predict the likelihood of voltage collapse at a specific bus under certain operating conditions. The specific formula or derivation of the VCPIbus may vary depending on the research or methodology used. However, the index generally takes into account various factors related to the bus, including its reactive power injection/absorption, load characteristics, voltage magnitude, and system parameters.

$$VCPI_{bus} = \min(VCPI_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

Where

$$VCPI_{bus} = \left| 1 - \frac{\sum_{\substack{m=1 \\ m \neq 1}}^{N} V'_m}{V_i} \right| \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

&

$$V'_m = \frac{Y_{im}}{\sum_{\substack{j=1 \\ j \neq i}}^{N} Y_{ij}} V_m \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(9)$$

By calculating the VCPIbus for different buses in the power system, operators can identify buses that are more prone to voltage collapse under certain conditions. This information helps in implementing appropriate preventive or corrective measures to maintain voltage stability and prevent system-wide blackouts or disruptions. its value varies between 0 and 1. If the value of VCPIbus reaches 1,the voltage at a bus has collapsed

- **L-index**

L index is used to identify the weak bus that is the best location for placement of SVC to improve the voltage profile of the power system. voltage stability index named L-indexpresenting the weak load bus.The values of this index for different buses determine their stability limit.With the consideration of L-Index, load bus prone to the instability or the bus confining magnitude of voltage away from permissible limit of stability can be identified using the equation below.

$$L_j = \left| 1 - \sum_{i=1}^{g} \bar{F}_{ij} \frac{V_i}{V_j} \right| \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

The *Fji* values Calculated with the help of ***Y*** bus matrix as follows

$$\begin{bmatrix} \bar{I}^G \\ \bar{I}^L \end{bmatrix} = \begin{bmatrix} Y_{GG} & Y_{GL} \\ Y_{LG} & Y_{LL} \end{bmatrix} \begin{bmatrix} \bar{V}^G \\ \bar{V}^L \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

Where *FLG*=[*YLL*]$^{-1}$[*YLG*] are obtained through above Y matrix .

$\bar{I}^G, \bar{I}^L$ represents generator node current and load node current$\bar{V}^G, \bar{V}^L$ represents generator node voltage and load node voltage respectively. Here the permitted limit of L-index is set between 0 to 1. If the value of L-Index is advancing towards value one, it will be considered as delicate or weak bus showing deteriorated voltage profile of particular bus

- **Voltage stability index (VSIbus)**

The Voltage Stability Index (VSIbus) is a voltage stability assessment index specifically applied to individual buses or nodes in a power system. It quantifies the proximity of a bus's voltage to a critical threshold or limit, indicating its voltage stability. Haque introduced VSI_{bus} comprising the similar concept of SDC [79].

$$\left[1 + \left(\frac{I_i}{V_i}\right)\left(\frac{\Delta V_i}{\Delta I_i}\right)\right]^a \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

here Ii &Vi depicts current and voltage at bus i, ΔIi & ΔVi depicts current and voltage deviation at bus i, and(α =constant number equal or greater than 1) which is used to approximate linear characteristic to the index. The value of VSIbus varies between 1 (at no load) & zero (at voltage collapse point).

- ***Simplified Voltage Stability Index (SVSI)***

Perez-Londono et al. demonstrated the SVSI rely on the similar concept as VSLBI shown as;

$$SVSI_r = \frac{\Delta V_r}{\beta V_r} \text{.................} (13)$$

where β denoted as correction factor and is formulated by;

$$\beta = 1 - [max(|V_m| - |V_l|)]^2 \text{.................} (14)$$

The ΔVr is the voltage drop on the Thevenin impedance and it is estimated by

$$\Delta V_r \cong |V_g - V_r| \text{..........................}(15)$$

here Vg and Vr denotes the voltage phasors of the generator to the load bus & the analyzed load bus, respectively.When the SVSI approachs 1 in a bus, the voltage collapse happens at that bus. The voltage of the generator close to the load bus is assumed to be equal to the Thevenin voltage in the network at that load bus In the SVSI.

Key differences between Bus Voltage Stability Index (BVSI) and Line Voltage Stability Index (LVSI) very well.

To reiterate, BVSI focuses on individual buses or nodes in a power system, assessing their voltage stability based on factors like voltage magnitude, reactive power injection/absorption, and load characteristics. It helps identify weak buses that may be prone to voltage instability and enables the implementation of remedial actions to maintain stability.

On the other hand, LVSI assesses the stability of power transmission lines by considering real power flow, reactive power flow, line impedance, and voltage magnitude at both ends of the line. It provides a broader perspective by considering the interdependencies and power flows between buses connected by the transmission line. LVSI helps identify critical transmission lines that may be operating close to their stability limits and require corrective measures to ensure voltage stability in the overall system.

By considering these distinct elements and perspectives, both BVSI and LVSI contribute to identifying vulnerable elements and guiding the implementation of appropriate corrective actions to maintain voltage stability in a power system**.**

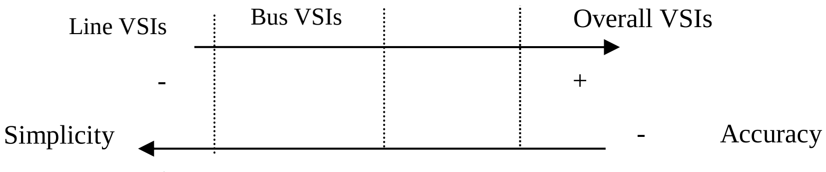

Fig. 1 Comparison between accuracy and simplicity of different types of VSIs

OVERALL VOLTAGE STABILITY INDEX (OVSI)

The overall voltage stability index (OVSI) is a comprehensive measure that provides an overall assessment of the voltage stability of a power system. It takes into account the collective behavior of various system components, including buses, lines, generators, and loads. The OVSI considers the system's ability to maintain stable voltage levels under different operating conditions and disturbances.

- **Network sensitivity approach (SG)**

Network Sensitivity Approach (SG), proposed by Althowibi et al., is a method used to calculate voltage stability and assess the proximity of a power system to its collapse point. It utilizes the concept of sensitivity analysis to evaluate the sensitivity of system variables to changes in operating conditions.

$$SG_p = \frac{P_{gt}}{P_{dt}} \text{....................}(13)$$

$$SG_q = \frac{P_{gt}}{Q_{dt}} \text{....................}(14)$$

Characteristics of VSIs are shown below in table no.1

Table no.1

TYPE OF INDICES		**FORMULA**	**ASSUMPTION**	**CRITICAL VALUE**
LINE VSIS	**FVSI**	$FVSI = \frac{4Z^2Q_r}{V_S^2X}$	SIN $\delta \approx 0$; COS $\delta \approx 1$	**1**
	LMN	$L_{mn} = \frac{4Z^2Q_rX}{(V_S\sin(\theta - \delta)^2}$	**EFFECT OF ACTIVE POWER NEGLECTED**	**1**
	LQP	$LQP = 4\left(\frac{X}{V_S^2}\right)\left(Q_r + \frac{P_S^2X}{V_S^2}\right)$	R$\approx 0, Y \approx 0$	**1**
	LP	$L_p = \frac{4RP_r}{(V_s\cos(\theta - \delta))^2}$	**EFFECT OF REACTIVE POWER NEGLECTED**	**1**
	NVSI	$NVSI = \frac{2X\sqrt{P_r^2 + Q_r^2}}{2Q_rX - V_S^2}$	R$\approx 0, y \approx 0$	**1**

	NLSI	$NLSI = \dfrac{P_r R + Q_r X}{0.25 V_S^2}$	$\delta \approx 0, y \approx 0$	**1**
BUS VSIS	**VCPIBUS**	$VCPI_{bus} = \min(VCPI_i)$	**VOLTAGE OF A BUS IS NOT DEPEND ON THE OTHER BUS VOLTAGES**	**1**
	L-INDEX	$L_j = \left\lvert 1 - \sum_{i=1}^{g} \overline{F}_{ij} \dfrac{V_i}{V_j} \right\rvert$	**ALL GENERATOR VOLTAGES REMAIN UNCHANGED**	**1**
	VSIBUS	$\left[1 + \left(\dfrac{I_i}{V_i}\right)\left(\dfrac{\Delta V_i}{\Delta I_i}\right)\right]^a$	$\Delta V_r \Delta I_r \approx 0$	**0**
	SVSI	$SVSI_r = \dfrac{\Delta V_r}{\beta V_r}$	**VOLTAGE OF THE NEAREST GENERATOR TO A LOAD BUS IS EQUAL TO THE THEVENIN VOLTAGE OF THE NETWORK AT THAT BUS**	**1**
OVERAL L VSIS	**SG**	$SG_p = \frac{P_{gt}}{P_{dt}}, SG_q = \frac{P_{gt}}{Q_{dt}}$	**POWER SYSTEM EFFICIENCY IS CONSTANT**	**SHARP RISE**

IV. CONCLUSION

In the above said Linevoltage stability indices like FVSI,$L_{mn,}$LQP shown the variation of reactive power load but not real power load. There are some merits of the index related to both real and reactive power on the otherside other indices relate only the reactive power of the system. The Novel Voltage Stability Index (NVSI) is trusted as more reliable index for estimation of voltage instability in comparison to other indices. It main motive is to provide a high standard of prediction for voltage collapse, ensuring the safety and stability of the power system. the accuracy of overall voltage stability indices (VSIs) is generally better than that of line and bus VSIs. Overall, VSIs play a crucial role in voltage stability analysis by considering the system-wide behavior and providing a more comprehensive assessment of voltage stability, enabling more effective monitoring and control of power systems. The consideration of Thevenin network impedance and the sensitivity of voltage stability indices (VSIs) to small changes in consecutive measurement data are important factors to consider in the development of robust and accurate VSIs. While some existing VSIs neglect Thevenin network impedance or are sensitive to data variations, there is potential for future work to introduce new VSIs that address these limitations.

In Bus voltage stability index a new VSI called SVSI had been introduced .SVSI taken into account the Thevenin impedance at a bus and is designed in such a way so to remain insensitive to minute changes in consecutive estimated data. However, SVSI is not capable of delivering information about weak facilities or potential voltage problems in the power system. Additionally, SVSI consider the voltage of the nearest generator to a load bus is equals the Thevenin voltage of the network at that bus, which may not be entirely true or accurate in all scenarios.

The choice of which type of voltage stability index (VSI) to use depends on various factors, including the specific requirements of the analysis, available computational resources, and the level of accuracy needed. In some cases, a comprehensive assessment of voltage stability may involve considering multiple VSIs to capture different aspects of the power system's voltage stability.

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