ABSTRACT

The main issue during the power system restoration (PSR) is to achieve minimum deficit of power supply during the outage condition. In PSR special attention is given to the identification of switching sequence through which the power will flow during outage condition. The various constraints during restoration are radiality, maximum load restored, feeder capacity, voltage limits and number of switching operations.

The outage or fault at a place can trigger certain other healthy portion into an ‘off’ state. To restore the power, a methodology based on graph theory is proposed. The proposed methodology is decomposed into two main stages. The first one is the power flow path identification. It consists of identifying the status of all the lines in order to restore all the healthy parts of the network. The second stage is load flow analysis which aims to supply power effectively by satisfying the power flow constraints.

The major contribution of this research work is concentrated in the first stage. A concept called Minimum Spanning Tree (MST) algorithm is proposed for the first time for this purpose. The four MST algorithms used are Kruskal’s algorithm, Reverse–Delete algorithm, Prim’s algorithm and Dijkstra’s algorithm. The resultant power flow path obtained automatically satisfies the radiality constraint of the distribution network. This is the notable usefulness of this proposed methodology.
In the second stage, forward sweeper load flow analysis result is used for checking the constraints. If there is any violation in these parameters then load transferring between the heavily and lightly loaded feeders are tried. If load transferring is not possible then load shedding is done based on the priority of customers.

The proposed methodology using the four MST algorithms is applied separately to a 33–bus single feeder test system. It is observed that the resultant losses and minimum p.u. voltage of the network obtained using the Dijkstra’s algorithm for the normal condition are less and higher respectively when compared to that of the test system and other three MST algorithms.

As a result, the Dijkstra’s algorithm is used as MST algorithm in the proposed methodology and it is applied for the various outage cases on 33–bus single feeder, 16–bus three feeder and 59–bus four feeder distribution network. To demonstrate the proposed methodology works in practice, a hardware implementation of the proposed methodology is implemented using Verilog Hardware Descriptive Language and microcontroller.