Report to the
State of New Jersey Board of Public Utilities
I/M/O the Board's Investigation
Into Reliability Issues related to
Jersey Central Power & Light Company's
Morristown Underground System

BPU Docket No. EO11090526

REDACTED VERSION

Confidential treatment has been given to certain information contained in this Report and its Appendix, including the description of circuit routing, system drawings and First Energy practices on the basis of system security and proprietary concerns.

February 3, 2012

Prepared by PJ Downes Associates, LLC

Table of Contents

EXECUTIVE SUMMARY

Jersey Central Power & Light Company (JCP&L) is a wholly owned electric utility operating subsidiary of First Energy Corp. It provides electric service to over one million customers in two distinct areas of New Jersey. The Northern Region's service territory includes all or portions of Essex, Hunterdon, Morris, Passaic, Somerset, Sussex, Union, and Warren Counties. Within Morris County, JCP&L serves the downtown business area of Morristown via an underground system of manholes and connecting duct lines. Approximately 1,125 customers are connected to this system referred to as the Morristown Underground Network.

Local elected officials and others have voiced their concern that the reliability of the system has deteriorated, and that public safety has been impacted. As a result of discussions between the New Jersey Board of Public Utilities (Board) and JCP&L, the Board directed JCP&L to "hire a Special Reliability Master, subject to Board approval, to evaluate JCP&L's design, operating, maintenance, and performance standards as they pertain to the Morristown underground electric distribution system, and make recommendations to the Company and the Board on the appropriate course of action necessary to ensure adequate reliability and safety in the Morristown underground network." A copy of the Board order is included in the Appendix to this report. JCP&L engaged PJ Downes Associates to perform the study, and the Board gave its approval.

The delivery of electricity can be divided into five processes. They are: Plan, Design, Build, Operate, and Maintain. It is through each of these that JCP&L's Morristown Underground Network was evaluated. JCP&L meets the reliability standards and their measures for electric service in a network zone. **This report contains twenty five recommendations for improvement.** They are primarily in areas of Operate and Maintain. When implemented they should further improve service and decrease the potential for other incidents similar to those that have occurred.

In addition, two recent equipment failures were reviewed. The first occurred on June 9, 2011, when a 500 KVA transformer failed in a vault on South Street, resulting in a fire and damage to other equipment and cables in the vault. The second occurred on August 31, 2011, during restoration work associated with Hurricane Irene in a manhole on the corner of South and James Streets when an underground oil switch failed and a motorist was injured as described in the Board's September 2, 2011, Order initiating this investigation. These incidents led to specific recommendations regarding the refurbishing of similarly designed transformers and the replacement of the two remaining oil switches in the network.

As of February 1, 2012, the planning, ordering of material, and scheduling associated with the transformers are all under way. For the oil switch replacements, the design phase is completed, steel for the required rebuilding of the roofs of the manholes is on order and delivery is anticipated February 10^{th}, the contractor to perform the rebuild has been engaged, one new vacuum switch is available and the other will be received March 1^{st} . The work is tentatively scheduled for completion by March 31^{st}. One switch does require a customer outage and the exact date will be determined after consultation with the customer.

OVERVIEW

This investigation comprised a detailed analysis to understand the Morristown Underground Network and the incidents. Key activities included:

- Interviews of personnel
- Review of photographs taken of the equipment
- Review of circuit prints
- Review of maintenance procedures and records
- Review of reports prepared internally and by others
- A timeline of events which was developed to recreate and understand the sequence of events
- A field inspection of Morristown Substation and the underground facility
- Physical inspection of the damaged transformers, cables, and network protectors

NETWORK SYSTEMS
Section A

Before reviewing the specific events that have occurred on the network and their impact on safe reliable service, it is appropriate to provide an overview of the system. The five circuits that supply network load originate at Morristown Substation. The station's source is two 230 kV transmission lines which when stepped down, feed a 34.5 kV grid that supplies local substations in the area as well as two other facilities on the same property. One of these supplies two 34.5/12.5 kV transformers rated at 40 MVA each, for local overhead distribution circuits and one supplies two 34.5/12.5 kV transformers rated at14.0 MVA for the five network distribution circuits. The prints depicting these substation assets are included in the Appendix. Please note that the Company has requested confidential treatment of certain information contained in the Appendix, including system drawings on the basis of system security concerns.

The design criterion for the station and the outgoing circuits is n-1. This states that at peak load conditions an outage to a piece of equipment or cable will not interrupt service to the customers. These outages may be planned to perform maintenance or construction, or unplanned, the result of an electrical short circuit associated with circuit breakers, electrical buses, or high voltage cables. An unplanned outage may also be caused by the failure or improper operation of control equipment such as protective relays, control cables, and potential and current transformers.
For the purpose of illustration, Figure 1 is a simplified diagram of a station as shown on page 5-1 of the "*Underground Systems Reference Book*" published by the Edison Electric Institute.
It depicts an underground network system with four primary circuits. Each circuit is supplied via its circuit breaker and its associated switches, controls, and protective relays. The outgoing cables are installed in a conduit and manhole systems along the public streets. Along the circuit route, transformers are connected to decrease the voltage to utilization level. At most

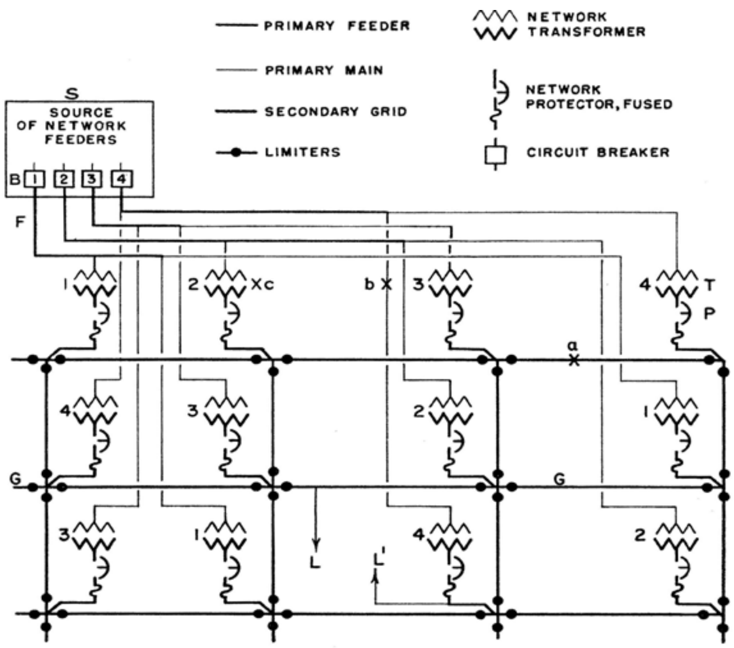


Figure 1

transformer manholes/vaults, there is a primary switch, a network transformer, and a network protector (NWP). The primary switch is a manually operated device that disconnects the transformer from its cable source. This device also is used to short and ground the cable to allow employees to safely work on the de-energized cable. The network transformer reduces the voltage to either 120/208 volts or 277/480 volts, depending upon the customer's requirements. The network protector is an automatic secondary switch that disconnects the transformer from the secondary grid.

Electrical faults may occur at various points in this system and may be the result of equipment failures, an operating error, or an outside influence such as an excavation contractor striking and damaging a cable. If, for example at Morristown Substation, the transformer designated Bank 4 as shown on the substation one line diagram in the Appendix, were to be removed from service for maintenance or experience an electrical fault, the transformer is electrically isolated by the operation of circuit breakers. Another example would be the maintenance or an electrical fault on the underground cable or network transformer as shown in Figure 1. The circuit breaker at the station designated 1, 2, 3, or 4 would operate to isolate the outgoing circuit from the source. In addition the NWP at each transformer associated with the affected circuit would open. This is necessary to separate the transformers and supply cable from a back feed of electric current that would result from the common secondary bus still being supplied by the other circuits.

The n-1 design allows cables and equipment to be out of service without customer outages. By comparison, it should be noted that in a non-network design the circuits leaving a station are radial, and customer outages are usually experienced when electrical faults occur. The outage continues until the fault can either be isolated from the system or repaired.

Planning and Design
Section B

The peak loads on the Morristown Network have been:

2009	9,400 KVA
2010	9,900 KVA
2011	10,200 KVA

These loads are within the present ratings of the transformer electrical buses and the network circuits and will also be sufficient for the anticipated growth in the area. The planning tool used for the network system is EasyPower. It allows the development of various scenarios of circuit and transformer outages under different load conditions. It is also a valuable tool for operational analysis.

It should be noted that not all the customers in the downtown area are supplied via the network. There are fifteen (15) large customers supplied from three non-network circuits originating at Morristown Substation. The town hall is also unique having two 3 phase secondary services, one at 120/208 volts and the other at 277/480 volts. Although supplied from network circuits, local electrical switching must be done manually at the facility when there is a circuit outage. This arrangement resulted from building alterations that were done when the building was converted from its previous owner.

Although the network has five circuits, they are not as symmetrical as the text book case shown in Figure 1. This means that under some conditions the ends of the network act more like a three circuit network, but service remains for all n-1 conditions.

To this point in this report, the loading of facilities, the n-1 criteria, and the network layout have been reviewed. These aspects of the planning and design of the Morristown Network System may be described as sound utility practices.

System Components
Section C

Substation

The design and construction of the station meet good utility practices. The operation and maintenance of the facility is appropriate. Four of the five network circuits have micro-processor relays for their system protection. The fifth circuit uses older electro-mechanical relays that provide proper relay protection but do not have the ability to store the attributes of the system at the time of the fault in memory.

The 12 kV circuit breakers are not animal proofed to avoid electric contacts from stray animals, and one circuit did not have lightning arrestors connected when visited.

Conclusions

1. The substation facilities are designed to n-1 criteria.
2. Circuit 37935 has electro-mechanical relays for fault protection.
3. The 12 kV network circuit breakers do not have animal guards.
4. The lightning arresters for Circuit 37939 were not connected.

Recommendations

1. Replace the electro-mechanical relays on Circuit 37935 with micro-processor type.
2. Install animal guards on the bushings of the 12 kV network distribution breakers.
3. Reconnect the lightning arresters associated with Circuit 37939.

The Company has indicated that these recommendations are scheduled for completion in 2012.

Underground Primary Cable

For the past ten years there have been major primary cable additions and replacements. Over 19,300 ft. have been installed. In addition for the circuits that feed local non network load in the downtown area, more than 4,800 feet have been installed. The cable standard for this work is EPR insulation which is the present state of the art.

It is common practice to wrap primary cables with fire retardant arc proofing tape when there are secondary cables or other primary cables in a manhole. This is done to limit damage to adjacent cables when there is a fault. Manhole inspections and feedback from employees indicated this was not common practice in the Morristown Network System. When clarification of this issue was requested in Data Request SRM-1130, the response was as follows:

> "Because of a misunderstanding within the cable group that new EPR cable was already fireproofed, it was believed that there was no need to follow Section 5.2.3. (Distribution Engineering Manual). This misunderstanding has been corrected and Section 5.2.3 will be followed going forward. During the 2012 annual inspections, conditions found not to be compliant with Section 5.2.3's requirements will have a CM order created to add fireproofing."

Manhole inspections also indicated that access to electrical cables and equipment are made more difficult because of the presence of fiber optic cables. Large loops of this cable are left on the floor in manholes for possible use with future customers. This practice makes it difficult to service electrical equipment. The various equipment inspections provide an opportunity to detail these problems for corrective action by the fiber optic personnel.

Conclusions

1. Over 19,000 feet of new primary cable has been added to the Morristown Network.
2. Arc proofing tape was not installed on all of the new cables added to manholes and/or vaults that have secondary facilities or other primary circuits.
3. The fiber optic cables are not always properly secured in many manholes and are in coils on the floor of the manholes.

Recommendations

1. Primary cables that were not covered with fire retardant arc proofing tape must be identified and the tape installed. The Company has committed to completing this recommendation by the end of 2012.
2. Fiber optic facilities must be properly secured to manhole walls and/or ceiling. The Company has indicated that it intends to work with the fiber optic cable owner/contractor immediately to assure compliance with this recommendation.

Underground Network Transformers and Network Protectors

There are 51 transformers connected to the Morristown Underground Network. As described earlier, two of these are padmounted and associated with the service to Town Hall. The remainder are submersible types with four specific compartments. They are:

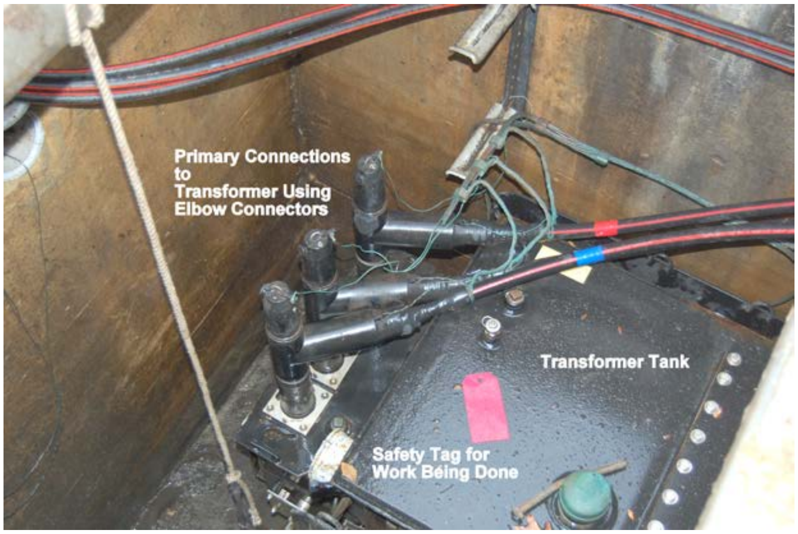
1. The cable termination compartment or the exterior cable connection using elbow connectors as the points where the transformer is connected to the primary circuit as shown in Photographs # 1 and # 2.

2. The switch compartment contains an electrical switch in an oil filled compartment. The switch can be used to isolate the transformers and ground the primary electric cable to allow work to be performed safely on the cable and transformer. The switch is shown in Photograph # 1.

3. The main transformer tank contains the electrical winding in a sealed compartment under oil. It too is shown in Photographs # 2 and # 4.

4. The network protector is shown in Photograph # 3 and # 4.

Photograph # 1



Photograph # 2

Photograph # 3

Photograph # 4

Age and installation dates are important factors for managing this asset. Twenty-two of the transformers have been manufactured since 2000. Although data was available to determine the

manufacturer and serial numbers of the other 27, the manufactured date is still being researched to determine precise age.
The load on each transformer is predicted using the EasyPower planning tool. With all facilities in service and at peak demand, the loads on each transformer would be described as light to moderate. In an outage of one circuit there is only one transformer that actually reaches its name plate capacity. No actual readings are taken on transformers during peak load periods. This practice would verify the accuracy of the software and that the secondary grid is performing as designed.

Conclusion

1. Load checks on individual transformers in the network during summer loading would verify the projections from the EasyPower software.

Recommendation

1. Once during 2012, validate the EasyPower model for the Morristown Underground network, utilizing summer loading information from spot load readings obtained on each transformer in the Morristown network during a period when the ambient temperature exceeds 90 degrees.
   The Company has indicated that this recommendation will be scheduled for completion in 2012.

Preventive Maintenance
Section D

The components of the network require both preventive and corrective maintenance. Preventive maintenance checks the health of an asset usually based on a time or operational criteria. Those required for the Network are described in First Energy's document titled "Section 24P Underground Ducted Systems" dated 02-26-10. A copy is included in the Appendix. Please note that the Company has requested confidential treatment of certain information contained in the Appendix, including First Energy practices on the basis of system security and proprietary concerns.

The planned maintenance on underground transformers and NWPs may be summarized as follows:

	EQUIPMENT	MAINTENANCE TYPE	FREQUENCY
# 1	Network Protector	Operational Test	Yearly where practical
# 2	Network Protector	Complete Inspection	4 Years
# 3	Network Transformer	Oil Screen & Dielectric Test	2 Years
# 4	Company Vaults	Inspection	6 Months

Chart 1

Operational Test

The "Operational Test" (#1 in Chart 1) checks that when a circuit is de-energized from its source as a result of the operation of its circuit breaker, the NWP detects current flowing back into the primary and then it opens, isolating the secondary grid from the transformer. Under normal operating conditions, if a NWP fails to operate, it allows current to feedback, possibly causing damage to its facilities, or at a minimum, delaying desired work schedules until the NWP feeding back is located and fixed.

This preventative maintenance program was not part of the work conducted on the Morristown Network. As a result of this investigation, the Company initiated these tests in December 2011. Two circuits have been checked and operated properly. The other three are scheduled to be done during January 2012.

Conclusion

1. This Operational Test is a significant part of the management of network facilities, and the intention of the program is good. It is believed the test should be performed twice per year, once before summer loading and once after summer loading.

Recommendation

1. Continue the Operational Test, but increase the frequency to twice per year. The Company has initiated these tests and has indicated that it intends to fully implement this recommendation.

Complete Inspection of Network Protector

The "Complete Inspection of Network Protector" (#2 in Chart 1) is presently scheduled every four years. This is a very thorough inspection and maintenance, detailed in the Appendix. Among other things the relays, the operating motor, control wiring, fuses, and electrical contacts are checked. The NWP case is pressure tested for leaks that if not detected, might allow moisture into the mechanism. The NWP is to be left with a positive pressure of 4 psi nitrogen. At the initiation of this investigation, all NWPs were beyond the four year test schedule. Thirteen periodic inspections have been completed in December 2011 and January 2012. The Company has indicated the remainder of the NWPs will be completed in the first quarter of 2012.

Conclusion

1. The "Complete Inspection of Network Protector" had not been on schedule. The Company has initiated corrective action which is appropriate.
2. The inspections should also capture information regarding the type of relays (electro-mechanical, analog or microprocessor) used in each NWP. The Company has indicated that it will begin to capture this data starting with the inspections on the remainder of the NWPs in the first quarter of 2012.

Recommendations

1. The Company should complete the preventative maintenance as scheduled, but to assure proper operation of the NWPs, all corrective maintenance should be tabulated by vault number and circuit for proper tracking. Generally, this work should be completed within 90 days of the preventive maintenance.
2. The electro-mechanical and analog relays should be upgraded to microprocessor units.

   As indicated, the Company has initiated corrective actions and has indicated that it intends to upgrade its existing electro-mechanical and analog relays associated with the NWPs for the Morristown Network.

Oil Screen & Dielectric Maintenance

The "Oil Screen & Dielectric Maintenance" (# 3 in Chart 1) assures that the quality of the oil used as an insulating medium has not deteriorated. The initial testing data provided as a result of a data request indicated that oil tests had not been performed on any transformer since October 29, 2009, and therefore all were due for testing. In the Company's supplemental responses to Data Request SRM-1104 (c) of January 20 and 21, 2012, it was indicated that all transformers have had oil samples taken, some test results have been received, and the remainder should be completed shortly.

Conclusion

1. The first portion of the Oil Screen and Dielectric Maintenance has been completed with the oil sampling. Results of testing and remedial action are still to be completed.

Recommendation

1. The Company should complete the preventive maintenance as scheduled. To assure any corrective maintenance that is required is scheduled and completed; records should be tabulated by circuit, vault number, and transformer number. The corrective maintenance should be completed by June 1, 2012.

Company Vault Inspection

The "Company Vault Inspection" (# 4 in the Chart 1) of all underground transformer manholes/vaults is conducted every six months. This is a very important program to assure that all the assets associated with the transformers are in satisfactory condition. A copy of a completed inspection sheet is in the Appendix and shows the level of detail of this work.

A review of five years of inspection sheets was made. During this period almost 600 inspections were completed. In general all sites were visited twice per year. As can be noted from the inspection sheet in the Appendix, this process is manual and paper driven. Some items are not fully completed by all inspectors so that there is not the robust history of inspection data that might be anticipated. Load readings, thermal checks, oil checks, and oil temperature are missing on many inspections. Additional training is required so that inspectors understand the reason and importance of data collection.

Conclusion

1. These inspections are being done on schedule, although frequently data was found to be incomplete.

Recommendations

1. Continue this important inspection process and provide additional training for the inspectors.
2. The use of a hand held remote storage device similar to what is used for substation inspections, should be considered to assist in getting complete information, to check accuracy of new information compared to the previous inspection, and to ultimately build an asset management data base to track these underground assets.

   The Company has indicated that these recommendations will be addressed during 2012

Corrective Maintenance
Section E

Although much data is collected today from the preventive maintenance programs, during the investigation it was clear that corrective maintenance has not always been completed in a timely manner, including the timely return of network equipment to service, and follow-up on corrective maintenance after inspection. Appropriate prioritization of corrective maintenance is paramount to the safe and reliable operation of the network. The Company needs to manage the corrective maintenance work for the network more effectively, taking into account relevant factors including if customers are affected, system loading and voltage conditions.

Conclusion

1. The Company must appropriately prioritize and complete identified network corrective maintenance work on a timely basis.

Recommendations

1. The Company needs to appropriately prioritize and manage the network corrective maintenance work more effectively and should report on an annual basis for the following three years, beginning calendar year 2012, to the Board regarding the number of network preventive and corrective maintenance work items identified and completed.
2. The Company should complete the identified corrective work that it has committed to complete during the first quarter of 2012.

3. The Company should modify business practices so that all out-of-service network equipment is logged in a data base for tracking and visibility, to which the Company has already agreed and implemented through its Energy Delivery Outage Application (EDOA) database, which is controlled by the regional dispatch center.

   The Company has indicated that it intends to implement these recommendations.

Secondary Grid
Section F

As was described earlier and depicted in Figure 1, the secondary system is connected to multiple sources to assure service continuity. When a fault occurs on secondary conductors, by design standards it is anticipated to burn clear, that is there will be sufficient current to burn-off the fault quickly. This is the basis of the design of the Morristown Network. Some secondary faults may not generate sufficient fault current to burn clear, and the fault current will cause damage to the insulation of the secondary cable. To avoid this, secondary limiters are installed. The limiter burns open before insulation damage is done to the conductors. The Company has not studied this aspect of secondary operations.

Unique engineering software is necessary to perform the modeling of the secondary grid to determine if limiters are needed. The Company has acquired the software and anticipates the study will be completed in February 2012.

Two customers served from the Morristown Network are supplied three phase 277/480 volts from network transformers with high voltage network protectors. Secondary cables run between the bushings on the NWP and the customer's service entrance equipment. The fuses within the protector are the clearing point should a failure occur within the protector or in the secondary runs. Many companies choose to install limiters at the NWP bushings and at the service connection to clear faults more quickly and limit damage. The secondary analysis of the Morristown Network should include these specific installations.

Conclusion

1. Analysis of the fault clearing characteristics of the Morristown Network is required and the Company is moving to have it completed.

Recommendation

1. The Company's announced plan for the analysis is appropriate. Upon completion of the study the results should be discussed with Board Staff and PJ Downes Associates to develop an implementation schedule. The Company has indicated that it will act in accordance with this recommendation.

Alternate Network Control Systems
Section G

As the five distribution circuits presently are constituted, the use of Supervisory Control and Data Acquisition (SCADA) is limited to substation equipment. Conditions can be observed, readings taken, and devices operated. Observations and operation of field equipment are done manually by field technicians. Their activities are initiated because of planned work, operation of an upstream device such as the station circuit breaker, a call received from a customer or from emergency management personnel. This is standard for a network of this size.

To understand what is being developed to supervise and control networks, representatives of the Company met with ETI, headquartered in Irvington, NJ. ETI manufactures network protectors for electric utilities around the world. They also design control systems to monitor and operate network systems. Their system can monitor transformer loads, temperature, oil pressure, and oil level. It determines the status of the NWP and if desired can open or close the device remotely.

All the data is transmitted to a central station for evaluation and data storage. The system is either operational or in the design stage for several large utilities.

Conclusion

1. At this time it would not be cost effective to install such a system on a 51 transformer network.

Recommendation

1. The further development of these and alternate designs should be tracked to understand future possibilities. The Company has agreed to this recommendation.

Underground Switches
Section H

JCP&L utilizes underground switches in their primary circuit design to provide greater flexibility for normal operations and emergency restoration. These switches may be installed on network circuits, on radial circuits that supply load in the downtown area, or on circuits that pass through the underground manholes to reach their connected overhead loads.

At this time there are 11 such switches in service. Nine of the switches are vacuum type, meaning the contacts that open or close as desired are in a vacuum bottle that acts as the insulating medium. There are two older switches that are oil filled which is the insulating medium. These are scheduled for replacement.

Portions of following description have been redacted from this public version as confidential for reasons of system security.

On August 31, 2011, while JCP&L was performing restoration switching for customers who were affected as a result of Hurricane Irene, an oil switch failed in manhole #___ (MH-___), at the corner of South Street and James Street. The oil switch in MH-___ was connected to the Morristown 37854 distribution circuit. This is a non- network feeder circuit that travels underground from the Morristown Substation on Ridgedale Avenue, south on ________ Avenue, south on _____ Street and east on _____ Street. At the intersection of ______ and _____ Streets, the circuit splits in two directions - one portion continues underground along _______ Street towards ______. It supplies a portion of _____________ as well as load in the area adjacent to the ________. The other section of the circuit travels a short distance underground on _____ Street and then continues overhead to feed residences along ______ Street and the surrounding area.

Earlier in the day on August 31, 2011, JCP&L crews had entered MH-___ at the corner of James and South Street to access the oil switch, which was completely de-energized at the time as a result of Morristown Substation being out of service.

The purpose of entering the manhole was to operate one position on the three way switch in order to isolate the circuit feed that runs from the Morristown Substation to the switch. This would allow crews to energize a portion of underground cable from the intersection of ______ Street and ___________ Rd, feeding west on ______ Street and south down ______ Street in order to restore electrical service to the area along _____ Street. The circuit feed going back to Morristown Substation could not be energized at this point due to damage in the substation from the flooding that had occurred three days earlier. During this operation nothing was observed as abnormal with the oil switch.

When the crew attempted to close the overhead tie point between the Morristown 37854 and Whitney 37736 circuits (thus energizing the oil switch), the switch failed and caused the Whitney circuit to lock out.

The failed switch was removed from the manhole and quarantined. A final determination of the cause of failure has not been established; however, among other causes, a potential cause may be dielectric failure. The circuitry in the manhole has been reconfigured to eliminate the need for a switch at this location.

Conclusion

1. The two existing oil switches are scheduled for replacement.

Recommendation

1. The Company should report to the Board Staff when this work has been completed. If not completed by May 1, 2012, an interim report should be provided to the Board detailing problems that have occurred and remediation being done to expedite the work. The Company has agreed to this recommendation.

Transformer Failure
Section I

On June 9, 2011, a Westinghouse 500 KVA transformer failed in Vault # 849. The resulting fire caused extensive damage to the transformer and the other circuits that were in the vault. An investigation by Company personnel and representatives of the Power Cable Consultants determined the primary cable failed in the cable termination compartment. Since this compartment is sealed after the cable has been connected, air tested for leaks and filled with oil, the Company, as many other utilities, conducted visual inspections as preventive maintenance.

Photographs # 5 and # 6 that were taken by a member of the BPU staff show the failed transformer. It is appropriate that additional preventive maintenance should be conducted on all transformers in the Morristown Network that use a cable termination compartment for connection to the primary circuit.

Photograph # 5

Photograph 6

Figure #2 depicts a typical connection compartment and switch compartment on the transformer.

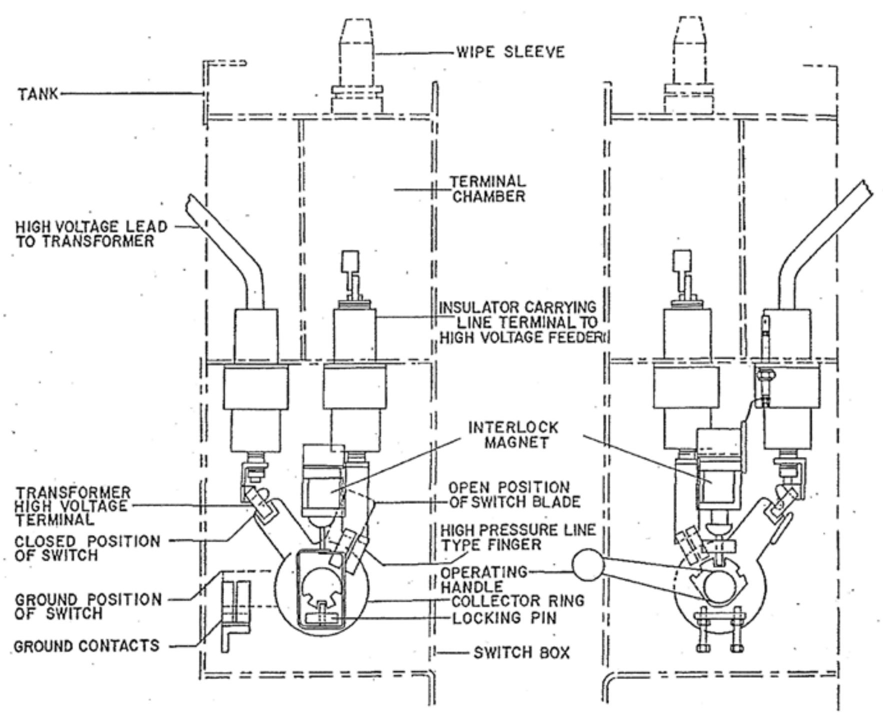


Figure 2

Initially it will be necessary to identify the number and location of these transformers. The maintenance should include the following items:

1. Sample the oil from the cable termination compartment and test. This will allow data collection regarding any deterioration of the oil up to this time.
2. Drain oil, remove terminal chamber cover, and inspect the compartment and cable terminations for signs of deterioration. If necessary make repairs. Reinstall terminal chamber cover and air test the compartment for leaks. If necessary make repairs.
3. Fill the compartment with Cooper Power System Envirotemp FR3 Fluid or an equivalent dielectric fluid. This is a non-petroleum product with a higher flash point than petroleum based products.

<u>Conclusion</u>

1. A preventive maintenance program as detailed above is necessary for transformers with cable termination compartments.

Recommendation

1. Initiate the program and complete refurbishing of transformers with cable termination compartments by June 1, 2012. The Company has agreed to this recommendation.

Transformer Ventilation
Section J

During the inspection of facilities it was noted that many transformer vaults would not meet the present Company standard regarding required ventilation for a new transformer installation. As a result, Data Request SRM-1129 was submitted to the Company, and a response was provided. The question and response are detailed below:

SRM-1129 A copy of the "Distribution Engineering Practices" was provided with the response to SRM-1116. Section 4.2.7 and 6.3 describe the need for minimum ventilation for transformers installed in vaults. Since many of the transformers located in the Morristown Network would not meet the thresholds suggested, what studies or evaluations have been conducted to assure the life expectancy of the transformers has not been compromised?

Response Section4.2.7 (adopted 12/29/06) states as follows:

All new vaults should use cover grates. The minimum ventilation should be twenty (20) square feet of clear opening per thousand (1000) kVA of transformer capacity. Overall vent dimensions should be larger as required to adjust for the width of the grate metal to determine the clear opening. Normally assume 70 percent of clear opening area in a grated cover. Ventilation of existing vaults should be reviewed against this criterion, and increased where practical to conform to this criterion when transformers are replaced or increased in size.

This section applies to new vaults and where there have been transformer replacements and upgrades.

We are not aware of any studies or evaluations having been conducted with respect to this issue in the Morristown Underground Network. However, the Company will review all transformer vaults in the Morristown Underground Network against the standard to (i) confirm proper application of the standard and (ii) redress the application of the standard, where necessary.

Conclusion

1. The planned study by the Company is appropriate.

Recommendation

1. The results of the study regarding transformer ventilation should be reported to the Board and should detail the number and location of vaults that do not conform to the present standard. Plans for corrections should also be submitted to the Board which the Company has agreed to do.

Manhole Covers
Section K

Over the last several years there have been incidents of failures in manholes/vaults that have dislodged the manhole covers. This is a result of pressure building in the manhole during the electrical fault from gases generated. The cover rises off its frame to allow the pressure to be diminished. All utilities experience similar incidents in their systems. Adjustments to system design and proper maintenance may help mitigate the number of these occurrences. There are also opportunities to reduce the pressure by using vented covers which allow the gas to escape before the pressure within the manhole becomes excessive. Another alternative is to tether the cover to the frame to limit its travel if pressure becomes excessive. Research has been conducted by the Electric Power Research Institute in this area. They conclude that tether systems and vented covers work, but further research and experience are necessary. It is appropriate that JCP&L initiate a pilot project to get field experience in this area.

Conclusion

1. Further research and experience is required to determine the best course of action for utilities to minimize the problems associated with dislodged manhole covers.

Recommendations

1. JCP&L should continue to work with other utilities and research groups to understand all the dynamics of this problem.
2. In addition, a trial project comprised of a minimum of twelve installations should be made in Morristown to gain field experience. The pilot installation should be coordinated with the earlier recommendation regarding transformer ventilation.

   The Company has agreed to continue its efforts to understand the dynamics of the problem and to carry out the recommended trial project.

Transformer Vaults
Section L

During the inspection phase of this investigation, vaults were observed with more than one transformer present. As a result, Data Request SRM-1128 was submitted to the Company, and a response was provided. The question and response are detailed below:

SRM-1128 A copy of the "Distribution Engineering Practices" was provided with the response to SRM-1116. Section 4.2.4 describes the present design criteria for new vaults requiring more than one transformer. Considering the number of vaults in the Morristown Network having two transformers as well as the dramatic failure experienced on June 9, 2011, what plans have been prepared to minimize damage on a circuit or transformer failure?

Response: Section 4.2.4 provides as follows:

> *Separate vaults should be constructed when more than one three-phase network transformer is required at a single location. Where this is not feasible, the design should include a concrete wall vault partition to isolate each transformer.*

This is the standard followed for construction of a new vault and does not apply to the four vaults on the Morristown Underground Network, each having two transformers installed, that were constructed prior to the applicability of the standard. However, although the current standard does not require retrofitting, the Company will evaluate the feasibility of constructing a concrete wall partition in these four existing double transformer vaults.

Conclusion

1. The planned study by the Company is appropriate.

Recommendation

1. The result of the study should be reported to the Board detailing remediation plans. If remediation is not planned, the engineering analysis that was conducted to reach that conclusion should be provided to the Board. As indicated in the Company's response to the data request, the Company has agreed to implement this recommendation.

Training
Section M

Discussions with the Acting Fire Chief of the Morristown Fire Department indicated that training provided by the Company to members of his department has decreased. He recommended that earlier training that was more oriented to overhead construction should be reestablished. He also suggested that additional training be provided regarding the layout of the Network System, its various components, and anticipated activities that would require the response of his department.

Conclusion

1. The feedback from the Acting Fire Chief is significant and is an opportunity for improved relations.

Recommendation

1. The earlier fire training program should be reinstituted with additional training being provided regarding the underground system. The Company has agreed to this recommendation.

Communication
Section N

Discussions with elected and appointed officials and the Acting Fire Chief indicate that better and more frequent communication is necessary to improve relationships. A good part of these discussions regard overall electric operations and, specifically, the storms of late 2011. This area is being addressed through other efforts being overseen by the Board.

Regarding the Morristown Network System, there are opportunities for better communication and understanding by all parties. The Company has initiated an internal document to track faults in the underground system as was described in their response to SRM-1140. The essence of the information contained in this document should be summarized and discussed initially on a monthly basis with appropriate local officials. Since not all responses to electric incidents by local emergency officials may be known to the Company, this is another area that should be included in discussions.

Conclusion

1. There is a need for more local communication regarding the network system.

Recommendation

1. For the near term, initiate monthly meetings to fully discuss electric incidents recorded by either party regarding the network system. The Company has indicated that it intends to implement this recommendation.

SUMMARY of RECOMMENDATIONS

Reliability Issues related to
Jersey Central Power & Light Company's
Morristown Underground System
BPU Docket No. EO11090526

System Components – Section C

C-1 Replace the electro-mechanical relays on Circuit 37935 with micro-processor type.

C-2 Install animal guards on the bushings of the 12 kV network distribution breakers.

C-3 Reconnect the lightning arresters associated with Circuit 37939.

C-4 Primary cables that were not covered with fire retardant arc proofing tape must be identified and the tape installed.

C-5 Fiber optic facilities must be properly secured to manhole walls and/or ceiling.

C-6 Once during 2012, validate the EasyPower model for the Morristown Underground network, utilizing summer loading information from spot load readings obtained on each transformer in the Morristown network during a period when the ambient temperature exceeds 90 degrees.

Preventive Maintenance – Section D

Operational Test

D-1 Continue the Operational Test, but increase the frequency to twice per year.

Complete Inspection of Network Protector

D-2 The Company should complete the preventative maintenance as scheduled, but to assure proper operation of the NWPs, all corrective maintenance should be tabulated by vault number and circuit for proper tracking. This work should be completed within 90 days of the preventive maintenance.

D-3 The electro-mechanical and analog relays should be upgraded to microprocessor units.

Oil Screen & Dielectric Maintenance

D-4 The Company should complete the preventive maintenance as scheduled. To assure any corrective maintenance that is required is scheduled and completed; records should be tabulated by circuit, vault number, and transformer number. The corrective maintenance should be completed by June 1, 2012.

SUMMARY of RECOMMENDATIONS CONTINUED

Company Vault Inspection

D-5 Continue this important inspection process and provide additional training for the inspectors.

D-6 The use of a hand held remote storage device similar to what is used for substation inspections, should be considered to assist in getting complete information, to check accuracy of new information compared to the previous inspection, and to ultimately build an asset management data base to track these underground assets.

Corrective Maintenance – Section E

E-1 The Company needs to appropriately prioritize and manage the network corrective maintenance work more effectively and should report on an annual basis for the following three years, beginning calendar year 2012, to the Board regarding the number of network preventive and corrective maintenance work items identified and completed.

E-2 The Company should complete the identified corrective work that it has committed to complete during the first quarter of 2012.

E-3 The Company should modify business practices so that all out-of-service network equipment is logged in a data base for tracking and visibility, to which the Company has already agreed and implemented through its Energy Delivery Outage Application (EDOA) database, controlled by the regional dispatch center.

Secondary Grid – Section F

F-1 The Company's announced plan for the analysis is appropriate. Upon completion of the study the results should be discussed with Board Staff and PJ Downes Associates to develop an implementation schedule.

Alternate Network Control Systems – Section G

G-1 The further development of these and alternate designs should be tracked to understand future possibilities.

Underground Switches - Section H

H-1 The Company should report to the Board Staff when this work has been completed. If not completed by May 1, 2012, an interim report should be provided to the Board detailing problems that have occurred and remediation being done to expedite the work.

SUMMARY of RECOMMENDATIONS CONTINUED

Transformer Failure – Section I

I-1 Initiate the program and complete refurbishing of transformers with cable termination compartments by June 1, 2012. The Company has agreed to this recommendation.

Transformer Ventilation – Section J

J-1 The results of the study should be reported to the Board and should detail the number and location of vaults that do not conform to the present standard. Plans for corrections should also be submitted.

Manhole Covers – Section K

K-1 JCP&L should continue to work with other utilities and research groups to understand all the dynamics of this problem.
K-2 In addition a trial project of a minimum of twelve installations should be made in Morristown to gain field experience. The pilot installation should be coordinated with the earlier recommendation regarding transformer ventilation.

Transformer Vaults – Section L

L-1 The result of the study should be reported to the Board detailing remediation plans. If remediation is not planned, the engineering analysis that was conducted to reach that conclusion should be provided to the Board.

Training - Section M

M-1 The earlier fire training program should be reinstituted with additional training being provided regarding the underground system.

Communication – Section N

N-1 For the near term, initiate monthly meetings to fully discuss electric incidents recorded by either party regarding the network system.

It should be noted that the Company has accepted all these recommendations and has committed to their implementation.