International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Analysis of OCR and DFR Relay Coordination on Transmission Lines

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ABSTRACT—

The electrical energy landscape undergoes continuous transformations throughout the years, with a growing inclination towards renewable energy sources as opposed to traditional thermal power generation facilities. The current generations are driven by the desire for access to high-quality power while taking into account economic factors. The primary purpose of the protection system is to promptly detect and separate the faulty sections from the functional sections of power systems within a certain timeframe, in order to prevent significant disruptions in power supply. Electrical power systems are susceptible to a range of symmetrical and unsymmetrical errors, as well as short circuits. Transformer protection is achieved through the utilization of protective relays, namely OCR and GFR. The proposed testing system is deployed on the ETAP platform and the outcomes are assessed. The Time Multiplier Setting (TMS) calculations are derived from the plots of Time Current Characteristics.

Keywords— Over Current Relay, Differential Relay, Wind power system, ETAP, Short Circuit Analysis, Load Flow Analysis

I.INTRODUCTION

Any electricity network needs protective relays to quickly deactivate faulty components to prevent system interruption and maintain network efficiency. After primary relay functionality stops, backup relays take over. The protective relay should distinguish normal, abnormal, and fault conditions.[1] Relay coordination involves identifying, selecting, and protecting against threats. Economically expanding nations use power more. Electrical firms use more complex networks. In order to ascertain the minimum margin of divergence of a relay and the back-up relays in an intricate electrical system, it is necessary to conduct a load flow evaluation, fault calculations, and compile a list of primary and stand by pairs. [2-4] It will also take several TMS calculation iterations. Only computer programming can do this. The ETAP load schedule program can monitor and report voltage and short-circuit current for 10,000,000 load items. In addition to 10,000,000 load items, it can manage 1000 buses. Due to rising load demand, power system designers and operators worldwide are concerned about system reliability and efficacy. Since its penetration has increased, Distributed Generation

(DG) in Distribution systems can now cover most load needs. DG units affect voltage stability, frequency deviation, and relay coordination, thus they must be carefully examined.[5] This work introduces a new relay coordination approach for wind turbine generator dependability evaluation. Change the pick-up value, PSM, and TDS to synchronize visually and physically. Further reliability testing is done

II. RENEWABLE POWER

A. Wind Power Forecasting

The system under consideration encompasses Wind Energy Conversion Systems (WECS), Diesel generators, and Solar generators. The performance study on ETAP load flow and short circuit analysis has been conducted. The assessment of relay coordination for different faults has been conducted, along with an examination of the behavior of distributed generators (DGs) during faults. This study provides a comprehensive analysis of the proposed test system across several operational scenarios including the aforementioned kinds of distributed generators (DGs). [15]

III. PROPOSED METHODOLOGY

A. Effect of WT Generation System on RC Digital grid (DG) systems distribute the load at their point of contact inside the electrical grid. The load can be handled by both islanding and non-islanding diesel generators. Distributed generation (DG) has the potential to induce fault current, so altering the amplitude and direction of the power flow, often characterized by uni-directionality. Every energy grid zone encompasses at least one aspect and aims to decrease the time required to clear faults.[16,17] The investigation of relay qualities involves the analysis of time current characteristic curves. The min and max curves of the relay are modified by TDS. Primary and backup protection are the two forms of protection that are offered. Backup security is the subsequent layer of protection that follows primary security measures. Backup security must exhibit greater resilience to faults compared to primary security, and it should also have a longer lifespan. The coordination time interval (CTI) refers to the temporal disparity between the tripping times of the primary and secondary relays. Typically, the duration ranges from 0.2 to 0.5 seconds. [18] Proposed System has been shown below in Fig. 1 developed on ETAP.

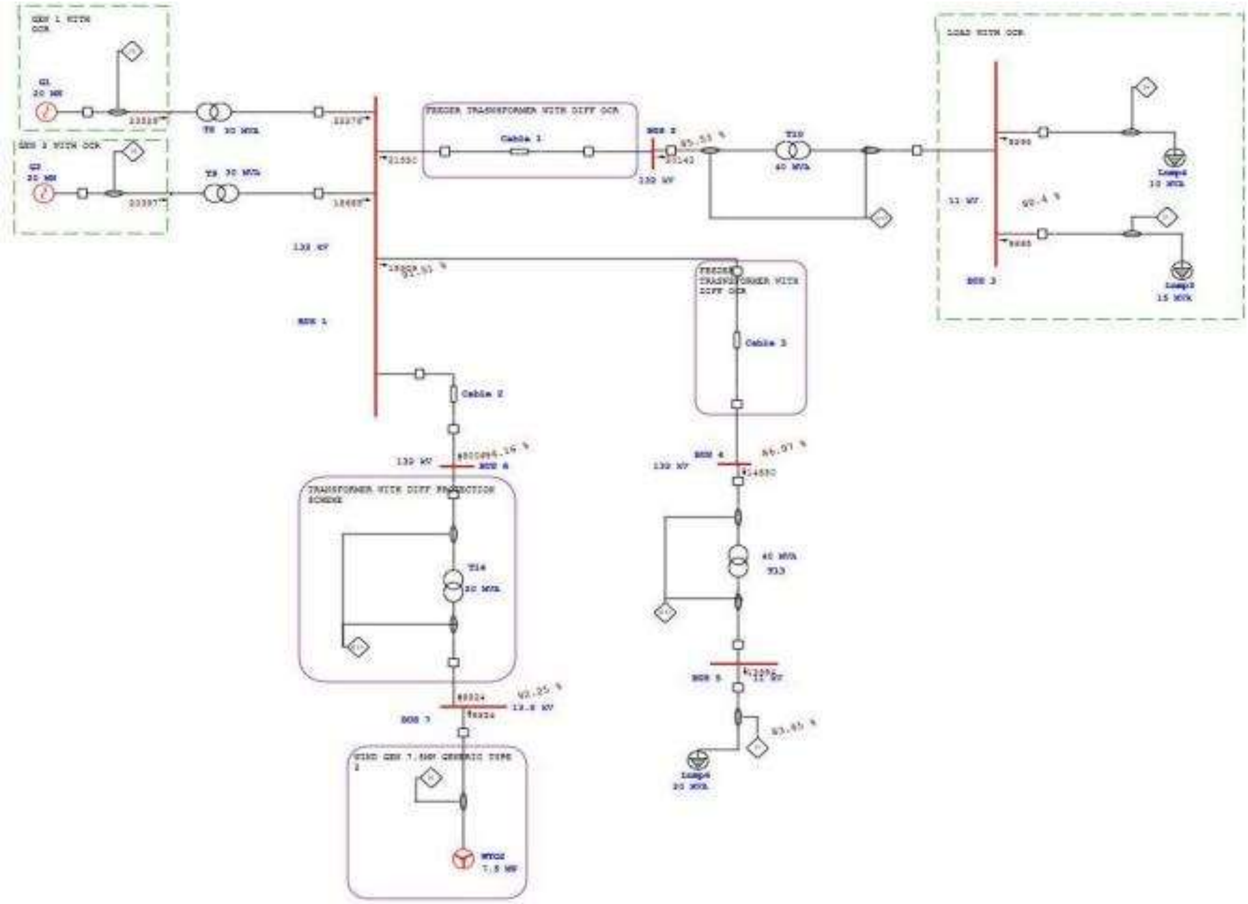


Figure 1: RES Integrated Network

B. Load Flow Analysis The proposed system underwent a LFA utilizing the ANRI method with 99 iterations and 10e4 accuracy.[19-20] Power flow at each bus is shown in the fig 3for the overall system and the WTG linked bus. Fig 1 shows the LFA study case editor to illustrate the approach. The LFA with 0 MW power discrepancy reports, bus loading, branches, branch losses, bus inputs, cables, transformers, generations, and others. [21]

C. Short Circuit Analysis

When used, electrical system and computer networks often malfunction. The network's devices' internal electromotive forces and system and network impedances control current flow during a malfunction. However, computer reactance changes from their original value to a range of values before a flaw is corrected. Net impedance may change if switching approaches solves the problem. Thus, SC current readings must be taken frequently when errors occur.[22-24]

D. RCA(RCA)

Also consider the following criteria for system devices: The feeder's OC relay CC must be below overload and short circuit damage curves on the TCC scale. The feeder's over current relay coordination curve should be greater than its ampacity curve. The transformer's synchronization curve should be lower than its damage to structure and thermal damage curves. Ensure OC relay synchronization curves for XMERs exceed transformer ampacity curves and synchronize inrush stages. The generator's over current relay synchronization curve should be higher than its maximum load ampere curve and lower than the decrement and overload curves.

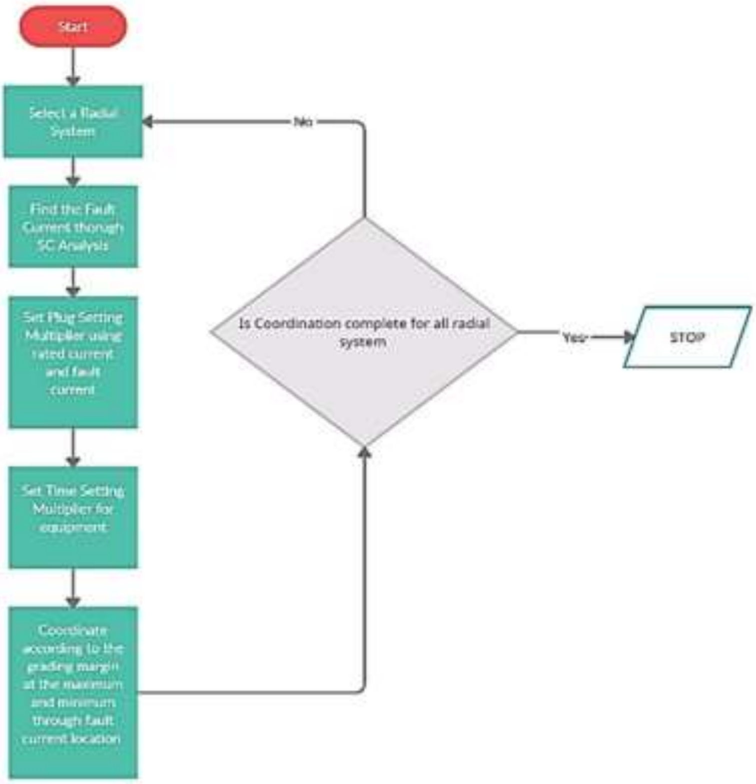


Fig 2: RCA Flow Chart

E. Reliability Assessment

By integrating these three basic indicators, namely the consumers connected at every loading point in a network and the customer disruption expense, it is possible to derive two extended sets of indices that encompass the size or significance of system failure. [30-32] There exists a collection of machine reliability indices.

$$\text{SAIFI} = \frac{\text{Total number of customer interruptions}}{\text{Total number of customers served}}$$

$$\text{SAIDI} = \frac{\text{Sum of all customer interruption durations}}{\text{Total number of customers served}}$$

$$\text{CAIDI} = \frac{\text{SAIDI}}{\text{SAIFI}} = \frac{\text{Sum of all customer interruption durations}}{\text{Total number of customer interruptions}}$$

$$\text{ASAI} = \frac{\text{SAIDI}}{\text{SAIFI}} = \frac{\text{Customer hours service availability}}{\text{Customer hours service demanded}}$$

ASUI =1-ASAI

These particular criteria are employed to assess the overall efficiency of the distribution system. The reliability cost/worth indices are an alternative set of measures. Expected Energy Not Supply (EENS),

$EENS_i = P_i U_i$

Expected Cost of Interruptions (ECOST),

$ECOST_i = P_i \sum_{j \in N_e} f(r_{i,j}) \lambda_{e,j}$

IEAR= ECOST / EENS

Either of these indices assess the dependability of a functioning electricity supply and protection system, offering valuable strategic information for improving both existing and future distribution systems. Furthermore, the reliability indexes

EENS or ECOST can be analyzed by considering the element inputs and their respective rankings, which can provide insights into the index's susceptibility to component breakdown rates. It is possible to rate either just one load area or an entire structure with loads at various locations.

IV. RESULTS AND DISCUSSION

The LFA for the complete system has been shown below in the Fig 2 and Fig 3 describes the power flow at bus 7. From the FIG 4 its can clearly seen that total generation by each generations is 21.368 MVA, 28.451 MVA and 6.985 MW respectively, and total demand in the system is 41.134 MVA.

The SCA was performed on the system wherein the fault was generated at the various buses. Fig 4 shows the fault currents at bus 7 for LLL faults, LG faults, LL faults, and LLG faults. The LL fault current values are used then to set the CT ratio and pick up current for the analysis purpose.

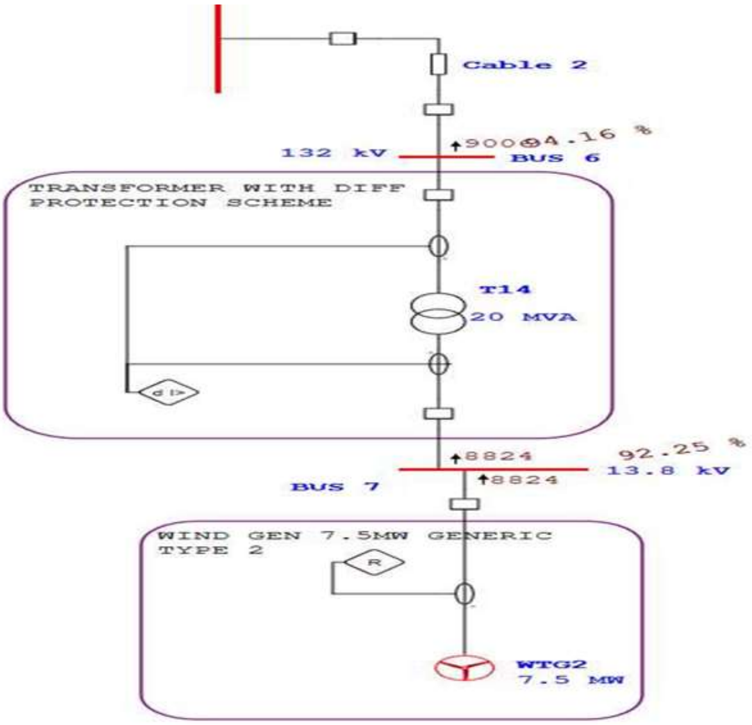


Fig. 3: LFA At bus 7

RA was performed on the entire system with Average Failure Rate and Average Outrage Duration. AFR, PFR and MRR for the CB are 0.0156, 0.1298, and 194.125, respectively. The Mean Time to Failure (MTTF) is determined automatically using λA and λP and is 27.5 years, while the default MTTR is 5.6 hrs. Relay coordination using Star View was successful. System relay sequences are coordinated by the sequence analyzer. Fig 6 shows relay coordination when bus 7 faulted. First, relay 12 near bus 7 functioned at fault current of 2.458 kA at 11ms. A 70-ms C.B. 21 trip with OC50 forwarded. Fig 8 shows CB operating when a transformer fault was detected and relay coordination was established. Isolating the problematic system from the healthy system showed that the CB tripped in the correct sequence. The TCC for the WTG System shows that Relay no twelve is regarded with the Very Inverse Time Characteristic with OC67 as Directional Overcurrent Relay safety for the transformer. The location used ALSTOM P343 manufacturer MiCOM. The Fig shows Relay 12 parameters like PSM , TDS, and others. The ground fault TCC curve is shown in Fig 11, whereas the phase fault curve is shown in Fig 9.

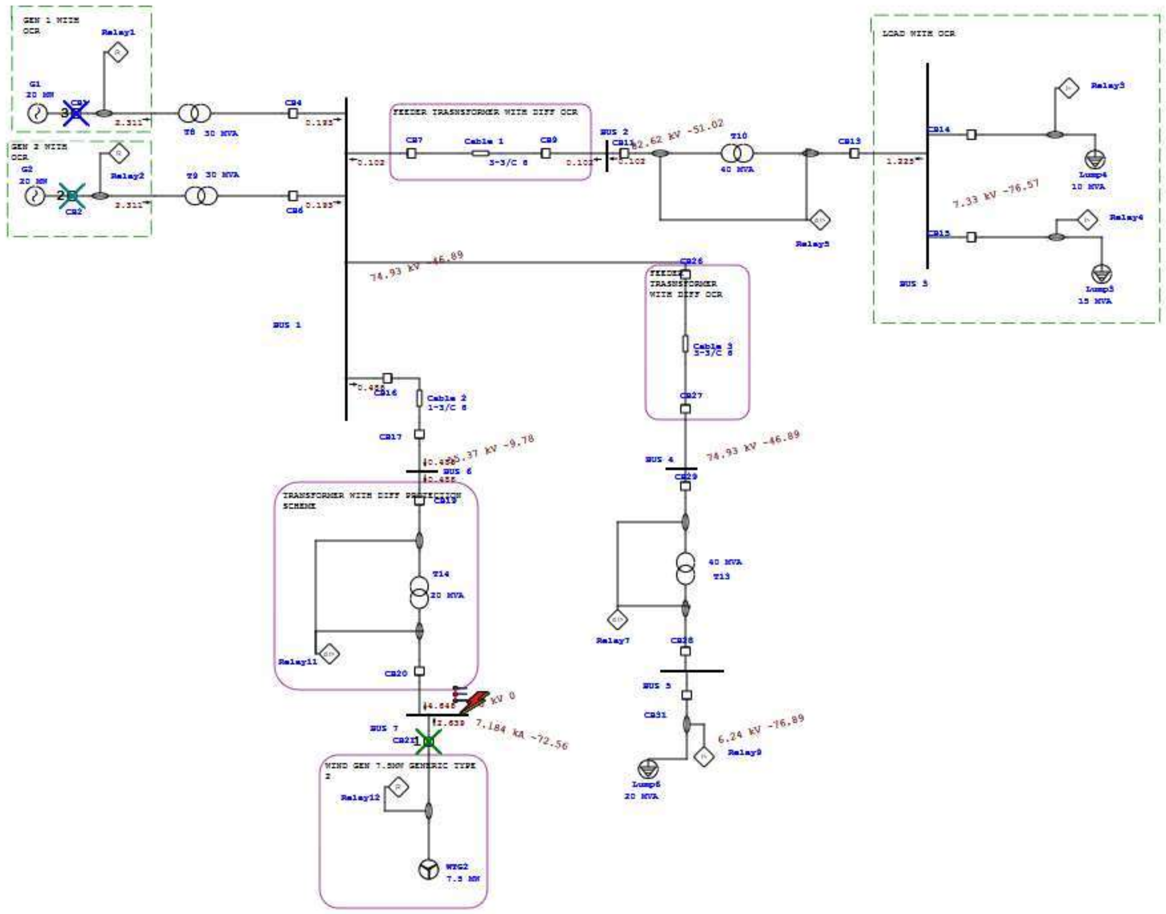
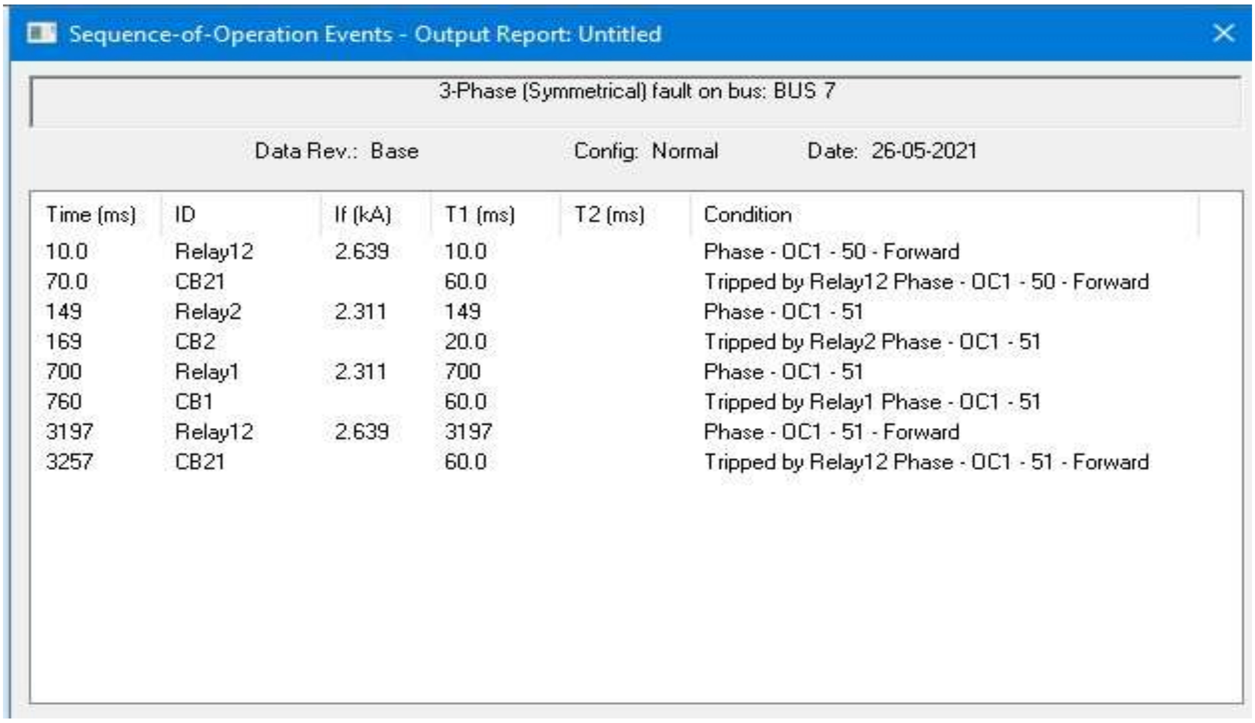


Fig 4: RCA at 7 bus


Sequence-of-Operation Events - Output Report: Untitled

3-Phase (Symmetrical) fault on bus: BUS 7

Data Rev.: Base Config: Normal Date: 26-05-2021

Time (ms)	ID	If (kA)	T1 (ms)	T2 (ms)	Condition
10.0	Relay12	2.639	10.0		Phase - OC1 - 50 - Forward
70.0	CB21		60.0		Tripped by Relay12 Phase - OC1 - 50 - Forward
149	Relay2	2.311	149		Phase - OC1 - 51
169	CB2		20.0		Tripped by Relay2 Phase - OC1 - 51
700	Relay1	2.311	700		Phase - OC1 - 51
760	CB1		60.0		Tripped by Relay1 Phase - OC1 - 51
3197	Relay12	2.639	3197		Phase - OC1 - 51 - Forward
3257	CB21		60.0		Tripped by Relay12 Phase - OC1 - 51 - Forward

Fig 5: Sequence of Operation of Events when fault at bus 7

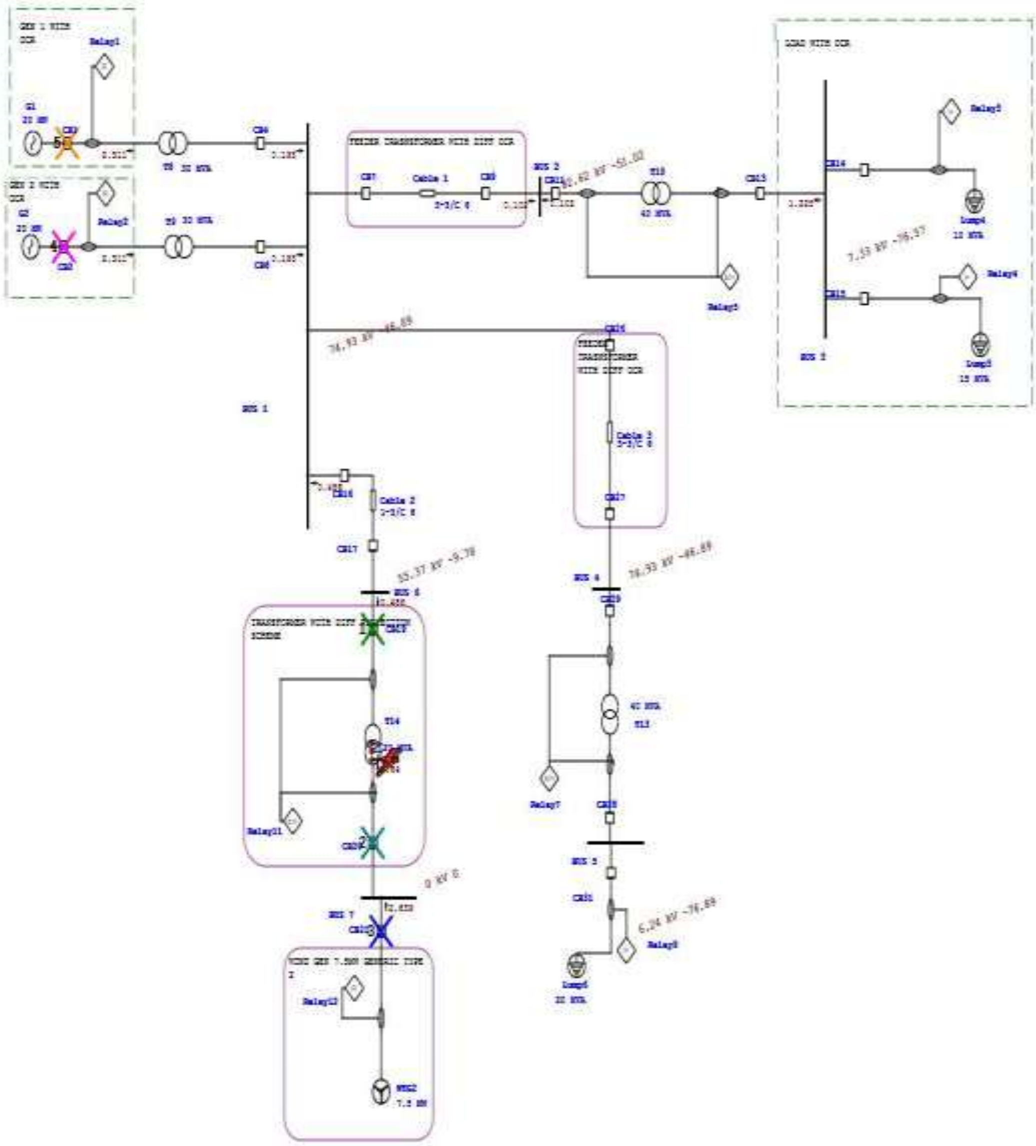


Fig 6: RCA for internal Fault

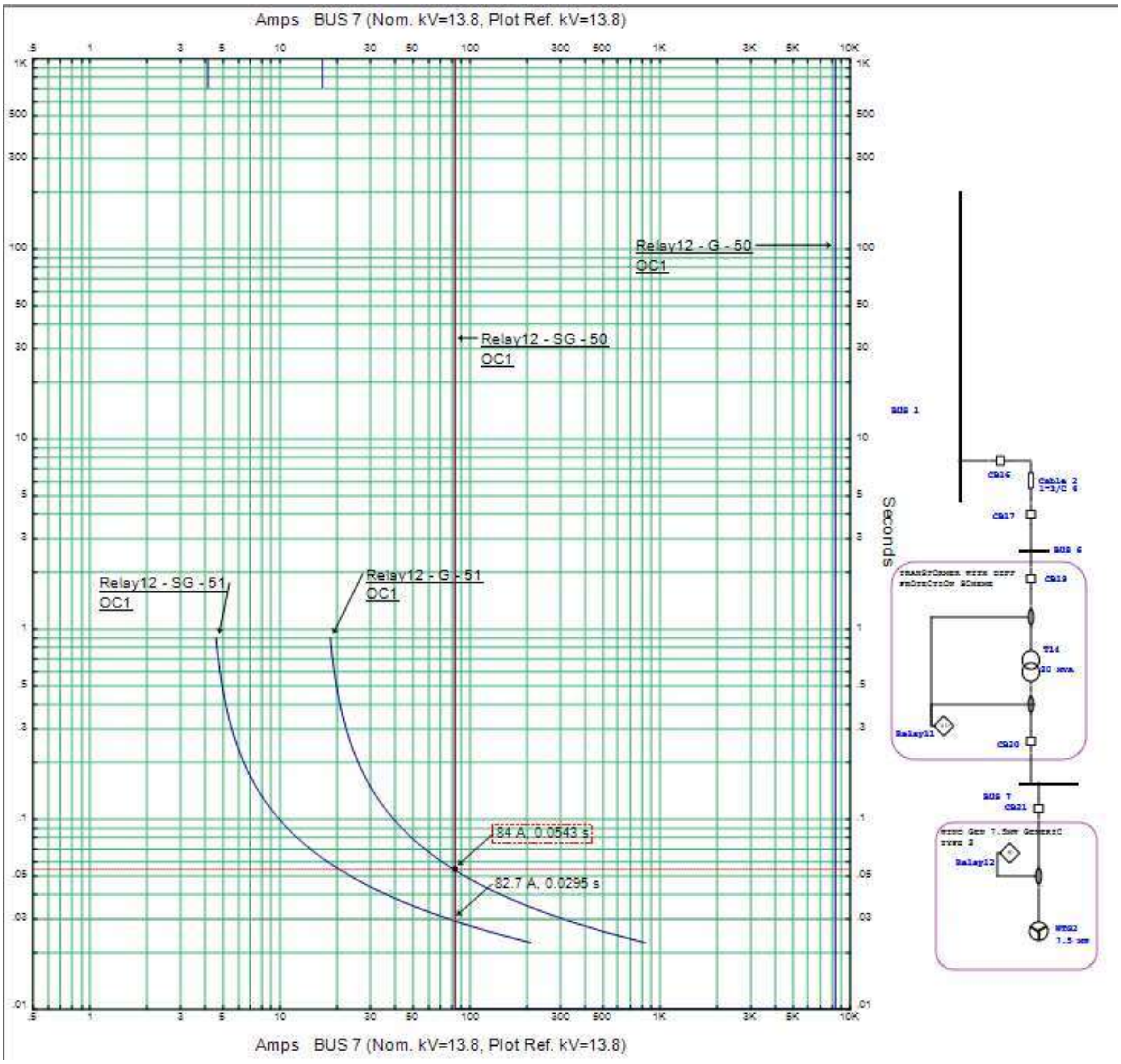


Fig 7: TCC for WTGS

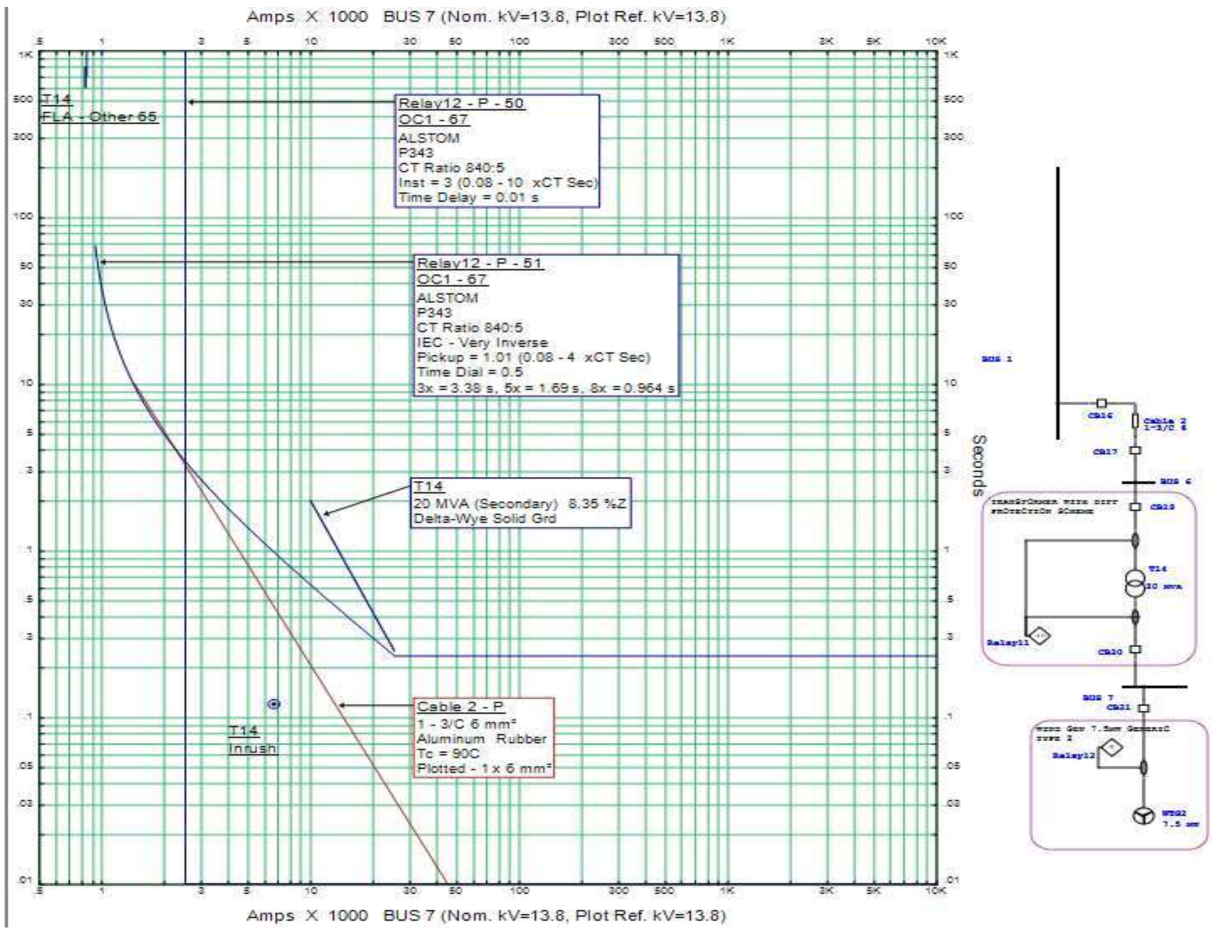


Fig 8: TCC for WTGS

V. CONCLUSION

As shown in the previous sections, the system's LFA, SCA, RA and RCA results show that relay coordination requires more than just setting relay settings. LFA is utilized in the RCS to determine and modify relay, circuits breakers, and current transformer configurations by estimating the average power flow, crucial and margin status of components, as well as the SCA values. A specialized approach coordinates relays and CBs in WTG systems. Coordination issues plague WTG integration. Maxing out the relay's pickup, clock dial, trip device, and low voltage circuit breaker promotes synchronization. Dependability tests measure network security without upsetting clients. ETAP simulates. Multiple safety procedures are activated after a 3-phase or single L-G failure. Using a consistent way to evaluate coordination and dependability for a large integrated system is tough. ETAP software improves speed and accuracy by reducing manpower and protective device failure. System reliability enhanced. Improving vast, linked power network safety yields greater results.

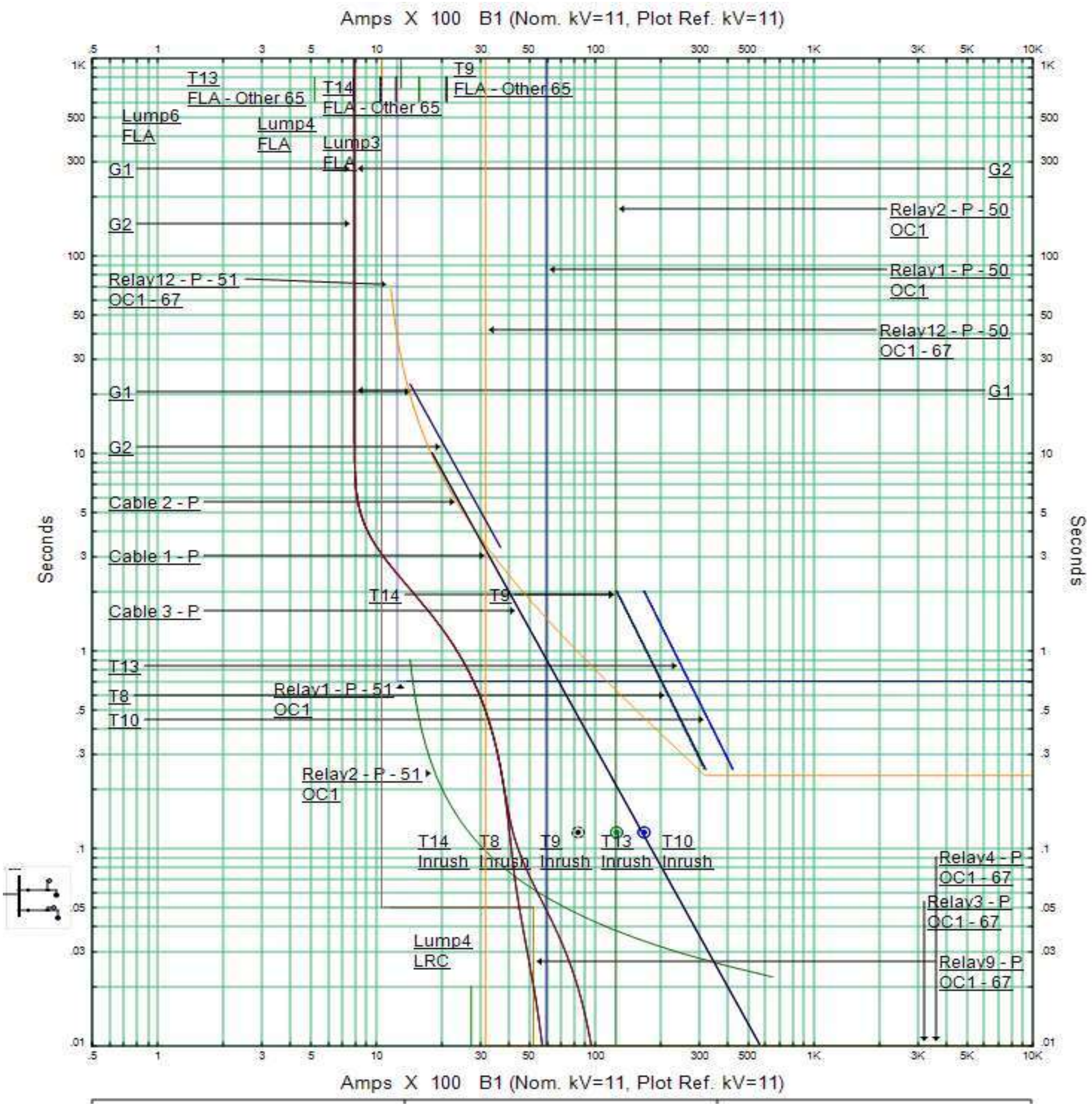


Fig 9: Overall TCC Curves

REFERENCES

[1] N. Rezaei, M. L. Othman, N. I. A. Wahab, and H. Hizam, “Coordination of over current relays protection systems for wind power plants,” in 2014 IEEE International Conference on Power and Energy (PECon), Dec. 2014, pp. 394–399. doi: 10.1109/PECON.2014.7062477.

[2] S. Khatua and V. Mukherjee, “Adaptive overcurrent protection scheme suitable for station blackout power supply of nuclear power plant operated through an integrated microgrid,” Electr. Power Syst. Res., vol. 192, p. 106934, Mar. 2021, doi: 10.1016/j.epsr.2020.106934.

[3] S. Subramanian, K. J., and V. Murali, “Analysis on Fault Current Contribution by Different Types of DGs and Relay Coordination in Non-Autonomous Micro-Grids,” in 2019 National Power Electronics Conference (NPEC), Dec. 2019, pp. 1–6. doi: 10.1109/NPEC47332.2019.9034858.

[4] S. Khatua and V. Mukherjee, “Application of integrated microgrid for strengthening the station blackout power supply in nuclear power plant,” Prog. Nucl. Energy, vol. 118, p. 103132, Jan. 2020, doi: 10.1016/j.pnucene.2019.103132.

[5] N. Sahbeni, A. Meddeb, N. Amor, and S. Chebbi, “Distance Protection Behavior during Integration of Distributed Generation: Case Study TunisianTransmission Network,” in 2019 International Conference on Advanced Systems and Emergent Technologies (IC_ASET), Mar. 2019, pp. 144–147. doi: 10.1109/ASET.2019.8871043.

[6] A. S. Omran, N. H. Abbasy, and R. A. Hamdy, “Enhanced performance of substation dynamics during large induction motor starting using SVC,” Alex. Eng. J., vol. 57, no. 4, pp. 4059–4070, Dec. 2018, doi: 10.1016/j.aej.2018.10.009.

[7] U. Uma, A. Ekwue, and E. Emelike, "Fault Current Contribution from Renewable Energy Sources on Distribution Network Protection Schemes," in 2019 IEEE PES/IAS PowerAfrica, Aug. 2019, pp. 290– 294. doi: 10.1109/PowerAfrica.2019.8928630.

[8] N. F. Sherbilla, T. A. Kawady, N. I. Elkalashy, and A.-M. I. Taalab, "Modified setting of overcurrent protection for distribution feeders with distributed generation," pp. 173–173, Jan. 2011, doi: 10.1049/cp.2011.0168.

[9] A. Chopra, T. K. Jain, N. Saxena, and A. Tiwari, "Predictive Analytics of a Community Survey Data by Artificial Neural Network - A Subset of Machine Learning," Indian Journal of Science and Technology, vol. 16, no. 34, pp. 2778–2788, Sep. 2023, doi: 10.17485/IJST/V16I34.1589.

[10] P. Kumar et al., "Economics of Implementing Solar Thermal Heating Systems in the Textile Industry," Energies 2022, Vol. 15, Page 4277,

vol. 15, no. 12, p. 4277, Jun. 2022, doi: 10.3390/EN15124277.

[11] K. Kumar, M. K. Gupta, N. Saxena, and V. Jaglan, "Homomorphic Encryption Based Privacy Protection for Personalised Web Search,"

Indian Journal of Science and Technology, vol. 15, no. 8, pp. 318–325, Feb. 2022, doi: 10.17485/IJST/V15I8.44.

[12] S. Mann, N. Saxena, and H. R. Tanwar, "Long Term Wind Power Forecasting using Deep Learning Techniques," IJREAT International Journal of Research in Engineering & Advanced Technology, vol. 10, no. 4, Accessed: Mar. 17, 2024. [Online]. Available: www.ijreat.orgwww.ijreat.org

[13] S. Mann, N. Saxena, and H. R. Tanwar, "Deep Learning Based Wind Power Forecasting: A Review," IJREAT International Journal of Research in Engineering & Advanced Technology, vol. 10, no. 4, doi: 10.4236/jpee.2014.24023.

[14] S. K. Mishra, R. Kumar, R. Joshi, H. Kumar, and N. Saxena, "Experimental Investigation, Exergy Analysis, and CFD Simulation of Solar Air Heater Roughened with Artificial V-Shaped Ribs on Absorber Surface Artificial Roughness on Absorber Plate," pp. 235–252, 2021, doi: 10.1007/978-981-16-0235-1_20.

[15] N. Saxena and S. Ganguli, "Solar and Wind Power Estimation and Economic Load Dispatch Using Firefly Algorithm," Procedia Computer Science,vol. 70, pp. 688–700, Jan. 2015, doi: 10.1016/J.PROCS.2015.10.106.

[16] N. Saxena, R. Kumar, R. Saxena, S. K. Mishra, R. Jain, and S. K. Verma, "Deep Learning Approach for Wind Power Forecasting," Lecture Notes in Electrical Engineering, vol. 902, pp. 355–367, 2023, doi: 10.1007/978-981-19-2004-2_32/COVER.

[17] N. Saxena et al., "Hybrid KNN-SVM machine learning approach for solar power forecasting," Environmental Challenges, vol. 14, p. 100838, Jan. 2024, doi: 10.1016/J.ENVC.2024.100838.

[18] N. Saxena, R. Saxena, and K. Murari, "Novel Fault Detection Scheme Using Stockwell Transform for Transmission Lines with Wind Power Penetration," Lecture Notes in Electrical Engineering, vol. 699, pp. 27– 38, 2021, doi: 10.1007/978-981-15-7994-3_3/COVER

[19] S. K. Yadav, N. K. Sharma, S. C. Choube, and A. Varma, "Optimal coordination of overcurrent relays in power systems for reliability assessment under the presence of distributed generation using ETAP," in 2017 6th International Conference on Computer Applications In Electrical Engineering-Recent Advances (CERA), Oct. 2017, pp. 51– 56. doi: 10.1109/CERA.2017.8343300.

[20] S. P. George and S. Ashok, "Over current relay coordination in a real system with wind farm integration using hybrid genetic algorithm approach," in IET International Conference on Resilience of Transmission and Distribution Networks (RTDN 2017), Sep. 2017, pp. 1–6. doi: 10.1049/cp.2017.0329.

[21] N. Hafiizh, H. Hermawan, and B. Winardi, "Perencanaan Setting Relay Arus Lebih (Ocr) Dan Relay Arus Lebih Berarah (Docr) Pada Jaringan Tegangan Menengah 20 Kv Feeder A – L1 Ps 2, Terminal 1 Bandara Soekarno-Hatta," Transient J. Ilm. Tek. Elektro, vol. 7, no. 1, Art. no. 1, Mar. 2018,doi: 10.14710/transient.7.1.166-173.

[22] H. Liang-you, J. Dongxiang, H. Qian, and D. Yong-shan, "Wind Speed Forecasting Using Fully Recurrent Neural Network in Wind Power Plants," 2008./paper/Wind-Speed-Forecasting-Using-Fully-Recurrent Neural-Liang-you Dongxiang/fef54b2b2ae713ebf8b08ad963d7dbbea15ad2fc (accessed

May 21, 2021)