International Journal of Electrical and Electronics Engineers
Vol. No.8 Issue 02, July-December 2016
ISSN (O) 2321-2055
ISSN (P) 2321 -2045

FUZZY LOGIC BASED CONTINGENCY ANALYSIS

Shaik Salima[1], Tegala. SrinivasRao[2], Reddipalli. Bhargav[3], P.Mallikarjuna Rao[4]

[1,2,3 ,4]Electrical and Electronics Engineering, Avanthi Institute of Engineering and Technology, Narsipatnam, Andhra University, Visakhapatnam (India)

ABSTRACT

Loading on present power system is increasing as power demand is increasing day today life. As a result of various instability problems occur in the power system; its security becomes one of the important aspect which is necessary to operational engineer for strategic analysis. So, contingency screening and ranking is one of the important analysis for security assessment. In this paper contingency screening and ranking is done using fuzzy logic. Ranking is based on overall performance index (OSI), highest value OSI gets rank first and proceeds in descending order for further ranking. The proposed work is simulated on IEEE 5 bus system on MATLAB environment.

Keywords: *voltage instability, contingency ranking, fuzzy logic.*

I. INTRODUCTION

Power system is a complex network consisting of various equipment. Demand for electric energy is rapidly increasing and unending demand. So it was important to power engineers, to maintain an efficient, secure and much reliable power dispatch without power interruption. A detailed study of system security assessment is necessary to deal with the possible failures in the system, its consequences and remedial actions which is known as power system security assessment and its revolves around the power system to withstand the effect of contingency.

There are number of methods for evaluating of contingency of power system i.e., conventional load flows, neural networks, fuzzy based etc. Load flow is important part of the contingency analysis. Work is carried out on the topics which consists of the potential contingencies cases by using ranking methods or screening method [1], distribution method [2], expert and new method for contingency selection [3-7].Speed of contingency screening was brought in the recent development using Artificial Neural Network [8].Particularly large power systems requires all the credible contingencies in short time period in ordered to take control measures for correction [9]. Load flow are necessary to have proper controlling,scheduling and operation of existing and operating power system and also need for proper planningin future expansion.

The (FLS) Fuzzy logic system is a logical system reasons in a fuzzy manner for reasoning under uncertainty or describes in imprecise for human interpretation .Sometimes it's very difficult to do mathematical model and calculations when facing problem with for real time operation then the fuzzy logic approach is the best method. Knowledge of human experts forms the base of the accuracy of fuzzy logic systems (FLS).Therefore it is as good as

International Journal of Electrical and Electronics Engineers
Vol. No.8 Issue 02, July-December 2016
ISSN (O) 2321-2055
ISSN (P) 2321 -2045

like validity of rules. The fuzzy logic system (FLS) only depends on complete and systematic understanding. It can be single input and output or multi input and multi output. Fuzzy inference system uses membership functions and linguistic inputs, fuzzy IF-THEN rules for understanding the human's reasoning.

The main components of fuzzy inference system are rule base(Contains all fuzzy rules), database (defines membership functions), aggregator fuzzification interface, defuzzification interface.

II. CONTINGENCY ANALYSIS

Concept of contingency was introduced by Ejebe and Wollenberg. Unpredictable events in the power system is known as contingency whereas outage is referred as temporary suspension of power .Contingency therefore defined as possible circumstance or as future outage which is possible but cannot be predicted with certainty. In order to analyze the contingency analysis easier it comprises of three important steps.

1) Contingency definition: This step involves the process of creating contingency list.

2) Contingency selection: In this step we get the information of list of contingencies that leads to limit violation.

3) Contingency evaluation: This is the last step used to evaluate the severe contingency i.e,taking necessary action

For the security maintenance we need to analyze the contingency analysis.

In order to know the severity of contingency in a number of transmission lines we need to do contingency analysis .For this purpose AC load flow solution done in MATLAB environment is used to get active, reactive power flows in a transmission lines and bus voltage magnitudes. There are two types of performance indices are used widely are for contingency ranking

1) **Voltage performance index**: This index reflects the violation of bus voltage and given as.

$$PI_v = \sum_{i=1}^{N_B} \{(|V_i| - |V_i^{SP}|) / \Delta V_i^{lim}\}^{2m} \quad (1)$$

Where,

N_B =Number of buses in the system

m =Penalty function and the value (=1)

$|V_i$ =Voltage magnitude at bus i obtained from FDLF load Flow solution

$|V_i|$ =Specified voltage magnitude at bus i

International Journal of Electrical and Electronics Engineers
Vol. No.8 Issue 02, July-December 2016
ISSN (O) 2321-2055
ISSN (P) 2321 -2045

V_i^{lim} =Deviation of voltage limit (In my case=1)

2) ***Active power performance index***: This index reflects the violation of active power (MW) flow and given as

$$PI_p = \sum_{l=1}^{N_L} (P_l / P_l^{max})^{2m} \quad (2)$$

Where,

N_L =Number of transmission lines in the given system

m =Penalty function

P_l =Active power (MW) flow in the transmission line

P_l^{max}=Maximum active power (MW) flow in the transmission line

$$P_l^{max} = (V_i * V_j)/X \quad (3)$$

Where,

V_i =Voltage magnitude of bus i by FDLF load flow

V_j =Voltage magnitude of bus j by FDLF load flow

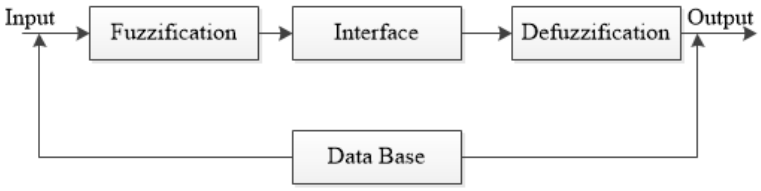
X =Reactance of the transmission line connecting bus i and j

III. POWER SYSTEM CONTINGENCY RANKING APPROACH USING FUZZY LOGIC

By using fast decoupled load flow (FDLF) the results of post contingency state of line power flows and bus voltages are obtained. For the post contingency quantities the membership function need to first recognize and defined .With this formed membership function is used to compute the overall severity index to get contingency ranking.

Line loadings and voltage profile indices are the inputs to the fuzzy inference system whereas the output for same fuzzy inference system is the severity indices both are computed using simple If-Then rules .The post contingency quantities must be expressed in fuzzy set notation firstly, and then only we can processed for reasoning rules of fuzzy

International Journal of Electrical and Electronics Engineers
Vol. No.8 Issue 02, July-December 2016
ISSN (O) 2321-2055
ISSN (P) 2321 -2045



3.1 Bus voltage profile:

Here, each post contingency quantity of bus voltage .Profiles are divided into three types which are described in fuzzy set notation. They are

(i) Low voltage(LV),

(ii) Normal voltage (NV),

(iii) Over voltage (OV),

Using the output membership functions the output severity of post contingent quantity is also divided into three types using fuzzy set notation. They are

(i) Below severe (BS)

(ii) Above severe (AS)

(iii) More severe (MS)

Fuzzy rules used to evaluate severity indices of post contingency of bus voltage profiles are
If bus voltage profile is LV then severity is BS
If bus voltage profile is NV then severity is AS
If bus voltage profile is OV then severity is MS

After knowing the severity indices of all the voltage profiles of the given power system, the overall severity index of bus voltage profile (OSIBV) for particular line voltage is given by

$$OSIBV = \sum SI \qquad (4)$$

3.2 Line loadings:

Here the post contingency of line loadings is design in fuzzy set notation which is divided into four types. They are
(i)Lightly loaded (LL),

(ii) Normal loaded (NL),

International Journal of Electrical and Electronics Engineers
Vol. No.8 Issue 02, July-December 2016
ISSN (O) 2321-2055
ISSN (P) 2321 -2045

(iii) Fully loaded (FL)

(iv)Over loaded (OL),

The output membership function for the above input is also described using fuzzy set notation and is divided into four types for the production of severity of post contingent quantity. They are

(i) Less severe (LS

(ii) Below severe (BS)

(iii) Above severe (AS)

(iv) More severe (MS)

After knowing the severity indices for all line loading of the given system, the overall severity index of the line loading (OSILL) for the particular line voltage is obtained using

$$OSILL = \sum SI \quad (5)$$

After obtaining the OSIBV, OSILL for each bus voltage and line loadings of given power system, the overall severity index (OSI) for every transmission line is calculated as

$$OSI = OSIBV + OSILL \quad (6)$$

After getting the OSI for each transmission line the highest value of OSI ranks first and next higher value gets next ranking and so on.

IV. IMPORTANT STEPS IN FUZZY LOGIC APPROACH

(1)Considered a single line outage for given 5 bus systemAnd perform load flow to determine bus voltage and loading of the line.

(2) Using membership function line loadings and bus voltages are represented in fuzzy set notation.

(3) Severity index of line loading and bus voltages are also necessary to represent in fuzzy set notation

(4) Overall severity index (OSI) for line loading and bus voltage is obtained by using fuzzy If-Then rules.

(5) Overall severity index is

$$OSI = OSILL + OSIBV$$

(6) For all other lines the above steps are done to get OSI of the particular line outage

V. RESULTS AND DISCUSSION

Entire analysis is done for IEEE standard 5 bus systems which consists of one slack bus and 4 load buses and these 5 buses are connected with seven transmissions lines. Table I. shows the active power flows in the pre and post contingency state of fifth transmission line outage using fast decoupled load flow. Table II. Shows the same transmission line outage that is Line -5 outage bus voltage in the pre and post contingency state using fast decoupled load flow. Table III. Shows the overall severity index of the line loading (OSILL) (Line -5 outage) using fuzzy logic based approach. Table IV shows the overall severity index of bus voltage OSIBV (Line -5 outage) using fuzzy logic based approach.

International Journal of Electrical and Electronics Engineers
Vol. No.8 Issue 02, July-December 2016
ISSN (O) 2321-2055
ISSN (P) 2321 -2045

Table I. Active power flows in the pre contingency state and post contingency state (Line -5 outage) using FDLF load flow

Line	Start bus	End bus	Pre contingency power flow (pu)	Post contingency power flow (pu)
1	1	2	0.889	0.889
2	1	3	0.407	0.546
3	2	3	0.247	0.456
4	2	4	0.279	0.544
5	2	5	0.548	0
6	3	4	0.189	0.516
7	4	5	0.064	0.639

Table II. Bus voltages in the pre contingency and post contingency (Line -5 outage) using FDLF load flow

Bus Number	Pre contingency voltage (pu)	Post contingency voltage(pu)
1	1.060	1.060
2	1.045	0.865
3	1.021	0.865
4	1.021	0.857
5	1.011	0.829

Table III. OSILL (Line -5 outage) using fuzzy logic based approach

Line	Start bus	End bus	Severity index
1	1	2	13.7556
2	1	3	32.5
3	2	3	13.7
4	2	4	18.6187
5	2	5	0
6	3	4	13.7563
7	4	5	45

Table IV OSIBV (Line -5 outage) using fuzzy logic based approach

Bus number	OSIBV
1	0
2	76.9576
3	23.2523
4	46.7752
5	77

International Journal of Electrical and Electronics Engineers
Vol. No.8 Issue 02, July-December 2016
ISSN (O) 2321-2055
ISSN (P) 2321 -2045

Table V. Severity index & contingency ranking using fuzzy logic based

Line outage number	OSIBV	OSILL	Overall severity index(OSI)	Ranking
1	307.8305	144.5630	452	1
2	142.8515	82.9674	225	7
3	145.1555	101.7667	246	5
4	144.8903	100.6611	245	6
5	223.9428	137.3861	361	2
6	169.2405	82.7778	252	4
7	192.8925	82.5564	275	3

Table V gives the Severity index & contingency ranking using fuzzy logic based for all seven transmission lines for a given power system. As per Table V the overall severity index of transmission line 1 outage has the highest value so it is ranked first and next higher value next ranking and so on. So this data is useful for the contingency analysis of a power system.

VI.CONCULUSION

The results can be concluded that the contingency analysis can be done by fuzzy logic based approach. As the power system is a complex network it need to focus on contingency analysis as it decrease the burden to operational engineers. Highest ranking of transmission line outage data helps to know which transmission line outage may cause problem to the system. This is also need to maintain the power system with safe and secure.

REFERENCES

[1] N.M.Peterson W.F.Tinney and D.W.Bree, "Iterative linear power flow for fast approximation outage studies,"IEEE Transactions on power apparatus systems, vol.91, No.5, Oct1972.

[2] R.Bacher,W.F.Tinney,"Faster local power flow solutions, the Zeromismatch."IEEE transactions'on power system vol. pp.1345-1354, October 1989.

[3] P.Maronnino.A.Berizzi,M.Merlo, G.Demartini, "Rule-based fuzzy logic approach for the voltage collapse risk classificat- on", IEEE power engineering society winter meeting,vol.2,pp 876-881,2002.

[4] P.R.Bijwe, M.Hanmandulu, V.N.Pande," Fuzzy power flow solutions with reactive limits" and multiple uncertainties, Electric power systems Research,no.76,pp.145-152,2005.

[5] A.NarendranathaUdupu, D.Thukaram, K.Parthasarathy," An expert fuzzy logic control approach to voltage stability enhancement",Electrical systems,no.21,pp.279- 287,1999.

[6] N.Yadaiah,A.Ganga Dinesh kumar, J.L.Bhatacharya," Fuzzy based coordinated controller for power systems stability and Voltage regulation", Electric power systems research ,no.69,pp.16 9-77,2004

[7] Contingency analysis in power systems. Amitkumar Roy.

[8] S.Saeh and A.Khairuddin,"Static security assessment using artificial neutral network",inproc.IEEEint.Conf.power and energy ,pp.1172-1177, dec.2008.

[9] G.d.irisarri and A.M.sasson, "An automatic contingency selection method for online security analysis" IEEE Trans.PAS,vol 100,pp. 1838-1844,1981.