**An Open Source Tool for Reliability Evaluation of Distribution System Using Monte Carlo Simulation**

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**Reliability Test system for Distribution System [2]**

D16

T16

D17

T17

LP17

LP16

**F4**

D18

T18

D19

T19

LP19

LP18

S12

D20

T20

LP20

S13

D21

T21

D22

T22

LP22

LP21

S14

D10

T10

LP10

**F3**

D11

T11

D12

T12

LP12

LP11

S8

S7

D13

T13

D14

T14

LP14

LP13

S9

D15

T15

LP15

S10

D8

S5

LP8

**F2**

D9

S6

LP9

D1

T1

D2

T2

LP2

LP1

**F1**

D3

T3

D4

T4

LP4

LP3

S2

D5

T5

D6

T6

LP6

LP5

S3

D7

T7

LP7

S4

N/O

N/O

S1

Supply 11kV

S11

**Figure8****1: RBTS Distribution System**

The following data is used.

Average failure rate for each section and distributor = 0.065 failures/yr-km

Average repair time for each section and distributor = 5 hours

Average failure rate for a transformer = 0.015 failures/year

Average replacement time for a transformer= 10 hours

Average switching time = 1 hour

The circuit breakers and fuses are assumed to be 100% reliable. The operation of the transformer is considered independent of weather conditions as they are generally housed in buildings. Hence transformers failure rate is taken as a constant value. A faulted transformer is replaced by a mobile transformer rather than repairing it. The detailed data of RBTS is given in the following tables.

Feeder Data and Customer Data

**Table2****1: Feeder section and lateral distributor lengths [2]**

|  |  |  |
| --- | --- | --- |
| **Length** | **Feeder sections** | **Lateral distributors** |
| 0.60 km | S4, S6, S9, S14 | D1, D4, D10, D15, D17, D18 |
| 0.75 km | S1, S2, S3, S5, S7, S10, S12, S13 | D6, D11, D13, D16, D21 |
| 0.80 km | S8, S11 | D2, D3, D5, D7, D8, D9, D12, D14, D19, D20, D22 |

**Table3****2: Customer Data and Load Data [2]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S. No** | **Load Points** | **Customer Type** | **Load Level per Load Point (MW)** | **No. of Customers** |
| **Average**  | **Peak** |
| 1 | 1, 2, 3, 10, 11 | Residential | 0.535 | 0.867 | 210 |
| 2 | 12, 17, 18, 19 | Residential | 0.450 | 0.729 | 200 |
| 3 | 8 | Small User | 1.000 | 1.628 | 1 |
| 4 | 9 | Small User | 1.150 | 1.872 | 1 |
| 5 | 4, 5,13, 14, 20, 21 | Govt./Inst. | 0.566 | 0.917 | 1 |
| 6 | 6, 7, 15, 16, 22 | Commercial | 0.454 | 0.750 | 10 |
|   |   |   | 12.291 | 20.000 | 1908 |

**Table4****3: Feeder data [2]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Feeder** | **Load****points** | **Average load****(MW)** | **Peak load****(MW)** | **Number of** **customers** |
| F1 | 1-7 | 3.645 | 5.934 | 652 |
| F2 | 8-9 | 2.15 | 3.5 | 2 |
| F3 | 10-15 | 3.106 | 5.057 | 632 |
| F4 | 16-22 | 3.39 | 5.509 | 622 |
| Total | 22 | 12.291 | 20 | 1908 |

**Table 4: Sector interruptions in (Rs/kW cost estimates (CDF))[3]**

|  |  |
| --- | --- |
| **User Sector** | **Interruption Duration (min.) & Cost (Rs/kW)** |
| **1 min** | **20 min** | **60 min** | **240 min** | **480 min** |
| Larger user | 1.005 | 1.508 | 2.225 | 3.968 | 8.24 |
| Industrial | 1.625 | 3.868 | 9.085 | 25.16 | 55.81 |
| Commercial | 0.38 1 | 2.969 | 8.552 | 31.32 | 83.01 |
| Agricultural | 0.06 | 0.343 | 0.649 | 2.064 | 4.12 |
| Residential | 0.001 | 0.093 | 0.482 | 4.914 | 15.69 |
| Govt.& Inst | 0.044 | 0.369 | 1.492 | 6.558 | 26.04 |
| Office | 4.778 | 9.878 | 21.06 | 68.83 | 119.2 |

**Table 5: System CCDF and sector CDF (Rs/kW) [3]**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  **Sector** | **1 min** | **20 min** | **60 min** | **240 min** | **480 min** |
| Residential | 0.001 | 0.09 | 0.48 | 4.91 | 15.6 |
| commercial | 0.381 | 2.96 | 8.55 | 31.3 | 83 |
| small user | 4.47 | 9.87 | 21.06 | 68.83 | 119 |
| institutional | 0.04 | 0.36 | 1.49 | 6.55 | 26 |
| CCDF | 0.92 | 2.43 | 5.9 | 21.6 | 49.4 |

**References**.

1. R. N. Allan, R. Billinton, I. Sjarief, L. Goel, K. S. So, “A Reliability test system for educational purposes - basic distribution system data and results,” IEEE Transactions on Power Systems, Vo1.6, No. 2, May 1991.\
2. R. Billinton and R. N. Allan, Reliability evaluation of power Systems, 2nd ed. New York, NY, USA: Plenum, 1996
3. Roy Billinton and Peng Wang, “Distribution System Reliability Cost/Worth Analysis Using Analytical and Sequential Simulation Technique”, IEEE Transactions on Power Systems, Vol. 13, No. 4, November 1998.