Study of Reliability Analysis to the Iraqi south Region Network

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Abstract - *The study of reliability analysis is an important subject for the development of high voltage electrical power systems and their work steps. This study deals with the study and analysis of the reliability of the high voltage network (400 KV) for the southern Iraq region by using one of the reliability methods (Path tracing method) designing matrix, the value of it depend on the power path from Generation Station to Distribution Stations, the Minitab program was used to calculate the reliability characteristics of the Southern Iraq network. In conclusion, we find that the quantitative calculations of reliability give a clear indication of the continuity of any system in the work within the limits of safety, and determine the amount of the failure of the system and the failure of this system. The results of this program have shown a realistic***.**

***Key words*: Reliability, Path Tracing Method, Iraqi 400 KV south Region Network**

1. INTRODUCTION

The study of reliability has been investigated with more extension in power systems, in the field of purely electrical engineering such as the reliability studies on transmission and distribution .Quantitative reliability and safety analysis are valuable for analyzing system design, demonstrating compliance with safety requirements, justifying system changes or additions , and optimally upgrading system safety and reliability. In this study I'm take analysis reliability of 400 KV Iraqi super grids (south region). Iraqi electrical national grid consists of 400 KV super grid and 132KV ultra high voltage for electrical power transmission, while for distribution purpose, the voltage level 33kv and 11kv system.

2. POWER SYSTEM RELIABILITY

The function of an electric power system is to satisfy the system load requirements with a reasonable assurance of continuity and quality. The ability of the system to provide an adequate supply of electrical energy is usually designated by the term of reliability. The concept of power system reliability is extremely broad and covers all aspects of the ability of the system to satisfy the customer requirements. There is reasonable subdivision of the concern designated as "system reliability", which is shown in figure (1).

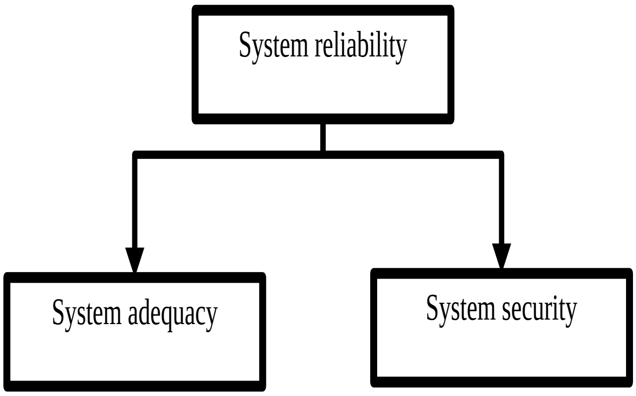

Fig-1: System reliability

Adequacy relates to the existence of sufficient facilities within the system to satisfy the consumer load demand .

These include the facilities necessary to generate sufficient energy and the associated transmission and distribution facilities required to transport the energy to the actual consumer load point . Security is therefore associated with response of the system to perturbations. Most of the probabilistic techniques presently available for power system reliability evaluation are in the domain adequacy assessment . [1]

2.1 Case Study of the Path Tracing Method

As the system becomes more complex, it becomes more difficult to establish MCSs by visual inspection. This problem can however be resolved by deducing all paths between the load point under consideration and all supply sources, it is the loss of those paths that causes load interruption. [2]

The steps of this method as follows:

1- Deduce all minimal paths.
2- Construct an incidence matrix that identifies all components in each path.
3- If all elements of any column of the incidence matrix are non-zero the component associated with that column forms a first order cut.

4- Combine two columns of incidence matrix at a time if all elements of the combined columns are non-zero, the components with those columns form a second order cut. Eliminate any cut containing first order cuts to give a second order MCS.

5- Repeat step (4) with three columns at a time to give the third order cuts, this time eliminating any cut containing first and second orders MCS.

6- Continue until maximum order of the cut has been reached.

3. SYSTEM ALGORITHM

Procedure for evaluating the reliability of a system is to decompose it into its constituents estimate the reliability of each of these components and finally combine the component reliabilities using one or more numerical techniques to estimate the reliability of complete system. Quantitative reliability and safety analysis are valuable for analyzing system requirement, justifying system changes or additions, and optimally up grading system safety and reliability. The steps in a system reliability or safety analysis are : [3]

1. Definition of the system to be analyzed .
2. Construction of the reliability or safety logic model .
3. Qualitative analysis.

The logic model can be obtained to determine the MCS_S of the model. Computer aid can be used to locate these MCS_S. Minitab programmer developed a method for calculating reliability characteristics of system and the importance of individual system components. [4]

The approximations are applicable to situations for which .

1. The primary event failures are s-independent .
2. The failures rate of the primary events is constant and known .
3. The component repair-time distribution is exponential and the mean dead time is known .
4. The crucial MCS_S are known and are from a s-coherent logic diagram.
5. None of the primary event are failed at t=0.

The following relationships are generally used.

1) Primary event

$$\bar{\underline{r}} = \lambda_i t \quad \text{.......} (1)$$

$$\bar{a}_i = \lambda_i t_I \quad \text{.......} (2)$$

2) Minimal cut sets failure information

$$\bar{A}_k = \bar{a}_i \quad \text{.......} (3)$$

$$\bar{A}_k = \lambda i / \bar{a}_i \quad \text{.......} (4)$$

$$\Lambda_k = f_k / R_k \quad \text{.......} (5)$$

$$R_k = 1 - R_k$$

3) Top event failure information

$$\bar{A}_t = \sum_{k=1}^{N} \bar{A}_k \quad \text{.......} (6)$$

$$\overline{R}_t = \sum_{k=1}^{N} R_k \quad \text{.......} (7)$$

$$\Lambda_t = \sum_{k=1}^{N} \Lambda_k \quad \text{.......} (8)$$

If all components are repairable, the MTF_t will be

$$MTF_t = 1/\Lambda_t \quad \text{.......} (9)$$

4. RELIABILITY MODELING OF THE IRAQI 400Kv SOUTHERN REGION NETWORK

Figure (2) shows (400KV for Southern region). Iraqi electrical national grid consists of 400 KV super grid and 132KV ultra high voltage for electrical power transmission, while for distribution purpose, the voltage level 33kv and 11kv system.

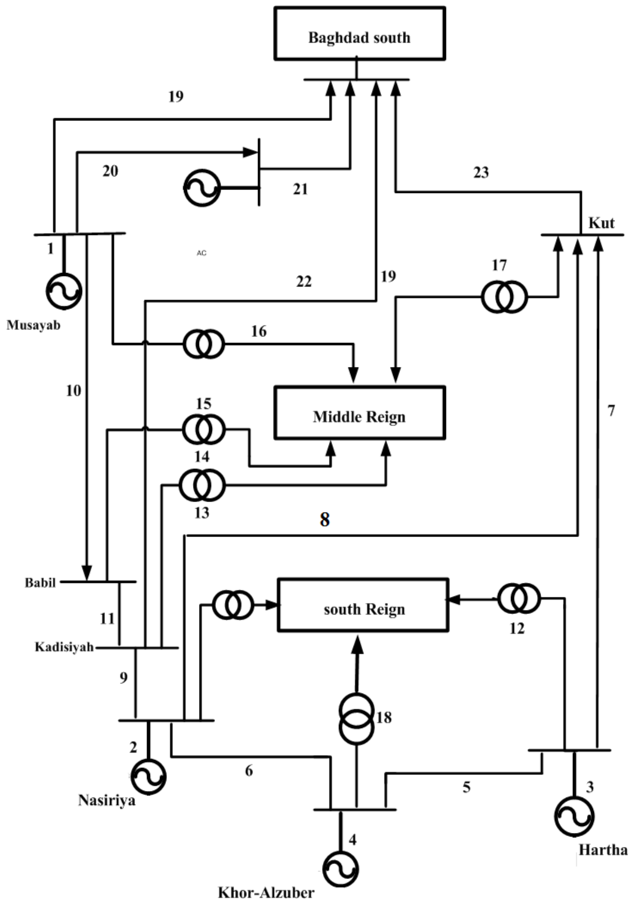

Fig- 2: The Iraqi 400Kv Southern Region Network

5. DATA OF FAILURE AND REPAIR RATE

Table (1) gives the failure rate, repair rate and mean dead time of each component in 400Kv south Iraqi Reign

NO	Component name	Failure rate (hr^{-1})	Repair rate (hr^{-1})	Mean Dead Time (hr)
1	Musayab p.s	1.32e-4	8.11e-4	1232
2	Nasiriya p.s	1.52e-4	4.58e-4	2182
3	Hartha p.s	1.57e-4	4.15e-4	2406
4	Khor – Alzuber p.s	1.34e-4	7.58e-4	1317
5	Hartha- Khor-Alzuber	5.81e-6	7.6e-4	1315
6	KhorAlzuber-Nasiriya	23.39e-6	6.86e-4	1457
7	Hartha- Kut	46.34e-6	4.58e-4	2183
8	Nasiriya- Kut	31.68e-6	9.66e-4	1034
9	Nasiriya-Kadisiyah	28.75e-6	5.31e-4	1881
10	Musayab- Babil	3.6e-6	7.28e-4	1327
11	Babil- Kadisiyah	19.6e-6	4.92e-4	2030
12	Hartha transformer	1.5e-6	0.005	200
13	Nasiriya transformer	1.2016e-6	0.005	200
14	Kadisiyha transformer	1.5e-6	2.08e-3	480
15	Babil transformer	1.01e-6	1.33e-3	747
16	Musayab transformer	1.2e-6	0.005	200
17	Kut transformer	1.01e-6	0.005	200
18	Khor Alzuber Transformer	1.5e-6	1.66e-3	600
19	Musayab – B.G		2.123e-4	4709
20	Musayab – Musayab G.P.S	/	/	/
21	Musayab G.P.S-B.G	/	/	/
22	Kadisiyah – B.G	21.6e-6	2.208e-3	452.69
23	Kut – B.G	18.14e-6	4.76e-4	2098

5.1 Power Flow Paths

When the analysis of 400Kv south Iraqi Reign in fig (2) we can deduce the following paths:-

1) { 1+19}
2) {2+13}
3) {4+18}
4) {3+12}
5) {2+9+22}
6) {2+8+23}
7) {3+5+18}
8) {3+7+23}
9) {4+6+13}
10) {3+5+6+13}
11) {4+6+9+22}
12) {4+6+8+23}

Table-3: The Minimal Cut Sets

order	Minimal Cut Sets
1st order	Nil
2nd order	Nil
3rd order	{1,9,23} {1,22,23} {9,22,23} {2,3,4} {3,4,13} {3,18,13} {9,19,23} {18,12,13} {19,22,23}
4th order	{1,2,3,10} {1,2,3,6} {1,2,4.7} {1,2,3,4} {1,7,8,9} {2,3,6,18} {2,4,5,12} {2,6,18,12} {2,3,4,9}{2,6,19,23} {4,5,12,13} { 7,8,9,19} {7,8,9,22} {7,8,19,22}

Table-4: Primary Event Failure Information

Primary Event	ā	r̄
1	1.63e-1	1.19e-7t
2	3.32e-1	1.37e-7t
3	3.78e-1	1.41e-7t
4	1.76e-1	1.21e-7t
5	7.64e-3	5.23e-9t
6	3.41e-2	2.11e-8t
7	1.01e-1	4.17e-8t
8	3.28e-2	2.85e-8t
9	5.41e-2	2.59e-8t
10	4.78e-3	3.24e-9t
11	3.98e-2	1.76e-8t
12	3.00e-4	1.35e-9t
13	7.20e-4	1.35e-9t
14	7.54e-4	9.09e-10t
15	2.40e-4	1.08e-9t
16	2.02e-4	9.09e-10t
17	9.00e-4	1.35e-9t
18	9.00e-4	1.35e-9t
19	2.68e-2	5.13e-9t
20	\	\
21	\	\
22	9.78e-3	1.94e-8t
23	3.81e-2	1.63e-8t

Table-2: Matrix for 400Kv south Iraqi Reign

Path No	Components																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**
2	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
4	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
5	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
6	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
7	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
8	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
9	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
10	**0**	**0**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
11	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
12	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**

Table-5: Minimal Cut Sets Failure Information Calculations

MCSs	$\bar{A}$	$\overline{R}$	F	Λ
1	6.88e-4	1.97875e-5t	1.97875e-5	1.97875e-5
2	5.17e-4	1.2777e-5t	1.2777e-5	1.2777e-5
3	2.23e-5	1.33934e-6t	1.33934e-6	1.33934e-6
4	3.20e-12	0.000180756t	0.000180756	0.000180756
5	3.16e-4	7.90041e-5t	7.90041e-5	7.90041e-5
6	3.53e-6	1.38757e-6t	1.38757e-6t	1.38757e-6t
7	2.97e-5	3.15508e-6t	3.15508e-6	3.15508e-6
8	3.38e-8	4.23e-9t	4.23e-9	4.23e-9
9	2.23e-5	0.026860292t	0.026860292	0.026860292
10	1.13e-7	7.06084e-5t	7.06084e-5	7.06084e-5
11	7.37e-7	8.26843e-5t	8.26843e-5	8.26843e-5
12	1.25e-6	9.0232e-5t	9.0232e-5	9.0232e-5
13	4.22e-6	0.000146823t	0.000146823	0.000146823
14	5.57e-8	2.35441e-5t	2.35441e-5	2.35441e-5
15	8.37e-9	0.00010956t	0.00010956	0.00010956
16	1.78e-9	7.12808e-5t	7.12808e-5	7.12808e-5
17	8.00e-2	1.29395e-5t	1.29395e-5	1.29395e-5
18	9.19e-7	0.000121808t	0.000121808	0.000121808
19	3.68e-9	1.36415e-5t	1.36415e-5	1.36415e-5
20	1.75e-2	2.05065e-6t	2.05065e-6	2.05065e-6
21	2.41e-9	5.80266e-6t	5.80266e-6	5.80266e-6
22	9.12e-9	6.17194e-6t	6.17194e-6	6.17194e-6
23	1.81e-9	5.35823e-6t	5.35823e-6	5.35823e-6

Table-6: System Failure Calculation

$\bar{A}_t$	**9.916e-2**
$\overline{R}_t$	**2.79e-2t**
Λ_t	**2.796e-2**
MTF_t	**35842.29 Hr**

Table-7: Results of Reliability and Unreliability Versus Time

Time (hour)	Reliability (R)	Unreliability (Q)
1	0.8999	3.32
1000	0.8658	4.32
2000	0.8316	6.73
3000	0.7975	1.01e+1
4000	0.7633	1.36e+1
5000	0.7292	1.70e+1
6000	0.695	2.04e+1
7000	0.6609	2.38e+1
8000	0.6267	2.72e+1
8760	0.6	2.98e+1

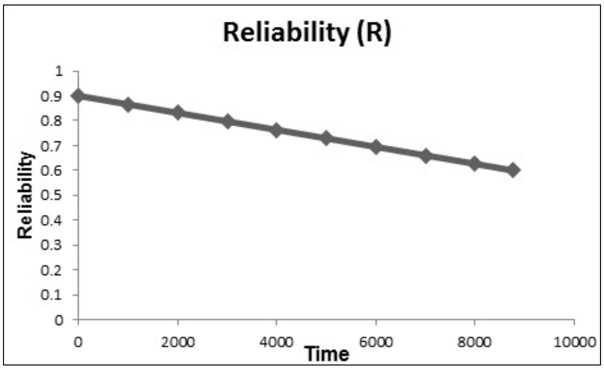

Chart -1: The relation between Reliability and Time

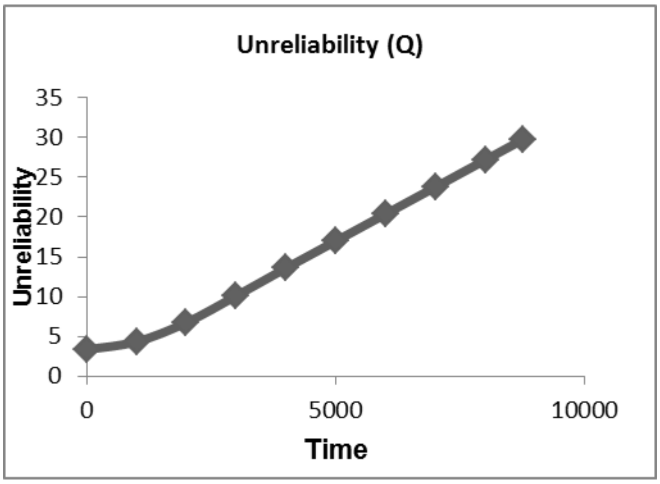

Chart -2: The relation between Unreliability and Time

6. SYMBOLE

M.C.S. …. Minimal Cut Set
M.C.S.s... Minimal Cut Set system
$M.T.F_t$ …. Mean Time Failure
$\bar{r}$ ………… Unreliability of system
$\bar{a}$…………. Unavailability of primary event
$\bar{A}$ ……….. Unavailability
$\bar{R}$ ……….. Unreliability
Λ_t ………. Failure rate of top event
Λ ……….. Failure rate
$\sum$ ……. Summation value
λ ………. Failure rate
μ ………. Repair rate

7. CONCLUTION

In generally the reliability and availability indices of the Iraqi 400Kv southern region network are very low equal to (60%) because of more loss in the 400Kv lines and poor connection with the national grid and the transmission lines. Can be improve the reliability and availability of the network by using more 400Kv transmission line in the poor reliability and availability indices zones and most importance to reconnect the broken lines and increase the link between the zones.

REFERENCES

[1] Dan Zhu, "Power System Reliability Analysis with distributed generators", master thesis Virginia poly technique Institute and State University, May 2003.

[2] J. B. Fussell"How To-Hand Calculate System Reliability and Safety Characteristic ", IEEE Trans. On Reliability, Vol.24, No.3

[3] McCormick N.J," Reliability and Risk Analysis-Methods and nuclear power Applications", Academic press, Inc., 1981.

[4] nR. Billinton And R.N. Allan "Reliability Evaluation of Power System", plenum press, 1984.

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