COMPUTERIZED OUTAGE REPORT[1]

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Abstract. The service area in which New England Electric System operates is the most heavily forested region in the United States. Trees have been the largest single cause of interruptions of electric service. A computerized program provides various types of reports. An analysis of these reports indicates that broken trees or branches falling on main line three phase 15 kV class distribution lines are having the greatest impact on service reliability goals. The availability of the reports are of great value in making wise decisions as to the best utilization of available resources.

New England is the most heavily forested region in the United States; the percent of forest cover varies from 60 percent in Rhode Island to 90 percent in Maine. The planting of shade trees along urban, suburban and rural streets and roads has been a tradition since colonial days. Many of these public ways are winding and narrow. New England is located at the convergence of two major storm tracts which contribute to our rapidly changeable weather. The types of storms include hurricanes, thunder squalls, ice storms, heavy wet snow storms, and blizzards, as well as the more usual storms of lesser intensity. The combination of trees and storms interact with electric lines to cause interruptions of electric service.

New England Electric System has three retail companies, one wholesale operating company, as well as a service company and an energy company. Transmission and distribution facilities located in the States of Massachusetts, New Hampshire, Rhode Island and Vermont serve just over one million customers.

System management has established service reliability goals to not exceed a frequency of 1.25 interruptions per year for a total duration not to exceed 90 minutes averaged for total customers served based on a certain formula.

Trees have historically been the largest single cause of interruptions of electric service within our System. Eleven professional arborists are responsible for planning, scheduling and inspecting the line clearing program on 15,000 miles of distribution lines and the vegetation management program on 30,000 acres of rights-of-way. The work is performed by approximately eighty crews which are employed by more than twenty-five independent tree service companies. This major effort costing more than $5,500,000 in 1979 is to achieve the service reliability goals.

A computerized program to record and provide information about interruptions of electric service to customers was developed by New England Electric System in 1965. Source documents are prepared on a daily basis in district offices and forwarded to the central data processing department. Two pairs of reports were developed which give interruption information by month and the most recent 12 month period for each District, showing the number of events by each cause. This program has been refined and updated in ensuing years.

The tree caused interruptions are broken down into four categories: Cause Code 35 is broken tree or limb; Code 36 is a tree or limb contact; Code 37 is tree or limb cut by Company employee or tree contractor; Code 38 is tree or limb cut by others not connected with the Company. Other important types of information included on the reporting form are weather conditions, feeder voltage, type of conductor such as bare, covered or spacer-type cable, and whether the location of the cause was on a main line or a fused branch line.

The computer is capable of producing special reports utilizing certain types of information. An example of special reporting is one listing information by area for tree caused outages only. This report is important as it indicates potential trouble spots which may need corrective action.

A special study report of interruptions during 1977 was prepared utilizing the vast amount of information available from the computer. A report is presently being prepared using the 1978 statistics. The 1977 report highlighted some interesting information pertaining to the impact of

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tree caused interruptions on distribution feeders (Table 1). During the five year period ending 1977, trees, excluding major storms, caused between 20 and 22% of the total interruptions. During 1978 the tree caused interruptions were reduced to 17% of the total, a significant reduction. The better clearances obtained as a result of the professionally managed line clearance program and sustained budgeting are the primary reasons for this reduction.

Interruptions caused by trees during major storms which present conditions beyond which the distribution lines were designed to withstand, are recorded as being caused by major storm and not one of the tree causes.

Evaluating the percent of interruptions caused by trees in the 15 kV class distribution indicates 27% of the total interruptions in 1977 and 22% in 1978. The same type of evaluation on 5 kV class distribution lines indicates 12% in 1977 and 9% in 1978. Another interesting comparison which developed was the percentage of tree caused interruptions on main lines versus branch lines. The number of incidents on the main lines was much greater than on branch lines, but the overall impact of interruptions on main lines are of greater significance because the entire feeder and all of the customers would be interrupted by a main line outage, whereas, only a few customers may be interrupted on a fused branch line. In both 1977 and 1978, 85% of the total tree caused interruptions were on 15 kV class distribution.

The 15 kV class lines and three phase construction are both more sensitive to trees than 5 kV class lines and/or single phase construction.

While interruptions caused by tree crews or linemen working to prevent outages are annoying, there are relatively few occurrences each year which attests to the care these workmen exercise in carrying out the line clearing. The incidents of tree interruptions caused by people not connected with company activities has increased during the last several years. Most of these interruptions are caused by inexperienced tree cutters, many of whom are harvesting firewood.

An analysis of tree caused interruptions indicates the largest percentage are caused by broken trees or broken branches falling on distribution lines and a smaller percentage caused by tree or branch contact. The tree or branch contact outages are caused by a lack of adequate tree clearance around conductors, whereas, the broken trees or branches are usually structural problems related to diseased, decayed, dead or otherwise weakened wood. Also, ice or snow weighted trees or branches may cause the problem. Often when people think of line clearance they only consider tree trimming which may pro-

Table 1. Tree caused interruptions

1977	*1978*	
22%	17%	Of total interruptions are caused by trees.
27%	22%	Of total interruptions on 15 kV class are caused by trees.
12%	9%	Of total interruptions on 5 kV class are caused by trees.
79%	83%	Of total tree interruptions are on main line.
16%	16%	Of total tree interruptions are on branch line.
87%	86%	Of main line tree caused interruptions are on 15 kV class.
72%	79%	Of branch line tree caused interruptions are on 15 kV class.
85%	85%	Of total tree caused interruptions are on 15 kV class.
73%	66%	Of tree troubles are caused by broken trees or broken branches.
22%	24%	Of tree troubles are caused by tree or branch contacts.
51.8%	51.9%	Of customers are on 15 kV class line distribution.

vide a cleared area around the primary conductors. We have to also consider the physically weakened trees or branches which may fall or bend onto the primary conductors from outside the primary zones. Special attention must be given to removal of physically weakened trees or branches while line clearance work is being performed.

The 1977 study pointed out that although there were only slightly fewer tree caused interruptions on covered conductor than on bare conductor, the covered conductor must be considered more reliable as it is used in the more heavily treed locations and thus has more exposure to trees. Spacer-type cable has been almost totally free of tree caused interruptions. Those few that have occurred were at a point where the cable was skinned bare to connect a tap or where a very large tree fell on the cable and broke it.

The above information led us to the conclusion that our line clearing program was being successful but an extra effort on three phase bare main line 15 kV class feeders to prevent interruptions caused by falling trees and branches could result in a significant improvement in meeting service reliability goals. A special field survey of these lines was completed before the 1979 growing season started. Hazardous trees and/or limbs and areas of excessive growth were identified. Tree crews were then assigned to clear these hazardous conditions. The arborists are unanimous in their opinion that this program should be carried out each year, particularly in locations where line clearance was performed one year or more earlier.

Another report was prepared which analyzed interruptions by distribution feeders. This report was reviewed and all feeders which exceeded the service reliability goals due primarily to tree related interruptions were field evaluated. Some of the feeders are more prone to tree caused interruptions because of the type of line construction, density of tree population and the amount of clearance allowed by governmental officials or property owners. Those feeders are also being evaluated by the Engineering Department to see if more sectionalizing devices are justified to improve overall reliability.

Another computer report is prepared monthly for transmission and substation supply line outages. Tree related problems are also considered in this report. For this report, tree related causes are listed as either natural or trees cut.

As budgets are being prepared, the statistical information pertaining to interruptions is considered along with the actual tree clearances as found in the field.

Design criteria for the construction of electrical facilities have been established. As areas or feeders are being considered for upgrading of line construction and/or voltage level, the past interruption history is considered while deciding which type of conductor and design will be utilized.

We have found service reliability goals and the availability of computerized reports and studies to be of great value in making wise decisions as to the best utilization of available resources to better serve our customers.

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