**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**.

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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.