A Load Shedding Scheme Based On Frequency Response Model With Fast Voltage Stability Index And Line Stability Index Consideration

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Abstract- *The load shedding scheme is vital for voltage and frequency stability. It is an important way for operators to keep the power system stable and reliable when it is subjected to severe disturbances. When the system frequency or voltage falls below a predetermined range, load shedding based on critical undervoltage or underfrequency protects the system. This paper presents a load shedding technique that stabilizes both undervoltage and underfrequency conditions. The scheme is developed in MATLAB where Frequency response model is used with reference to enhancement of under frequency. Voltage stability is achieved considering the Fast voltage stability index as well as line stability index. The presented method is verified in an IEEE 6 bus system which is developed in power world simulator.*

Key Words: Frequency, Voltage, critical, Load

1.INTRODUCTION

The most important aspect of an electrical power system under an overload or imbalanced scenario is the ability to balance energy demand and power generation shortfalls [11]. Because of real and reactive power inadequacies, severe system disturbances such as generation insufficiency, tripping of the primary generating unit, and overload contingency would result in under frequency and low voltage. Electrical islanding might occur as a result of cascaded outages and area isolation. Due to a lack of producing units in these electrical islands, system frequencies will continue to fall, causing the generation unit to trip under frequency protective relays [3, 16]. The most significant fact of frequency response in an electrical power system is to give important integrity and security. Frequency response is basically the functionality of a power system to secure a fast alternate in frequency following a large disturbance. A lack of system frequency instability might result from an unexpected mismatch between system generation and load demand. Normally, the voltage of a power system is stable; however, when a malfunction or disturbance occurs, the voltage becomes unstable and unpredictable. Frequency and voltage instability in the worst-case circumstances, might force the system to shut down. Load shedding is the most effective approach for the system to deal with transmission line overloading during a contingency [5]. To avoid excessive load shedding, the amount of load to be shed must be kept to a minimum value. Time, the amount of load to unload, and place to discharge are the three key considerations that go into load shedding [2]. Load shedding can assist reduce the electrical system's severely loaded branches, decreasing the danger point of frequency and voltage instability [8].

This paper presents an advanced load shedding strategy that combines voltage and frequency stability. Frequency response models is a kind of computational approach that uses real-time system variables to determine load shedding amount. The fast voltage stability index (FVSI) is implemented to determine the voltage of contingency evaluation in a power system caused by a line loss [10]. It's a straightforward mathematical strategy for analysing voltage stability. The stability and contingency analyses is carried out using the IEEE 6 bus test system, which is constructed in the power world simulator.

2.TEST SYSTEM DESCRIPTION

An IEEE 6 bus system is used to verify the outcomes of the proposed load shedding schemes. This system consists of three generators and works at 33 KV, 50HZ. The generator model (version) used is the standard Round Rotor Generator Model with DC offset Torque Component (GENDCO), and Governor GAST_PTI and GASTD Gas Turbine- governor Model. Table no. 1 and 2 show the system data. The system is developed in power world simulator as shown in Fig1.

Table-1: Generator data of IEEE 6 bus system

Generator Bus No.	Real Power Generator (MW)	Reactive Power Generation (MVAR)	Maximum Real power Generation (MW)	Minimum Real Power Generation (MW)	Maximum Reactive Power Generation (MVAR)	Minimum Reactive Power Generation (MVAR)
1	0	0	200	50	100	-100
2	50	0	150	37.5	100	-100
3	60	0	180	45	100	-100

Table- 2: Bus data of IEEE 6 bus system

Bus No	Bus Type	Voltage Magnitude	Voltage Angle	Real Power Load	Reactive Power Load	Maximum Voltage Magnitude	Minimum Voltage Magnitude
1	SB	1.05	0	0	0	1.1	0.9
2	PV	1.05	0	0	0	1.1	0.9
3	PV	1.07	0	0	0	1.1	0.9
4	PQ	1	0	70	70	1.1	0.9
5	PQ	1	0	70	70	1.1	0.9
6	PQ	1	0	70	70	1.1	0.9

3.LAYOUT OF LOAD SHEDDING SCHEME

Electricity is a necessary energy carrier for human activities, so the electric utility company must provide a stable and consistent supply of high-quality electricity. This can be done by regularly monitoring and assessing the security of the power system, as well as building a proper control system.

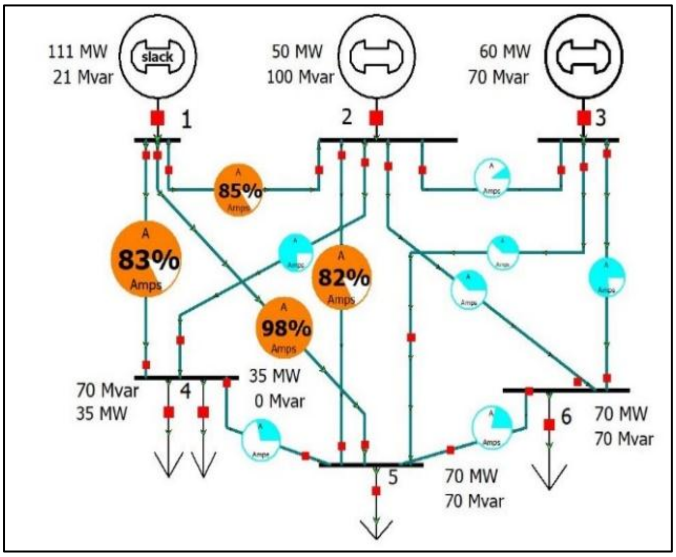

Fig.-1: IEEE 6 bus system developed in power world simulator

3.1 Load shedding based on the circumstances

(i) Forced outages

Load shedding is carried out automatically as a last line of defense in order to avoid the black out during severe perturbation in the system. Here load shedding improves the stability of the system by enhancing the system voltage profile and the system frequency.[15]

(ii) Scheduled outages

Available electricity is dispatched to a limited consumer while other consumers' loads are shed in a pre-scheduled stage.[14]

3.2 Electric load can be categorized according to priority-

(i) Vital Load

Vital load is that customers who cannot afford any loss of power, such as hospitals, are considered crucial loads.

(ii) Non vital Load

Non vital load is that not necessary for customers. Consider non vital load may be followed critical path of the system which leads to gradually unstable state of the system.

Table-3: classification of loads as vital and non-vital loads

Non-Vital Load	Vital Load
Not instantly used	Instantly used
Lead to correctly predicted branch	Lead to mis-predicted branch

3.2 Load shedding problem can be classified-

(i) Under frequency load shedding using frequency response model

Under frequency load shedding (UFLS) must be carried out quickly in order to prevent power system frequency drop by reducing power system load. For this reason, frequency threshold values are specified to begin underfrequency load shedding. The minimum suitable frequency is determined by the system equipment. The standard frequency range for the system is 49.5 Hz to 50.2 Hz [1]. Frequency response model is used for under frequency load shedding scheme. The rate of change of frequency drop, which is directly impacted by the load generation mismatch, must be used to accomplish UFLS in this scheme, as shown in equation (1).

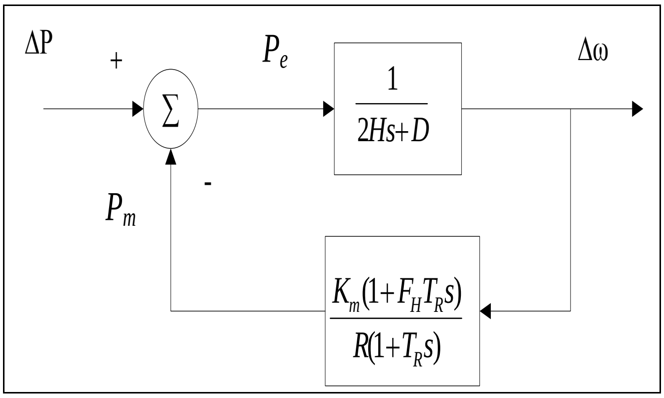

Fig.-2: Simplifies system frequency model

$$\left.\frac{df}{dt}\right|_{t=0} = \frac{P_d}{2H} \quad (1)$$

Where- P_d: Load generation mismatch

H: Inertia constant

Once the load generation mismatch is calculated, load shedding action can be initiated using Eq. (2) derived from the SFR model in "Fig.1" as shown [5]. The load shedding amount can be calculated with respect to the frequency response of the system. Equation (2) shows the response of the simplified system frequency response model by using Laplace Transform.

$$\Delta\omega(t) = \frac{RP_d}{DR+K_m}[1 + ae^{-\zeta\omega_n}\sin(\omega_r t + \varphi] \quad (2)$$

Where,

$$a = \sqrt{\frac{1-2T_R\zeta\omega_n + T_R^2\omega_n^2}{1-\zeta^2}} \quad , \quad \omega_r = \omega_n\sqrt{1-\zeta^2}$$

$$\varphi = \varphi_1 - \varphi_2 \quad , \quad \varphi_1 = tan^{-1}\left(\frac{\omega_r T_R}{1-\zeta\omega_n T_R}\right)$$

$$\varphi_2 = tan^{-1}\left(\frac{\sqrt{1-\zeta^2}}{-\zeta}\right)$$

The load shedding amount is calculated based on minimum allowable frequency that is taken as 48Hz and minimum non-shedding overload.

(ii) Under voltage load shedding Scheme using Fast voltage stability index and line stability index

The purpose of the undervoltage load shedding scheme is to provide safeguard of the electricity system against voltage breakdown. Essential power shortages have occurred in recent years as a result of voltage instability, according to studies. Voltage instability is frequently caused by a forced outage of the generator or the line, as well as overloading. When this happens, the reactive energy demand for transmission lines fluctuates dramatically, potentially resulting in a blackout. The undervoltage load shedding strategy is used by power companies to reduce voltage instability and restore voltage to its nominal level [9]. Electric power systems are currently approaching their stability limit. As a result, this problem represents a significant challenge for power system stability and control. The main source of instability is the power system's inability to convert reactive power to load, which may be avoided by increasing the static voltage stability margin.

Fast Voltage Stability Index- The power transmission idea of a single line model is used to calculate line stability indices. The primary goal of employing voltage and line stability indexes is to locate the collapse point in a complicated linked power system. These indices are used to access power system voltage and line stability. These voltage stability indices can be applied to either a bus or a line. The stability of linked buses (receiving buses) on that line is indicated by the line stability [12]. The load shed, however, is done on a bus or line with a high index value.

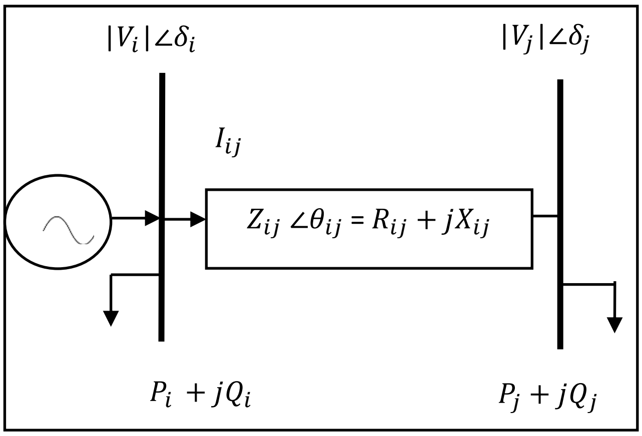

Fig.-3: schematic diagram of two bus power system

In a large power system, the fast voltage stability index (FVSI) may be used to estimate the point of voltage collapse, critical zones, and maximum permitted load. It may also be used to determine the maximum load capacity of a power system, as well as weak buses and the most vital line in an interconnected system.

The Fast voltage stability index must be used to identify the state of voltage stability in a power system. This index can be found in either a bus or a line. The FVSI (Fast Voltage Stability Index) is applied in line.

The FVSI is derived from a two-bus system model (Fig. 3). Here P, Q and S are the active, reactive and apparent power respectively. The sending end and receiving end bus are represented by *i* and *j* respectively.

V_i & V_j - voltage at sending and receiving bus (i^{th} & j^{th}) buses

I_{ij} = Branch current of every line connecting (i^{th} & j^{th}) buses

The voltage quadratic equation on the receiving end bus at the system is used to calculate the fast voltage stability index. Here an each line impedance is referred to as

$$Z_{ij} = R_{ij} + j X_{ij} \quad (3)$$

$$V_j^2 - \left(\frac{R_{ij}}{X_{ij}}\sin(\delta) + \cos(\delta)\right) V_i V_j + \left(X_{ij} + \frac{R_{ij}^2}{X_{ij}}\right) Q_j = 0$$
(4)

Here we find real roots for V_j from eq. 4, Equation 7 is discriminant value is set greater than or equal to '0'

$$\left[\left(\frac{R_{ij}}{X_{ij}}\sin(\delta) + \cos(\delta)\right) V_j\right]^2 - \left(X_{ij} + \frac{R_{ij}^2}{X_{ij}}\right) Q_j \geq 0$$
(5)

$$\frac{4Z_{ij}^2 Q_{ij} X_{ij}}{V_i^2 (R_{ij}\sin(\delta) + X_{ij}\,Cos(\delta))^{\wedge}2} \leq 1$$
(6)

When δ value is very small then, in this condition $\delta \approx 0$, then R_{ij} Sin≈ 0 & X_{ij} Cos$\delta \approx X_{ij}$

$$FVSI_{ij} = \frac{4Z_{ij}^2 Q_j}{V_i^2 X_{ij}} \quad (7)$$

Where- Z_{ij} = line impedance

X_{ij} = line reactance

Q_j = At the receiving end, reactive power

V_i = Sending end voltage

For the power system to operate efficiently, the FVSI value must be less than one. The value around one indicates that the line is approaching the point of instability, resulting in voltage collapse inside the system [7].

Line Stability Index (L_{i-j})- The power transmission concept on a single line is used to calculate the line stability index. A two-bus system is depicted in Figure 4. Li-j is the line's stability index. It's used to calculate the stability index for each bus line. The line stability index measures the line's stability for linked buses (receiving buses). This model's line stability index may be written as

$$L_{i-j} = \frac{4XQ_j}{[V_i \sin(\theta-\delta)]^2}$$
(8)

To keep the line stable, the voltage collapse margin must be less than one. The voltage collapse margin directly affected by the line stability index.

Table- 4: voltage stability indices formula

INDEX	FORMULA	INPUTS	CRITICAL VALUE
L_{i-j}	$\frac{4XQ_j}{[V_i \sin(\theta-\delta)]^2}$	X,Q,V,θ, δ	1
FVSI	$\frac{4Z_{ij}^2 Q_j}{V_i^2 X_{ij}}$	Z,Q,V,X	1

Table no. 4 represent voltage stability indices formulation which is used to determine the voltage collapse point at receiving end at bus or line.

4.METHODOLOGY

This paper's load shedding scheme combines both underfrequency and undervoltage techniques. Figure 4 depicts the technique for a purposed load shedding plan. The steps followed are as below-

- The amount of load shedding is the output of the simplified frequency response model as shown in figure 2. The frequency response is studied using Eq. 2.
- Once an unexpected overload is introduced in the system, amount of load shedding is calculated.
- Before applying load shedding scheme. The loads are divided into two categories vital load & non vital. Vital load is that load shed is important for the customers. Non-vital load is first priority load shedding steps.
- After application of unexpected load of the system, each line's FVSI & line stability index value is now computed. The line with the closest value to 1 is considered unstable, and 50% of the load shedding amount is shed in the bus that correspond to that line.
- Repeat the above steps until all of the lines have FVSI & line stability index values close to zero.

5. SIMULATION RESULTS

An IEEE 6 bus system developed in power world simulator is used to perform the presented scheme. This system is tested to ensure that it is effectiveness of the scheme.

The amount of load shedding mentioned in this paper was determined using a frequency response model. The total load shedding amount 97.86MW for 100 MW unexpected load. The amount of load shedding divided into 4 section- The load shedding amount are 48.86 MW, 24.46 MW, 12.23 MW, 12.23 MW these amounts are used for load shedding scheme. The load shedding amounts for a 60 MW unexpected load are 24.46 MW, 14.44 MW, 12.23 MW, & 12.23 MW, sequentially. These are the values that were applied in this load-shedding system.

5.1 Case: Unexpected load change of 100 MW

An unexpected overload of 100 MW is applied first at bus no. 6 for 1 second. The frequency drops to 49.6 Hz in 1.9 seconds and afterwards stabilizes at 50.40 Hz, which is outside the system's stable range. Furthermore, the voltage in the system continues to fall. According to SFR, the amount of load shedding is 97.86 MW

- Determined the FVSI value of each line at this moment. If the FVSI value of a transmission line is near to one, the line is considered unstable. Table 5 represents the steps in FVSI value when the load is suddenly increased to 100 MW. Calculate the FVSI value for each line, and at this moment, non-vital load is determined at line (5-6), which is close to one of the others. Perform the 50 percent load shedding of 48.93 MW at bus no. 5'1 at 1.1 second at this moment.

- There is still a persistent decrease in frequency and voltage and an overload of 51.11 MW, therefore again determine the FVSI value of each transmission line at this moment. The non-vital load in line (5-6) is around 1. As a result, the remaining 50% of load shedding, total 24.46 MW, is removed at bus no. 5'1 at 1.2 sec.

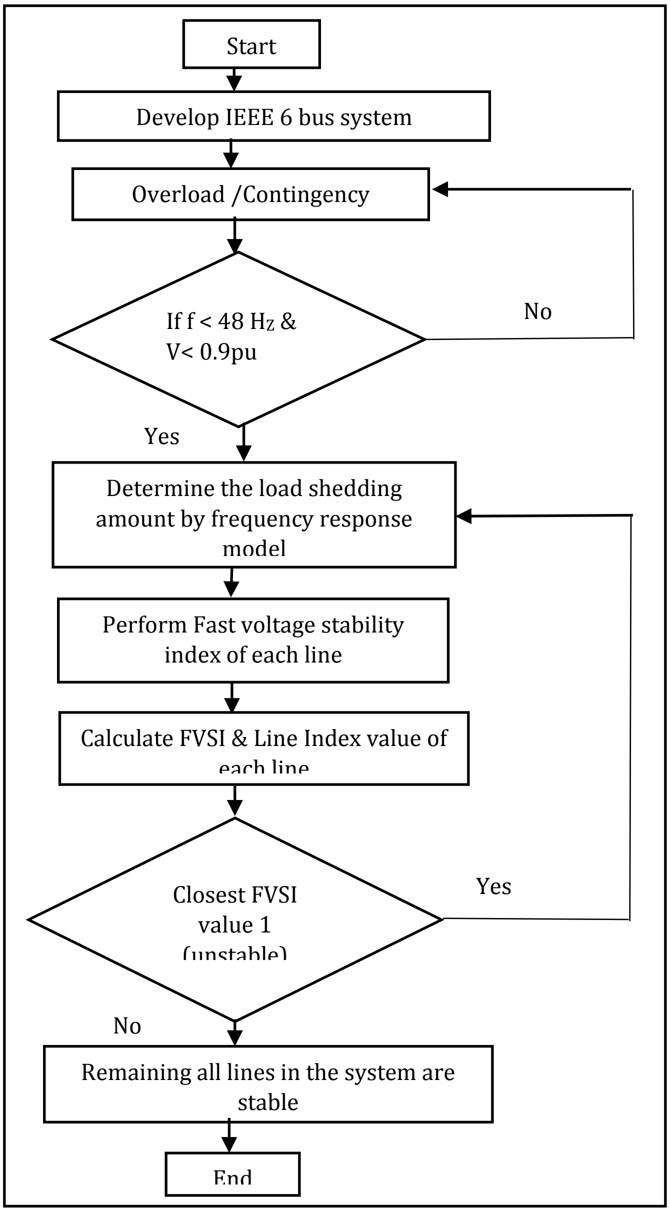

Fig -4: Flow chart for purposed SFR based load shedding using FVSI & line stability index

- Again frequency and voltage are not in the desirable range, and an overload of 26.61 MW still exists, the FVSI value of each transmission line was recalculated, and the largest nonvital load was found at line 5-6. The remaining 50% of load shedding is now removed at bus number 6'1 at 1.3 second.

- When calculating the FVSI value of each line, there is still a portion of sudden load 14.23 MW. At this time, the FVSI value at line 2-4 was determined to have the highest nonvital load. For this moment, remove the load shedding amount at bus number 42 at 1.4 second.

Simultaneously, the line index value of each line is calculated using Equation 8; if the line stability index value is close to 1, the line is considered unstable.

- When a 100 MW overload is applied to bus no. 6 at 1 second, at which moment the frequency drops to 49.6 Hz in 1.9 seconds, which is outside the system's normal operating range, and the voltage continues to drop. The frequency response model has determined 97.86 MW amount of load shedding.

- After applying a sudden load of 100 mw, determine the line index value of each line. If the line stability index value is close to 1, consider the transmission line to be unstable. Table no. 6 represents the step of line stability index. At this moment, the largest non-vital load is at line 5-6, so perform 50% load shedding at bus no. 5'1 at 1.1 second.

- Now that just 51.11 MW is left, calculate the line index value of each line again, and find the maximum non-vital load at line 2-5. Following that, a 50 percent load shedding amount of 24.46 was applied at bus number 5'1 at 1.2 second.

- The 26.61 MW unexpected load continues thus the line index value of each transmission line was determined again, and the highest nonvital load was found at line 5-6. At this point, the remaining 50% of load shedding is eliminated at bus number 5'1 at 1.3 second.

- At the final time the remaining portion of the sudden load 14.23 MW remains again line's line index value was calculated. The highest nonvital load was found at line 2-6 at this time. At this moment, remove the load shedding amount at bus number 6'1 at 1.4 second.

The frequency and voltage responses of a 100 MW unexpected load are shown in Figures 5 and 6. Figure 5.6 Three cases of the system were verified in these figuers i.e. when there is no load shedding, load shedding using the Fast voltage stability index and load shedding using the line stability index. The above steps are summarized as below.

When the IEEE 6 bus system is used, a sudden load of 100 MW is introduced. At this moment, the frequency drops to 49.6 Hz for 1.9 seconds before stablizes at 50.4 Hz, which is outside the system's allowable range. After then, the load shedding amount is calculated to be 97.86 MW. After calculating the FVSI value of each line, use a simplified frequency response model. And use the fast voltage stability index to perform out the load shedding scheme. At this point, the frequency is steady at 50.15 Hz, and the voltage response is 0.99 volts. The following scenario is based on line stability stability index. When the line stability index is applied, the frequency becomes stable at 49.2 HZ, and the voltage range continuously increases. This is outside the system's permitted range. according to the system's performance In comparison to others, the system is stable when load shedding is used with FVSI.

Table- 5: Value of fast voltage stability index and load category of overload 100 MW

Sequence No.	**Value of Fast Voltage Stability Index & Load Category**			
Line no.	**100 MW**	**51.11 MW**	**26.61 MW**	**14.39 MW**
1-2	0.2864 Non vital	0.1887 Vital	0.1412 Vital	0.1105 Vital
1-4	0.4648 Non vital	0.3644 Non vital	0.3216 Non vital	0.2946 Non vital
1-5	0.5485 Non vital	0.3410 Non vital	0.2248 Non vital	0.1851 Vital
2-3	0.3058 Non vital	0.2287 Non vital	0.2058 Non vital	0.1363 Vital
2-4	0.5574 Non vital	0.4365 Non vital	0.3858 Non vital	**0.3567 Non vital**
2-5	0.6205 Non vital	0.0764 Vital	0.3369 Non vital	0.1953 vital
2-6	0.0895 vital	0.3603 Non vital	0.0665 vital	0.0616 Vital
3-5	0.6472 Non vital	0.3088 Non vital	0.2656 Non vital	0.2175 Non vital
3-6	0.0347 vital	0.0319 Vital	0.0027 Vital	0.0264 Vital
4-5	0.1745 vital	0.2082 Non vital	0.2828 Non vital	0.0581 Vital
5-6	**0.8302 Non vital**	**0.710 Non vital**	**0.6208 Non vital**	0.1717 Vital

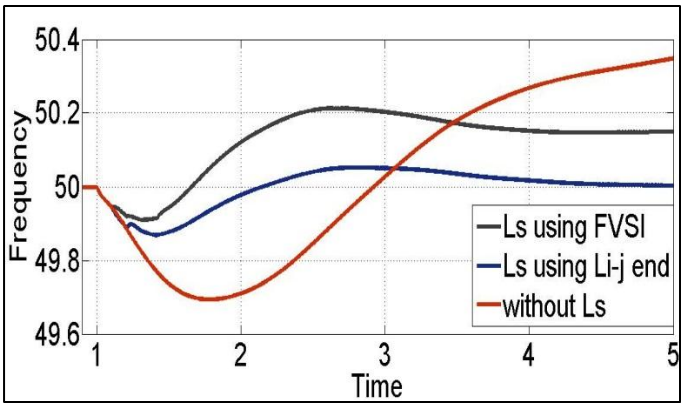

Fig.-5: Frequency response of overload (100 MW)

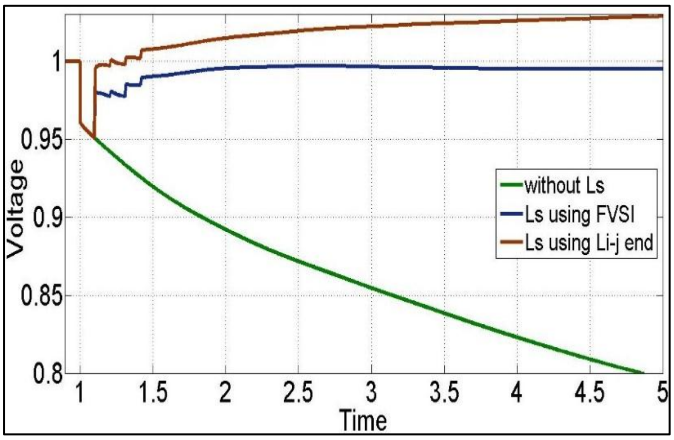

Fig.-6: voltage response of overload (100 MW)

Table-6: Value of line stability index and load category of overload 100 MW

Sequence No.	Value of Line stability Index value & Load Category			
Line no.	**100 MW**	**51.11 MW**	**26.61 MW**	**14.39 MW**
1-2	0.0726 Vital	0.0535 Vital	0.0429 Vital	0.0337 Vital
1-4	0.1241 Vital	0.1370 vital	0.1000 Vital	0.0997 Vital
1-5	0.1300 Vital	0.1151 vital	0.1032 Vital	0.1762 Vital
2-3	0.0068 Vital	0.0048 Vital	0.0039 Vital	0.0028 Vital
2-4	0.0176 Vital	0.1554 Vital	0.1131 Vital	0.1123 vital
2-5	0.0766 Vital	**0.3890 Non vital**	0.1690 Vital	0.1605 Vital
2-6	0.0127 Vital	0.2711 Non	0.4412 Non	**0.3270 Non**

		vital	vital	**vital**
3-5	0.110 Vital	0.0106 vital	0.0097 Vital	0.0092 Vital
3-6	0.1155 Vital	0.0864 vital	0.070 Vital	0.0618 Vital
4-5	0.1770 Vital	0.1161 Vital	0.1385 Vital	0.1342 Vital
5-6	**0.3076 Non vital**	0.1382 vital	**0.4923 Non vital**	0.1652 Vital

5.2 Case: Unexpected load change of 60 MW

The procedures in Table No. 7 are used to apply an unexpected 60MW overload. At bus number 5’1 a 60 MW load is applied at 1 second. The frequency dips to 49.8HZ after 1.8 seconds. The frequency settled at 50.25 Hz in the end. Furthermore, the voltage in the system continues to diminish. According to LS using SFR model, the amount of load shedding is 57.79 MW. According to FVSI value calculation in table 7 and load shedding amount estimated from SFR, first step shedding of 28.89 MW is applied on bus no. 5'1 at 1.1 sec. Following the procedures outlined in the approach, 14.44 MW is shed from bus 6'1 at 1.2 seconds, followed by 12.23 MW from bus 4'1 at 1.3 seconds, and bus 5'1 at 1.4 seconds. When these procedures are performed, the system becomes stable.

When an unexpected overload is applied at bus no. 5 at 1 second. At this moment frequency drop below 49.8 H_z at 1.8 second and voltage continue decreased at this moment load shedding amount is used which calculates by frequency response model a load shedding amount is 57.79 MW. After that calculate line index value of each line and which line near to 1 that transmission line considered zero. Table 8 shows the step and used the load shedding amount which derived from equation no. 8

The quantity of load shedding executed initially is 28.89 MW at bus number 5'1 at 1.1 second. Again step followed according table 8 and 14.44 amount of load is shed at bus no. 4’1 at 1.2 second. Then 12.23 mw load at bus no 6’1 at 1.3 second is shed. In the final stage, 12.23 MW is shed at bus no 4’2 at 1.4 second.

The frequency response and system voltage for this situation are shown in Figure 7,8. When the load shedding scheme is not used, Fig. 7,8 clearly indicates that when the system's sudden load increases, the voltage drops and the frequency increase. When a load of 57.79MW is shed in four steps without using the FVSI

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values of the lines, the minimum frequency reached 49.8 HZ. However, the system stabilizes around 50.30 Hz, which is outside of the desired range. When the load shedding scheme combines the SFR load shedding with the FVSI values of each line at each stage, system voltage also achieves 0.85 p. u. At 50.12 HZ, the frequency becomes steady. At 50.12 HZ, the frequency becomes steady. This frequency range is stable and. At 0.99 p. u., the system voltage also becomes steady.

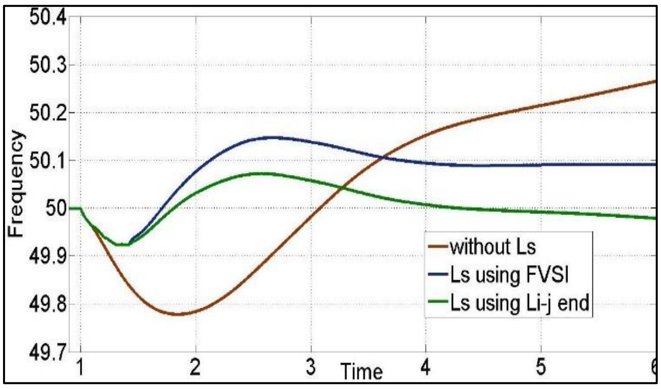

Fig.-7: Frequency response of overload (60 MW)

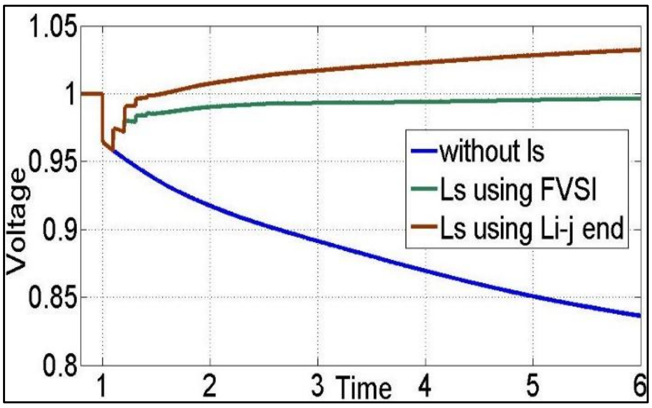

Fig.-8: voltage response of overload (60 MW)

Table-7: Value of fast voltage stability index and load category of overload 60 MW

Sequence No.	**Value of Fast Voltage Stability Index & Load Category**			
Line no.	**60 MW**	**35.51MW**	**21.07 MW**	**8.84 MW**
1-2	0.1916 Vital	0.1385 Vital	0.1071 Vital	0.0680 Vital
1-4	0.4092 Non vital	0.3764 Non vital	**0.6117 Non vital**	0.3281 Non vital
1-5	0.6037 Non vital	0.5278 Non vital	0.6096 Non vital	0.4090 Non vital
2-3	0.1496 Vital	0.1644 Vital	0.0850 Vital	0.0486 Vital
2-4	0.4833 Non vital	0.4419 Non vital	0.4136 Non vital	0.3858 Non vital
2-5	0.6283 Non vital	0.5481 Non vital	0.4539 Non vital	**0.4716 Non vital**
2-6	0.0478 Vital	0.0422 vital	0.0390 Vital	0.0318 Vital
3-5	**0.6852 Non vital**	0.6514 Non vital	0.4955 Non vital	0.4616 Non vital
3-6	0.0019 Vital	0.00017 Vital	0.0159 Vital	0.0129 Vital
4-5	0.1895 Vital	0.3276 Non vital	0.1370 Vital	0.1279 vital
5-6	0.4978 Non vital	**0.7291 Non vital**	**0.3904 Non vital**	0.3166 Non vital

Table-8: Value of line stability index and load category of overload 60 MW

Overload	**State**	**Without Load Shedding**	**Line stability index based Load shedding ($L_{i\text{-}j}$)**	**Fast voltage stability based load shedding**	**Frequency response model based load shedding**
100 MW	Min Frequency	49.65	49.9	49.9	49.9
	Stable frequency	50.40	50.0	50.15	50.5
	Stable voltage p. u.	0.75	1.04	0.99	0.95
60MW	Min Frequency	49.8	49.96	49.9	49.9
	Stable frequency	50.30	49.9	50.12	48.95
	Stable voltage p. u.	0.83	1.04	0.99	0.91

Table- 9: comparison of load shedding scheme

Sequence No.	Value of line index value & Load Category			
Line no.	**60 MW**	**35.51 MW**	**21.07 MW**	**8.84MW**
1-2	0.1533 Vital	0.0035 Vital	0.0757 Vital	0.0194 Vital
1-4	0.1140 Vital	**0.3754 Non vital**	0.2824 Non vital	0.0067 Vital
1-5	0.1473 Vital	0.1324 Vital	0.1082 Vital	0.0940 Vital
2-3	0.0033 Vital	0.0016 Vital	0.0005 Vital	0.0878 Vital
2-4	0.2126 Non vital	0.0419 Vital	0.0315 Vital	0.0074 Vital
2-5	0.1207 Vital	0.2145 Non vital	0.1741 Vital	0.1558 Vital
2-6	0.3168 Non vital	0.2697 Non vital	**0.2975 Non vital**	0.1115 Vital
3-5	0.0138 Vital	0.0010 Vital	0.0102 Vital	0.0100 Vital
3-6	0.0636 Vital	0.0515 Vital	0.0394 Vital	**0.2391 Non vital**
4-5	**0.9840 Non vital**	0.1706 Vital	0.1432 Vital	0.1227 Vital
5-6	0.3372 Non vital	0.1560 Vital	0.1105 Vital	0.09565 Vital

6. CONCLUSIONS

The main concerns in the power system are frequency and voltage instability, which can be caused by a sudden loss of generator, overloading, or transmission line damage. An advanced load shedding approach is used to maintain the voltage and frequency stability of the system within the standard range. Using Frequency response model base load shedding amount is calculated. While load shedding keeping in view the fast stability index as well as line stability index leads to more stable voltage and frequency range as shown in table 9. This method helps in the implementation of a rapid system stability solution. The scheme is more efficient as load shedding is more accurate and maintains system stability more precisely. This method has been evaluated in the IEEE 6 bus system power world simulator. It is concluded that load shedding amount as calculated by the system frequency response model along with FVSI and line stability index enables to identify the exact weakest lines and buses where are action should be taken. With the presented scheme both voltage and frequency stability can be achieved.

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