شبكة المعلومات الجامعية

بسم اللّه الرحمن الرحيم

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

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شبكة المعلومات الجامعية

بالرسالة صفحات لم ترد بالأصل

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electrical Power and Machines Engineering

Contingency Based Power System Security

A Thesis submitted in partial fulfillment of the requirements of the degree of Doctor of Philosophy in Electrical Engineering
(Electrical Power and Machines Engineering)

By

Shazly Nasser Fahmy Ahmed
Master of Science in Electrical Engineering
(Electrical Power and Machines Engineering)
Faculty of Engineering, Ain shams University, 2016

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Cairo - (2020)

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Statement

This thesis is submitted as a partial fulfillment of Doctor of Philosophy in Electrical Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no Part of it has been submitted for a degree or a qualification at any other scientific entity.

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2- Ahmed R. Abul'Wafa, Aboul'Fotouh El'Garably, Shazly N. Fahmy Ahmed "Static Security Analysis of Transmission System," *International Journal of Engineering and Information Systems (IJEAIS),* vol. 2, no. 7, pp. 34-41, July 2018.

3- Ahmed R. Abul'Wafa, Aboul'Fotouh El'Garably, Shazly N. Fahmy Ahmed "Remedies Scheme for Single and Multiple Severe Contingencies of Transmission System," *(IJEAIS)*, vol. 3, no. 2, pp. 1-8, Feb. 2019.

4- Ahmed R. Abul'Wafa, Aboul'Fotouh El'Garably, Shazly Nasser "Power System Security Assessment under N-1 and N-1-1 Contingency Conditions," *International Journal of Engineering Research and Technology*, vol. 12, no. 11, pp. 1854-1863, Nov. 2019.

Thesis Abstract

A contingency in the electric power system is termed as a disturbance resulting from single or multiple equipment outages. This disturbance is a sudden change in the system configuration causing severe violations on the operating constraints such as branch overloads and bus voltage limits violation. These violations may result in successive interruptions leading to the occurrence of a partial or a total blackout phenomenon. This means that the resulting effects of contingency cases are investigated on the operating constraints of the system to prevent the occurrence of this phenomenon and hence to maintain the power system security that aims to keep the system operation in normal condition and especially in the event of a contingency.

The purpose of this thesis is to study the effect of power system component outages in terms of their severity on the system operating constraints to select and rank all severe contingencies, and then to apply the Remedial Action Schemes (RASs) that are necessary to withstand these contingencies and return the system into a secure state.

The N-1 Contingency Analysis (CA) technique using Newton Raphson Load Flow (NRLF) method in a DIGSILENT Power Factory environment is applied for each outage to investigate the resulting effects on the operating constraints of the remaining system. This thesis uses a hybrid of contingency screening method and the contingency Performance Index (PI) ranking method to select and rank all severe contingencies.

The contingency screening method is used to reduce the numerous calculations by eliminating the outages having no effect on the system operating constraints and selecting only the contingencies those lead to violations on the operating constraints.

All severe contingencies are ranked based on the Overall Performance Index (OPI) of test systems, considering Voltage Performance Index (PI_V) and Active Power Performance Index (PI_P) for each severe contingency case in MATLAB environment.

The Remedial Action Scheme (RAS) approach is applied to mitigate and remedy all severe contingencies in order to get the system back to its normal operation. In this thesis, Remedial Action Scheme -1 (RAS-1) and Remedial Action Scheme-2 (RAS-2) approaches are proposed. The RAS-1 approach is applied to correct both of branches overloads and bus voltage margin's violations. The RAS-2 approach is applied to remove the probably load shedding in the RAS-1 approach and hence, to enhance the system reliability in post contingency cases. Load flow assessment is performed for each corrected system to validate the perfect effectiveness of RAS-1 and RAS-2 on the operating constraints.

This thesis underlines the necessity of considering RAS-1 and RAS-2 in all severe contingencies to reach a final test system configuration which successfully recovers from any kind of N-1 severe contingencies for getting a secure proper operation.

Reliability assessment is performed to examine the effect of equipment unavailability on the system reliability. Also, the most economical remedial scheme from the proposed RAS-1 and RAS-2 is discriminated to be used as a certificated remedial action from the economic point of view in the N-1 contingency criterion.

The N-1-1 CA is performed on the corrected system of the most severe contingency case to investigate the technical robustness of its certificated remedial action from the economic point of view.

This proposed work is implemented on the IEEE 5 bus system, IEEE 9 bus system, IEEE 14 bus system and IEEE 39 bus system in DIgSILENT Power Factory environment.

Key words: Contingency Analysis (CA), contingency screening, Newton Raphson Load Flow (NRLF), Remedial Action Scheme (RAS), severity.

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