Non-intrusive Predictive Distribution Maintenance

Radio Frequency Interference/Ultrasonic Surveys of Distribution Lines

Technical Report

Non-intrusive Predictive Distribution Maintenance

Radio Frequency Interference/Ultrasonic Surveys of Distribution Lines

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Final Report, July 2000

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REPORT SUMMARY

This study was performed to determine if improved maintenance procedures using existing technology could be developed that are both effective and economical. The effort sought to identify the benefits of combining two or more nonintrusive inspection procedures.

Background
In today's environment, utilities find themselves stretched in many different ways. Not only must they offer the lowest cost, they also must provide an acceptable level of service (for example, number of service interruptions/year). Maintenance performed on the lines is one of the more inexpensive ways to decrease interruptions. Preventative maintenance of the distribution system is performed by either periodic visual inspection of the lines or by use of the infrared camera to detect “hot spots” that indicate a poor connection or a component malfunction and can be predictive of future equipment failure. Other inspection procedures include sonic/noise sensing and Radio Frequency Interference (RFI) detection. This project tested combinations of these inspection methods/procedures.

Objectives
To investigate the feasibility of combining multiple inspection procedures; to operationally combine procedures for multiple method inspections; to correlate exception reports from each procedure; to determine if multiple inspection methods improve predictive ability; and, to reduce operating and inspection costs for multiple inspection procedures.

Approach
Multiple inspection was performed on overhead circuits and substations on the Orange and Rockland Utility systems. A significant portion of underground residential distribution (URD) transformers also were inspected. The multiple inspection procedure included the use of ultrasonic detection and radio frequency sensing technology in combination with infrared inspection. Also investigated was the use of corona detection using a research prototype.

Results
During the survey, 400 infrared condition reports and 94 ultrasonic condition reports were generated. There were only three instances where each procedure collected data on the same equipment item; this could indicate equipment problem.

There were 72 instances from the ultrasonic collection classified as corona. Arcing was reported on 19 equipment items, while tracking was reported three times. Indications of arcing and/or tracking might be considered precursors to equipment problems. Corona, however, occur under normal operations when conditions such as adverse weather conditions exist. Potential problems

on equipment exhibiting abnormal ultrasonic conditions can only be ascertained through equipment tear-down and examination.

Results from the ultrasonic detection procedure performed on underground pad-mounted equipment and within substations were promising. Ultrasonic detection has potential as a method for predictive maintenance of the underground system. Ultrasonic activity, classified as corona, was detected at the high-voltage elbow connectors of several pad-mounted transformers. The internal transformer panels where the ultrasonic corona activity was evident also exhibited discoloration at some of the elbow termination locations.

The reports suggest that ultrasonic detection can surface conditions leading to eventual equipment failure. Ultrasonic emissions were detected at 20 underground locations (mostly pad-mounted transformers). Most of these emissions were classified as corona. However, five of the pad-mount transformer locations also had a visible discoloration on the transformer panel at the dead-end elbow termination, and three of these had a “hot spot” near that same location. Where a discoloration on the transformer panel was detected and/or “hot spots” identified, the ultrasonic activity was classified as arcing or tracking.

Ultrasonic tests also were performed within all 87 O & R substations. Ultrasonic emissions were detected and reported at 31 equipment sites within 21 of the 87 substations surveyed. All but two of these reports were corona. Corona is often emitted from substation equipment due to the normally higher operating voltages within a substation and is not considered a symptom of potential failure.

EPRI Perspective
One of the project's major objectives was the investigation of possible synergy created by combinations of noninvasive inspection methods. Unfortunately, results obtained were rather disappointing; the synergy was much less than originally anticipated. However, ultrasonic inspection was found able to detect defects that could lead to problems on the above surface portion of underground pad-mounted equipment. Use of ultrasonic inspection should be investigated more completely and the benefits of its use quantified.

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Keywords
Distribution system maintenance
Distribution system inspection
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ABSTRACT

Predictive maintenance of distribution facilities is done either by periodic visual inspection of plant facilities or by infrared camera to detect “hot spots” that are indicative of a poor connection or a malfunction of the component itself and can be predictive of future equipment failure.

Other forms of distribution line inspection procedures exist that are used for locating specific problem conditions. These include sonic/noise sensing and Radio Frequency Interference (RFI) detection, which are used to resolve interference complaints received from customers.

The purpose of this project was to test a combined inspection procedure and determine the following:

- Will infrared inspection combined with other non-intrusive inspection methods on distribution equipment improve the prediction of system failure?
- Will combined inspection procedures improve the predictive accuracy of distribution equipment failure prediction?
- Can RF or TV interference problems be identified before customer complaints are received?
- Can a combined inspection procedure reduce overall costs?
- Will periodic RFI inspections reduce the number of interference complaints?
- Can a combined inspection program provide predictive failure information if performed during off peak periods?
- Will development of a combined inspection device produce more effective results in predicting equipment failure?

Study results show that multiple survey protcedures (RFI/TVI/Ultrasonic) used for predictive maintenance can locate system conditions that are not detected through infrared surveilance alone. The conditions detected can be source locations that result in eventual customer interference complaints.

The collection vehicle can be operated at the same speed during the multiple inspection procedure as operated under the infrared inspection procedure alone.

The suspect equipment surfaced with the RFI/TVI/Ultrasonic procedure were not analyzed to determine whether or not they were in a mode of eventual failure. However, a data base of potential interference sources was obtained.

Application of a multiple survey procedure can be done at minimal increased cost, approximately 8 % more. Companies that normally perform their own periodic in-house infrared surveys and also perform RFI/TVI interference investigations in reaction to customer complaints can combine these procedures at a minimal cost increase when investigating customer interference problems.

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Investigative Procedure

Orange and Rockland Utilities, Inc. was contracted by EPRI in September, 1998 to perform a study to determine if additional predictive maintenance procedures, utilizing existing technology, could be developed which are both effective and economical. The effort sought to prove if benefits could be achieved by combining two or more non-intrusive inspection procedures. The effort was designed to accomplish the following objectives:

- Investigate the feasibility of combining two or more inspection procedures.
- Operationally combine the procedures for multiple method inspections.
- Correlate the exception reports from each procedure.
- Determine if use of multiple inspection methods improves predictive ability.
- Investigate if a device can be developed which provides the capability to capture and record multiple data measurements.
- Obtain a reduction of operating and inspection costs for multiple inspections' procedure.

The multiple inspection procedure has been performed on almost all circuits and substations in the company and on a significant portion of the company's URD transformers. The multiple inspection procedure included the addition of both ultrasonic detection technology and radio frequency technology to the company's annual infrared inspection program.

During the survey, 400 infrared condition reports and 94 ultrasonic condition reports were generated. There have only been three (3) instances where each of the procedures collected data on the same item, which might be construed as indicative of an equipment problem.

There were 72 reported instances from the ultrasonic collection, which were classified as corona. Arcing was reported on 19 equipment items, while tracking was reported three (3) times. Indications of arcing and/or tracking might be considered precursors to equipment problems. Corona, however, may occur under normal operations when other conditions such as adverse weather conditions exist which may cause their occurrence. Potential problems on equipment exhibiting the abnormal ultrasonic conditions can then only be ascertained through equipment tear-down and examination.

Results from the ultrasonic detection procedure performed on underground pad-mounted equipment and within substations were the most promising. Ultrasonic detection may have potential as a method for predictive maintenance of the underground system. Ultrasonic activity, classified as corona, was detected at the primary elbow of several pad-mounted transformers.

The internal transformer panels where the ultrasonic corona activity was evident also exhibited discoloration at some of the elbow termination locations of these pad-mounted equipment.

The reports generated suggest that ultrasonic detection may surface equipment conditions which, if not corrected, may lead to eventual failure of that equipment. Ultrasonic emissions were detected at twenty (20) underground equipment locations (mostly pad-mounted transformers). Most of these emissions were classified as corona. However, five (5) of the pad-mount transformer locations also had a visible discoloration on the transformer panel at the dead-end elbow termination, and three (3) of these had a “hot spot” near that same location. Where a discoloration on the transformer panel was detected and/or “hot spots” identified, the ultrasonic activity was classified as arcing or tracking. These situations may suggest that ultrasonic “corona” could be a precursor or the first sign of a potential elbow termination problem on pad-mounted equipment. Further evaluation is necessary to determine if the ultrasonic emissions may be a precursor of equipment failure.

Ultrasonic tests were also performed within all eighty-seven (87) O & R substations. Ultrasonic emissions were detected and reported at thirty-one (31) equipment sites within twenty-one (21) of the 87 substations surveyed. All but two of these reports were corona. Corona is often emitted from substation equipment due to the normally higher operating voltages within a substation and should not be considered as a symptom of potential equipment failure.

While ultrasonic activity was detected emanating from underground pad-mounted equipment and at numbers of devices within substations, the inspection of the overhead system with this technology was disappointing, as only one potential problem condition was reported.

Finally, the collection of ultrasonic activity was initially performed in areas where major reconstruction has taken place over the last several years, which were specifically directed toward reliability improvements. This could have skewed our results as potential equipment problems may have been corrected during the reliability reconstruction program.

Note: Based on the early inspection results, the following project changes were made midstream.

- **Added TVI/RFI collection method to the collection procedure.**
- **Performed the ultrasonic inspection procedure in areas where reliability reconstruction had not yet been done.**
- **Returned to a vehicle survey collection speed of 20-25 mi/hr (32.19-40.23 km/hr) to reduce the unit costs for the inspection procedure.**

Consideration was also given, midway through the study, to remove and test various items of equipment found to be suspect during the combined procedure survey. This was not done. Since the collection results located relatively few equipment items where unusual ultrasonic emanations were present and which could be collaborated on a return inspection, we decided that the cost to do this analysis, based on the proposals received, would not be justified.

Conclusions

Conclusions reached and lessons learned during this study to evaluate various predictive distribution maintenance procedures follow:

- RFI/TVI and Ultrasonic surveys can be combined and performed in conjunction with the infrared survey without affecting the results of the infrared inspection procedure.
- The RFI/TVI/Ultrasonic collection procedure can locate suspect line equipment.
- RFI/TVI/Ultrasonic Surveys can identify potential noise sources that could be input into a database for future investigation of RFI/TVI complaints.
- Infrared inspections can be cost effectively combined with RFI/TVI/Ultrasonic inspections performed to locate interference complaints.
- The speed of the collection vehicle under the combined RFI/TVI and ultrasonic collection procedures could be maintained at the same speed as used with the collection of infrared data alone without adverse impact on the collection results.
- The RFI/TVI collection procedure was very effective in locating a general area where ultrasonic emissions were being produced in comparison to the ultrasonic detector. The collection vehicle had to be close to the source of the emission, before it could be detected by the ultrasonic equipment.
- The ultrasonic detector was much more effective in pin pointing the actual source of an ultrasonic emission.
- Seasonal changes in load had no impact on the number of line equipment ultrasonic source emissions located.
- Results obtained with the RFI/TVI and ultrasonic collection procedures often could not be duplicated and confirmed when a repeat inspection was done.
- Programmed periodic over the road RFI/TVI/Ultrasonic surveys are not effective in locating potential equipment suspect for failure.
- Surveys performed using the combined inspection procedures in substations and on pad-mounted equipment substantially increased the number of suspect equipment located as substation and pad-mounted equipment accounted for more than half of the number of suspect equipment sites identified.

1
INTRODUCTION

Background

Orange & Rockland Utilities uses contract crews to perform an annual infrared (IR) inspection. All three (3) phase overhead primary distribution lines are inspected including transformers and secondary, where three phase distribution exists. IR inspections are also performed on stress cones, elbows, bushings and pad-mounted transformers on underground distribution lines. At present, IR inspections on single phase distribution line sections are not performed, but are planned in the future for every three (3) to four (4) years.

The intent of the IR inspection is to identify distribution equipment which exhibit “hot spots”. These “hot spots” are a result of a poor connection or a malfunction of the component itself and are predictive of future equipment failure.

“Hot spots” are equipment locations which have temperatures above a reference level, the normal operating temperature of the equipment being inspected. The differential in the “hot spot” temperature to the reference establishes the immediacy of potential failure. Infrared photographs are taken of all “hot spots”.

Infrared testing locates high resistive connections such as contaminated switch contacts or loose connectors. These conditions produce heat and appear as lighter areas on infrared photographs. Corona or tracking produces high voltage insulator failures. Infrared testing normally can not detect corona or tracking. Corona and tracking produces signal interference which causes electrical noise on radios and TV and can be detected by TVI/RFI noise measurement.

Mechanical vibration produces an easily discerned spectral pattern, while electrical corona or tracking produces a noise pattern. Detection of a higher magnitude of noise emanating from electrical distribution equipment may indicate future problems with that equipment.

In addition to IR Inspections, other forms of inspection are available that might predict pending failures on distribution lines. Other inspection procedures include Television/Radio Frequency Interference (TVI/RFI) measurements and Sonic/noise sensing.

An ultrasonic noise measuring device, was used by the infrared inspector to obtain additional measurements at the same time and on the same facilities as the data collection for the infrared inspection.

TVI/RFI noise measurements are made on distribution line sections when traditional inspection methods cannot locate intermittent faults and when radio frequency (RF) or television (TV) interference complaints are received from customers. TVI/RFI noise measurements can detect sparking or tracking which cause RF or TV interference. While IR inspection is a predictive maintenance procedure, TVI/RFI noise measurements are generally a reactive process. However, since potential distribution equipment faults may radiate TV/RF noise before the actual failure occurs, combining TVI/RFI noise measurements with the IR inspection could provide potential benefits.

Sonic/noise sensing or ultrasonic detection is used to detect equipment mechanical problems, locate gas leaks, verify valve and steam trap leakage or blockage and capture various forms of electrical noise emanations indicative of potential electrical equipment problems.

- Ultrasonic readings are not generally indicative of poor electrical connections. Poor connections increase the impedance between the connected equipment/conductors and can result in higher temperatures to occur at the poor connection point. Therefore, infrared is the prescribed inspection procedure to use for detection of poor connections.
- Ultrasonic readings are used to locate corona, tracking or arcing. Changes in sound pattern indicate possible corona, tracking or arcing conditions.
- Sound intensity, generated by an item of equipment under normal operation, may increase when the equipment begins to fail.

Objective

This research study is testing the idea that other inspection procedures may exist, which can be used either separately or in conjunction with current procedures, to provide improved predictive maintenance results. The project seeks to prove the advantages of combining two or more non-intrusive inspection methods. Specifically this effort seeks to accomplish the following objectives:

- Investigate the feasibility of combining two or more non-intrusive inspection procedures designed for predictive detection of equipment failure.
- Operationally combine the procedures for the multiple method inspections.
- Correlate the exception reports from each procedure.
- Obtain a reduction of operating and inspection costs for a multiple inspections' procedure.
- Investigate if a device can be developed which provides the capability to capture and record, multiple data measurements.
- Determine if the use of multiple inspection methods improves predictive failure ability.
- Determine if the combined inspection program provides predictive failure information if performed during off peak periods.
- Determine if RF or TV interference problems can be identified before customer RFI/TVI complaints are received.

- Determine if the total cost of TVI/RFI noise inspection can be decreased due to a reduction of interference complaints.
- Determine if the accuracy of distribution equipment failure prediction can be improved.

Scope of Work

While this effort is being performed on one utility's system, the general results will be made as broad as possible to make the results applicable to many different utilities. This work is restricted to consideration of the distribution system only, which is defined as any voltage below 40 kV and includes consideration for the secondary low voltage system used to provide service to customers. The effort required is to prove that the concept of multiple inspection methods offer advantages, prove that the benefits exist, and conduct training sessions to transfer this knowledge.

Tasks Performed

Starting in September, 1998, concurrent with an IR inspection, an ultrasonic inspection was performed on all three (3) phase distribution lines. Data was collected on the same distribution equipment utilizing ultrasonic collection equipment. The results of the inspection were reviewed to determine if the collected data provided additional distribution equipment failure prediction information, either by itself or in conjunction with the IR inspection. (If a correlation could be made between the inspection methods and equipment failure prediction or could improve the prediction of equipment failures when both inspections are performed, the possibility of designing equipment, which performs the combined inspections, would be investigated.)

Ultrasonic noise measurements were taken along the distribution circuits as the infrared inspection was performed. Reports, which included photographs, were prepared on all equipment exhibiting either ultrasonic noise or thermal "hot spots". The following is a list of the data collected for the initial ultrasonic inspection:

- Inspector Name
- Date
- Humidity, Temperature
- Equipment Location
- Time
- Type of TVI/RFI noise sound

    1. Steady (Corona)
    2. Build Up and Drop Off (Tracking)
    3. Buzzing, frying, etc. (Arcing)

- Instrument Sensitivity
- Measurement Reading
- Distance to Device

Where “hot spots” were located during the concurrent inspection procedure, infrared photographs were taken.

The information collected was reviewed and evaluated as follows:

- The output reports of the two procedures were reviewed and tabulated.
- All survey costs related to the combined inspections were captured and evaluated to develop costing methodology for each procedure and the combined survey.
- Unit costs for the individual and combined inspection procedures were developed.

The project direction was reviewed in early January, 1999 to assess our progress and, if needed, revise the approach taken based on the results obtained to date. The proposals developed during that review are described in the Conclusions portion of this report, which is on page 5-1.

2
INSPECTION PROCEDURE

Infrared (IR) surveys are performed periodically on the Orange and Rockland Utilities overhead and underground distribution lines, substations and transmission facilities. The infrared survey of the overhead distribution facilities is performed on all main three phase circuit sections.

The infrared survey is performed from a four wheel drive vehicle traveling at between twenty (20) - twenty-five (25) mi/hr (32.19-40.23 km/hr). An infrared camera is mounted on a support which extends outside the front passenger side door window. The infrared camera is manually aimed for quick response time. The infrared image from the camera is viewed by the technician on a monitor mounted on top of the dashboard.

When a problem is detected, an infrared image and a natural picture from a digital camera are taken. They are then both processed through a lap top computer input onto a fault report, which is also computer generated, and then printed out on a printer located in the rear of the vehicle. The vehicle has an inverter installed to supply the 120 volt AC current to operate the printer and the laptop. The IR camera is fed directly off the vehicle through the 12 volt DC system. The infrared camera is also able to perform away from the vehicle utilizing batteries whenever necessary.

The primary distribution facilities, including the conductor, are IR viewed continuously and in real time from pole to pole. Incorporated in the overall survey is the entire secondary network installed below the three phase primary, up to and including the customer service weather head, i.e. the building service entrances, on most commercial and industrial facilities, but not residential.

Since September, 1998, Orange and Rockland Utilities has been under contract to EPRI to perform a combined inspection program utilizing the IR collection technique in conjunction with another procedure to determine if a combined survey process can be found which will provide additional predictive maintenance results.

Ultrasonic collection and analysis was selected as the second procedure to test as a process for predictive distribution maintenance. This technique had been shown to be an effective method in locating corona, tracking and arcing emanating from electrical equipment; which are conditions that can precede equipment failure.

Concurrently with the infrared inspection procedure, ultrasonic detection and collection is also performed from the same four wheel drive vehicle. However, since the abnormal audio sounds are more difficult to discern, the vehicle must travel at a slower rate of between ten (10) and fifteen (15) mi/hr (16.09-24.14 km/hr).

The ultrasound collection is performed with an ultrasound receiving horn mounted next to and parallel to the infrared camera. The horn is connected to a speaker mounted on the dashboard. When an abnormal electrical discharge noise is identified, the vehicle is stopped and the technician exits the vehicle to utilize a waveform concentrator parabolic dish which specifically locates the suspect distribution line component. Ultrasonic instrument readings of the suspect component are taken and recorded, along with temperature and humidity readings. A natural photo of the suspect item, identified as the target, is also taken; and the technician prints out a report similar to that of an IR problem, which is also entered into the computer database.

All overhead problems, whether infrared or ultrasound, are entered into a database for O&R recovery purposes and both photos are eliminated from the database once the hard copies are printed out in order to save space on the hard drive.

Infrared surveys of substations are performed from a vehicle, when accessible, or by walking in order to better target blind areas where the vehicle can not access. The high voltage side of the station, which has a bigger profile, can usually be done from the vehicle, saving time. The low voltage side of the station, which has a lower profile, normally requires walking the station using the batteries attached to the infrared camera. The IR substation report is the same style and format as the overhead distribution lines report and the results are also put into the database on the computer hard drive. However, both the infrared and natural photos are retained in the database for the substations.

When performing the ultrasonic survey of substations, the technician walks the entire station with the waveform concentrator parabolic dish, including the interior of the bays as well as from the outside of the bays. The survey can not be effectively performed from a vehicle, as many blind spots and adjacent reflective surfaces inhibit the ultrasound signal. The final report for the substation ultrasound survey is documented the same as the ultrasound survey on the overhead lines and input into the computer database. The photo taken for the ultrasonic report is not retained in the computer database, again in order to save space on the hard drive; although it is on the hard copy that is submitted to the supervisor in charge of the operation.

The IR survey of the underground padmount transformers and switches is done with the equipment door open and can be performed either by both shooting from the vehicle, or walking up to the equipment, depending on accessibility of the apparatus to be analyzed. The IR report submitted for underground equipment is in the same style and format as the overhead distribution lines report except that the photos are retained in the database.

The ultrasonic survey of the underground system padmount transformers and switches is also normally done with the equipment door open. The survey is done by walking directly up to the equipment and using the waveform concentrator parabolic dish to collect the ultrasonic emanations. Should conditions prevent the opening of the equipment, the ultrasonic survey can be performed from outside the door with the trisonic ultrasonic collection attachment. The report is again done in the same style and format as on overhead lines, with results also put into the database; although the photo on the ultrasound report is eliminated from the database after the hard copies are printed out to save space on the hard drive.

The I R survey of transmission or EHV power lines is performed from a helicopter, with all other aspects of the procedure being similar to that of surveying the overhead distribution lines. The particulars for doing the aerial patrol are that of speed and altitude. The overall range of the speed is from approximately 40 - 60 mi/hr (64.37-95.56 km/hr). The speed is adjusted to accommodate the size and configuration of the lines; usually the lower the transmission line kV, the slower the flight speed. The elevation or altitude of the flight is adjusted to accommodate the tower size, as well as ground terrain for safety reasons. At present, no ultrasonic survey is performed on the transmission lines.

Early on during the ultrasonic inspection survey it became apparent that the collection procedure used for the detection of ultrasonic emanations significantly reduced the rate of speed required for the infrared survey alone. You had to be within approximately 100 ft (30.48 m) of the ultrasonic emanation to ensure detection and confirm the source. While the ultrasonic detection procedure could pin-point unusual ultrasonic emissions, the rate of speed for the collection procedure had to be slowed considerably to avoid missing suspect equipment.

An RFI/TVI Locator was purchased and mounted in the inspection vehicle to test as an additional method of survey procedure for predictive distribution maintenance. The RFI/TVI Locator is an instrument used for the initial process of locating unwanted electrical interference caused by the breakdown or improper installation of hardware that comprise the various components of high voltage overhead distribution.

The Locator permits an operating technician to efficiently cover large segments of circuits in search of abnormal electrical discharge such as tracking, corona and arcing. Use of the locator allows the technician to effectively track down areas with sources of unusual ultrasonic emanations to within a few select poles. This can be done from within the vehicle. After the sources of the unusual emanations are determined to within the few poles, the technician exits the vehicle and, using the Wave Form Concentrator, attempts to pin-point the source.

Use of the Locator in conjunction with the Wave Form Concentrator allows the vehicle to proceed at the same rate of speed as required for the infrared collection procedure alone. The only impact on the rate of collection occurs when a source area of unusual sonic emanations is located and the technician exits the vehicle to pin-point the source.

Photographs of the inspection vehicle and the infrared and ultrasonic inspection equipment are illustrated below.

Figure 2-1
Collection Vehicle

Figure 2-2
Ultrasonic Long Range Module (Horn) on Left Infrared Camera on right

Figure 2-3
Technician Using Ultrasonic Concentrator to Detect Ultrasonic Emissions from Overhead System

Figure 2-4
Technician Using Waveform Concentrator to Detect Ultrasonic Emissions from Underground Pad-mount Transformer

3
INSPECTION DATA ANALYSIS AND RESULTS

The combined infrared/ultrasonic survey of the Orange and Rockland Utilities, Inc. primary distribution system, which was initiated on September 2, 1998, included all substations and the three (3) phase sections of all 13.2 kV and 34.5 kV distribution lines.

The multi-procedure survey was performed from September, 1998 to June, 1999. From September, 1998 to March, 1999, the inspection survey combined only the ultrasonic collection with the infrared collection program. Since there had been a lack of success in locating overhead equipment problems with the use of the ultrasonic collection procedure, other methods for predictive maintenance inspections were considered and evaluated.

Since Orange and Rockland Utilities, Inc. experiences approximately 150-200 interference complaints annually and use of the RFI/TVI collection procedure had been an effective tool to locate the source of these complaints, this inspection procedure was considered to be a viable choice to enhance the ultrasonic collection program.

In 1998, there were 133 RFI/TVI complaints. Using the RFI/TVI collection technology, 61 were correlated to conditions on the O&R system, while the majority of the complaints were shown to be caused by internal customer conditions. Thus, TVI/RFI collection equipment had been shown to be an effective procedure in locating system problems when they occur and are reported.

Based on this consideration, TVI/RFI equipment was purchased to test as an additional tool for predictive maintenance.

Orange and Rockland had also been informed that EPRI was evaluating a new type camera (Daytime Corona Camera) which was being tested for use as a method for detecting corona activity on transmission lines during daylight conditions. The camera had been shown to be effective in photographing corona activity around a damaged insulator operating at transmission level voltages.

Arrangements were made with the EPRI Program Research Engineer to visit their site in Lenox, MA with examples of damaged equipment and test the capabilities of the camera on these damaged equipment when operated at distribution level voltages. The capability of the camera to capture images of corona activity became more pronounced as the level of the operating voltage was increased. Camera images of a damaged 23 kV insulator at the EPRI site clearly demonstrated the capability of the camera to capture corona activity at that voltage. However, images of corona activity on the damaged equipment supplied by Orange and Rockland Utilities, Inc., when operated at 13.2 kV, were not as easily identifiable. The EPRI laboratory at Lenox will be developing a next generation camera, which should be more sensitive and provide higher resolution images and be able to detect corona activity at the lower primary distribution voltages. When the next generation camera is available, its ability to identify corona activity at the 15 kV primary distribution voltage level should be tested as it may make corona detection an attractive method to consider for predictive distribution maintenance.

In June, the ultrasonic/RFI collection was terminated, while the infrared survey continued. The collection data includes the infrared reports generated through November, 1999. During this study survey, the contractor generated 400 infrared condition reports and 94 ultrasonic condition reports on system equipment.

The data shown in the tables within this section include all conditions reported for the entire length of the project, regardless of the collection procedure combinations used. Tabulations of the collected data follow:

Table 3-1
Infrared Condition Reports

Division	Substations	Overhead	Underground
Central	6	74[1]	16
Eastern	41	126[2]	1
Western	40	94	2
Totals	87	294	19

1. Includes one transmission line report.
2. Includes eight transmission line reports.

Table 3-2
Ultrasonic Condition Reports

Division	Substations			Overhead			Underground		
	Corona	Arcing	Tracking	Corona	Arcing	Tracking	Corona	Arcing	Tracking
Central	15[1]	1	0	5	3	0	3	4	2[2]
Eastern	0	0	0	24[3]	9[4]	1	0	0	0
Western	14	1	0	1	0	0	10	1	0
Totals	**29**	**2**	**0**	**30**	**12**	**1**	**13**	**5**	**2**

1. One substation report for Central Division did not indicate the ultrasonic type and was listed as corona.
2. One Central Division underground report identified both corona and tracking and was listed as tracking.
3. One Eastern Division overhead report did not list the ultrasonic type and was listed as corona.
4. One Eastern Division overhead report was for a transmission line and listed corona as the type of ultrasonic sound pattern.

The previous chart on infrared condition reports illustrates that the infrared technology captured 294 distribution overhead equipment with “hot spots”. Most of the overhead “hot spots” were at termination locations. Where “hot spots” are found and reported, repairs are scheduled, as previous experience has shown that many of these sites would have eventually resulted in equipment failure and customer outages. Use of the infrared collection procedure also surfaced equipment at 106 substation and underground locations operating at elevated temperatures. This technology has been proven to be a productive source for locating equipment with potential for near term failure and provides a valuable tool for a predictive maintenance program.

The collection of ultrasonic emanations was tested to determine if this technology could also be a source for predictive maintenance of distribution equipment and facilities. No correlation to the infrared collection technology was made. While 94 ultrasonic reports were generated, there were only three (3) instances of equipment exhibiting both an infrared thermal condition and emanating an ultrasonic condition.

Of note, many ultrasonic reports were generated on conditions collected on equipment within substations. Almost all substation ultrasonic reports were logged as corona activity and there were no visible signs of near term equipment failure apparent where the ultrasonic activity was collected.

Consideration was given to perform a laboratory tear down and test of equipment found suspect during the survey. Test proposals were solicited and received from two labs and approval for the tear down test and engineering analysis was obtained from EPRI. Prior to the removal of the suspect equipment, each location was resurveyed to confirm the initial collection results. Fifteen (15) were selected to be resurveyed. Strong ultrasonic signals indicating corona, arcing or tracking were confirmed at seven (7) sites. At about four other locations the results were considered inconclusive. No unusual ultrasonic emissions were obtained at the remaining locations.

The ultrasonic collection program on the overhead system did not generate any reports which were correlated directly to equipment with potential for near term failure. However, some potential could exist for use of this procedure on underground equipment. Corona activity was detected at the dead-end elbows of several pad mount transformers. In each case, there was a discoloration on the transformer panel. In one case, the location of ultrasonic activity coincided with a “hot spot”. This could suggest that the initiation of a failure mode at the dead-end elbow produces corona activity which precedes development of a “hot spot” and eventual failure. If this is found to be true, the use of ultrasonic surveys on pad-mounted equipment may have potential.

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INSPECTION PROCEDURE COST ANALYSIS

The utilization of any predictive maintenance process must result in either an economic benefit which equals or exceeds the rate of return expected through normal investments, or in an improvement in customer service and satisfaction through enhanced system reliability.

An economic evaluation of a predictive maintenance program must first assess the costs of that program and then relate those costs to any resulting savings. Comparison of costs is simplified if a method can be developed which assigns costs on a per unit basis.

The Appendix Table on page C-2 illustrates the information collected to determine unit costs for the combined inspection program. Initial efforts were directed toward capturing actual hours for both the ultrasonic and infrared inspection programs and developing the incremental costs for the combined inspection procedure with the addition of the ultrasonic inspection. However, this proved difficult as the inspections were done simultaneously and no clear cut time separation could be established between the two procedures as the surveys were being performed.

Since actual times for each procedure of the combined inspection program proved to be difficult to capture, some other measure of per unit cost had to be developed. The Interim Report used the miles of overhead line inspected per period of time for each survey procedure as the unit to evaluate and compare per unit costs. Note that use of this method limits the analysis to overhead lines only.

Cost Analysis 1

To arrive at the average miles of overhead line inspected, we had to review the data obtained during previous surveys utilizing the infrared inspection procedure alone.

During 1997, Asplundh averaged 61.6 mi/day (99.14 km/day) on infrared inspections of the overhead lines and 39.2 mi/day (63.09 km/day) on the underground lines in O & R's Central Division. Based on these numbers, discussions with the subcontractor and a perception that, on average, the entire O & R territory would be more difficult to inspect, and therefore, maintain this average; a standard of 50 mi/day (80.47 km/day) for overhead line inspections was established. Using the per unit standard of 50 mi/day (80.47 km/day) for the overhead line infrared inspection alone, the reduction in daily per mile inspections can be attributed to the ultrasonic inspection activity. This reasoning can then be used to convert to overhead line inspection hours to charge for the ultrasonic inspection activity, over and above the infrared inspection, by use of the following equation.

$$\textbf{Survey Hrs} = \frac{\textbf{[50 mi/day (80.47 km/day) - Comb. Ins. mi/day (km/day)][8 hr/day]}}{\textbf{50 mi/day (80.47 km/day)}}$$

It was assumed that use of the previous equation will give one a reasonable estimate of the impact on collection time with the addition of the ultrasonic inspection to the infrared inspection for any one day. The equation could not be used if the collector achieved or exceeded 50 mi (80.47 km) in one day, as the equation goes negative. Based on this analysis, over a longer period of time, the actual increase in time due to the dual inspection program added about 50% to the time required for the infrared inspection alone. Based on the work performed through February, 1999, the dual collection program averaged about 34 mi/day (54.72 kilometers/day) against the 50 mi/day (80.47 km/day) for the infrared collection procedure. Converting these costs to a per mile basis provided the following results which were reported within the Interim Project Report:

$$\textbf{Infrared Inspection Program} = \frac{\textbf{Cost of technician per day}}{\textbf{Miles surveyed per day}} \qquad \textbf{eq. 1}$$

$$= \frac{\textbf{(\$66.31/hr)(8 hr)}}{\textbf{50 mi}}$$

$$= \textbf{\$10.61/mi (\$6.59/km)}$$

$$\textbf{Combined Inspection Program} = \frac{\textbf{Cost of technician per day}}{\textbf{Miles surveyed per day}} \qquad \textbf{eq. 2}$$

$$= \frac{\textbf{(\$66.31/hr)(8 hr)}}{\textbf{34 mi}}$$

$$= \textbf{\$15.60/mi (\$9.69/km)}$$

The infrared inspection is done with the vehicle traveling at an average speed of 20 - 25 mi/hr (32.19-40.23 km/hr). During the first 4 - 6 weeks of the inspection program, the subcontractor technician maintained this speed. Since no ultrasonic problems were detected during this period, UE Systems, the ultrasonic equipment vendor, was contacted to determine if we were not properly performing the collection procedure. This discussion led to a reduction in collection speed to 10 - 15 mi/hr (16.09-24.14 km/hr), which reduced the daily collection rate.

The implementation of the changes in Spring, 1999, return to the normal infrared survey speed and the addition of the RFI/TVI collection procedure, were expected to improve the combined inspection survey speed. This did not occur. The changes resulted in the reduction of the average collection distance covered within one day from 34 miles (54.72 kilometers) to 27.5 miles (44.26 kilometers).

Based on the distance of 27.5 mi/day (44.26 km/day), the cost of the three procedure survey on overhead lines was calculated as follows:

$$\textbf{Infrared/Ultrasonic/RFI Inspection Program} = \frac{\textbf{Cost of technician per day}}{\textbf{Miles surveyed per day}} \qquad \textbf{eq. 3}$$

$$= \frac{\textbf{(\$66.31/hr)(8 hr)}}{\textbf{27.5 mi (44.26 km)}}$$

$$= \textbf{\$19.29/mi (\$11.99/km)}$$

This produced a cost differential for the combined procedures of almost double the cost of the infrared procedure alone, which appears to be unrealistic.

Further discussions with the infrared technician revealed that the assumed survey distance covered per day of 50 mi/day (80.47 km/day) only applied to days when no problems were detected and no equipment reports were generated. Normal distances of 30 – 35 mi/day (48.28 – 56.33km/day) would be expected when one includes the time to locate and report the problems which are found. Using 35 mi/day (56.33 km/day) results in the following cost for the infrared procedure alone:

$$\textbf{Infrared Inspection Program} = \frac{\textbf{Cost of technician per day}}{\textbf{Miles surveyed per day}} \qquad \textbf{eq. 1}$$

$$= \frac{\textbf{(\$66.31/hr)(8 hr)}}{\textbf{35 mi/day (56.33 km/day)}}$$

$$= \textbf{\$15.16/mi (\$9.42/km)}$$

Note: Actual mileage covered per day for the performance of the infrared survey alone was captured and reported for the period January 1, 2000 through March 24, 2000. This was done to verify if the assumption of 35 mi/day (56.33 km/day) used in the previous equation was reasonably accurate. The actual average calculated for this period was 36.1 mi/day (58.1 km/day). Using this figure, the combined survey cost came to $15.64/mi ($9.72/km).

If one assumes that each collection procedure produces equivalent results in locating equipment to be suspect for failure, and that the distance of 35 mi/day (56.33 km/day) is more realistic, from the results shown above; the incremental per unit cost for each item of equipment collected under the combined collection procedures is about 27 % greater than the per unit cost of the infrared collection procedure alone. However, this is not the case. Each item of equipment found with a “hot spot” under the infrared collection procedure can be assumed to be in a failure mode, while this has not been shown to be true of equipment surfaced as suspect under the ultrasonic collection procedure.

Cost Analysis 2

The previous analysis resulted in substantial, and what was felt as unrealistic, incremental per unit cost differences. Since the analysis was based on the assumption of the average distance covered each day under the infrared collection program alone and a true assessment of this value was difficult to obtain, it was decided to use another approach to evaluate differential costs associated with the additional procedures.

The additional procedures required a set up period of fifteen (15) minutes or 0.25 hours each day. It also took a total of approximately 45 minutes to locate and pin point a source of an unusual ultrasonic emission and generate the associated report. If 94 reports were generated over a 254 day period and we exclude weekends, holidays and vacation days; the 94 reports were generated over approximately 200 working days. If we add the 0.25 hours per day, or 50 hours over the 200 day period (0.25hours/day x 200 days), for set up to the total additional time of 70.5 hours (94 reports x 0.75 hours per report); we get an additional time of 120.5 hours over the 200 days to incorporate the RFI/TVI/Ultrasonic procedures to the infrared survey. This equates to the following percentage increase in time to perform the combined survey.

$$= \frac{\textbf{120.5 hours}}{\textbf{(200 days)(8 hours/day) – (120.5 hours)}}$$

$$\textbf{Incremental Time Increase} \quad = \quad \textbf{8.2 \%}$$

Cost Analysis 3

A comparison of the cost per suspect item of equipment collected under the infrared collection procedure and the incremental cost per item collected under the combined procedures was made to evaluate the efficiency of each collection procedure.

> There were 400 “hot spots” located with the infrared procedure over 476 calendar days, and subtracting weekends, holidays and vacation days; the actual collection took place over approximately 385 working days.

Cost per Suspect Item Located

$$\textbf{Infrared Procedure} = \frac{\textbf{[(Cost/Hour)(Hours/Day)][Survey Days]}}{\textbf{Items Collected}}$$

$$= \frac{\textbf{[(\$66.31/Hour)(8 Hours)][(385)-(120.5 Hours/8 Hours/day)]}}{\textbf{400 Items}}$$

$$= \textbf{\$490.69/Equipment Item}$$

Incremental Additional Cost Per Item Collected

Combined Procedure = $\dfrac{\textbf{Incremental Additional Cost}}{\textbf{Additional Items Collected}}$

= $\dfrac{\textbf{(120.5 Hours)(\$66.31/Hour)}}{\textbf{94 Items}}$

= **$85.00/Additional Equipment Item**

If one assumes that each collection procedure produces equivalent results in locating equipment to be suspect for failure; from the results shown above, the per unit cost for each additional item of equipment collected under the combined collection procedures is substantially less than the cost of the infrared program alone to capture suspect equipment. However, this is not the case. Each item of equipment found with a “hot spot” under the infrared collection procedure can be assumed to be in a failure mode, while this has not been shown to be true of equipment surfaced as suspect under the ultrasonic collection procedure.

True savings will result only if the predictive maintenance program surfaces system problems which can be repaired during normal scheduled maintenance to prevent failures; rather than performing required repairs, under emergency conditions, at greater costs, when failures occur. However, the total savings evaluated through this analysis must exceed the cost of the predictive maintenance program to be economically beneficial. Therefore, the number of system problems which are found through a predictive maintenance program and the total savings associated with the differential costs of emergency versus scheduled repairs must be compared to the total cost of the program which surfaces the potential failures.

Improvements in customer service reliability can also accrue through predictive maintenance programs. While methods have been developed to express these improvements in economic terms, the economic value relationships tend to be subjective and benefits, therefore, are generally stated in reductions in outage frequencies, reductions in average outage durations and/or reductions in customers affected.

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CONCLUSIONS

During the initial portion of the survey where the ultrasonic procedure was combined with the infrared collection procedure little, if any, benefits had surfaced which would allow us to prescribe ultrasonic collection as an effective procedure to use for predictive maintenance of distribution overhead facilities.

The combined infrared/ultrasonic detection procedures performed on the underground distribution system and within substations did, however, capture ultrasonic activity which might be an indication of potential equipment failure. There were twenty (20) underground equipment locations, (mostly pad-mounted transformers) where ultrasonic emissions were detected. At three (3) of these 20 locations, “hot spots” were detected by the infrared collection procedure. Also, at five (5) of the pad-mount locations, discoloration was found on the transformer panel at the dead-end elbow termination. This may strongly suggest that ultrasonic emissions, which are detected at the dead-end elbows of underground pad-mounted equipment, are an initial precursor of eventual failure of that equipment. Corona activity, which was collected from various equipment within substations, might also suggest potential for equipment problems

Based on the results obtained during the initial six months of the collection survey, the project’s focus was redirected in Spring, 1999 to incorporate the following five (5) activities:

1. ***Include the collection of TVI/RFI as an additional procedure.***

   The existing results through February, 1999 showed that the ultrasonic survey had been disappointing as a tool for predictive maintenance. Therefore the survey was changed with the addition of TVI/RFI collection techniques. TVI/RFI collection technology can be used to survey and locate equipment problems to satisfy interference complaints received from our customers. Utilizing this technology on a continued basis may surface problems before complaints are received.

2. ***Perform the combined inspection program in an area where Orange and Rockland Utilities, Inc. had not yet initiated a reliability rebuild program.***

   The areas surveyed prior to Spring, 1999 had all been rebuilt in stages to incorporate various construction enhancements designed to improve reliability.

Significant improvements performed under the reliability enhancement program included the following:

- Install MOV line and riser arresters
- Bond messenger, bond guy wires, bond ground to neutral
- Replace 600 amp disconnect and GOAB taps with 500 MCM copper
- Replace porcelain cutouts
- Replace pre 1973 S & C cutouts
- Perform phase balancing
- Replace 5 kV class arresters and insulators with 15 kV class equipment
- Install animal guards on reclosers and stress cones
- Ground control boxes of line devices to standard
- Ground transformers on delta systems
- Replace rubber ties on open wire lines

Combined ultrasonic and infrared collections were done in areas where the reliability rehabilitation work had not been done. This allowed us to ascertain if collection of ultrasonic/RFI activity is conducive to predictive maintenance in an area which has experienced limited enhancement programs in recent years. Collection in the non-rehabilitated areas also allowed comparison of ultrasonic/RFI collection results between an area which had been rehabilitated against one which has not.

3. ***Return to performing the combined overhead survey with the vehicle traveling at a rate of 20 - 25 mi/hr (32.19-40.23 km/hr).***

At the beginning of this study, the combined survey was performed with the vehicle driven at a rate of 20 - 25 mi/hr (32.19-40.23 km/hr). Since no ultrasonic emissions were detected at that initial speed, and after discussion of the collection procedure with the ultrasonic equipment manufacturer; it was decided to reduce the speed of the vehicle to 10 - 15 mi/hr (16.09-24.14 km/hr) to determine if the higher vehicle speed prevented collection of ultrasonic emissions. Since the reduced survey vehicle speed did not improve collection results, the speed of the 3vehicle was increased to the original 20 - 25 mi/hr (32.19-40.23 km/hr) which is the rate of speed normally used for the infrared survey alone. This had the benefit of maintaining the incremental operating costs at a minimum.

4. ***Remove, examine and test dead-end elbows from several pad-mounted transformers where ultrasonic corona activity had been collected and where discoloration had occurred on the transformer panel at the location of the elbow connection.***

Ultrasonic arcing activity emanating from the termination of the elbow at the transformer panel on pad-mounted transformers had been collected and coincided with “hot spots” collected at those same termination locations.

Ultrasonic corona activity had been collected from several pad-mounted transformers where a discoloration was also apparent on the transformer panel where the dead-end elbow terminates. Infrared inspections of these same locations have not detected “hot spots”.

Removal, examination and a thorough test of the dead-end elbows which exhibit ultrasonic corona activity and are adjacent to transformer panels with obvious discoloration at the termination site will enable determination of a possible method for predictive maintenance of pad-mounted transformers.

5. ***Perform a thorough visual inspection of substation equipment where ultrasonic corona activity had been collected during the initial survey project. Remove the substation equipment on which ultrasonic corona activity had been collected, and which is also suspect from the visual inspection, and perform an engineering analysis and integrity test on that equipment.***

   During the ultrasonic survey of the substations, corona activity was detected at or near approximately 18 switches and disconnects. While no visual problems were obvious, the recommendation was made to identify several of these items of substation equipment for removal and test. Potential problems might surface which would correlate to an ultrasonic survey for substation predictive maintenance. In a few cases, ultrasonic sound patterns indicative of arcing was detected on the equipment and it was recommended that this equipment should be specifically targeted for test.

In addition to the project redirections described, we were informed of the Daytime Corona Camera being developed by EPRI and decided to consider and test its use as an additional tool for predictive maintenance of distribution facilities.

During Spring, 1999, the speed of the survey vehicle was again operated at the speed used for the infrared survey alone, the RFI/TVI equipment was purchased and added as an additional collection procedure for the remainder of the study and the survey was focused on Orange and Rockland Utility circuits where rehabilitation construction had not been done. The removal and testing of line equipment, which was considered to be suspect for eventual failure based on the RFI/TVI and/or ultrasonic collection survey, was not done.

Conclusions reached and lessons learned during the study to evaluate various predictive distribution maintenance procedures follow:

- RFI/TVI and Ultrasonic surveys can be combined and performed in conjunction with the infrared survey without affecting the results of the infrared inspection procedure.

  The only overall impact of the dual collection procedure was an increase in collection time of about 8 %.

- The RFI/TVI/Ultrasonic collection procedure can locate suspect line equipment.

  There were 94 equipment items collected and identified as suspect with the RFI/TVI/Ultrasonic collection procedure. While an engineering tear-down test and analysis would be the only way to confirm if the suspect equipment was in a failure mode, the 94 identified sites can be considered as prospective locations for customer interference complaints.

- RFI/TVI/Ultrasonic Surveys can identify potential noise sources that could be input into a database for future investigation of RFI/TVI complaints.

- Infrared inspections can be cost effectively combined with RFI/TVI/Ultrasonic inspections performed to locate interference complaints.

  Some companies perform both infrared and RFI/TVI/Ultrasonic inspections with in-house employees. At these companies, the infrared inspections are generally performed on a programmed basis, while the RFI/TVI/Ultrasonic inspections are performed in response to interference complaints. Companies, which operate this way, can combine the infrared surveys with the RFI/TVUI/Ultrasonic inspections performed at a minimal cost increase. The differential increase in collection time, which can be equated to the cost increase, is approximately 8 % and would surface potential equipment problems which would easily offset that cost increase.

- The speed of the collection vehicle under the combined RFI/TVI and ultrasonic collection procedures could be maintained at the same speed as used with the collection of infrared data alone without adverse impact on the collection results.

  When initial collection results were less than promising, it was felt that performing the survey at reduced speeds would improve the potential for capturing unusual ultrasonic activity. As the technician became more proficient in operation of the ultrasonic collection equipment, it became apparent that the speed had little effect on collection results.

- The RFI/TVI collection procedure was very effective in locating a general area where ultrasonic emissions were being produced in comparison to the ultrasonic detector. The collection vehicle had to be close to the source of the emission, before it could be detected by the ultrasonic equipment.

  The ultrasonic collection equipment had a very short range where signals could be received from a source of ultrasonic emissions (approximately 50–100 m). The RFI/TVI locator is capable of locating an area of unusual emissions which is much larger, but limited in identifying a specific source.

- The ultrasonic detector was much more effective in pin pointing the actual source of an ultrasonic emission.

  The ultrasonic detector could pin point the location of an unusual ultrasonic emission to the specific insulator on a cross arm.

- Seasonal changes in load had no impact on the number of line equipment ultrasonic source emissions located.

  The survey was performed throughout the year with no discernable difference in collection results based on the load or season of collection.

- The Daytime Corona Camera can be effective in locating sources of corona activity at voltages of 34.5 kV and above. At the existing level of this technology, use of this camera at distribution voltages of 15 kV and below was not as effective.

  O & R brought various damaged distribution line equipment to the EPRI test facility at Lenox, MA to apply the Daytime Corona Camera to test for corona discharges at distribution operational voltages levels. EPRI was able to demonstrate that the camera is very effective in locating corona activity at voltage levels of 23 kV and above. Corona was clearly evident on camera images of a damaged 23 kV insulator. Images of corona activity on the damaged equipment supplied by Orange and Rockland Utilities, Inc., when operated at 13.2 kV, was not as easily identifiable . A next generation camera is under development by EPRI. This camera will be more sensitive and have a higher resolution. If identification of corona activity at the 15kV primary voltage level can be made more identifiable with the newer generation camera, corona detection may be an attractive method for predictive distribution maintenance and should be tested.

- The per unit incremental cost per additional suspect item of equipment collected under the combined survey is substantially less than the per unit cost of the infrared procedure alone.

  The per unit incremental cost for the additional suspect equipment surfaced with the combined inspection procedure was $85/equipment item, while the unit cost for each suspect equipment identified under the infrared survey is $491/equipment item.

- Results obtained with the RFI/TVI and ultrasonic collection procedures often could not be duplicated and confirmed when a repeat inspection was done.

  Fifteen equipment locations with the most obvious sources of ultrasonic emanations were revisited and the ultrasonic collection procedure was redone. The intent was to determine if the initial results could be duplicated, and also allow us to select the best equipment for removal and submission to a neutral testing laboratory for tear down and engineering analysis.

- Programmed periodic over the road RFI/TVI/Ultrasonic surveys are not effective in locating potential equipment problems.

- Surveys performed using the combined inspection procedures in substations and on pad-mounted equipment substantially increased the number of suspect equipment located as substation and pad-mounted equipment accounted for more than half of the number of suspect equipment sites identified.

Of the 94 sites detected with the RFI/TVI/Ultrasonic procedures, 31 were in substations and 20 were on underground equipment.

- The combined RFI/TVI and ultrasonic inspection procedure is not a cost effective procedure for locating equipment suspect for eventual failure.

  The combined inspection procedure only cost about 8 % more than the cost of the infrared survey alone and about $85.00 for each additional suspect item of equipment collected in comparison to the infrared survey which cost about $491.00 per suspect item collected. However, while each equipment item collected under the infrared program could be considered to be in a failure mode, this is not true of the suspect equipment found with the RFI/TVI and ultrasonic procedures. Suspect equipment found with the RFI/TVI/ Ultrasonic procedure would probably cause interference complaints, but an engineering tear-down and analysis would be the method for evaluating if the equipment in question was in a failure mode.

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A
ULTRASONIC SURVEY REPORTS

Table A-1
Ultrasonic Survey Reports

Date	Division	Sequential	Location	Substation	Circuit/Pole/ Structure	OH	UG	Equipment	Condition	Distance (Meters)
9/28/98	Western	98WOH051	Rio, NY	Rio			X	Generator # 2 (Bank # 3)	Corona	1
9/29/98	Western	98WOH051	Greenville, NY		42779/49712	X		Lightning Arrester	Corona	15
10/1/98	Western	98WSS023	Rio, NY	Rio		X		Stand-off-Insulator on O.C.B. # 53-2	Corona	12
10/1/98	Western	98WSS024	Rio, NY	Rio		X		Off Free Standing Potential Transformer	Corona	9
10/1/98	Western	98WSS025	Rio, NY	Rio			X	Generator # 2 (Bank # 13)	Corona	1
10/5/98	Western	98WSS026	Middletown, NY	Genung St.		X		Phase 2 Regulator	Arcing	1
10/5/98	Western	98WSS027	Middletown, NY	State Hospital		X		1107-A (Solid Blade Disconnects)	Corona	7
10/5/98	Western	98WSS028	Summitville, NY	Summitville		X		Phase 3 (Regulator)	Corona	1.5
10/6/98	Western	98WSS029	Port Jervis, NY	Port Jervis		X		Off Switch # 16-A	Corona	12
10/6/98	Western	98WSS030	Middletown, NY	Silver Lake		X		Off 69 kV Bus Pots	Corona	8
10/6/98	Western	98WSS031	Middletown, NY	Silver Lake		X		113-3-3D	Corona	3
10/6/98	Western	98WSS032	Middletown, NY	Silver Lake		X		T-113-3 Switches	Corona	7
10/6/98	Western	98WSS033	Middletown, NY	Shoemaker		X		211-2 (Above Potential Transformer)	Corona	3
10/6/98	Western	98WSS034	Middletown, NY	Shoemaker		X		211-7 Switch	Corona	7
10/6/98	Western	98WSS035	Middletown, NY	Shoemaker		X		111-7 Switch	Corona	8
10/7/98	Western	98WSS036	Middletown, NY	Shoemaker		X		111-4 Switch	Corona	10
10/7/98	Western	98WSS037	Middletown, NY	Washington Hts.		X		Transformer Bank # 1109	Corona	4
10/7/98	Western	98WSS038	Chester, NY	Sugarloaf		X		Circuit # 25	Corona	6
12/2/98	Central	98CSS002	West Point, NY	West Point # 1 (Station # 74)		X		Switches 74-10 & 74-9	Arcing	3
12/2/98	Central	98CSS003	Highland Falls, NY	Highland Falls		X		Off Switch # 841-73-4	Corona	8

Date	Division	Sequential	Location	Substation	Circuit/Pole/ Structure	OH	UG	Equipment	Condition	Distance (Meters)
12/2/98	Central	98CSS004	Fort Montgomery, NY	Queensboro (# 75)		X		Off Switch # 92-75-4	Corona	10
12/2/98	Central	98CSS005	Fort Montgomery, NY	Dean (# 88)		X		Main Station Transformers	Corona	1
12/2/98	Central	98CSS006	Fort Montgomery, NY	Dean (# 88)		X		Located on Pole Inside Yard		1
12/3/98	Central	98CSS008	Tuxedo Park, NY	Sterling Forest		X		Near Switch # 98-67-2	Corona	5
12/3/98	Central	98CSS009	Tuxedo Park, NY	Sterling Forest		X		Transformer High-side Disc. # 367-3	Corona	4
12/3/98	Central	98CSS010	Tuxedo, NY	Lake Road (# 82)		X		Bank # 282-A	Corona	4
12/3/98	Central	98CSS011	Tuxedo, NY	Lake Road (# 82)		X		Switch # 282-A	Corona	4
12/3/98	Central	98CSS012	Tuxedo, NY	Lake Road (# 82)		X		Switch # 182-A	Corona	4
12/4/98	Central	98CSS013	Goshen, NY	South Goshen		X		Below Switch # 24-89-4	Corona	10
12/4/98	Central	98CSS015	Pine Island, NY	Pine Island		X		Station Transformers	Corona	3
12/4/98	Central	98CSS016	Warwick, NY	Wisner (80)		X		Transformer Bank # 380	Corona	5
12/4/98	Central	98CSS017	Chester, NY	Chester		X		Fuse Disconnects # 262-A	Corona	3
12/7/98	Central	98CSS018	Greenwood Lake, NY	Hunt		X		Associated with Switch # 99-84-5	Corona	3
12/7/98	Central	98CSS021	Blooming Grove, NY	Blooming Grove		X		Associated with Switch # 176A	Corona	9
12/9/98	Eastern	98EOH125	Pearl River, NY	Rockland State Sub.	58962/38212	X		Primary Recloser Bushings	Arcing	8
12/23/98	Central	98CUG008	Woodbury, NY		Circuit 71-7-13		X	Switchgear Cabinet # 84/26 (PMS # 6)	Corona	1
1/4/99	Central	98CUG010	Chester, NY		Pad # 14/82		X	Transformer secondary bushing	Arcing	1
1/5/99	Western	98WUG001	Milford, PA		Pad # 37145/48798		X	Primary Dead-End Elbow	Corona	1
					L7-6-34					
1/7/99	Western	98WUG002	Milford. PA		Pad # 37602/48453		X	Primary Elbow	Corona	1
					L7-6-34					
1/20/99	Central	98CUG011	Chester, NY		Pad # 51108/49646		X	Primary Dead-End Elbow ***(Infrared Report)***	Corona	2
1/21/99	Central	98CUG013	Chester, NY		Pad # 51034/49620		X	Primary Dead-End Elbow	Corona	1
1/21/99	Central	98CUG012	Chester, NY		Pad # 51016/49644		X	Primary Dead-End Elbow ***(Infrared Report)***	Arcing	2
1/26/99	Western	98WUG003	Middletown, NY		Pad # 47421/53258		X	Primary Dead-End Elbow	Corona	1
1/26/99	Western	98WUG004	Middletown, NY		Pad # 47355/53271		X	Top Stand-off Insulators	Corona	1

Date	Division	Sequential	Location	Substation	Circuit/Pole/ Structure	OH	UG	Equipment	Condition	Distance (Meters)
1/26/99	Western	98WUG006	Deerpark, NY		Pad # 40993/50777		X	Primary Lead Cable below Elbow of Bushing	Corona	1
1/28/99	Western	98WUG007	Wurtsboro, NY		Pad # 46670/58354		X	Primary Dead-End Elbow ***(Infrared Report)***	Arcing	2
1/29/99	Western	98WUG008	Mt. Hope, NY		Pad # 45672/54828		X	Primary Dead-End Elbow	Corona	1
1/29/99	Western	98WUG009	Crawford, NY		Pad # 49326/57066		X	Primary Dead-End Elbow	Corona	1
2/5/99	Central	98CUG014	Florida, NY		Pad # 48/80		X	Primary Dead-End Elbows	Corona & Tracking	1
2/8/99	Central	98CUG015	Goshen, NY		Riser Pole # 49633/49395		X	Primary Dead-End Elbow	Arcing	1
2/16/99	Central	98CUG019	Goshen, NY		Pad # 01/18		X	Primary Dead-End Elbow	Tracking	1
2/22/99	Central	98CUG021	Warwick, NY		Pad # 34/18		X	Primary Dead-End Elbow	Arcing	1
2/26/99	Western	98WUG010	Greenville, NY		Pad # 19/48		X	Primary Dead-End Elbow	Corona	1
3/3/99	Eastern	98EOH139	New City, NY		59423/41174	X		Primary "Pin Insulators"	Corona	12
3/3/99	Eastern	98EOH140	New City, NY		59553/41??? 1 pole from 59550/41218	X		Lightning Arrester	Corona	10
3/16/99	Eastern	98EOH146	Monsey, NY		56949/40416	X		Primary Double Pin Insulators	Corona	13
3/16/99	Eastern	98EOH147	Monsey, NY		1 pole east of 56960/39613	X		Primary Double Pin Insulators	Corona	15
3/16/99	Eastern	98EOH148	Blauvelt, NY		60384/38644	X		Primary Pin Insulator	Corona	13
3/17/99	Eastern	98EOH149	West Nyack, NY		60566/39957	X		Primary Center Phase Insulators	Corona	10
3/17/99	Eastern	98EOH150	Valley Cottage, NY		60554/40559	X		Primary Road and Field Phase Insulators and Secondary Insulators	Corona	15
3/18/99	Eastern	98EOH151	Blauvelt, NY		59993/38872	X		Primary Pin Insulator		10
3/24/99	Eastern	98EOH153	Upper Saddle River , NJ		56038/38319	X		Lightning Arrester	Corona	13
3/24/99	Eastern	98EOH152	Nanuet, NY		Several Poles in Area	X		Primary Pin Insulators	Corona	11
3/24/99	Eastern	98EOH154	Mahwah, NJ		54092/38366	X		Lightning Arrester	Corona	15
3/25/99	Eastern	98EOH155	Bordonia, NY		59767/41035	X		Primary Dead-End Bells	Arcing	15
3/25/99	Eastern	98EOH156	Bordonia, NY		59902/41089	X		Lightning Arrester	Corona	12
3/26/99	Central	98COH050	Florida, NY		49742/49051	X		Lightning Arrester	Arcing	13
3/26/99	Central	98COH051	Florida, NY		49344/48852	X		Transformer Secondary Bushings	Arcing	12

Date	Division	Sequential	Location	Substation	Circuit/Pole/ Structure	OH	UG	Equipment	Condition	Distance (Meters)
3/26/99	Central	98COH052	Florida, NY		49384/48967	X		Primary Pin Insulator	Corona	10
4/12/99	Central	US-99COH001	Monroe, NY		54084/48371	X		Primary Pin-Insulators	Corona	15
4/13/99	Central	US-99COH002	Monroe, NY		One pole west of 54616/47422	X		Neutral Insulator	Corona	9
4/14/99	Central	US-99COH003	Blooming Grove, NY		53928/50672	X		Primary Dead-End Bells	Arcing	10
4/15/99	Central	US-99COH004	Washingtonville, NY		54949/51966	X		Primary Dead-End Bells	Corona	12
4/15/99	Central	US-99COH005	Washingtonville, NY		54953/51949	X		Primary Dead-End Bells	Corona	13
4/26/99	Eastern	US-99EOH001	Norwood, NJ		60499/36159	X		28-2-13/Lightning Arrester	Corona	15
4/27/99	Eastern	US-99EOH002	Closter, NJ		60227/35511	X		28-4-13/Primary Dead-End Bells	Corona	16
4/28/99	Eastern	Rivera #1	Monsey, NY		?????/39771	X		Primary Pin Insulators	Corona	14
4/28/99	Eastern	Rivera #2	Monsey, NY		56900/39754	X		Primary Pin Insulators	Corona	13
4/28/99	Eastern	Rivera #3	Monsey, NY		56913/40039	X		Primary Pin Insulators	Corona	11
4/28/99	Eastern	Rivera #4	Monsey, NY		56902/39789	X		Primary Pin Insulators	Corona	11
4/28/99	Eastern	Rivera #5	Monsey, NY		***3***6902/39801 ?	X		Primary Pin Insulators	Corona	12
4/29/99	Eastern	US-99EOH003	Tallman, NY		56635/40778	X		51-5-13/Lightning Arrester	Arcing	12
5/4/99	Eastern	US-99EOH004	Montebello, NY		1 Pole West of 55895/41496	X		Pin Insulator	Corona	13
5/11/99	Eastern	US-99EOH005	Nanuet, NY		58892/40415	X		Primary Pin Insulator	Corona	13
5/11/99	Eastern	US-99EOH006	Nanuet, NY		58882/40415	X		Lightning Arrester	Arcing	13
5/12/99	Eastern	US-99EOH007	Demarest, NJ		60657/34302	X		Primary Pin Insulator	Arcing	14
5/17/99	Eastern	US-99EOH008	Nanuet, NY		58961/39362	X		Primary Pin Insulator	Arcing	8
5/21/99	Eastern	US-99EOH009	Nanuet, NY		58988/39689	X		Primary Pin Insulator	Arcing	11
5/21/99	Eastern	US-99EOH010	Nanuet, NY		58987/39695	X		Primary Dead-End Bells	Corona	14
5/28/99	Eastern	US-99EOH011	Haverstraw, NY		59536/43953	X		Primary Dead-End Bells	Arcing	3
5/28/99	Eastern	US-99EOH012	West Haverstraw, NY		59545/44123	X		Lightning Arrester	Corona	15
6/2/99	Eastern	US-99EOH013	Stony Point, NY		1 pole past 57190/44757	X		Primary Pin Insulator	Corona	12
6/3/99	Eastern	US-99EOH014	Rt. 202, NY		59054/?????	X		Primary Pin Insulators	Tracking	12
6/9/99	Eastern	US-99EEHV001	West Haverstraw, NY		43-2	X		Primary Dead-End Insulators	Arcing	25

B
INFRARED SURVEY REPORTS

Table B-1
Infrared Survey Reports

Date	Division	Sequential	Location	Substation or Structure	Circuit / Equipment	OH	UG	Hot Spot Cel.	Ref. Temp. Cel.
8/5/98	Western	98WSS001	Middletown, NY	Silver Lake	Circuit 113-2-1D, Solid Blade Disconnect	X		64	37
8/5/98	Western	98WSS002	Middletown, NY	Silver Lake	Circuit 113-2-3D, Solid Blade Disconnect	X		56	37
8/5/98	Western	98WSS003	Middletown, NY	Silver Lake	Circuit 113-2-4D, Switch (Jaw)	X		62	39
8/5/98	Western	98WSS004	Mount Hope, NY	Ottisville	Circuit 7-1-24 Regulator Bushing	X		203	46
8/5/98	Western	98WSS005	Mount Hope, NY	Ottisville	Circuit 7-2-24	X		68	40
8/12/98	Western	98WSS006	Sugarloaf, NY	Sugarloaf	25-108-1 Switch Hinge	X		63	24
8/12/98	Western	98WSS007	Sugarloaf, NY	Sugarloaf	6108-1, Hex Nut on side of Hinge on phase 2 & 3 switches	X		77	31
8/12/98	Western	98WSS008	Sugarloaf, NY	Sugarloaf	27-108-3 Top; Jaw of Switch	X		79	28
8/12/98	Western	98WSS009	Bloomingburg, NY	Bloomingburg	Transformer High Side Fuse	X		67	37
8/12/98	Western	98WSS010	Middletown, NY	Shoemaker	Circuit 24-11-2, 3(# 5 Bushing)	X		82	46
8/12/98	Western	98WSS011	Middletown, NY	Shoemaker	Circuit 25-11-2, 3*(# 6 Bushing)	X		62	44
8/13/98	Western	98WSS012	Middletown, NY	Shoemaker	Circuit 211-8, Jaws on Fused Disconnect	X		96	20
8/13/98	Western	98WSS013	Middletown, NY	Shoemaker	Bank # 111, Radiator (Cold)	X			
8/13/98	Western	98WSS014	Middletown, NY	Shoemaker	27-11-1X Switch (Jaws)	X		56	22
8/14/98	Western	98WSS015	Middletown, NY	Shoemaker	811-1 Switch	X		50	24
8/14/98	Western	98WSS016	Middletown, NY	Shoemaker	13-11-3 Switch, Down-drop wire between bus and switch	X		41	22
8/14/98	Western	98WSS017	Middletown, NY	Shoemaker	Transformer Bank # 311, Tap Changer	X		42	38
8/14/98	Western	98WSS018	Middletown, NY	Shoemaker	311-4D Switch, (Jaws)	X		52	28
8/14/98	Western	98WSS019	Middletown, NY	Shoemaker	111-7Switch, (Jaws)	X		92	27
8/14/98	Western	98WSS020	Forestburg, NY	Mongaup	2-1-2K Recloser	X		72	26
8/17/98	Western	98WSS021	Grahamsville, NY	Grahamsville	HG 1291 Breaker (OCB), Lightning Arrester	X		35	24
9/1/98	Western	98WOH019	Greenville, NY	42229/49652	Circuit 6-7-13, Primary Fused Cutouts	X		47	28
9/1/98	Western	98WOH020	Port Jervis, NY	40518/49882	Circuit 6-8-13/24, Primary Fused Cutouts	X		75	27
9/2/98	Western	98WOH021	Wallkill, NY	48251/53067	Circuit 113-1-13, Primary In-Line Splice	X		41	23
9/3/98	Western	98WOH022	Wallkill, NY	48784/52796	Circuit 11-3-13, Primary Fused Cutout	X		48	22
9/3/98	Western	98WOH023	Wallkill, NY	49059/53060	Circuit 11-3-13, Primary Fused Cutout	X		56	25
9/3/98	Western	98WOH024	Wallkill, NY	48918/52940	Circuit 11-3-13, Primary Fused Cutout	X		37	23
9/3/98	Western	98WOH025	Wallkill, NY	48177/52655	Primary Solid Blade Disconnect	X		68	33

Date	Division	Sequential	Location	Substation or Structure	Circuit / Equipment	OH	UG	Hot Spot Cel.	Ref. Temp. Cel.
9/4/98	Western	98WOH026	New Hampton, NY	47809/50797	Primary In-Line Splice	X		51	26
9/8/98	Western	98WOH027	Middletown, NY	47756/52460	Primary Jumper Tap	X		53	24
9/8/98	Western	98WOH028	Middletown, NY	47752/52451	Primary Metering	X		56	30
9/9/98	Western	98WOH029	Middletown, NY	47723/52477	Primary Solid Blade Cutouts	X		40	15
9/9/98	Western	98WOH030	Port Jervis, NY	40332/49927	Circuit 6-9-13, Secondary Transformer Bushing	X		37	24
9/10/98	Western	98WOH031	Middletown, NY	47521/52699	Circuit 113-2-13, Secondary Transformer Bushing	X		65	29
9/11/98	Western	98WOH032	Silverlake, NY	48504/53378	Circuit 113-3-13, Primary Solid Blade Disconnect	X		138	24
9/11/98	Western	98WOH033	Silverlake, NY	48486/53354	Circuit 113-3-13, Primary Solid Blade Disconnect	X		129	28
9/14/98	Western	98WOH034	Middletown, NY		Circuit 15-2-13, 25 KVA Transformer	X		35	0
9/14/98	Western	98WOH035	Middletown, NY	49114/53273	Circuit 15-1-13, Crimp Connectors on UG Stress Cones	X		101	32
9/14/98	Western	98WOH036	Middletown, NY	49050/53318	Circuit 15-6-13, Transformer Secondary Leads	X		69	35
9/14/98	Western	98WOH037	Middletown, NY	49562/53432	Circuit 15-1-13, Primary Switch (Jaw of GOAB)	X		88	34
9/15/98	Western	98WOH038	Middletown, NY	49287/52784	Circuit 15-1-13, Primary Fused Cutout - Top Jaw	X		41	22
9/15/98	Western	98WOH039	Middletown, NY	49493/52934	Circuit 15-1-13, Secondary Crimp on Service Wire	X		83	27
9/15/98	Western	98WOH040	Middletown, NY	49531/53003	Circuit 15-1-13, Primary Splice	X		81	29
9/15/98	Western	98WOH041	Scotchtown, NY	49147/53571	Circuit 15-3-13, Capacitor Bank Oil Switch	X		49	30
9/16/98	Central	98CSS001	Goshen, NY	South Goshen	High Side Transformer Disconnects off Bank # 189	X		450	34
9/16/98	Central	98COH001	Goshen, NY	49178/49440	Circuit 89-11-34/13, Secondary Transformer Bushings	X		88	37
9/16/98	Central	98COH002	Goshen, NY	49412/49314	Circuit 89-11-34, Jaws of GOAB Switch	X		51	24
9/17/98	Central	98COH003	Pine Island, NY	46642/46858	Circuit 65-1-48, Solid Blade Cutouts	X		51	32
9/18/98	Central	98COH004	West Milford, NJ	48830/40943	Primary Fused Cutout	X		38	27
9/21/98	Western	98WOH042	Scotchtown, NY	50633/53859	Circuit 15-1-13/4, Primary Hot Line Clamp to Stirrup	X		72	30
9/21/98	Western	98WOH043	Scotchtown, NY	49846/53447	Circuit 15-1-13/4, Service Wire Splice	X		93	32
9/21/98	Western	98WOH044	Scotchtown, NY	49675/53441	Circuit 15-1-13/4, Primary Fused Cutout	X		83	32
9/21/98	Western	98WOH045	Scotchtown, NY	49290/53992	Circuit 15-3-13, Secondary Transformer Bushing	X		84	32
9/21/98	Western	98WOH046	Silverlake	48806/53570	Circuit 15-6-13, 50 KVA Transformer	X		51	38
9/22/98	Western	98WOH047	Middletown, NY	47730/54036	Circuit 109-4-34, Crimp on Transformer Secondary	X		243	27
9/22/98	Western	98WOH048	Fair Oaks, NY	47884/54282	Circuit 109-4-34/4, Primary Fused Cutouts	X		64	25

Date	Division	Sequential	Location	Substation or Structure	Circuit / Equipment	OH	UG	Hot Spot Cel.	Ref. Temp. Cel.
9/25/98	Western	98WOH049	Wurtsboro, NY	45892/57376	Circuit 9-1-4, Primary Hot Line Clamp to Stirrup	X		38	16
9/25/98	Western	98WOH050	Wurtsboro, NY	46401/57891	Circuit 9-2-4, Primary Aluminum Dead-End Bell	X		41	23
9/29/98	Western	98WOH051	Greenville, NY	42779/49712	Crimp on Cutout Tap to Step-down Bank	X		33	22
9/29/98	Western	98WOH052	Wurtsboro, NY	45076/57957	Circuit 9-1-4, Primary Fused Cutouts	X		73	23
9/30/98	Western	98WOH053	Wurtsboro, NY	45029/59029	Circuit 9-1-4, Transformer Secondary Leg	X		73	27
9/30/98	Western	98WOH054	Port Jervis, NY		Citgo Service Center, Primary Hot Line Clamp To Stirrup	X		77	24
10/2/98	Western	98WOH055	Phillipsport, NY	47148/60297	Circuit 10-2-13, Transformer Secondary Bushing	X		41	23
10/13/98	Central	98COHPR001	Monroe, NY	53918/48620	Circuit 61-3-13, Secondary Lead off Transformer	X		36	17
10/13/98	Central	98COH005	Monroe, NY	53853/48886	Circuit 61-4-13, Primary Solid Blade Disconnect	X		26	15
10/13/98	Central	98COH006	Monroe, NY	54192/48926	Circuit 61-3-13/24, Primary Fused Cutout	X		37	18
10/13/98	Central	98COH007	Kyriasjoel, NY	54388/48908	Circuit 61-3-13, Primary Dead-End Bells	X		22	16
10/13/98	Central	98COH008	Monroe, NY	54241/48029	Circuit 61-1-13, Primary Fused Cutout	X		28	17
10/13/98	Central	98COH009	Monroe, NY	54098/47506	Circuit 61-1-13, Primary Fused Cutouts	X		42	16
10/14/98	Central	98COH010	Monroe, NY	53906/47726	Circuit 61-1-13, Primary Solid Blade Cutout	X		26	18
10/14/98	Central	98COH011	Monroe, NY	53743/48446	Circuit 61-2-13/48, Primary Fused Cutout	X		51	21
10/15/98	Central	98COH012	Monroe, NY	53500/48998	Circuit 61-1-13/24, Primary Cutout Box	X		66	17
10/16/98	Central	98COH013	Warwick, NY	50972/46284	Secondary Transformer Bushing	X		73	19
10/16/98	Central	98COH014	Warwick, NY		Circuit 80-3-13, Primary Splice - Upper Wisner Rd.	X		27	16
10/16/98	Central	98COH015	Sugarloaf, NY	51255/48039	Circuit 80-4-13/48, Secondary Splice	X		59	23
10/20/98	Central	98COH016	Warwick, NY	48840/45752	Circuit 80-2-13, Primary Fused Cutout	X		197	22
10/20/98	Central	98COH017	Chester, NY	51604/49586	Circuit 62-4-48, Secondary Transformer Bushing	X		68	21
10/21/98	Central	98COH018	Warwick, NY	Wisner 75/90	Circuit 80-4-13, Primary Solid Blade Disconnect	X		21	11
10/22/98	Central	98COH020	Goshen, NY	50015/50953	Circuit 89-2-13/24, Primary Crimp Connector	X		33	12
10/26/98	Central	98COH021	Pine Island, NY	46038/47287	Circuit 65-2-48, Primary Fused Cutout	X		24	17
10/27/98	Central	98COH022	Florida, NY	Riser Pole	Circuit L83-57/28-34, Primary Fused Cutout - Shop-Rite	X		36	18
10/28/98	Central	98COH023	Chester, NY	52501/49647	L82-56/64-34/48, Jumper Tap & Bolted Tap to Cutout	X		47	13
10/28/98	Central	98COH026	Chester, NY	51406/4?158	Circ. L82-74/46-34, Primary Bolted Tap to Fused Cutout	X		26	17
11/3/98	Central	98COH027	Blooming Grove, NY	54932/49222	Circuit 71-5-13/48, Primary Fused Cutout	X		15	8

Date	Division	Sequential	Location	Substation or Structure	Circuit / Equipment	OH	UG	Hot Spot Cel.	Ref. Temp. Cel.
10/28/98	Central	98COH025	Chester, NY	51490/49143	Circuit L82-74/46-34, Primary Hot Line Clamp to Stirrup	X		29	16
11/3/98	Central	98COH028	Arden, NY	Riser Pole	Circuit 71-2-13/24, Primary Fused Cutouts	X		17	6
11/4/98	Central	98COH029	Arden, NY	55650/47356	Circuit 71-2-13/24, Primary Fused Cutout - Saddle	X		191	18
11/6/98	Central	98COH030	Arden, NY	55650/47356	Circuit 71-2-13/24, Primary Fused Cutout - "Screw Cap"	X		22	5
11/6/98	Central	98COH031	Tuxedo Park, NY	53354/43770	Circuit 67-1-13/24, Primary Fused Cutout - Bolted Tap	X		23	4
11/9/98	Central	98COH032	Ft. Montgomery, NY	59413/48290	Circuit 75-1-48, Primary Bushing on Oil Switch	X		43	18
11/10/98	Central	98COH033	Ft. Montgomery, NY	59458/47910	Circuit 75-1-48, Primary Wire Tap on Cross Arm	X		37	9
11/12/98	Central	98COH034	Greenwood Lake, NY	50584/43124	Circuit 84-2-13/48, Secondary Transformer Bushing	X		29	13
11/16/98	Central	98COH035	Ringwood, NJ	50884/41400	Circ. 79-8-13Primary Capacitor Tank Bushings & Oil Sw.	X		44	9
11/16/98	Central	98COH036	Ringwood, NJ	51419/41079	Circuit 79-8-13, Primary Aluminum Connectors	X		31	12
11/17/98	Central	98COH037	Ringwood, NJ	52115/40018	Circuit 78-2-13, Primary "Automatic" Splice	X		26	12
11/17/98	Central	98COH038	Ringwood, NJ	52088/40027	Circuit 78-2-13, Secondary Crimp Connector	X		67	14
11/17/98	Central	98COH039	Ringwood, NJ	51900/?9811	Circuit 78-2-13, Secondary Service	X		35	0
11/17/98	Central	98COH040	Ringwood, NJ	51889/39787	Circuit 78-2-13, Primary Splice	X		42	14
11/18/98	Central	98COH041	Ringwood, NJ	51928/39523	Circuit 78-1-13, Secondary Service Connector	X		43	9
11/20/98	Central	98COH042	West Milford, NJ	49637/41383	Circuit 79-8-13, Secondary Service Connector	X		116	18
11/20/98	Central	98COH043	West Milford, NJ	49734/41386	Circuit 79-8-13, Primary Crimp Connector	X		19	12
11/20/98	Central	98COH044	West Milford, NJ	50129/41525	Circuit 79-8-13, Primary Fused Cutout	X		57	15
11/20/98	Central	98COH045	West Milford, NJ	49785/41430	Circuit 79-8-13, Primary Switch - Jaw of GOAB	X		28	15
11/20/98	Central	98COH046	West Milford, NJ		Circ. 79-1-13, Sec. Connector - 1950 Greenwood Lake Turnpike	X		34	15
11/23/98	Central	98COH047	West Milford, NJ	49372/42044	Circuit 79-6-13, Secondary Transformer Bushing	X		37	20
11/24/98	Central	98COH048	West Milford, NJ	49123/41275	Circuit 79-3-13, Secondary Connector	X		28	14
11/24/98	Central	98COH049	West Milford, NJ	?9066/41280	Circuit 79-3-13, 50 KVA Transformer	X		49	28
12/3/98	Central	98CSS007	Tuxedo Park, NY	Sterling Forest	Secondary Transformer Bushing	X		41	20
12/4/98	Central	98CSS014	Florida, NY	Florida	64-3-48 Regulators, Main Bushing Terminal	X		49	23
12/7/98	Central	98CSS019	Monroe, NY	Monroe	Recloser # 61-4-2K, Main Tap Termination To Recloser	X		42	29
12/7/98	Central	98CSS020	Monroe, NY	Monroe	Switch # 161-A, Jaw of Switch	X		38	24
12/8/98	Eastern	98EEHV005		Steel Tower # 9	Compression Crimp in Jumper Tap below Dead-End	X		38	9

Date	Division	Sequential	Location	Substation or Structure	Circuit / Equipment	OH	UG	Hot Spot Cel.	Ref. Temp. Cel.
12/8/98	Eastern	98EOH121	Nanuet, NY	58120/40702	Primary Hot Line Clamp - Bethune Blvd.	X		19	9
12/8/98	Eastern	98EOH122	Nanuet, NY	58068/40841	Primary Splices - 24 Ewing St.	X		26	10
12/8/98	Eastern	98EOH123	Spring Valley, NY	55712/41202	Secondary Automatic Splice, Union Rd. - Avon Gardens	X		33	9
12/9/98	Eastern	98EOH124	Montvale, NJ	58424/38234	Circuit 29-1-13, Primary UG Stress Cone		X	41	12
12/9/98	Eastern	98EOH126	Pearl River, NY	59876/38207	Circuit 54-5-13, Primary Fused Cutout	X		43	10
12/10/98	Eastern	98EOH127	Pearl River, NY	58804/38674	Circuit 29-3-13/4, Three Phase Transformer Bank	X		29	22
12/10/98	Eastern	98EOH128	Pearl River, NY	58504/38586	Circuit 29-1-13, Three Phase Transformer Bank	X		29	19
12/11/98	Eastern	98EOH129	Northvale, NJ	60504/36932	Circuit 30-4-13, Transformer Secondary Bushing	X		58	13
12/11/98	Eastern	98EOH130	Tappan, NY		Circ. 30-2-13, Primary In-Line Splice - Off Livingston St.	X		47	10
12/16/98	Eastern	98EOH131	Nanuet, NY		Circuits 19-10-13 & 19-14-13, Primary Solid Blade Disc.	X		17	11
12/16/98	Eastern	98EOH132	Nanuet, NY	59317/43808	Circuit 27-1-13, Primary Solid Blade Disconnect	X		51	14
12/16/98	Eastern	98ESS027	W. Haverstraw, NY		Crimp on Down-Drop Tap - Rt. 202, Inside Sub	X		32	12
12/17/98	Eastern	98EOH133	Pomona, NY	57294/42675	Circuit 27-6-13, Transformer Secondary Bushing	X		31	10
12/17/98	Eastern	98EOH134	Pomona, NY	5???9/4???5	Circuit 27-7-13, Automatic Splice	X		44	11
12/17/98	Eastern	98EOH135	Mt. Ivy, NY	58161/43239	Circuit 27-7-13, Primary Solid Blade Disconnect	X		31	11
12/17/98	Eastern	98EOH136	Mt. Ivy, NY		Circuit 27-7-13, Primary Splice - Old Rt. 202, Sunoco	X		27	10
12/18/98	Eastern	98EOH137	Garnerville, NY	59296/43763	Circuit 27-2-13, Primary Solid Blade Disconnect	X		53	8
12/21/98	Central	98CUG001	Woodbury, NY	Pad # 55611/4	Circuit 71-4-13, Primary Dead-End Elbow		X	21	13
12/21/98	Central	98CUG002	Woodbury, NY	Switch Pad # 6	Circuit 71-4-13, Primary Dead-End Elbow		X	16	11
12/21/98	Central	98CUG003	Woodbury, NY	Pad # 29/79	Circuit 71-4-13, Primary Dead-End Elbow		X	23	18
12/21/98	Central	98CUG004	Woodbury, NY	Pad # 10/59	Circuit 71-4-13, Secondary Transformer Bushing		X	47	21
12/21/98	Central	98CUG005	Woodbury, NY	Pad # 10/59	Circuit 71-4-13, Primary Dead-End Elbow		X	29	22
12/22/98	Central	98CUG006	Woodbury, NY	Pad # 02/31	Circuit 71-4-13, Secondary Transformer Bushing		X	39	20
12/22/98	Central	98CUG007	Woodbury, NY	Pad # 09/33	Circuit 71-7-13, Secondary Transformer Bushing		X	67	21
1/4/99	Central	98CUG009	Chester, NY	Primary Meter	Primary Stress Cone, Elizabeth Dr. - CSI Co.		X	9	6
1/20/99	Central	98CUG011	Chester, NY	Pad # 51108/49646	Primary Dead-End Elbow ***(Ultrasound Report)***		X	26	11
1/21/99	Central	98CUG012	Chester, NY	Pad # 51016/49644	Primary Dead-End Elbow ***(Ultrasound Report)***		X	21	9

Date	Division	Sequential	Location	Substation or Structure	Circuit / Equipment	OH	UG	Hot Spot Cel.	Ref. Temp. Cel.
1/26/99	Western	98WUG005	Middletown, NY	Pad # 47389/53295	Top ¼ of Transformer Tank has an Elevated Temperature		X	14	10
1/28/99	Western	98WUG007	Wurtsboro, NY	Pad # 46670/58534	Primary Dead-End Elbow ***(Ultrasound Report)***		X	19	11
2/10/99	Central	98CUG016	Goshen, NY	Transformer #4	Bottom 2 bolt terminator on center coil of transformer (Termination Marked # 5 on coil)		X	37	19
2/10/99	Central	98CUG017	Goshen, NY	Pad # 61/91	Primary Dead-End Elbow		X	19	13
2/16/99	Central	98CUG018	Goshen, NY	Pad # 77/22	Secondary Bushings		X	79	52
2/17/99	Central	98CUG020	Goshen, NY	Pad # 14/67	Secondary Bushing		X	17	9
3/3/99	Eastern	98EOH138	New City, NY	Pole 59122/41193	50 KVA Transformer	X		43	20
3/3/99	Eastern	98EOH141	New City, NY	Pole 59493/41573	Transformer Secondary Bushing	X		43	14
3/5/99	Eastern	98EOH142	New City, NY	Pole 59480/41560	Secondary Bushings on all three (3) 100 kVA Transformers	X		61	30
3/5/99	Eastern	98EOH143	Bardonia, NY	Pole 59436/40846	Primary Fused Cutout	X		64	13
3/5/99	Eastern	98EOH144	West Nyack, NY	Pole 59990/40280	Primary Compression Tap	X		72	9
3/9/99	Eastern	98EOH145	Oakland, NJ	Next to Pole #51931/37259	Secondary Transformer Bushing	X		18	7
4/13/99	Central	IR-99COH001	Monroe, NY	53846/47670	Stepdown Transformer	X		40	30
4/13/99	Central	IR-99COH002	Monroe, NY	53965/48381	Transformer Secondary Bushing	X		29	17
4/15/99	Central	IR-99COH003	Blooming Grove, NY	54154/51068	Primary Switch GOAB - Jaw (Blade-Clip)	X		52	24
4/15/99	Central	IR-99COH004	Blooming Grove, NY	54093/51560	Transformer “Low” on Oil	X		34	0
4/19/99	Central	IR-99COH005	Goshen, NY	1 Pole from 50297/51227	Transformer Secondary Neutral Bushing	X		29	21
4/21/99	Eastern	IR-99EEHV001	Closter, NJ	Pole # 61	Primary Bolted Tap Connector in Mid-span of Double Dead-end Jumper Loop	X		128	26
4/21/99	Eastern	IR-99EOH001	Closter, NJ	60321/35833	Primary “Concentric Neutral” Tap off U. G. Stress Cone		X	55	21
4/21/99	Eastern	IR-99EOH002	Northvale, NJ	60828/36714	Secondary Transformer Bushing	X		39	25
4/21/99	Eastern	IR-99EOH003	Northvale, NJ	3 Phase Transformer Ground Mat	Secondary Transformer Bushing “Spade connectors”	X		104	42
4/22/99	Eastern	IR-99EOH004	Harrington Park, NJ	59952/36028	50 kVA Transformer low on Oil	X		37	0
4/22/99	Eastern	IR-99EOH005	Harrington Park, NJ	59919/36008	Secondary wrapped crimp connector on bottom open service bus	X		31	20
4/22/99	Eastern	IR-99EOH006	Harrington Park, NJ	59816/35868	50 kVA Transformer	X		53	27

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4/22/99	Eastern	IR-99EOH007	Harrington Park, NJ	59863/36072	Primary fused cutout	X		26	19
4/23/99	Eastern	IR-99EOH008	Norwood, NJ	59888/36247	Primary “Oil Switch” and “Hot Line Clamp” of Capacitor Bank	X		26	15
4/23/99	Eastern	IR-99EOH009	Norwood, NJ	60585/36291	Secondary Transformer Bushing	X		49	26
4/26/99	Eastern	IR-99EOH010	Northvale, NJ	60716/36598	28-7-13/Transformer Secondary Bushing	X		58	23
4/26/99	Eastern	IR-99EOH011	Norwood, NJ	60650/36430	28-2-13/Transformer Secondary Bushing	X		47	29
4/26/99	Eastern	IR-99EOH012	Rockleigh,NJ	61101/36419	28-6-13/Capacitor Bank “Oil Switch”	X		51	29
4/26/99	Eastern	IR-99EOH013	Rockleigh,NJ	61036/36793	28-7-13/Bolted Top Connector to Bottom of Fused Cutout	X		138	27
4/28/99	Eastern	!R-99EOH014	Norwood, NJ	60649/36960	30-2-13/Primary Aluminum “Crimp Connector on Buck Arm	X		33	19
4/28/99	Eastern	IR-99EOH015	Norwood, NJ	60754/36950	30-2-13/Secondary Service Connector	X		57	22
4/30/99	Eastern	IR-99EOH016	Tappan, NY	! Pole from 60784/37072	30-2-13/Sedondary Transformer Bushing	X		92	31
4/30/99	Eastern	IR-99EOH017	Old Tappan, NJ	Outside Harings Corner Sub	30-5-13/Concentric Neutral - Aluminum Crimp off U.G. Primary Cable		X	60	24
5/3/99	Eastern	IR-99EOH018	Old Tappan, NJ	59812/37575	Primary (Covered) Splice	X		43	18
5/3/99	Eastern	IR-99EOH019	Old Tappan, NJ	59816/37535	Primary Ampact Connector	X		33	16
5/3/99	Eastern	IR-99EOH020	Spring Valley, NY	57588/40447	Primary Hot Line Clamp	X		31	18
5/3/99	Eastern	IR-99EOH021	Mahwah, NJ	1 Pole West of Williams Drive	Primary Fused Cutout	X		62	16
5/4/99	Eastern	IR-99EOH022	Tallman, NY	55918/40517	Secondary Wrapped Crimp Connector	X		57	17
5/4/99	Eastern	IR-99EOH023	Suffern, NY	55597/40744	Primary Switch (GOAB)	X		31	17
5/4/99	Eastern	IR-99EOH024	Suffern, NY	55655/40874	Primary Fused Cutout	X		37	17
5/4/99	Eastern	IR-99EOH025	Suffern, NY	55186/40897	Hot Line Clamp on Stirrup	X		41	22
5/5/99	Eastern	IR-99EOH026	Suffern, NY	55568/40557	Primary Solid Blade Disconnect	X		49	20
5/5/99	Eastern	IR-99EEHV002	Tallman, NY	In Rear Parking Lot of Caldor’s	Compression Connector in Jumper Loop	X		82	26
5/5/99	Eastern	IR-99EOH027	Suffern, NY	56037/40653	Solid Blade Cutout and Compression Tap Connector	X		112	21
5/5/99	Eastern	IR-99EOH028	Airmont, NY	56210/40481	Transformer Secondary Neutral Bushing	X		40	27
5/6/99	Eastern	IR-99EOH029	Suffern, NY	56597/39765	75 kVA Transformer “low on oil”	X		36	0
5/6/99	Eastern	IR-99EOH030	Upper Saddle River, NJ	56434/38575	Primary “Automatic” Splices	X		42	23
5/7/99	Eastern	IR-99EOH031	Upper Saddle River, NJ	55845/38827	Neutral Hot Line Clamp	X		149	16
5/7/99	Eastern	IR-99EOH032	Saddle River, NJ	55846/38814	Primary Hot Line Clamp to Stirrup	X		30	15
5/7/99	Eastern	IR-99EOH033	Saddle River, NJ	1 span from 56383/38211	Primary “Automatic” Splices	X		35	19
5/17/99	Eastern	IR-99EOH040	Nanuet, NY	58772/39354	Fused Cutout	X		51	27
5/18/99	Eastern	IR-99EEHV002	Tallman, NY	Caldor’s ROW	Aluminum Compression in Jumper Tap	X		47	24

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5/18/99	Eastern	IR-99EEHV003	Mahwah, NJ	South Side of Ramapo River	In-line Aluminum Compression Splice	X		36	22
5/18/99	Eastern	IR-99EEHV004	Pearl River, NY	Pole # 28	Aluminum Ampack	X		71	24
5/18/99	Eastern	IR-99EEHV005	Nanuet, NY	Tower # 23	Static Line Shoe	X		61	20
5/24/99	Eastern	IR-99EOH041	Oakland, NJ	52540/37734	Secondary Wrapped Compression Connectors	X		37	19
5/24/99	Eastern	IR-99EOH042	Oakland, NJ	52560/37381	3 Phase Transformer	X		41	0
5/25/99	Eastern	IR-99EOH043	Oakland, NJ	52202/36940	Secondary Bushing	X		73	21
5/25/99	Eastern	IR-99EOH044	Franklin Lakes NJ	52567/36708	Secondary Bushing	X		46	27
5/25/99	Eastern	IR-99EOH045	Oakland, NJ	52228/36892	Hot Line Clamps and Oil Switch	X		57	24
5/27/99	Eastern	IR-99EOH046	Haverstraw, NY	59562/43989	Fused Cutout	X		41	27
6/1/99	Eastern	IR-99EOH047	Stony Point, NY	59552/44502	Hot Line Clamp	X		61	29
6/1/99	Eastern	IR-99EOH048	Stony Point, NY	59564/44575	Secondary Compression	X		145	24
6/1/99	Eastern	IR-99EOH049	Stony Point, NY	59586/44571	Fused Cutout	X		57	37
6/2/99	Eastern	IR-99EOH050	Tompkins Cove, NY	59389/45555	Secondary Wrapped Crimp Connector	X		53	28
6/2/99	Eastern	IR-99EOH051	Stony Point, NY	59274/45017	Transformer Secondary Bushing	X		62	37
6/3/99	Eastern	IR-99EOH052	Mt. Ivy, NY	58217/43235	Wrapped Splice	X		59	34
6/4/99	Eastern	IR-99EOH053	Pearl River, NY	58648/38622	Transformer Secondary Bushing	X		55	31
6/7/99	Eastern	IR-99EOH054	Upper Nyack, NY	Off 61486/40186	Automatic Splices in Bottom two open service wires	X		142	32
6/7/99	Eastern	IR-99EOH055	Nyack, NY	61486/39745	Bolted Tap Connection off Oil Switch	X		62	37
6/10/99	Eastern	IR-99EOH064	West Nyack, NY	60480/40134	Transformer Secondary Bushing	X		56	42
6/10/99	Eastern	IR-99EOH065	West Nyack, NY	59787/39914	Top Jaw of Fused Cutout & Hot Line Clamp On Stirrup	X		47	25
6/10/99	Eastern	IR-99EOH066	West Nyack, NY	59621/39955	Fused Cutout - Entire Length of Tap Cable	X		49	32
6/11/99	Eastern	IR-99EOH067	Wyckoff, NJ	54582/37136	Primary Covered Automatic Splices	X		47	25
6/11/99	Eastern	IR-99EOH068	Wyckoff, NJ	54538/36931	Transformer Secondary Bushing	X		92	35
6/14/99	Eastern	IR-99EOH069	Ramsey, NJ	54?58/38644	Hot Line Clamp to Stirrup	X		41	26
6/14/99	Eastern	IR-99EOH070	Ramsey, NJ	55270/38557	Secondary to Transformer Bushing	X		42	28
6/14/99	Eastern	IR-99EOH071	Ramsey, NJ	55548/38453	Top Jaw of Solid Blade Disconnect	X		69	37
6/14/99	Eastern	IR-99EOH072	Ramsey, NJ	55536/38609	Secondary Automatic Splices	X		81	26
6/15/99	Eastern	IR-99EOH073	Orangeburg, NY	60586/38113	Top Jaw of Solid Blade Disconnect	X		64	27
6/15/99	Eastern	IR-99EOH074	Orangeburg, NY		Entire Length of Tap from Primary Hot Line Clamp Down to Top of Cutout	X		114	33
6/15/99	Eastern	IR-99EOH075	Orangeburg, NY	60549/38431	Top Jaws of Fused Cutouts	X		76	28
6/15/99	Eastern	IR-99EOH076	Blauvelt, NY	60515/39203	Top Jaw of Fused Cutouts	X		66	27

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6/16/99	Eastern	IR-99ESS001	Orangeburg, NY		Tap Changer Compartment	X		59	45
6/16/99	Eastern	IR-99EOH077	Orangeburg, NY	59876/38207	Top jaw of Fused Cutout	X		74	28
6/23/99	Central	IR-99COH006	Washingtonville, NY	54093/51560	Transformer Low on Oil	X		34	0
6/23/99	Central	IR-99COH007	Blooming Grove, NY	53375/50884	Primary Wrapped Compression Splice	X		71	38
6/23/99	Central	IR-99COH008	Blooming Grove, NY	52631/50461	Primary Fused Cutout	X		213	34
6/23/99	Central	IR-99COH009	Warwick, NY	50470/45668	Solid Blade Disconnect	X		51	36
6/23/99	Central	IR-99COH010	Warwick, NY	47605/45154	Aluminum Crimp in Jumper Tap	X		104	29
6/23/99	Central	IR-99COH011	Goshen, NY	49178/49440	Secondary Termination on Three Phase Transformer Installation	X		66	30
7/8/99	Central	IR-99CSS001	Florida, NY		Bolted Tap Connection to top of “Source” Side Bushing of Phase 1 Regulator	X		56	33
7/9/99	Western	IR-99WOH001	Summitville, NY	46699/59009	Bottom Hinge (Saddle) of Fused Cutout	X		67	27
7/14/99	Central	IR-99CEHV001	Highland Falls, NY	Tower # 242	Primary Dead-End Tap	X		55	27
7/16/99	Central	IR-99COH012	West Milford, NJ	49607/41884	Bolted Tap Connection Atop “Rear” Bushing of “Road” Side Capacitor Tank	X		92	39
7/20/99	Central	IR-99COH013	West Milford, NJ	49389/41892	Secondary Crimp Connector	X		92	27
7/20/99	Central	IR-99COH014	Warwick, NY	48684/45093	Right Side Secondary Bushing On “Road” Phase Transformer	X		110	29
7/21/99	Western	IR-99WOH002	Wallkill, NY	49196/53335	25 kVA Transformer “low” on oil	X		33	0
7/21/99	Western	IR-99WOH003	Wallkill, NY	49074/53263	Center secondary Neutral Bushing on ”west” side Transformer	X		59	28
7/21/99	Western	IR-99WOH004	Wallkill, NY	48963/53622	Transformer Secondary Bushings	X		64	34
7/21/99	Western	IR-99WOH005	Wallkill, NY	49147/53571	Top Half of Field Phase “Oil Switch”, Also, Phase Cutout Blown	X		49	26
7/21/99	Western	IR-99WOH006	Wallkill, NY	49252/53240	Bolted Tap Connection to Bottom Hinge End of Fused Cutout	X		188	53
7/22/99	Western	IR-99WOH007	Wallkill, NY	No #	Bolted Tap Connection to Top of “Pot Head”	X		137	27
7/22/99	Western	IR-99WOH008	Wallkill, NY	49493/52934	Secondary Aluminum ”Crimp” Connector on “Bottom” Open Service Bus	X		88	27
7/22/99	Western	IR-99WOH009	Wallkill, NY	49448/52929	Transformer Secondary Bushings	X		115	29
7/22/99	Western	IR-99WOH010	Wallkill, NY	49169/52558	Primary In-Line Compression Splice Mid-span Between Poles # 69/58 & 62/45	X		55	26
7/22/99	Western	IR-99WOH011	Wallkill, NY	48244/52734	Primary Compression Splice	X		68	25
7/23/99	Western	IR-99WOH012	Wallkill, NY	48432/53071	2 Bolt Tap Connection to “Top” of Solid Blade Disconnect	X		76	37
7/23/99	Western	IR-99WOH013	Wallkill, NY	48177/52655	Solid Blade Disconnects, Entire Tap Wire Between Primary and Top of Disc	X		131	43
7/26/99	Eastern	IR-99EOH078	New Hempstead, NY	58417/42646	Fused Cutout: “Top Jaw”	X		67	26
7/26/99	Eastern	IR-99EOH079	New Hempstead, NY	54820/43106	Secondary Aluminum “Crimp” Connector	X		110	35
7/26/99	Eastern	IR-99EOH080	Pomona, NY	58001/42521	Secondary Transformer Bushing	X		88	43
7/26/99	Eastern	IR-99EOH081	Pomona, NY	West of 58206/41894	Primary In-line “Compression” Splice	X		149	37
7/28/99	Eastern	IR-99ESS005	West Haverstraw, NY	Minisceongo Switch	Switch: Heat Concentrated in “Blade End” (Not Finger Contacts	X		84	45

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7/28/99	Eastern	IR-99ESS006	Stony Point, NY	Lovett Substation	4 Bolt Tap Connector to Top of # 6 O.C.B. Bushing	X		77	41
7/28/99	Eastern	IR-99ESS007	Stony Point, NY	Lovett Substation	Entire Lengths of Tap Cables from Tops of # 5 & 6 Bushings to Bottom of Top Switches	X		79	40
7/29/99	Eastern	IR-99ESS008	Spring Valley, NY	Burns Substation	Tap Changer Compartment (LTC)	X		61	44
7/29/99	Eastern	IR-99ESS009	Spring Valley, NY	Burns Substation	“Both” Bolted Connectors to “Bottom” of Switch	X		69	34
7/29/99	Eastern	IR-99EOH082	Spring Valley, NY	58318/40534	2 Bolt Tap Connection to “Bottom” Hinge End of Solid Blade Disconnect	X		290	33
7/29/99	Eastern	IR-99ESS010	Nanuet, NY	Nanuet Substation	“Jaw” (Finger Contacts) of Switch	X		73	35
7/29/99	Eastern	IR-99ESS011	West Nyack, NY	West Nyack Substation	Several “Strands” Along Entire Length of Tap Cable from High Side Transformer Bushing To Top of Lightning Arrester	X		78	36
7/29/99	Eastern	IR-99ESS012	West Nyack, NY	West Nyack Substation	“Jaw” (Finger Contacts) of Switch	X		77	38
7/29/99	Eastern	IR-99ESS013	West Nyack, NY	West Nyack Substation	Several “Strands Along Entire Length of Tap Cable from O. C. B. Bushing to Switch	X		72	39
7/29/99	Eastern	IR-99ESS014	Congers, NY	Congers Substation	4 Bolt “Pad” Connection on Jaw End of Switch	X		89	44
7/30/99	Eastern	IR-99ESS015	Orangeburg, NY	Orangeburg Substation	Bolted Bus Connections to “Top” of Low-side Bushings	X		59	33
7/30/99	Eastern	IR-99ESS016	Orangeburg, NY	Orangeburg Substation	Concentric Neutral Wire off U. G. Stress Cone	X		43	29
7/30/99	Eastern	IR-99EEHV006	Orangeburg, NY	Orangeburg Substation	Bolted Tap Connections to “Hinge” Ends of GOABS	X		61	28
7/30/99	Eastern	IR-99ESS017	Cresskill, NJ	Cresskill Substation	Entire Length of Tap to Jaw End on Field Side Disconnect & “Hinge” of Center Phase Disconnect	X		71	41
7/30/99	Eastern	IR-99ESS018	Old Tappan, NJ	Harings Corner Substation	Double U-Bolt Tap Connection to Bottom of Disconnect Switch	X		86	40
7/30/99	Eastern	IR-99ESS019	Old Tappan, NJ	Harings Corner Substation	Bolted Tap Connection to Top of # 5 O. C. B. Bushing	X		90	44
8/2/99	Eastern	IR-99EOH083	Upper Saddle River, NJ	54655/38512	Primary “Compression” Splice on Top Circuit on South Side of Pole on South Side of 1st Spacer Out	X		123	42
8/2/99	Eastern	IR-99ESS020	Oakland, NJ	Oakland Substation	Bolted Top Connection to Top of “Source” Side (Transformer Side) Recloser Bushing	X		83	42
8/3/99	Eastern	IR-99ESS021	South Mahwah, NY	South Mahwah Substation	4 Bolt Tap Connector to Top of Bushing	X		60	35
8/9/99	Eastern	IR-99EOH084	Piermont, NY	61375/37952	Bolted Top Connection to “Bottom” of Fused Cutout	X		85	27
8/10/99	Eastern	IR-99EOH085	New City, NY	59474/41833	Secondary Aluminum “Crimp” Connectors off Right Side Bushings of Both Wing Pots.	X		134	33
8/10/99	Eastern	IR-99EOH086	New City, NY	45943/42048	Left Side Secondary Bushing, Including Entire Top ¼ Circumference of Transformer	X		52	31
8/16/99	Eastern	IR-99EOH087	New Hempstead, NY	59122/41193	Top 3/5’s of Transformer is Abnormally Hot Around Entire Circumference	X		61	41
8/19/99	Eastern	IR-99EOH088	Hillburn, NY	54492/40982	Secondary “Mechanical “ Connector	X		49	30
8/20/99	Eastern	IR-99EOH089	Hillburn, NY	54720/41019	Jaw (Blade Clip) of Switch	X		57	24
8/20/99	Eastern	IR-99EOH090	Suffern, NY	55008/40613	Secondary “Crimp” Connector on Open Service Wire	X		47	26

Date	Division	Sequential	Location	Substation or Structure	Circuit / Equipment	OH	UG	Hot Spot Cel.	Ref. Temp. Cel.
8/20/99	Eastern	IR-99EOH091	Suffern, NY	54997/40549	Secondary “Crimp” Connector on Bottom Open Service Wire	X		88	25
8/20/99	Eastern	IR-99EOH092	Suffern, NY	55319/40559	Jaws (Blade Clips) of all Three Switches	X		44	23
8/23/99	Western	IR-99WOH014	Wallkill, NY	49114/53273	Aluminum “Crimp” Connectors	X		76	25
8/23/99	Western	IR-99WOH015	Wallkill, NY	49247/53394	Primary “automatic” Splice	X		79	24
8/23/99	Western	IR-99WOH016	Wallkill, NY	49645/53371	Primary “covered” Splices	X		164	33
8/23/99	Western	IR-99WOH017	Wallkill, NY	49764/53198	Jaw of Switch	X		55	33
8/24/99	Western	IR-99WOH018	Wallkill, NY	49381/52876	Primary (compression) Splices	X		47	16
8/24/99	Western	IR-99WOH019	Wallkill, NY	?????/52700	Transformer Secondary (neutral) Bushing	X		36	26
8/24/99	Western	IR-99WOH020	Wallkill, NY	49256/52753	Bolted Tap Connections, Jaw of Center Cutout and “Hot Line Clamp” on Road Phase Primary	X		114	24
8/25/99	Eastern	IR-99EOH093	New City, NY	59214/42221	Wrapped Secondary Conductor	X		63	27
8/25/99	Eastern	IR-99EOH094	New City, NY	59414/41402	Jaw of Switch	X		305	32
8/25/99	Eastern	IR-99EOH095	New City, NY	59038/42478	Secondary Aluminum “Crimp” Connector	X		78	25
8/25/99	Eastern	IR-99EOH096	New City, NY	59375/43104	Primary “Hot Line Clamp”	X		65	31
8/27/99	Western	IR-99WOH021		48116/52467	Secondary Aluminum “Crimp” Connector on “bottom” open wire of service bus	X		56	33
8/27/99	Western	IR-99WOH022	Middletown, NY	48233/52801	All three 25 KVA Transformers	X		51	0
8/30/99	Western	IR-99WOH023	Middletown, NY	47548/52635	Aluminum “Crimp” Connectors (2) on “Top” Open Service Bus	X		88	23
8/30/99	Western	IR-99WOH024	Middletown, NY	47521/52699	Center & Right Side Secondary Bushings of Center Phase Transformer and Right side Bushing of Field Phase Transformer	X		67	30
8/30/99	Western	IR-99WOH025	Middletown, NY	48162/52972	Secondary “Hot Leg” Termination to “Right“ Side Bushing of East Side Transformer	X		66	24
8/31/99	Western	IR-99WOH026	New Hampton, NY	48610/51126	25 KVA Transformer Heavily Loaded	X		56	0
9/1/99	Eastern	IR-99EUG001	New City, NY	Bardonia Elementary School	Left Side Transformer	X		47	41
9/2/99	Western	IR-99WOH027	Middletown, NY	47756/52460	Bolted Tap Connections to Top of Field Cut Out and Bolted Tap to Bottom of Center Cut Out	X		77	35
9/2/99	Western	IR-99WOH028	Middletown, NY	Near Corner of Sprague Ave.	Bolted Tap Connection to top of “Neutral” Bushing on Step-down Transformer	X		68	37
9/7/99	Western	IR-99WOH029	Waywayanda, NY	48036/51145	Top “Jaw” (Blade Clip) of Solid Blade Disconnect	X		40	26
9/7/99	Western	IR-99WOH030	New Hampton, NY	46989/50145	Mechanical (Bolt) Connector On Primary Lead Joining Center & Right Phase Step-down Transformers	X		43	26
9/7/99	Western	IR-99WOH031	Waywayanda, NY	47665/50643	Primary Compression ”Splice” on Center Phase Conductor on East Side of Pole	X		35	23
97/99	Western	IR-99WOH032	Johnson, NY	44794/50026	Aluminum “Crimp” Connector on Main Line Primary Feeding “Indigot Dr.” (Jumper Tap)	X		39	27
9/8/99	Western	IR-99WOH033	Waywayanda, NY	44352/50240	Center (Neutral) Secondary Bushing of Transformer	X		42	27
9/8/99	Western	IR-99WOH034	Greenville, NY	44255/50258	Bolted Tap Connection to “Bottom” of Fused Cutout	X		58	27
9/8/99	Western	IR-99WOH035	Waywayanda, NY	46261/50680	“Jaw” (Blade-clip) of Switch	X		53	29

Date	Division	Sequential	Location	Substation or Structure	Circuit / Equipment	OH	UG	Hot Spot Cel.	Ref. Temp. Cel.
9/8/99	Western	IR-99WOH036	Port Jervis, NY	39760/50439	Field Side Step-down Transformer (Internal Oil) Approximately 18 Degrees Cooler Than Adjacent Transformers	X		67	49
9/13/99	Western	IR-99WOH037	Sparrow Bush, NY	39429/50921	Top "Jaw" (Blade Clip) of Solid Blade Cut Out.	X		69	31
9/14/99	Western	IR-99WOH038	Port Jervis, NY	40501/49420	Primary In-line "Compression" Splice	X		59	22
9/14/99	Western	IR-99WOH039	Port Jervis, NY	40623/49786	Approx. 10 Foot of Primary Conductor	X		37	15
9/14/99	Western	IR-99WOH040	Port Jervis, NY	40445/49644	Bolted Tap Connection to Bottom of Fused Cut Out	X		63	24
9/14/99	Western	IR-99WOH041	Port Jervis, NY	40825/50488	Bolted Tap Connection to Top of "Field" Phase Cut Out & Fuse Link Exiting Bottom of Road Phase Cut Out	X		51	26
9/14/99	Western	IR-99WOH042	Port Jervis, NY	40581/50368	Top "Jaw" (Blade Clip) of Fused Cut Out	X		52	28
9/14/99	Western	IR-99WOH043	Port Jervis, NY	40849/50604	Jaws of All Three Switches	X		450	27
9/15/99	Western	IR-99WOH044	Cuddebackville, NY	42932/53328	Jaw (Blade Clip) of Switch	X		37	21
9/15/99	Western	IR-99WOH045	Cuddebackville, NY	42379/52708	Primary In-line "Automatic" Splice on Northeast Side of Pole Next to Pole Top Pin Insulator	X		54	28
9/15/99	Western	IR-99WOH046	Cuddebackville, NY	42053/52079	Primary In-line "Automatic" Splice on:"South" Side of Pole Approx. 4 Foot Out From Arm	X		62	26
9/15/99	Western	IR-99WOH047	Cuddebackville, NY	41975/52011	Primary I-line "Compression" Splice on "North" Side of Pole Approx. 5 Foot Out From Arm	X		77	26
9/15/99	Western	IR-99WOH048	Huguenot, NY	41828/51645	Aluminum "Crimp" Connector (Jumper Tap) on Field Side of Bottom Buck Arm	X		60	28
9/15/99	Western	IR-99WOH049	Huguenot, NY	41828/52645	Primary In-line "Compression" Splice Approx. 50 Foot South of Pole # 28/45	X		73	26
9/15/99	Western	IR-99WOH050	Huguenot, NY	41747/51462	Primary In-line "Compression" Splice on South Side of Pole Near Insulator	X		78	28
9/15/99	Western	IR-99WOH051	Huguenot, NY	41737/51434	Primary In-line "Compression" Splice Approx. 5 Foot Out From South Side of Arm	X		85	28
9/21/99	Western	IR-99WSS001	Pocatello, NY	Pocatello	Bottom 3 "Skirts" of Lightning Arrester Leaking Current	X		22	19
9/21/99	Western	IR-99WSS002	Chester, NY		Top "Jaw" (Fuse Clip) of Fused Cut Out	X		43	20
9/22/99	Western	IR-99WSS003	Gramsville, NY	Gramsville	Jaw (Finger Contacts) of Switch	X		33	13
9/22/99	Western	IR-99WSS004	Wurtsboro, NY	Wurtsboro	Regulator Internal Oil) 12 Degrees C Warmer Than all Other Regulators	X		41	29
9/22/99	Western	IR-99WSS005	Bloomingburg, NY	Bloomingburg	Top "Jaw" (Clip) of Oil Filled Fuse Disconnect	X		43	17
9/22/99	Western	IR-99WSS006	Middletown, NY	Genung	"Joint" of Copper Bus	X		22	16
9/23/99	Western	IR-99WOH052	Westbrookville, NY	43748/54636	Top "Jaw" (Fuse Clip) of Fused Cut Out	X		46	24
9/27/99	Western	IR-99WOH053	Bloomingburg, NY	48623/56568	Bolted Tap Connections to Both Top And Bottom of Lowside Fused Cut Out	X		39	18
9/27/99	Western	IR-99WOH054	Wurtsboro, NY	45076/57957	Top "Jaw" (Fuse Clip) of Fused Cut Out	X		63	24
9/28/99	Western	IR-99WOH055	Wurtsboro, NY	45814/57423	Primary "Crimp" Connector on West (Intersection Side) of Double-end Jumper Tap	X		42	23

Date	Division	Sequential	Location	Substation or Structure	Circuit / Equipment	OH	UG	Hot Spot Cel.	Ref. Temp. Cel.
9/28/99	Western	IR-99WOH056	Wurtsboro Hills, NY	45375/58085	Primary Dead-End Bells Leaking Current	X		28	23
9/29/99	Western	IR-99WOH057	Glen Spay, NY	37846/53278	Aluminum “Crimp” Connector in “Low-side” Tap Wire Between Top Primary and Road Side Bushing of Road Phase Pot.	X		57	26
10/1/99	Western	IR-99WSS007	Port Jervis, NY	Port Jervis Sub	Entire Length of Copper Tap from Bushing to Top Bus	X		159	29
10/1/99	Western	IR-99WSS008	Otisville, NY	Otisville	Bolted Tap Connections to Top of “Source” and “Load” Side Bushings of Regulator.	X		64	24
10/4/99	Western	IR-99WSS009	Middletown, NY	Middletown	Top “Jaw” of Fuse Disconnect	X		58	18
10/4/99	Western	IR-99WSS010	Middletown, NY	Middletown	Top “Jaws” of All Three Fuse Disconnects	X		78	18
10/4/99	Western	IR-99WSS011	Middletown, NY	Middletown	Entire Length of Stranded Copper Downdrop Tap Between Bottom of Dead-end Shoe and Lightning Arrester	X		43	19
10/4/99	Western	IR-99WSS012	Middletown, NY	Middletown	Entire Length of Downdrop Tap Between Dead-end Shoe and Top of Disconnect	X		264	28
10/4/99	Western	IR-99WSS013	Middletown, NY	Middletown	Upper Most Bolted (Tap) Connector Atop # 6 O.C.B. Bushing	X		51	23
10/4/99	Western	IR-99WSS014	Middletown, NY	Middletown	Interior “Finger Contacts” in Hinge of Switch	X		56	18
10/4/99	Western	IR-99WSS015	Middletown, NY	Middletown	Bolted Tap Connection Atop Bushing	X		63	21
10/5/99	Western	IR-99WSS016	Middletown, NY	Middletown	“Jaws” of All Three Tie Switches	X		61	11
10/5/99	Western	IR-99WSS017	Highland Falls, NY	Highland Falls	“Jaws” of Switch	X		59	17
10/5/99	Western	IR-99WSS018	Harriman, NY	Harriman	Bolted Connections on Collar of Blade Entering “Hinge” of Switch	X		27	15
10/6/99	Western	IR-99WSS019	Sugarloaf, NY	Sugarloaf	Bottom “Hinge” (Rotating Pivot Portion) of Switch	X		96	21
10/8/99	Central	IR-99COH015	Goshen, NY	48267/49034	Aluminum “Crimp” Connector on Top Open Service Wire	X		29	14
10/13/99	Central	IR-99COH016	Warwick, NY	49274/45792	Secondary Aluminum “Crimp” connector on Service Wire	X		62	21
10/18/99	Central	IR-99COH017	Woodbury, NY	54996/49605	Center Phase Step-down Transformer	X		24	18
10/18/99	Central	IR-99COH018	Woodbury, NY	55660/48724	Secondary Neutral “Case Ground” Connections on both “Outside” Transformers	X		144	24
10/19/99	Central	IR-99COH019	Woodbury, NY	@ Arden house	Stirrup Connection to Primary Conductor and Bolted Tap Connection To Bottom of Fused Cutout	X		37	10
10/19/99	Central	IR-99COH020	Tuxedo, NY	53561/45250	Center Secondary “Neutral” Bushing, Including “Case Ground Strap” of Single Phase Transformer	X		79	19
10/21/99	Central	IR-99COH021	Tuxedo Park, NY	53640/43675	Top “Jaw” (Including Barrel of Fuse) of Fused Cutout	X		49	14
10/22/99	Central	IR-99COH022	Tuxedo Park, NY	53771/43798	Secondary Service Connector off Left Side Hot Leg of Transformer	X		55	11
10/26/99	Central	IR-99COH023	Chester, NY	52394/49230	Road Phase Step-down Transformer (Internal Oil)	X		27	17
10/27/99	Central	IR-99COH024	Ringwood, NJ	52014/41076	Aluminum “Crimp” Connector on Jumper Tap (Between Bottom and 2nd X-arm up)	X		63	14
10/28/99	Central	IR-99COH025	Ringwood, NJ	Off 51917/39511	Aluminum “Crimp” Connector on Left Secondary Hot Leg	X		139	24
11/1/99	Eastern	IR-99ESS022	Hillburn, NY	Hillburn Substation	2 Bolt Pad Connector on Hinge End of Disconnect	X		49	23
11/1/99	Eastern	IR-99ESS023	Hillburn, NY	Hillburn Substation	Top Jaw (Blade-clip) of Solid Blade Disconnect	X		67	27
11/1/99	Eastern	IR-99ESS024	Oakland, NY	Oakland Substation	Source Side (Transformer Side) Bushing of Reclosure	X		48	23

Date	Division	Sequential	Location	Substation or Structure	Circuit / Equipment	OH	UG	Hot Spot Cel.	Ref. Temp. Cel.
11/2/99	Eastern	IR-99ESS025	Spring Valley, NY	Burns Substation	Several "Strands" of Tap Wire (From High-side Bushing to Bus) Abnormally Hot	X		29	22
11/2/99	Eastern	IR-99ESS026	Spring Valley, NY	Burns Substation	Tap Changer Compartment (LTC)	X		45	32
11/2/99	Eastern	IR-99ESS027	Spring Valley, NY	Burns Substation	O> C> B> Bushing: Heat Concentrated in "Hex Nut" (of stem) Directly Atop Red Cap of Oil Sight Glass	X		32	21
11/2/99	Eastern	IR-99ESS028	New Hempstead, NY	New Hempstead Substation	Hinge of Disconnect Switch	X		42	21
11/2/99	Eastern	IR-99ESS029	Ladentown, NY	Ladentown Substation	4 Bolt Connector on "Bus-side" Jaw of Disconnect	X		39	21
11/3/99	Eastern	IR-99ESS030	South Mahwah, NJ	South Mahwah Substation	Tap Changer (LTC) Compartment 3 Degrees Warmer than Main Body of Transformer	X		25	22
118/99	Eastern	IR-99ESS031	West Haverstraw, NY	West Haverstraw Substation	Several Strands Hot On Down-drop Tap Cable (Between Top of Switch and Center Compression Splice)	X		34	11
11/8/99	Eastern	IR-99ESS032	West Haverstraw, NY	Minisceongo Substation	Switch: Heat Concentrated in "Swivel" End of Blade	X		23	14
11/8/99	Eastern	IR-99ESS033	Thompkins Cove, NY	Lovett Substation	North Side Regulator Appears "Low" on Oil	X		22	0
11/8/99	Eastern	IR-99ESS034	Thompkins Cove, NY	Lovett Substation	O. C. B. Tank (Internal Oil) 8 Degrees Warmer than Adjacent Two Tanks	X		22	14
11/8/99	Eastern	IR-99ESS035	Thompkins Cove, NY	Lovett Substation	Entire Length of Cables (From Top of Bushings to Bottom of Associated Switches)	X		45	16
11/9/99	Eastern	IR-99ESS036	Nanuet, NY	Nanuet Substation	Jaw (Finger Contacts) of Switch	X		37	9
11/9/99	Eastern	IR-99ESS037	Nanuet, NY	Nanuet Substation	Jaw (Finger Contacts) of Switch	X		43	16
11/9/99	Eastern	IR-99ESS038	West Nyack, NY	West Nyack Substation	Several Strands of Tap Cable Hot (Between High-side Bushing and Top of Lightning Arrester)	X		36	23
11/9/99	Eastern	IR-99ESS039	West Nyack, NY	West Nyack Substation	Jaw (Finger Contacts) of Switch	X		79	18
11/9/99	Eastern	IR-99ESS040	Cresskill, NJ	Cresskill Substation	"Hinge" of Disconnect Switch	X		59	26
11/10/99	Eastern	IR-99ESS041	Old Tappan, NJ	Harings Corner Substation	Top "Jaw" (Blade-clip) of Solid Blade Disconnect	X		32	24
11/10/99	Eastern	IR-99ESS042	Old Tappan, NJ	Harings Corner Substation	Top "Jaw" (Blade-clip) of Solid Blade Disconnect	X		33	24
11/10/99	Eastern	IR-99ESS043	Old Tappan, NJ	Harings Corner Substation	Bolted Tap Connection Atop Low-side Bushing of Transformer	X		41	36
11/12/99	Eastern	IR-99EOH097	Old Tappan, NJ	Between 60013/37330 60008/37342	Primary In-line Covered (Automatic) Splice	X		43	11
11/12/99	Eastern	IR-99EOH098	Old Tappan, NJ	59856/37479	All4 Primary In-line Covered (Automatic) Splices on Both Sides of Pole	X		49	16
11/12/99	Eastern	IR-99EOH099	Old Tappan, NJ	59845/37481	Primary In-line Covered Splice (Automatic) in Mid-span on South side of Pole	X		52	16
11/12/99	Eastern	IR-99EOH100	Old Tappan, NJ	59810/37559	Primary In-line Covered Splice	X		51	11
11/12/99	Eastern	IR-99EOH101	Town of Orangeburg, NY	59591/37879	Hot Line Clamp on Stirrup	X		38	7
11/12/99	Eastern	IR-99EOH102	Town of Orangeburg, NY	59717/37864	Top "Jaw" of Fused Cutout	X		60	7
11/18/99	Central	IR-99CUG003	Goshen, NY	Pad # 02/76	Primary Dead-end Elbow		X	14	11
11/18/99	Central	IR-99CUG003	Chester, NY	Pad # 88/88	Secondary Bushing (Where spade connects with Hex Nut)		X	141	33

Date	Division	Sequential	Location	Substation or Structure	Circuit / Equipment	OH	UG	Hot Spot Cel.	Ref. Temp. Cel.
11/22/99	Eastern	IR-99EOH103	Franklin Lakes, NJ	54047/37238	Top “Jaw” (blade-clip) of solid blade cutout	X		244	19
11/22/99	Eastern	IR-99EOH104	Wyckoff, NJ	54686/36792	Secondary “Crimp” connector on service arm	X		39	11
11/23/99	Eastern	IR-99EOH105	New Allendale, NJ	54868/37321	Secondary wrapped connector on Tri-plex	X		59	18
11/23/99	Eastern	IR-99EOH106	Allendale, NJ	55649/37462	Top “Jaw” (Fuse-clip) of Fused Cutout	X		31	17
11/23/99	Eastern	IR-99EOH107	Allendale, NJ	55982/37679	Primary “Splice” ()Covered) on West Side of Pole, next to top Insulator				
11/24/99	Eastern	IR-99EOH108	Allendale, NJ	55897/38464	Right side Secondary Bushing Hot Leg Termination and “Low Oil Level”	X		61	25
11/24/99	Eastern	IR-99EOH109	Allendale, NJ	Next to Pole # 55603/7	Left Side Secondary Bushing Hot Leg Connection	X		67	23
11/24/99	Eastern	IR-99EOH110	Allendale, NJ	55226/38546	Secondary Aluminum “Crimp” Connectors at Building Weather Head	X		93	22

C

COMBINED COLLECTION PROCEDURE TIME REPORTS

Table C-1
Combined Collection Procedure Time Reports

		Column A	Column B	Column C	Column D	Column E
Date	Total Hours Worked	Notes	Collection Hours Ultrasonic and Infrared Combined Collections, If Specified	Charged Hours Ultrasonic Collection, If Specified	Total Miles Actual Survey Miles	Charged Hours Ultrasonic Collection
2/1/99		Western Underground	8	0		Infrared Survey Only - 0
2/2/99		Western Underground	8	0		Infrared Survey Only - 0
2/3/99		Central Underground	8	2		2
2/4/99		Central Underground	8	2		2
2/5/99		Central Underground	8	2		2
2/8/99		Central Underground	8	2		2
2/9/99		Central Underground	8	2		2
2/10/99		Central Underground	8	2		2
2/11/99		Central Underground	8	2		2
2/12/99		Central Underground	3.5	1		1
2/15/99			0	0	Holiday	0
2/16/99		Central Underground	8	2		2
2/17/99		Central Underground	7	2		2
2/18/99			0	0	Rain	0
2/19/99		Western Underground	8	2		2
2/22/99		Central Underground	8	2		2
2/23/99		Central Underground	8	2		2
2/24/99		Central Underground	8	2		2
2/25/99			0	0	Family Emergency	0
2/26/99		Western Underground	8	2		2
Totals						

		Column A	Column B	Column C	Column D	Column E
Date	**Total Hours Worked**	**Notes**	**Collection Hours Ultrasonic and Infrared Combined Collections, If Specified**	**Charged Hours Ultrasonic Collection, If Specified**	**Total Miles Actual Survey Miles**	**Charged Hours Ultrasonic Collection**
3/1/99		Western Underground	8	8		8
3/2/99		Western Overhead	7.5 Hours Ultrasound Only 0.5 Hours Downtime		27	7.5
3/3/99		Eastern Overhead			19	5
3/4/99		Central Overhead	4 Hours Ultrasound Only - 4 Hours Downtime	4		4
3/5/99		Eastern Overhead	8		36	2
3/8/99		Eastern Overhead	8		68	0
3/9/99		Eastern Overhead	8		29	3
3/10/99		Eastern Overhead	8		39	2
3/11/99		Eastern Overhead	8		51	0
3/12/99		RFI/TVI Training - All Day	8 Hours RFI/TVI Training	8		8
3/15/99		Snow	0	0		0
3/16/99				8		8
3/17/99				8		8
3/18/99				8		8
3/19/99				8		8
3/22/99				8		8
3/23/99		Eastern Division		8		8
3/24/99		Eastern Division		8		8
3/25/99		Eastern Division		8		8
3/26/99		Central Overhead		8		8
Totals						

		Column A	Column B	Column C	Column D	Column E
Date	**Total Hours Worked**	**Notes**	**Collection Hours Ultrasonic and Infrared Combined Collections' If Specified**	**Charged Hours Ultrasonic Collection, If Specified**	**Total Miles Actual Survey Miles**	**Charged Hours Ultrasonic Collection**
4/12/99	8	Central			36	2
4/13/99	8	Central			29	3
4/14/99	8	Central			49	0
4/15/99	8	Central			51	0
4/16/99		Vacation				
4/19/99	8	Central	4 Hours Ultrasound 4 Hours Combined	6	13	6
4/20/99		Rain				
4/21/99	8	Eastern		7	8	7
4/22/99	8	Eastern		5	17	5
4/23/99	6	Eastern -2 Hours Rain		3	18	3
4/26/99	2	Eastern - Dave Rivera 6 Hours	2 Hours Combined 6 Hours test		8	1
4/27/99	8	Eastern			34	3
4/28/99	2	Eastern - Dave Rivera 6 Hours	2 Hours Combined 6 Hours test		8	1
4/29/99	4	Eastern - Dave Rivera 4 Hours	4 Hours Combined 4 Hours test		25	1
4/30/99	8	Eastern			34	2
Totals						

		Column A	Column B	Column C	Column D	Column E
Date	Total Hours Worked	Notes	Collection Hours Ultrasonic and Infrared Combined Collections, If Specified	Charged Hours Ultrasonic Collection, If Specified	Total Miles Actual Survey Miles	Charged Hours Ultrasonic Collection
5/3/99	8	Eastern			13	6
5/4/99	8	Eastern			22	4
5/5/99	8	Eastern			18	5
5/6/99	8	Eastern - Underground, 5 Hours			7	3
5/7/99	8	Eastern			17	5
5/10/99	8	Eastern			34	3
5/11/99	8	Eastern			27	4
5/12/99	8	Eastern			20	5
5/13/99	3	Eastern - 3 Hours Combined Survey, 5 Hours Rain			3	1
5/14/99	8	Eastern			26	4
5/17/99	8	Eastern			27	4
5/18/99	8	Aerial Survey				0
5/19/99	2	2 Hours Aerial Survey, 6 Hours Rain				0
5/20/99	8	Aerial Survey				0
5/21/99	8	Eastern			23	4
5/24/99	4.5	Eastern			9	2
5/25/99	8	Eastern			21	5
5/26/99	8	Eastern			6	7
5/27/99	8	Eastern			26	4
5/28/99	8	Eastern			19	5

		Column A	Column B	Column C	Column D	Column E
Date	**Total Hours Worked**	**Notes**	**Collection Hours Ultrasonic and Infrared Combined Collections, If Specified**	**Charged Hours Ultrasonic Collection, If Specified**	**Total Miles Actual Survey Miles**	**Charged Hours Ultrasonic Collection**
5/31/99		Memorial Day - Holiday				
6/1/99	8				22	4
6/2/99	8				27	3
6/3/99	8				22	4
6/4/99	8	Infrared Collection Only				
6/7/99	8	Infrared Collection Only				0
6/8/99	8	Infrared Collection Only 7 Hrs, 40 Min	20 Minutes	0.5		0.5
6/9/99	8	Infrared Collection Only - 5.5 Hours Ultrasound Collection Only - 2.5 Hrs.	Transmission Line 56	2.5		2.5
6/10/99	8	Infrared Collection Only - 7 hours Combined Collection - 1 Hour	0.5	0.5		0.5
6/11/99	8	Infrared Collection Only				0
6/14/99		Off - Medical				
6/15/99	8	5 Hours infrared 3 Hours Combination		1		1
6/16/99	8	6 Hours infrared 2 Hours Combination		1		1
6/17/99		Bad Weather - No Work				0
6/18/99	8	Aerial Survey No Ultrasound				0

D
INFRARED FAULT REPORT SAMPLE

ASPLUNDH INFRARED SERVICES
708 Blair Mill Road, Willow Grove, PA 19090
(215) 674-2558

1998 Infrared Fault Report

Repair: 3 Months

Division/District:	Central	**Sequential:**	98CUG012
Inspector:	P. S. Bruder	**Circuit/Equipment No:**	?
Substation:			
Pole/Structure:	Pad # 51016-49644 (Field (on x-former hood) 11/42	**Phase:**	H1B (Bushing)

Address:
Block # 3500 - 3600 (Off Wispering Hills Blvd.)
Between Apts. # 3611 & 3613.

Hardware Description:
Primary Dead-end Elbow: Heat concentrated at 2 o'clock position on circumference of Main Push-pin terminator. Also, Ultrasound # 3 (Arcing) evident.

Address Notation:
@ "Wispering Hills"

City: Chester **State:** NY
Date: 1/21/98 **Time:** 10:06 AM

Hot Spot:	21
Ref Temp:	9
Temp Rise:	12

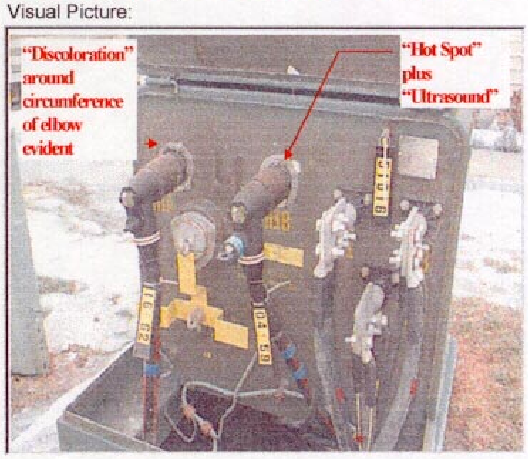
Classification Table

1	50° C - or More	Repair Immediately	
2	21° - 49° C	Repair in 7 Days	
3	11° - 20° C	Repair in 3 Months	X
4	10° C - or Less	Monitor Regularly	

Remarks: No "Bleed-off" wires for both primary bushings. Also, discoloration evident around H1A bushing, although No I.R. or U.S. problems detected. U.S. Instrument Sensitivity= 6.4 @ 50% Measured Reading. Humidity= 26%. Ambient= 2 deg. Celsius. D. to D.= 2 Met.

Thermal Image:

Visual Picture:



by TPN

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E
ULTRASONIC FAULT REPORT SAMPLE

ASPLUNDH INFRARED SERVICES
708 Blair Mill Road, Willow Grove, PA 19090
(215) 674-2558

1998 Infrared Fault Report

Repair: Monitor Regularly

Division/District:	Central	**Sequential:**	98CUG013
Inspector:	P. S. Bruder	**Circuit/Equipment No:**	?
Substation:			
Pole/Structure:	Pad # 51034-49620	**Phase:**	H1A (Bushing)

Address:
Block 3400 (Off Wispering Hills Blvd.) Between Apts. # 3412 & 3414

Address Notation:
@ "Wispering Hills"

Hardware Description:
Primary Dead-end Elbow exibiting # 1 (Corona) Ultrasound Noise around circumference of Main Push-pin termination.

City: Chester **State:** NY
Date: 1/21/98 **Time:** 10:37 AM

Hot Spot:	0
Ref Temp:	0
Temp Rise:	0

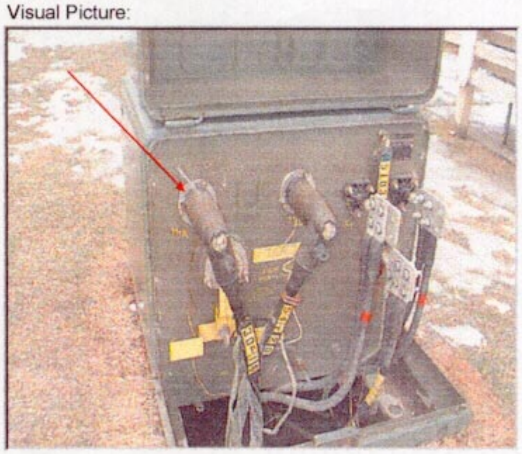
Classification Table

1	**50° C - or More**	**Repair Immediately**	
2	**21° - 49° C**	**Repair in 7 Days**	
3	**11° - 20° C**	**Repair in 3 Months**	
4	**10° C - or Less**	**Monitor Regularly**	X

Remarks: Ultrasound Instrument Sensitivity= 6.9 @ 50% Measured Reading. Humidity= 26 %. Ambient= 2 deg. Celsius. Distance to Devise= 1 Meter.

Thermal Image:

Visual Picture:



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Target:
Distribution Systems

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