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Assessment of Sensitive Node for IEEE-30 Bus System by Load Variant

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***Abstract*—**Nowadays the load demand increases,these increases need to strengthen the system to fulfill the charge requirement reliably. To overcome such requirements, current systems have become more and more complex in nature. As of today.In this paper, we will have anemphasis on the weakness of most sensitive node in IEEE – 30 bus scheme. For this revision, we are using PSAT, a MATLAB Based Simulink & Simulation toolbox which utilizes L-index method for voltage strength analysis and sensitive nodes determination. For the evaluation of sensitive node, we have analyzed IEEE-30 bus system under the standard test data and then subjected to increase in load data by 5%, 10% and so on up to 40%. Moreover, then all the results are compared with the original power flow results of the IEEE-30 bus system for determining a furthermost sensitive node.

Keywords: *UVLS (Under voltage Load Shedding), SPS (System Protection Scheme), L-Index, Sensitive Node, PSAT (Power System analysis toolbox).*

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1. INTRODUCTION:

The main functions of an electric power system are to satisfy the system load requirement with a reasonable assurance of continuity and quality. The system's ability to provide and maintain anadequate supply of electrical energy is usually termed as reliability. The perception of power-system reliability is comprehensive and covers all aspects of the ability of the system to satisfy the customer requirements.Primarily, the interconnections were means for associated power systems in case of emergencies and sharing the responsibility for the frequency regulation in general operation, therefore reducing the load and expenses of each participant. As the generation in one power system tended to be less expensive than in another system, or the load centers were closer to the neighboring power system generation, interchange trans- actions were established, providing for these long-term contracts. As a result, thetimelineshave become internal lines to the entire interconnected grid and are an indispensable part of the whole load supply process.

In this paper, we emphasis on the determination of most sensitive node in IEEE -30 bus test system by increasing the load data by 5%, 10%, 15% and so on and the results are compared to the original power flow results of the IEEE-30 bus system. The blackout in July 2012 in India was the largest power outage in history and the investigation committee consisting of three members S. C. Srivastava, A. Velayutham and A. S. Bakshi issued its report on 16 August 2012. It concluded that four factors were responsible for the two days of blackout [5] They are Weak inter-regional power transmission corridors due to multiple existing outages (both scheduled and forced); high loading on 400 kV Bina–Gwalior–Agra link; inadequate response by State Load Dispatch Centers (SLDCs) to the

2. CLASSIFICATION OF POWER SYSTEM STABILITY

Power system stability is an only problem. Though, it is unreasonable to deal with it as such. Instability of the power system can take different forms and is subjective by a wide range of factors. Classification of stability greatly facilitates analysis of stability problems, counting identifying essential factors that contribute to instability and devising methods of improving stable operation into appropriate categories. These are based on the following considerations:

- The physical nature of the resulting instability related to the main system parameter in which instability can be observed.
- The size of the disturbance considered indicates the most appropriate method of calculation and prediction of stability.
- The devices, processes, and the time span that must be taken into consideration to determine stability.

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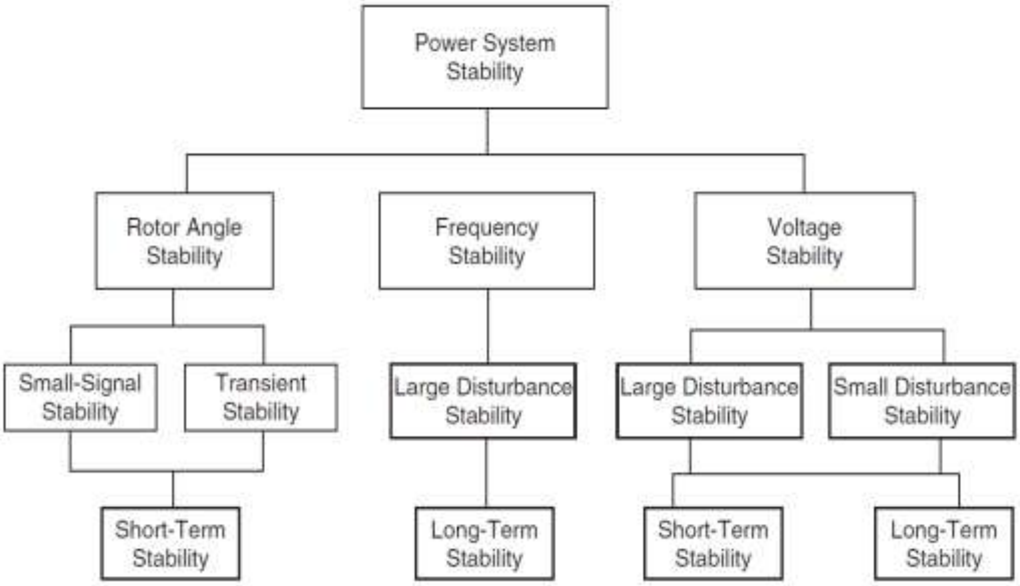

Figure 1. Possible classification of power system stability into different categories and subcategories.

3. IDENTIFICATION OF WEAK BUS L-INDEX

The best location for reactive power compensation for theimprovement of static voltage stability margin is byconsidering the identified “weakest bus” of the system. L-indexIdentify the weakest bus of the system [1] for a given loadcondition and is evaluated for all load buses. The estimatedvalue of L-index is varying between 0 and 1. Based on thisvalue, it is possible to identify the voltage stability margin. Ifthe assessed value approaches, 1 refers the voltage collapsewhere as the assessed value approaches 0 refers the under noloaddisorder. Otherwise, the system is under normal operatingcondition [1]. The high value of L indices indicates the mostcritical buses in the system, and thus a maximum of L-indices isan indicator of proximity in the system to represent voltagecollapse. TABLE- I show that bus 15, bus 18, bus 19, and bus23 are considered as the best location to provide desiredreactive power support [1].

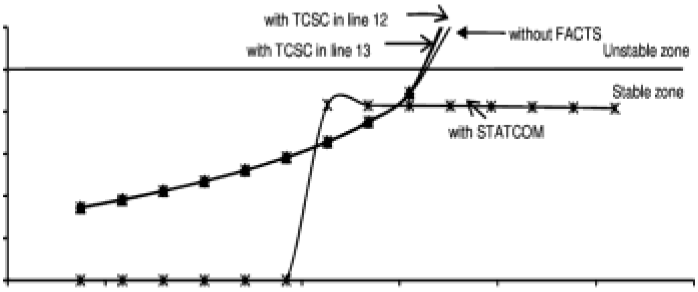

Figure 2. Variation in L-index of weakest bus under different operating condition

4. INTRODUCTION TO UNDER VOLTAGE LOAD SHADING

A collapse of the tension of part of the electrical system is a suggestion that for the existing conditions and contingencies, some portion of the combined generation and transmission system has been operated beyond its capability. Voltage collapse can also be a symptom of a much larger problem, and when the system starts to collapse, there is a real danger that the localized problem will cascade into wider areas. The purpose of proper system planning and operating philosophies is for the system to function reliably, and failing that, to contain the impacts of disturbances to localized areas. While UVLS is not mandatory for member systems, it can be a useful tool to protect the system from voltage collapse or unrestrained loss of load or cascade. Voltage collapse or uncontrolled loss of load or cascading may occur, for instance, when sending sources are far enough removed from an area that tension at its loads experiences a important drop, especially during outage contingencies. System studies are needed to determine which systems are the potential candidates for a suitable UVLS scheme. It is most useful in a slow-decaying voltage system with the under-voltage relay time delay settings typically between 3 to 10 seconds. When overloads occur on long transmission lines in conjunction with a significant local voltage dip, then the effect of UVLS action would also be to alleviate such overloads.

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5. ANALYSIS AND RESULTS OF IEEE TEST BUS SYSTEM

In the proposed solution we are experimenting with IEEE-30 bus system. This study has been done using PSAT a Matlab based Simulink & Simulation tool used for Power System Analysis. For doing so, we have designed a Simulink model of IEEE- 30 bus system & have used the standard test data for it as shown in Figure.1The power flow study will be done on the IEEE-30 bus test system using theNewton-Raphson method in PSAT tool used for Power System Analysis. Now after the power flow study we would be increasing the load data by 5%, 10% and so on up-to 40% which are connected at bus no:2, 3, 4, 5, 7, 8, 10, 12, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 26, 29 & 30 respectively. After changing the load values 5% we have performed power flow analysis and have tabulated the results as shown the voltage values as shown in table-I &have repeated the process for 10% change in load value, then 15% and so on upto 40% whose power flow result is tabulated below in Table-I.

	OPF	5% change	10% change	15% change	20% change	25% change	30% change	35% change	40% change	AVG.	DIFF.
V1	1.0600	1.0600	1.0600	1.0600	1.0600	1.0600	1.0600	1.0600	1.0600	1.0600	0
V2	1.0450	1.0450	1.0450	1.0450	1.0450	1.0450	1.0450	1.0450	1.0450	1.0450	0
V3	1.0613	1.0613	1.0612	1.0612	1.0612	1.0612	1.0611	1.0611	1.0611	1.0612	0.0001
V4	1.0474	1.0473	1.0471	1.047	1.0468	1.0467	1.0465	1.0463	1.0461	1.0467	0.0007
V5	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	0
V6	1.0396	1.0393	1.0391	1.0388	1.0386	1.0383	1.0380	1.0378	1.0375	1.0384	0.0012
V7	1.0157	1.0149	1.0141	1.0133	1.0125	1.0117	1.0109	1.0100	1.0092	1.0121	0.0036
V8	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	0
V9	1.0270	1.0248	1.0226	1.0203	1.0179	1.0154	1.0129	1.0101	1.0075	1.0164	0.0106
V10	0.9947	0.9907	0.9866	0.9824	0.9781	0.9737	0.9691	0.9644	0.9595	0.9756	0.0190
V11	1.0820	1.0820	1.0820	1.0820	1.0820	1.0820	1.0820	1.0820	1.0820	1.0820	0
V12	1.0369	1.0351	1.0333	1.0315	1.0295	1.0276	1.0255	1.0234	1.0212	1.0284	0.0085
V13	1.0710	1.0710	1.0710	1.0710	1.0710	1.0710	1.0710	1.0710	1.0710	1.0710	0
V14	0.9940	0.9895	0.9849	0.9802	0.9753	0.9703	0.9652	0.9599	0.9545	0.9725	0.0215
V15	0.9517	0.9449	0.9379	0.9308	0.9235	0.9160	0.9083	0.9003	0.8922	0.9192	0.0324
V16	1.0075	1.0042	1.0008	0.9973	0.9937	0.9899	0.9862	0.9823	0.9783	0.9916	0.0159
V17	0.9914	0.9872	0.9829	0.9786	0.9741	0.9694	0.9647	0.9598	0.9548	0.9714	0.0199
V18	0.9484	0.9415	0.9344	0.9272	0.9198	0.9122	0.9044	0.8964	0.8881	0.9155	0.0328
V19	0.9511	0.9445	0.9376	0.9307	0.9235	0.9161	0.9086	0.9008	0.8928	0.9193	0.0318
V20	0.9608	0.9547	0.9485	0.9421	0.9356	0.9289	0.9219	0.9149	0.9075	0.9318	0.0290
V21	0.9744	0.9694	0.9642	0.9589	0.9535	0.9479	0.9422	0.9363	0.9302	0.9503	0.0241
V22	0.9746	0.9696	0.9645	0.9592	0.9538	0.9483	0.9426	0.9367	0.9307	0.9507	0.0239
V23	0.9449	0.9380	0.9310	0.9239	0.9165	0.9089	0.9012	0.8933	0.8851	0.9122	0.0326
V24	0.9486	0.9424	0.9361	0.9296	0.9229	0.9162	0.9092	0.9020	0.8946	0.9191	0.0294
V25	0.9667	0.9627	0.9586	0.9545	0.9501	0.9457	0.9412	0.9364	0.9316	0.9476	0.0191
V26	0.9404	0.9349	0.9293	0.9236	0.9177	0.9117	0.9056	0.8992	0.8927	0.9144	0.0260
V27	0.9909	0.9890	0.9871	0.9851	0.9830	0.9808	0.9786	0.9762	0.9738	0.9817	0.0092
V28	0.9967	0.9952	0.9937	0.9922	0.9906	0.9889	0.9871	0.9853	0.9835	0.9896	0.0071
V29	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0
V30	0.9669	0.9645	0.9621	0.9596	0.9570	0.9544	0.9518	0.9490	0.9462	0.9556	0.0113

NOTE: OPF in TABLE I represents the Original Power Flow results. After obtaining the power flow result at each change is tabulated and anaverage of each change is estimated. Then after obtaining the average, we have subtracted the average power flow value to original power flow result. The voltage at the bus where the difference is most is considered as the most sensitive load. From Table-I it is clear that the voltage profile is weak on buses 15, 18, 19, and 23 when they undergo percentage changes in load that results in voltage collapse.

6. CONCLUSION

In this paper I have concluded that the voltage profile is weak at bus 15, bus 18, bus 19, and bus 23 when they undergo percentage change in load which may cause voltage collapse. Hence, a special protection scheme can be applied to these buses to avoid this problem of voltage collapse.

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