DISTRIBUTION OPERATIONS AND MAINTENANCE

PREVENTIVE MAINTENANCE

Preventive Maintenance is intended to maintain or improve customer service reliability, extend equipment life and ensure employee and public safety. Preventive Maintenance represents the work required to enable THESL distribution assets to function as specified and to promote continued reliable system performance. This work entails the inspection and overhaul of distribution assets and replacement of specific components at fixed intervals. Preventive Maintenance program requirements are prescribed in THESL’s Annual Plant Maintenance Manual. Preventive Maintenance is derived from RCM II, which is designed to determine the optimal maintenance tasks for assets within their operating context. Optimal, in this sense, means the most cost effective maintenance tasks so that everything spent on maintenance is spent where it will do the most good to ensure reliability, safety and compliance with environmental requirements.

As all preventive maintenance programs are derived from RCM analyses, each program represents the most cost-effective alternative for maintaining a specific class of assets. A more frequent maintenance cycle may not be more effective for maintenance of assets and may actually induce failures; a less frequent cycle would lead to more costly failures over time and over the population of the asset class.

DISCUSSION

Distribution assets and their components are subject to deterioration and failure over time. Appropriate maintenance practices increase the probability that assets will continue to operate as expected over their life cycle and help protect against major equipment failures and associated reliability problems. Maintenance programs are designed to reflect the fact that asset integrity is influenced by factors such as environmental condition, design, location, age and equipment utilization. Asset deterioration usually
manifests itself as a decline in equipment performance, which can negatively impact supply to customers and negatively impact benchmark measures such as System Average Interruption Duration Index (“SAIDI”) and System Average Interruption Frequency Index (“SAIFI”).

THESL maintenance crews and qualified THESL contractors are responsible for carrying out, capturing data on and reporting on various Preventive Maintenance activities as outlined in THESL’s Annual Plant Maintenance Manual. The following sections discuss some of the types of equipment and activities that are addressed under preventive maintenance. A comprehensive explanation of all activities is contained in the Annual Plant Maintenance Manual.

**Overhead/Underground Distribution**

The following are some of the activities performed in the Preventive Maintenance program:

- Compact Radial Vaults are inspected twice a year and an inspection checklist is completed to identify any deficiencies. A thermograph is taken of all elbows to identify hot spots and is reported on the checklist. A determination is made as to whether these vaults require power washing and, if so, arrangements are made to schedule this activity.

- Network Protectors are overhauled every three years for those with 120/208V supply and every five years for those with 240/416V supply (the differing maintenance frequencies are due to different mean times between failures for the failure modes assessed during the RCM analysis for each protector type). A checklist is completed to verify that the protector is cleaned, relays are replaced and a function test is performed to verify that loads are picked up automatically.
Finally, a “protector card” is signed and placed on the front door of the protector to clearly identify completion of the maintenance.

- Three-Phase Gang-Operated Switches are maintained every three years to ensure safe and reliable operation during routine and emergency switching. A Certified Power Lineperson completes a checklist identifying the physical and mechanical condition and verifies the correct blade alignment, blade penetration, travel stops and arc interrupter operation. The switches are then lubricated for efficient and proper operation.

- The Network Vault inspection and maintenance program is typically performed in two stages. Initially, inspection and documenting of deficiencies is conducted. Any minor deficiencies are usually repaired during this inspection. Major deficiencies are documented in the Inspection Report for follow-up repairs in the same year as the inspection. Critical deficiencies that pose a safety hazard or impact system reliability are corrected as soon as possible.

- The Underground Residential Distribution (“URD”) vaults are inspected annually. These vaults are located on public road allowance and usually supply power to residential or small commercial areas. Inspections focus on the electrical equipment and civil structure. Any deficiencies are identified for corrective work.

**Stations**

THESL Substations use several different types of Circuit Breakers that incorporate Magnetic Air, Air Blast, Vacuum, Sulphur-hexafluoride (SF₆) and Oil as arc interrupting mediums. Maintenance cycles vary from three to eight years depending on the type of breaker that each substation contains. These units are inspected for leaks and tested to ensure proper functionality in maintaining a reliable flow of power to downstream
customers and interrupting the flow of power when required. Carbon dioxide (CO₂) and FM200 (Waterless Fire Protection) fire protection inspections are performed every six months to ensure that the intended functions are maintained and items such as alarms, sensors and manual electric dischargers are all operating properly.

Power transformer and Primary Load Break Switches (“LBSs”) are used to supply the primary load of a power transformer at Municipal Stations with a capacity of less than 10 MVA or at customers’ locations. The work to maintain these devices includes cleaning insulators, contacts and gears; checking alignment; and performing operational tests.

**External Contracts**

As is detailed in Exhibit C2, Tab 3 Schedule 3, THESL engages a number of qualified external entities to perform preventive maintenance tasks for several programs. External contractors are engaged to provide these services due to the seasonal nature of the work and the specialized expertise and equipment required. This practice of using external contracts is considered utility best practice in meeting seasonal maintenance requirements. As an example, insulator washing is required for only two, six-week periods each year. Equipping a THESL crew with a wash truck that operates only twelve weeks per year is not cost-effective because the truck will remain idle for the remaining 40 weeks of the year. As a second example, external forestry contractors are hired for their expertise and experience in tree-trimming services.

The tree trimming program is a reliability improvement initiative. Overhead distribution systems are prone to tree branch contacts resulting in feeder outages. To reduce the frequency and impact of tree contacts, a tree trimming program is used to maintain adequate clearance between tree branches and overhead conductors.
Starting in 2008, THESL adopted and implemented a Reliability-Based tree trimming program. It is a departure from the traditional fixed area and cycle approach. The new methodology takes into consideration the reliability performance of each feeder from tree related outages as well as the cost of pruning. The analysis yields a trim cycle for each feeder that delivers the optimum reliability performance for the amount of resource spent. The approach is considered to be a utility best practice for tree trimming programs.

THESL also started an additional proactive program in 2008 to supplement the regular pruning work. The intention of the additional work is to prune beyond the regular pocket of tree branches around the power conductors and to identify branches outside of the pruning zone that carry a high risk of breaking and falling on power conductors during adverse weather conditions. Going forward, THESL will monitor all tree-related outages and investigate their cause along with “last trimmed” information to update and further improve the program.

The washing of porcelain insulators on 27.6 kV overhead line poles takes place in areas where insulators experience extraordinary contamination from road salts and sprays. Regular pressure washing every six months is performed using clean water to remove contaminants that accumulate over time. Dirt, salt and hydrocarbon deposits, when combined with moisture, can provide a conducting surface or path on the line insulators and lead to current leakage (tracking) which can increase over time. This contamination and tracking can overcome the minimum insulation requirement of the insulator and lead to a “flash-over”. This insulation failure will trip the upstream protective device and cause a forced outage, which impacts reliability.

CO₂ cleaning of pad-mounted switchgear reduces the risk of tracking and, ultimately, reduces switch failure. Switches that are found to be dirty can be cleaned while still energized using CO₂ pellets. CO₂ is projected against the insulating surfaces of the
switches, releasing the dirt, and thereby cleaning the switch. The CO₂ evaporates into the atmosphere. The CO₂ used in this process is in the form of dry ice produced from industrial CO₂ by-products and does not have any harmful impact on the environment.

Pressure washing and vacuuming of submersible (underground) transformer vaults keep drains from plugging, thus preventing the submersion of transformers in water mixed with salt, contaminants and other organic debris. This maintenance prevents premature rusting of the transformer chassis and failure of elbow connectors.

Table 1 summarizes the total preventive maintenance costs for the 2011 Test year, as well as the Historical and Bridge years:

Table 1: Preventive Maintenance Costs ($ millions)

<table>
<thead>
<tr>
<th>Preventive Maintenance Costs</th>
<th>2008 Historical</th>
<th>2009 Historical</th>
<th>2010 Bridge</th>
<th>2011 Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>OH/UG Distribution Assets</td>
<td>2.8</td>
<td>5.0</td>
<td>4.7</td>
<td>5.0</td>
</tr>
<tr>
<td>Stations Assets</td>
<td>2.4</td>
<td>2.6</td>
<td>2.5</td>
<td>2.9</td>
</tr>
<tr>
<td>External Contracts</td>
<td>3.4</td>
<td>3.2</td>
<td>4.3</td>
<td>4.1</td>
</tr>
<tr>
<td>Total Preventive Maintenance</td>
<td>8.6</td>
<td>10.8</td>
<td>11.5</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Planned Preventive Maintenance spending increases by $0.5 million from the 2010 Bridge to the 2011 Test year. Overhead/Underground and Stations costs increase while External Contract costs decline. Overhead/Underground Distribution program costs increase by $0.3 million primarily due to conversion of the existing network protectors function test task to an overhaul task. In addition, there has been a slight increase in the unit cost for Network Vault Maintenance to reflect field conditions. The Stations Preventive Maintenance program costs increase by $0.4 million primarily due to a changing mix of maintenance activities and annual inflationary increases. External contract costs decline by $0.2 million from the 2010 Bridge to the 2011 Test year primarily due to the reassignment of costs for the wood pole inspection program from the
preventive maintenance budget in 2010 to the predictive maintenance budget in the 2011 Test year.

Preventive maintenance costs increase by $0.7 million from the 2009 Historical year to the 2010 Bridge year. Spending declines for the OH/UG Distribution and Stations Assets, but increases by 1.1 million for external contracts. This increase is primarily attributable to an increase in the tree trimming program costs and an increase in the amount of CO$_2$ washing for pad mounted switches and transformer vault washing.