Transient Stability Analysis of Typical Power System Scheme for Offshore Platform

Supriya Rakshit
Dept. of Electrical Engineering
Parul Institute of Engineering and Technology Vadodara, India
sup2624rak@gmail.com

Prakash Makhijani
OHMENCON Pvt. Ltd.
prakash@ohmencon.com

Falguni Bhavsar
Dept. of Electrical Engineering
Parul Institute of Technology
Vadodara, India
falu_29@ymail.com

***Abstract*— Recently, the security and stability of power system are the concerned issues, especially the transient stability. In this paper, typical offshore power system scheme is modeled in detail in order to assess the transient stability. Transient stability is important in such cases because the system is isolated from grid and even small disturbance can make generator to go out of step. Further, the computation of critical clearing time (CCT) in different scenarios is proposed and simulation is also done to analyze the different characteristic. The result of CCTs in different scenarios can evaluate the impact of transient stability.**

Index Terms— **Critical clearing time, ETAP, typical offshore power system scheme, transient stability.**

I. Introduction

Electrical power systems are highly complex and dynamic in nature: circuit breakers are closing and opening, faults are being cleared, generation is varying in response to load demand, and the power systems are subjected to atmospheric disturbances, that is, lightning[1]. Assuming a given steady state, the system must settle to a new acceptable steady state in a short duration. Power-system stability is a term applied to alternating current electric power systems, denoting a condition in which the various synchronous machines of the system remain in synchronism, or "in step," with each other. Conversely, instability denotes a condition involving loss of synchronism, or falling "out of step." Transient stability is the ability of the power system to maintain synchronism when subjected to a severe transient disturbance [2].

II. FACTORS INFLUENCING TRANSIENT STABILITY

Transient stability of the generator is dependent on the following: [3][4]

- How heavily generator is overloaded
- Generator output during fault.
- Fault clearing time
- Post fault transmission system reactance
- Generator reactance
- Generator inertia
- Infinite bus voltage magnitude
- Generator internal voltage magnitude.

III. CLASSIFICATION OF TRANSIENTS

Transient are studied in two categories, based upon on their origin: [5]

- Of atmospheric origin, that is lightning
- Of switching origin, that is, all switching operations, load rejection and faults.

Another classification can be done based upon mode of generation of transients: [6]

Electromagnetic transients - Generated predominantly by the interaction between the electrical fields of capacitance and magnetic fields of inductances in the power systems. The electromagnetic phenomena may appear as traveling waves on transmission lines, cables, bus sections, and oscillations between inductance and capacitance

Electromechanical transients - Interaction between the electrical energy stored in the system and the mechanical energy stored in the inertia of the rotating machines, that is, generators and motors.

IV. TRANSIENT STABILITY ANALYSIS OF TYPICAL POWER SYSTEM SCHEME FOR OFFSHORE PLATFORM

Single line diagram of typical power system scheme for offshore platform where generator turbine runs on gas which comes out from oil is shown below. Transient stability is important since system is isolated and not connected to main grid and even a small disturbance can make the generator to go out of step. Depending on critical clearing angle the time required should be estimated because of the presence of dc component.

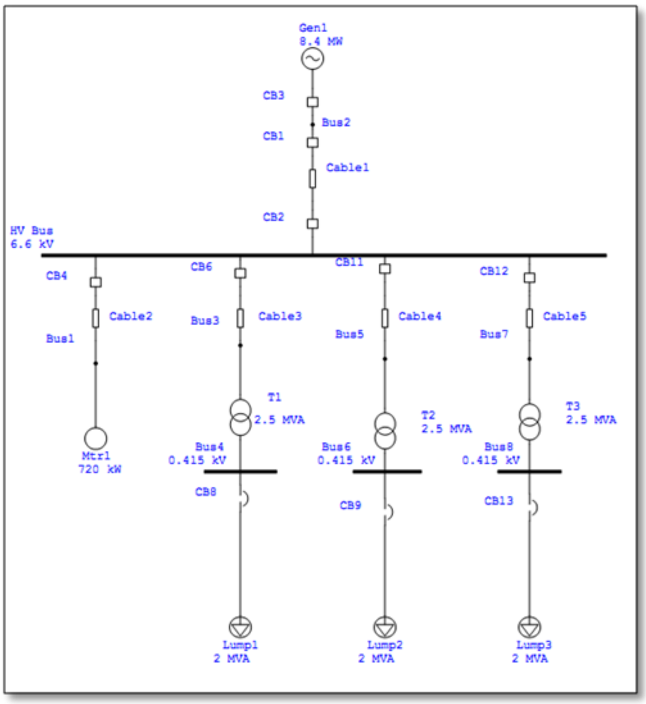

Fig. 1. Single Line Diagram of Offshore Platform

To analyze the impact of external fault on above mentioned scheme, the computer simulation for contingency cases has been carried out. In this paper several fault cases at power plant that serves industrial customers have been considered. By screening contingencies, cases are selected for load flow analysis and transient stability analysis to verify the effectiveness of fault.

Case1

This case simulates the contingency when a three phase short circuit occurs at HV bus in fig. 1. Due to low inertia of generator results in the collapse of the whole power system scheme because of decay in system frequency. The fault is cleared in 0.3secs. According to simulation, system frequency is then reduced further to 48 Hz and then restored to 50 Hz after transient frequency oscillation

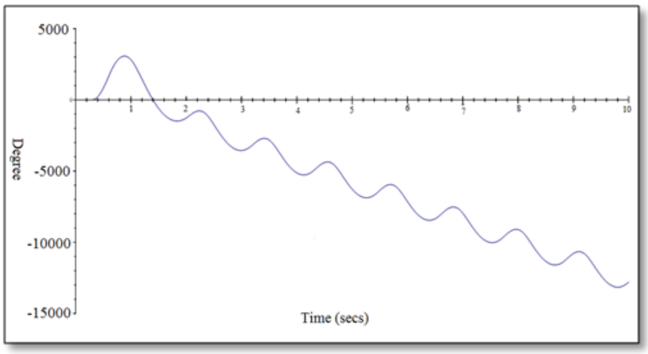

Fig. 2. Absolute angle response of Generator during fault at HV bus

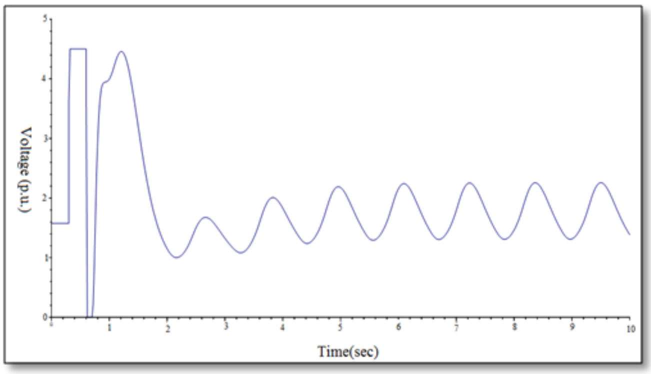

Fig. 3. Voltage response of Generator during fault at HV bus

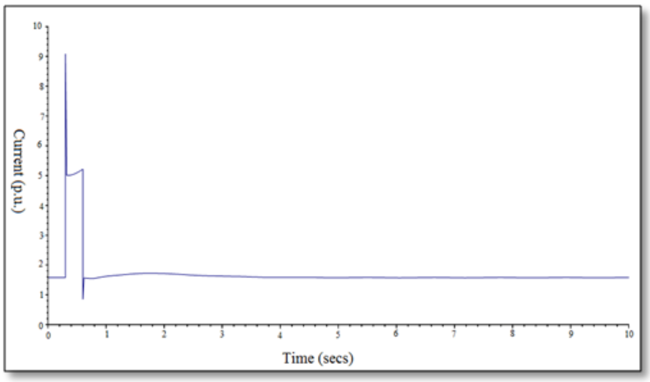

Fig. 4. Current response of Generator during fault at HV bus

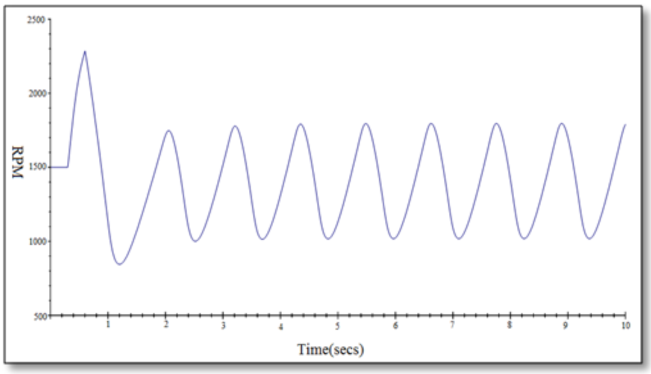

Fig. 5. SPEED response of Generator during fault at HV bus

Case2

This case simulates the contingency when circuit breaker i.e. CB12 is opened as shown in fig. 1. According to simulation, system frequency is then reduced further to 48 Hz and then restored to 50 Hz after transient frequency oscillation.

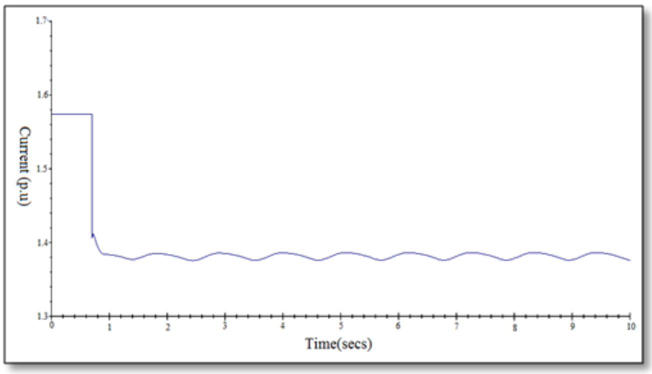

Fig. 6. Current response of Generator when CB12 is open

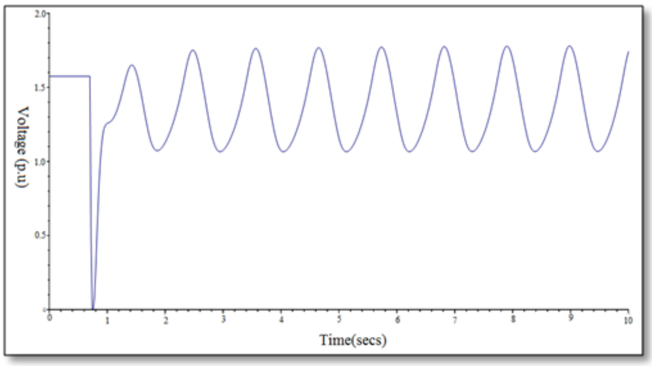

Fig. 7. Voltage response of Generator when CB12 is open

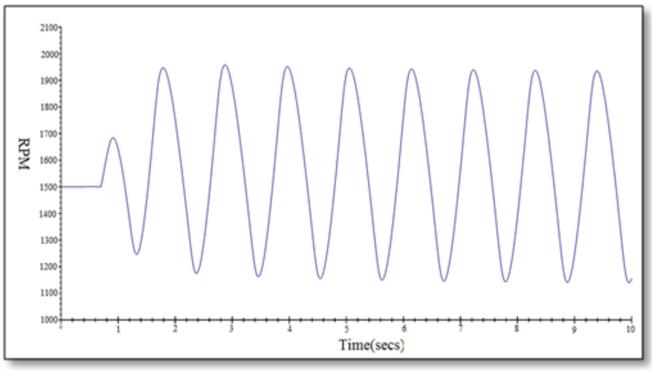

Fig. 8. SPEED response of Generator when CB12 is open

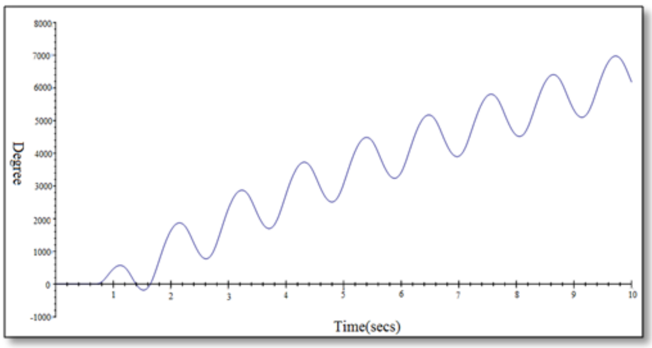

Fig. 9. Absoulte angle response of Generator when CB12 is open

V. MITIGATION

The drawback can be overcome by increasing the rating of the generator or the system can be stabilized by increasing the inertia of the system. To minimize the effect of transients the generator's inertia is increased and again simulation is carried out. After analysis it has been found that the system is easily stabilized with same fault level in HV bus as in previous studies.

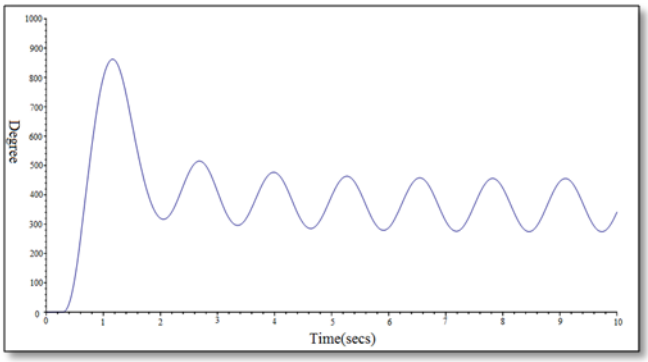

Fig. 10. Absolute angle response of Generator when inertia is increased

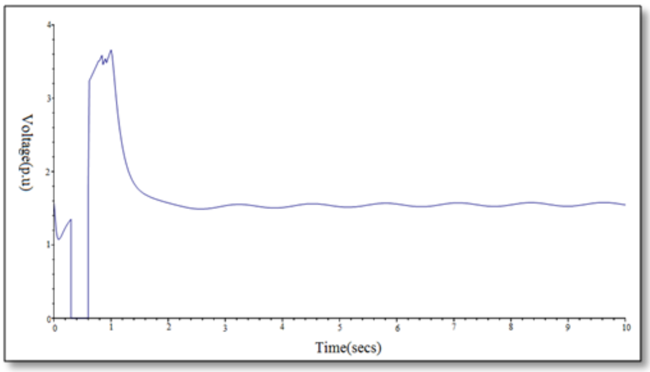

Fig. 11. Voltage response of Generator when inertia is increased

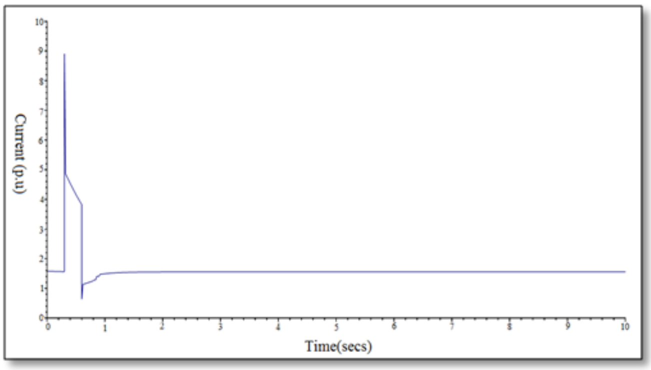

Fig. 12. Current response of Generator when inertia is increased

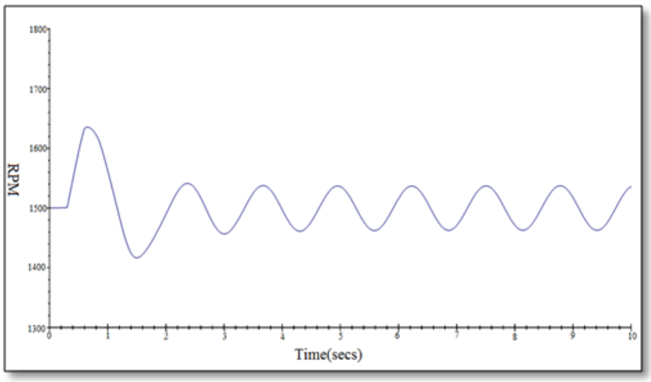

Fig. 13. SPEED response of Generator when inertia is increased

VI. CONCLUSION

Transient stability is the ability of the power system to maintain synchronism after subjected to severe disturbance. The synchronism is assessed with relative rotor angle violations among the different machines. Accurate analysis of the transient stability requires the detailed modeling of generating units and other equipment. Transient stability is critical in offshore plant which is isolated from the grid. Even small disturbance can make the generator to go out of step. This analysis allows to assess that the system is stable, unstable and also allows to determine the critical clearing time of power system with three-phase faults.

REFERENCES

[1] P.Kundur, "Power system stability and control," McGraw-Hill International Editions, 1994.

[2] Devender Kumar and Balwinder Singh Surjan, "Transient Stability of a Multi Machine Power System," International Journal of Engineering and Advanced Technology, Volume-2, Issue-4, April 2013.

[3] Hadi sadat, "Power system analysis," McGraw-Hill International Editions, 1999.

[4] John J Grainer and Willam D Stevenson, "Power system analysis," McGraw-Hill International Editions, 1999.

[5] I. J. Nagrath and D. P. Kothari, "Modern Power system analysis," Tata McGraw-Hill, 2003.

[6] Gundala srinivasa rao and A.Srujana, "Transient Stability Improvement of Multi-machine Power System Using Fuzzy Controlled TCSC," International Journal of Advancements in Research & Technology, Volume 1, Issue 2, July-2012.