

**New York State Department of Public Service
Verizon New York, Inc.
Network Review Plan Compliance Audit
Final Report - Redacted**

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September 14, 2010

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I. Introduction and Background

Verizon has been deploying its fiber-to-the-premises service throughout New York State since 2004. This service, which Verizon markets under the name FiOSSM, has the ability to offer customers high-speed internet access, telephone, and video services. With FiOS, Verizon provides these services entirely through an optical fiber medium terminating at an Optical Network Terminal (ONT) installed either inside (Inside Installation) or immediately outside (Outside Installation) a customer location. The signals are carried between the ONT and other devices within the location (*e.g.*, computers, set-top boxes, telephones) through non-fiber media, such as coaxial cable. The New York State Department of Public Service (NYS DPS) became aware of potential problems with the grounding and bonding of connections to the ONT. These concerns led the NYSDPS Staff (Staff) to conduct several audits of FiOS installations during 2007 and 2008. During the course of these audits, Staff uncovered a large percentage (over 50 percent) of installations that did not comply with the National Electric Code (NEC) requirements for grounding and bonding. Although optical fiber is non-conducting, other media connected to the ONT for distribution within the customer location, such as coaxial cable, generally are conducting, and thus must be grounded or bonded (*i.e.*, properly connected to other ground circuits) to protect against such hazards as electric shocks.

In response to the improper grounding conditions uncovered by Staff, Verizon submitted its Network Review Plan (NRP) on July 15, 2008. The plan was designed by Verizon to remediate deficiencies in past installations, require detailed inspections of new installations, and provide additional training for Verizon technicians. Verizon issued a supplement to its NRP on August 15, 2008. On November 3, 2008, the New York State Public Service Commission (Commission) issued an order approving Verizon's NRP with modifications.¹ Verizon issued its revised plan on November 21, 2008, to comply with the modifications identified in the Commission's order. On January 29, 2009, the Commission issued another order finding Verizon's revised NRP non-compliant with its November 3, 2008 Order and directed Verizon to make further modifications to its plan.² Verizon issued its second revised, and most current, NRP on February 6, 2009 containing the modifications identified in the Commission's January 29, 2009 Order. The Commission also reviewed the applicability to FiOS of the grounding requirements in the NEC and issued an order on January 14, 2009 that allowed a modification in those requirements for certain installations.³ The January 14, 2009 Order also required the implementation of grounding blocks on a prospective basis to ensure proper grounding of the ONT and the coaxial cable connecting the ONT to the customer's equipment.

Verizon's NRP is designed to provide a program to:

¹ State of New York Public Service Commission, *Order Approving FiOS Remediation Plan with Modifications*, issued and effective November 3, 2008 ("November 3, 2008 Order").

² State of New York Public Service Commission, *Order Requiring Changes to the Network Review Plan Submitted by Verizon New York Inc.*, issued and effective January 29, 2009 ("January 29, 2009 Order").

³ State of New York Public Service Commission, *Order Concerning the Grounding of FiOS Installations*, issued and effective January 14, 2009 ("January 14, 2009 Order").

- Inspect all installations made prior to August 1, 2008 (Past Installations) and remediate any problems found with these installations
- Inspect an ongoing sample of installations made on or after August 1, 2008 (New Installations) to ensure compliance with grounding and bonding requirements specified in the Commission’s orders
- Provide additional training for technicians.

The NRP specified that Verizon would complete the inspection of Past Installations by March 31, 2009, and would complete remediation of any problems found by May 31, 2009. The NRP also specified that Verizon establish an Optical Network Quality Assurance Team, whose role is to help ensure through an internal inspection program that Verizon i) complies with all methods and procedures for grounding and bonding for 95 percent of New Installations, and ii) has at least some grounding and bonding for 100 percent of these installations.

The NYSDPS selected the Liberty Consulting Group (Liberty) to conduct an independent review of Verizon’s performance under the NRP. The main requirement of this review is a visual inspection of a statistically valid sample of Verizon’s FiOS installations in each of 16 geographic areas (Relevant Areas) in New York State. These 16 Relevant Areas are shown in Table I below.

Table I
Relevant Areas in New York State

Relevant Area	Definition	Percentage of Installations in New York State on March 1, 2010
Bronx	Bronx County	[Redacted]
Brooklyn	Kings County	[Redacted]
Capital North	Latham, Schenectady	[Redacted]
Capital South	Albany, Bethlehem, Cornwall, Fishkill, Guilderland, Newburgh, Poughkeepsie-Hamilton, Wappingers Falls	[Redacted]
Central	Baldwinsville, Cicero, Clay, Fayetteville, North Syracuse, Syracuse	[Redacted]
Manhattan	New York County	[Redacted]
North Nassau	North Nassau County	[Redacted]
South Nassau	South Nassau County	[Redacted]
Queens	Queens County	[Redacted]
Staten Island	Richmond County	[Redacted]
North Suffolk	North Suffolk County	[Redacted]
South Suffolk	South Suffolk County	[Redacted]
Rockland	Rockland County	[Redacted]
North Westchester	Armonk, Bedford, Carmel, Chappaqua, Katonah, Mahopac, Mt. Kisco, Ossining, Peekskill, Pleasantville, Yorktown	[Redacted]
South Westchester	Dobbs Ferry, Fairview, Harrison, Larchmont, Mamaroneck, Mt. Vernon, New Rochelle, Port Chester, Rye, Scarsdale, Tarrytown, Tuckahoe, White Plains, Yonkers	[Redacted]
Western	Amherst, Buffalo, Hamburg, Orchard Park, West Seneca	[Redacted]

After gathering initial information from Verizon through data requests and an in-person interview during December 2009 and January 2010, Liberty drafted an Audit Work Plan. Liberty provided the draft Audit Work Plan to Staff on February 4 and received comments on the plan from Staff on February 18. Liberty provided a revised Audit Work Plan to Staff on February 26. After some additional wording changes agreed upon by Liberty and Staff on March 5, the NYSDPS accepted the Work Plan. Staff provided a copy of the approved Work Plan to Verizon on March 9. Verizon requested a few modifications to the plan.⁴ After discussions among Verizon, Liberty, and Staff, Liberty revised the Work Plan, issuing a final revised Audit Work Plan on March 19. The inspections commenced on March 22 and ended on May 10.

II. Inspection Process

A. Scope and Objectives

The objective of the physical inspections was to examine a statistical sample of FiOS installations in each of the 16 Relevant Areas to determine Verizon's compliance with the Commission's grounding rules. Liberty conducted these inspections simultaneously with a team of nine inspectors. To help ensure consistency of results, these inspections were performed using the common procedures described in Appendix A of this report.

Liberty used the data from the sampled installations to estimate Verizon's overall rate of compliance with the Commission's grounding rules across New York State and to determine whether there is any significant variation in the compliance rate among the Relevant Areas. As described in Appendix B, Liberty used statistical precision criteria provided by Staff to determine the appropriate target sample size to be at least 73 completed inspections per Relevant Area, with a total statewide sample size of 1,168 inspections (16 Relevant Areas multiplied by 73 inspections per area). Liberty's inspectors visited a random sample of locations selected from the population of FiOS installations within each of the Relevant Areas. Liberty drew this random selection of locations from a Verizon-provided database of all FiOS installations in New York State that Verizon had successfully subjected to the NRP process as of March 1, 2010.⁵

⁴ On page 2 of the *Comments of Verizon New York Inc. on the Draft Audit Report* ("Verizon's Draft Report Comments"), dated September 7, 2010, Verizon claimed that Liberty's "non-compliance findings for many locations reflect the application of unreasonably stringent or simply incorrect compliance criteria." In fact, the compliance criteria Liberty used were clearly and completely articulated in the Audit Work Plan that Verizon reviewed prior to the start of the inspections. Verizon raised no objection to the compliance criteria after review of the work plan.

⁵ The universe from which the sample was drawn excluded: i) those locations for which Verizon was aware of a non-compliance condition and for which it has scheduled but not yet completed remediation and ii) Past Installation (pre-August 1, 2008) locations that Verizon had not yet been able to inspect for compliance due to no access to the customer's premises. Liberty requested data on all in-service FiOS installations in the state as of March 1, 2010 in order to be able to determine the number of installations excluded from the universe from which the inspection sample was drawn. Liberty's analysis indicates that 8.29 percent of all FiOS installations in service as of March 1, 2010, as noted in Verizon's database, were excluded from the sample universe for these reasons. Of these, 52.5 percent (4.35 percent of the total installations) were excluded because Verizon had not yet completed remediation and 47.5 percent (3.94 percent of the total installations) were excluded because Verizon had not yet been able to inspect the locations.

Based on Verizon's experience and that of the NYSDPS inspectors, Liberty expected that there would be a significant number of sampled locations where Liberty's inspectors would not be able to obtain access to Inside Installations, because no one would be at the location or a person at the location would refuse to provide access. Therefore, in order to meet at least the target inspection sample size of 73 completed inspections per area and taking into consideration Verizon's input concerning the rate of no-access,⁶ Liberty drew a sample of 112 locations for each relevant area at which to attempt inspections. A sample of 112 locations for inspection attempts would yield the target completed inspection sample size of at least 73 as long as no more than 35 percent of the locations needed to be excluded because of no access or other reasons.

In order to improve the access rate, Liberty's inspectors made a second attempt to access those locations where no one or no adult was home during the initial visit. This procedure successfully lowered the no-access rate from 39 percent to 32 percent statewide. In addition to the lack of access at a number of locations, Liberty's inspectors encountered other situations that prevented them from completing the inspection; these conditions included invalid addresses, dangerous conditions, inaccessible ONTs or grounding points, and some other miscellaneous conditions noted in Section III below. These conditions required the exclusion of another three percent of the sample locations, or a total of 35 percent of locations excluded from the sample. Although this is identical to the expected loss of 35 percent used in developing the sample sizes, the rate varied significantly among the Relevant Areas.⁷ Liberty was unable to reach the target sample size even after the second inspection attempts in four of the Relevant Areas because of no-access rates higher than the expected 35 percent.⁸ In those Relevant Areas, Liberty drew additional location samples from the Verizon database, as described more fully below in Section E, "Inspection Process." Using these additional samples, Liberty was able to complete at least 73 inspections in each Relevant Area.

To maintain the randomness of the samples, Liberty's followed the procedure described above for all locations in the samples even after achieving the target number of inspections in a Relevant Area. All valid completed inspections of the sampled locations were used in the analysis, even if the number of these inspections exceeded the target sample size in a Relevant Area.

B. Organization

Because a team of nine inspectors conducted these inspections simultaneously, it was important that each of the Liberty inspectors fully understood and complied with the Audit Work Plan to help ensure consistency of results. The Audit Work Plan provided the specific instructions and Appendix A describes the detailed process used by the inspectors to complete the inspections. As

⁶ Interview on December 29, 2009.

⁷ The highest no-access rates were in Manhattan (81 percent after the first attempt and 71 percent after the second attempt). The lowest no-access rates were in North Suffolk (eight percent after the first attempt and five percent after the second attempt).

⁸ These four Relevant Areas are Central, Manhattan, Queens, and Western.

noted below, Liberty introduced procedures to help ensure inspectors' compliance with the Work Plan.

Prior to starting any of the inspections, the inspectors were asked to thoroughly review the Audit Work Plan, and each inspector certified that he had read, understood, and agreed to comply with the plan. Liberty conducted an inspector training session via conference call to help verify that the inspection team members understood the goals of the project and the exact process that the team members were to follow during the course of their work. The inspectors recorded all inspection results in a standardized tracking sheet (described in Appendix C) and documented the status of the FiOS grounding conditions with digital photographs of the grounding conditions found at each inspection location.

Appendix D shows the dates the inspections were performed in each of the 16 Relevant Areas. Liberty began inspections the week of March 22, restricting them initially to only two Relevant Areas (Queens and South Suffolk) to test that the process was working properly. Because of the religious holidays the following week, Liberty suspended inspections for a week, resuming them the week of April 5 with an expansion to simultaneous inspections in nine Relevant Areas. Liberty concluded the inspections in all but one Relevant Area by the week of April 26. Because of the large number of no-access situations encountered in the remaining Relevant Area, Manhattan, inspections continued there until May 10. In the Manhattan and Western Relevant Areas, which experienced a much higher than average no-access rate, Liberty used multiple inspectors, shifting inspectors to work in those areas once they had completed the ones to which they had originally been assigned.

All Liberty's inspectors resided in New York State. For the most part, Liberty assigned inspectors to Relevant Areas based on each inspector's home location in order to reduce travel expenses. To minimize non-productive travel time, the random sample of inspection locations for each Relevant Area was organized in a sequence based on the most efficient travel routes between locations.

C. Customer Contact and Communications

Relying on the inspection experiences and suggestions of the Verizon and NYSDPS inspectors, Liberty decided not to make calls to customers to set up appointments for the inspections; all inspections were attempted by arriving without a prior appointment at the sampled FiOS locations. Each inspector was accompanied by a Verizon employee who had proper Verizon identification. Liberty's inspectors had photo identification badges indicating their association with Liberty Consulting, which were visibly displayed by the inspectors. NYSDPS inspectors also accompanied each of the Liberty inspectors on a few of their inspections during the early stage of the inspection process.

The Verizon escorts made the initial customer contact, asking for permission to conduct the inspection at the location. To the extent possible, Liberty's inspectors had minimal contact with the FiOS customers. However, the inspectors had instructions as to what they should and should

not say to the customers in response to questions they might be asked. The inspectors also had NYSDPS contact information to allow validation of the reasons for the inspection if they were challenged by persons at the inspection locations. Liberty's inspectors were instructed to never enter the interior of a location unless permission was granted by an adult at that location. Liberty's inspectors were instructed not to enter the interior or the grounds of a location if the inspector considered the situation to be potentially unsafe. Liberty experienced five incidences of locations that were considered unsafe to inspect. Four of these locations were in the South Capitol Relevant Area and the other was in Manhattan.

D. Verizon's Role in the Inspection

The principal role of the Verizon escorts was to use their Verizon credentials as an aid to gain access to the customer location for the Liberty inspectors and thus minimize the likely increase in the rate of refusal to grant access for unescorted location visits. To maintain the confidentiality of Liberty's inspection results, once access was granted by a person at the location, the Verizon escort did not accompany the Liberty inspector to the ONT location, unless absolutely necessary. Once the ONT was located, to the extent possible, the Liberty inspector conducted the inspection unobserved by the Verizon escort. Once the Liberty inspector fully completed an inspection, the Verizon inspector had the opportunity to go to the ONT and perform a separate inspection. The Liberty inspectors and Verizon escorts did not share with each other either a verbal assessment of the results of any of their inspections or any of their written inspection notes.

At the start of the inspections in each of the Relevant Areas, Liberty's inspectors contacted the Verizon escort assigned to that area to make meeting arrangements for the inspections. To maintain the integrity and independence of the project, the sample locations were provided to Verizon one location at a time when the inspector was ready to move to the next location. Under no circumstance did the Liberty inspector provide his Verizon escort with the list of addresses to be visited. As a further check on Verizon's activities, Liberty requested, after the conclusion of the inspections, that Verizon provide the status of its own inspection, repair activity, and remediation of FiOS locations and that of the Optical Network Quality Assurance Team (ONQAT) subsequent to the date (March 1, 2010) of the data from which Liberty drew its inspection sample.⁹

Liberty observed that Verizon's escorts understood the procedures for the inspections established in Liberty's Audit Work Plan and cooperated well with Liberty's inspectors. Verizon also was very cooperative with Liberty in making escorts available for the inspections in the different Relevant Areas, and adjusted plans, sometimes on short notice, when Liberty needed to make changes from the schedule originally provided to Verizon. This included making escorts available on weekends in some cases and providing additional escorts in Relevant Areas that had high no-access rates, allowing Liberty to assign multiple inspectors to these areas. Liberty also noted that the escorts efficiently completed their inspection of the locations after the Liberty inspectors were finished at a location and thus the Verizon inspections did not materially prolong the inspection process.

⁹ Verizon June 1, 2010 response to a Liberty data request.

Liberty encountered one apartment building in Manhattan containing three sample locations at which Verizon uses rack-mounted ONTs, rather than the standard single-unit ONTs used in most locations in New York State. Verizon claimed that these ONTs should not be included in the inspections and asked the Liberty inspector not to inspect them. This was resolved after intervention from Staff, who clarified that all installed ONTs should be subject to inspection. The Liberty inspector subsequently returned to that location and inspected the three sample ONTs.

Liberty also encountered three instances of ONTs in the sample located at Verizon facilities. Verizon did not permit the inspections at those locations. Liberty treated these as no-access locations.

E. Inspection Procedures

To maintain the integrity of the sample, all the locations identified within each of the Relevant Areas were treated equally. Specifically, the Liberty inspectors attempted to inspect all locations provided to them regardless of the number of inspections actually achieved. For example, in a Relevant Area where the actual no-access rate experienced by the inspector was below the assumed 35 percent, the inspector completed the required 73 inspections before visiting all 112 sample locations. In that case, the inspector did not stop after completing the 73rd location but continued to visit locations until he visited and, if possible, inspected each of the 112 locations provided. On the other hand, if the inspector experienced a no-access rate that exceeded the assumed 35 percent, he was not able to achieve the required 73 inspections before exhausting the list of locations. In that case, the inspector received additional sampled locations for that Relevant Area. The number of additional locations was based on the number of actual inspections the inspector was able to accomplish from the original list of locations (*i.e.*, the closer to the 73 target inspections that were achieved the smaller the second sample). This second sample was drawn using the same random selection process used to select the original locations, except that the original locations were removed from the universe of locations prior to selecting the second sample to prevent duplication. As was the case with the original list, all locations on the second list were treated equally and an attempt to inspect all of them was made even if this produced more than the required 73 inspections. All valid inspections of sampled locations were used in the analysis even if the number of such locations in a Relevant Area exceeded 73.

As was noted, the inspectors were unable to complete the inspections for all locations in the sample for various reasons. In most cases this occurred because no one was present at the location, no adult was present, or the inspector was refused access. In some cases, customers expressed annoyance because other inspectors (presumably from Verizon or the NYSDPS) had already inspected their installation and either refused access or allowed access reluctantly; however, this was not common. In a few cases after successfully achieving access to the location, an inspector was still not able to complete the inspection because of various situations, such as unsafe conditions in the building unrelated to the ONT installation, inability to locate the

installation, and grounding points hidden behind furniture. A complete list of such reasons is provided in the Findings section (Section III) below.

The fact that the inspectors were unable to complete inspections at all the sample locations has the potential for introducing bias in the estimation of the true grounding status based on the sample. Such bias would occur if there is a correlation between the ability to access a location or complete an inspection after achieving access and the grounding status of that location's installation. Liberty's inspectors therefore made best efforts to obtain access to and complete inspection in all the locations. The inspectors made a second attempt to gain access to those locations where they experienced a no-access condition either because no one was at the location or because there was no adult there, usually upon completion of the initial visits to all the sample locations in an area. Inspectors did not revisit locations where they were denied access, where there were potentially unsafe conditions, or where the customers indicated they had disconnected FiOS service. Inspectors did not make any further attempts to inspect a location if they were unable to access the location on the second visit.

Generally, the Liberty inspectors conducted a visual examination for compliance with the Commission's grounding rules. The only physical check the inspectors made was a slight tug on the ground wire in cases for which: i) it appeared the wire might not be securely connected to a clamp or other device, ii) there was doubt that the wire was connected within the ONT, or iii) to trace the wire to its ground connection point. Any loose ground connection was recorded as a non-compliant condition. There were no other physical tests of compliance. As requested by Staff, the Liberty inspectors did not perform electrical tests of the ground source used by Verizon to determine whether it was grounded.

For sample locations that had more than one ONT installed (*e.g.*, in multiple dwelling units) Liberty's inspectors made every effort to distinguish the specific ONT chosen for the sample (*e.g.*, look for apartment identification on the ONT or ground tag, look for ONT serial number, or attempt to trace the coaxial cable to apartment unit). In the event that the proper ONT could not be identified, the inspector inspected all the ONTs present at that location and recorded on the tracking sheet that multiple ONTs were installed and inspected at the location. To prevent multiple inspections from adding bias to the sample, the results from that location were excluded from Liberty's reported results in cases where the inspection yielded different results (*i.e.*, one ONT was properly grounded and the other ONT was not). Conversely, in cases where the inspector found the same results for all the ONTs installed at that location (*i.e.*, all ONTs were properly grounded or all were not properly grounded), the results from that location were included in Liberty's reported results. However, in such a case, only the result for the single location that was in the inspection sample was counted in the statistical analysis, regardless of how many ONTs were inspected at the location. Liberty needed to exclude only three locations from the sample because of differing results for multiple ONTs at the location.

Liberty tracked all inspection results using the standardized tracking sheet found in Appendix C to help ensure consistency of results compilation and reporting. Because of the impracticality of electronically recording each location's inspection results directly onto the spreadsheet, the inspectors used a hard copy facsimile of the tracking spreadsheet to manually record each location's results immediately after completing the inspection. Additional detailed inspection

notes of what was observed were recorded in a separate pad or notebook. All locations visited were recorded on the tracking sheet, including instances of no access. The causes of the no-access condition (*e.g.*, no one present at the location, access denied, or unsafe condition) were documented in the notes section of the tracking sheet.

All inspectors completed the electronic tracking form and transmitted the completed forms to a centralized location daily. The inspectors backed up all photos taken onto a CD or flash drive, which was sent to a centralized location at the completion of the inspector's work in each Relevant Area. Liberty also collected all manual inspection sheets used by the inspectors during the course of the audit at a central location.

For quality control, Liberty's inspection team leader accompanied inspectors on some of their inspections and was in frequent contact with the inspectors particularly during the early stages of the project to help ensure the inspections were conducted in a consistent manner and according to the Work Plan. The team leader also reviewed each of the electronic tracking sheets daily and contacted the inspectors with questions and to address any inconsistencies found on the sheets. This process sometimes led to corrections to the recorded results. Further details about the inspection and quality control process can be found in Appendix A of this document. Instructions for completing the standardized tracking form can be found in Appendix C.

F. Acceptable Grounding Methods

The purpose of Liberty's inspection, as specified by Staff, was to verify Verizon's conformance with the Commission's rules for proper grounding of the ONT.¹⁰ The guidelines Liberty used to determine whether an installation is compliant with the Commission's rules were derived from Staff's letter to Mr. Thomas McCarroll, Verizon's Executive Director of Public Affairs, Policy and Communications, dated August 5, 2008, and from the Commission's January 14, 2009 Order regarding the use of coaxial grounding blocks and the conditions for which the TII-442 module can be used for Inside Installations of the ONT. Using these documents, as well as the *NEC 2008 Handbook*, Liberty provided all its inspectors with explicit instructions for assessing the various conditions that need to be in place to be considered an approved grounding method for the ONT. Any deviation from these conditions was noted as a non-compliant installation on the inspection tracking sheets. To provide data for assessing Verizon's compliance with the Commission's January 14, 2009 Order regarding the need for grounding blocks on a prospective basis, the inspectors were also required to note the presence or absence of a grounding block on all locations. Details of the grounding arrangements and conditions that Liberty's inspectors looked for can be found in the "Acceptable Grounding Methods" section of Appendix A.¹¹

¹⁰ As such, this was not a review of Verizon's conformance with the NRP or Verizon's grounding and bonding methods and procedures but with the grounding and bonding rules underlying the NRP as articulated by the Commission in its orders and in the documented communications between Staff and Verizon.

¹¹ In Verizon's Draft Report Comments (page 2), Verizon suggested that this audit report "would benefit if Liberty provided a broader perspective on its findings," including comparisons with the grounding requirements and status of Verizon's competitors. Although FiOS and such competing technologies as coaxial cable may be subject to different grounding requirements because of differences in their electrical characteristics, the exact nature of such differences and the status of grounding in New York State for providers of competing services are beyond the scope

III. Findings

A. Initial Data Review

Liberty’s inspection team leader carefully reviewed all the inspection tracking sheets and photographs for accuracy and completeness and to help validate that all the data represent valid inspections. The inspection team leader discussed any inconsistencies or other questions about the sheets with the inspectors and, in collaboration with the inspector, adjusted the tracking sheets as necessary to correct or remove questionable findings. Based on this analysis, Liberty developed a master results sheet to use for statistical analysis. The inspection team leader also identified any additional qualitative findings from the inspector comments recorded on the results and tracking sheet.

Table II below summarizes the inspection results after this initial data review:

Table II
Inspection Results After Initial Data Review¹²

Relevant Area	Total Location Sample Size	Invalid Locations	Locations Not Inspected	Completed Inspections	Fully Compliant Locations
Bronx	112	3	20	89	84
Brooklyn	112	1	22	89	81
Capital North	112	2	33	77	73
Capital South	112	4	33	75	65
Central	137	3	55	79	63
Manhattan	462	19	333	110	95
North Nassau	112	4	23	85	81
South Nassau	112	3	13	96	90
Queens	132	0	59	73	63
Staten Island	112	1	20	91	75
North Suffolk	112	3	5	104	94
South Suffolk	112	1	11	100	91
Rockland	112	2	15	95	90
North Westchester	112	2	27	83	74
South Westchester	112	0	35	77	65
Western	142	0	64	78	70
Total	2,217	48	768	1,401	1,254

of Liberty’s review. This review was designed to be only an examination of Verizon’s compliance with the Commission’s grounding and bonding requirements, as described in Liberty’s Audit Work Plan that was approved by Staff and reviewed by Verizon prior to commencement of the inspections.

¹² Please note that these numbers changed slightly after the analysis described in Section III.B. For the final inspection results, see Table III below in Section III.C.

The columns in this table are defined as follows:

- “Total Location Sample Size” is the total number of locations drawn from the Verizon database of locations as of March 1, 2010 (excluding those Past Installations for which Verizon had not yet completed inspection and remediation). For Relevant Areas in which Liberty needed to draw an additional sample beyond the original 112, this number includes the additional sample.
- “Invalid Locations” is the total number of locations in the sample for which there is evidence that a customer no longer exists because the customer disconnected service or moved.¹³
- “Locations Not Inspected” is the total number of locations, except for Invalid Locations defined above, for which Liberty inspectors were unable to complete an inspection after two attempts.
- “Completed Inspections” is the number of locations at which Liberty inspectors were able to successfully complete an inspection.
- “Fully Compliant Locations” is the number of locations at which the Liberty inspectors found the grounding and bonding of the ONT to be fully compliant with the Commission’s rules.

There were a number of reasons why Liberty’s inspectors were unable to complete an inspection for the 768 locations classified as “Locations Not Inspected.” These reasons included:

- Access was impossible because i) no one was present at the location, ii) someone was present at the location but refused entry to the inspector, or iii) no adult was present at the location. (675 locations – 88 percent)
- The inspector was unable to observe grounding conditions at the location because they were obscured in some fashion (*e.g.*, behind furniture, in a crawl space, or in a drop ceiling) (38 locations)
- The Verizon database appeared not to have a correct address for the location either because there was no building at the address shown in the database (22 cases) or the customer name in an apartment building directory did not identify apartment numbers and the name displayed in the directory did not match the name in the Verizon database (14 cases)
- There were dangerous conditions at the location (5 locations)
- The inspector was unable to find the ONT at the location (3 locations)
- There were multiple ONTs at the location, the sample ONT could not be distinguished from the others, and the grounding status of the ONTs was different (3 locations)

¹³ In one case there had been a recent fire at the sample location. Liberty only excluded locations for which the inspector could determine at the time of the inspection that service had been disconnected. There are likely to be a few locations remaining in the inspection sample at which service was disconnected but that fact was not apparent to the inspector at the time of the inspection. This can happen, for example, in the case of Outside Installations when the inspection was completed without any contact with the customer.

- The location was a Verizon-owned facility and Verizon refused access to it (3 locations)
- There was evidence that the grounding condition had been changed since the time of the Verizon installation either because the customer had tampered with it (2 locations), because the electric service had been replaced and the ground clamp had not been replaced (1 location), or because there was evidence of recent storm damage (1 location)
- There was a Verizon repair in progress at the location (1 location).

To assess whether any recent Verizon inspection, remediation, or repair activity may have contaminated the sample, Liberty requested from Verizon data on such activity around the time of the Liberty inspections, specifically from March 1 through May 14, 2010.¹⁴ Liberty examined whether the existence of any locations in the inspection sample associated with such activity may have compromised the results of the inspections. In this data, Liberty found some locations that were included in the inspection sample and for which Liberty was able to complete the inspection. Specifically, out of the 1,401 locations Liberty inspected, there were 93 unique locations at which there had been a Verizon or ONQAT inspection, remediation, or repair visit, including:

- 12 locations that Verizon or the ONQAT had inspected or remediated
- 81 locations at which Verizon has made repair visits, one of which was also inspected by the ONQAT prior to Liberty's inspection.

Liberty found that 83 of these 93 locations (89.2 percent) were fully compliant with the Commission's grounding rules. This number is nearly equivalent to the 89.5 percent (1,254 divided by 1,401) of locations that Liberty found to be compliant as part of this initial data review in the full sample of completed inspections. Based on this analysis, Liberty found no compelling reason to exclude such locations from the inspection results.

B. Verizon's Objections to Liberty's Findings

After compiling these initial findings, Liberty provided to Staff and Verizon the master results sheet along with preliminary statistical analysis of the results, including estimates of the compliance rates and confidence intervals of the compliance rates statewide and in each Relevant Area. In addition, Liberty provided estimates of the fraction of locations that were not only non-compliant but for which the external grounding of the ONTs was missing or doubtful. A more complete description of the statistical analysis and the determination of locations with no or doubtful ground is provided in Sections III.C and D below.

In response to this information, Verizon provided Staff and Liberty a list of objections to Liberty's findings in a memorandum on July 1, 2010. Verizon also provided a number of photographs taken by the Verizon inspection escorts as support for some of the company's

¹⁴ Verizon June 1, 2010 response to a Liberty data request.

contentions. On July 6, representatives from Liberty and Verizon held a conference call to review Verizon's objections. In answer to some questions raised during this call, Liberty provided additional information to Verizon, and Verizon provided further information to Liberty and Staff in an additional memorandum on July 7, 2010.

Verizon's objections to the findings of non-compliance fall into the 10 categories described below.

1. *Interference of Grounding Arrangements by Third Parties (7 locations: Verizon location numbers 52, 66, 67, 97, 99, 110, and 120).*

Verizon identified in the July 1 memorandum seven locations¹⁵ Liberty found to be non-compliant that the company claimed show evidence of tampering either by the customer or other parties since the time of the Verizon installation. In the July 7 memorandum Verizon dropped one location¹⁶ from this list based on photographic evidence Liberty provided but added another location¹⁷ that the company originally classified differently.

As noted above, Liberty found evidence that the grounding connections had been changed since the Verizon installation at four other locations in the original sample and determined that these locations should not be included in the inspection sample. Based on the information provided by Verizon and after consulting our inspectors, Liberty concluded that there was sufficient evidence of tampering at three of the seven additional locations Verizon contends are of this type (Verizon location numbers 52, 97, and 99). At one of these three locations (Verizon location number 52), Verizon provided convincing evidence that the TII-442 device used to ground the ONT has been moved and the ground wire connecting the TII-442 to the ONT had been disconnected during construction work by the customer. In the other two locations (Verizon location numbers 97 and 99), Verizon provided convincing evidence that the ONT had been connected to the electrical meter panel and that the electrical service had been replaced subsequent to the Verizon installation; during the installation of the new meter panel, the Verizon grounding clamp was removed and never replaced. To be consistent with the four similar cases Liberty had identified earlier, we determined that these three locations should be dropped from the inspection sample, reducing that sample size of inspected locations from 1,401 to 1,398.

For the other four locations Verizon identified, Liberty's analysis follows:

- (1) For Verizon location number 66, the ground wire is connected through a clamp to a water pipe, but the location is non-compliant because the clamp is loose.¹⁸ Verizon claims that a new water meter had been installed after the FiOS installation and that the water meter installer loosened the clamp at that time.

¹⁵ Verizon location numbers 34, 52, 66, 97, 99, 110, and 120.

¹⁶ Verizon location number 34.

¹⁷ Verizon location number 67.

¹⁸ The *NEC 2008 Handbook* Article 250.68(B) states, "The connection of a grounding electrode conductor or bonding jumper to a grounding electrode shall be made in a manner that will ensure an effective grounding path." Additionally, Verizon's *FiOS Single Family Unit ONT Grounding Practices Issue F* states on page 20, "When making grounding connections Technicians must ensure that the connections are tightened properly." Appendix B of the same document provides a matrix of the torque that should be used for each of various types of ground connections that can be made to ensure tightness of the connection.

Liberty finds no evidence that the water meter was installed after the FiOS installation, given that that dwelling itself is relatively new. Even if it had been installed later, there would have been no reason for the water meter installer to loosen the grounding clamp to do so.

- (2) For Verizon location number 67, the ONT ground wire is connected to a cable television strap clamp thereby putting two wires on the same clamp and making the grounding non-compliant.¹⁹ Verizon indicates that the customer at this location recently disconnected FiOS service and that the cable television installer added the second connection to the strap clamp. Liberty finds no evidence that this is the case; our photographs indicate that the cable television connection appears to be the older of the two connections.²⁰
- (3) For Verizon location number 110, the grounding connection was made through a clamp at the electric meter panel, but the grounding wire is loose at the clamp thereby making the grounding non-compliant as with Verizon location number 66 above. Verizon indicates that the electric service was recently replaced because of storm damage and claims that the electrician performing this service rendered the grounding connection non-compliant at that time. Liberty agrees that there is evidence that electrical work was performed at this location, but finds no convincing evidence that the electrician loosened the wire connection at the clamp during the electrical work because there would have been no reason for the electrician to do so. The homeowner at this location also informed the Liberty inspector that, as suggested by the electrician, the homeowner called Verizon to reinstall the clamp on the electrical panel after the electrician finished his work.
- (4) For Verizon location number 120, Liberty found the location to be non-compliant because two ground connections were attached to the same ground point, as with Verizon location number 67 above. Verizon claims that this occurred because the grounding conditions were tampered with by a cable television installer. Liberty finds no convincing evidence that this was the case, and questions the plausibility of Verizon's scenario. The presence of a coaxial cable exiting the ONT makes it unlikely that a cable television installer came to the customer's premises after rather than before the Verizon installer.

¹⁹ The *NEC 2008 Handbook* Article 250.70 states, "Not more than one conductor shall be connected to the grounding electrode by a single clamp or fitting unless the clamp or fitting is listed for multiple conductors." Additionally, Verizon's *FiOS Single Family Unit ONT Grounding Practices Issue F* states on page 20, "When making grounding connections Technicians must ensure that only a single grounding connection is made."

²⁰ In the July 1 memorandum (page 11), Verizon had originally classified this location as one where service was disconnected and therefore should be excluded from the audit, but changed the nature of the objection in the July 7 memorandum to that stated here. In Verizon's Draft Report Comments (page 9), the company has raised again the objection that service was disconnected and therefore this location should be removed from the audit sample. However, as noted above, Liberty only excluded such locations from the sample when the Liberty inspector was able to determine at the time of the inspection that service had been disconnected. As Liberty pointed out to Verizon during the July 6 conference call, the sample would be biased if only non-compliant locations were removed from the sample based on subsequent information that the customer had disconnected service. The only non-biased way to treat such instances is to remove all disconnected locations from the sample, whether or not they were found to be compliant. Verizon has not provided data to Liberty that would allow such a procedure to be performed.

2. Attachments to Painted Surfaces (6 locations: Verizon location numbers 13, 64, 81, 108, 109, and 116).

Verizon presented evidence of continuity testing at these six locations, demonstrating that the ONTs are grounded. As noted earlier in this report, Liberty's inspections were based entirely on visual observations and did not include continuity testing. Liberty did not observe Verizon's conduct of the continuity tests; as a result, although Verizon provided photographs of the test meters, Liberty is unable to independently verify the test results. Liberty's review was intended to include independent inspections of the sampled installations and not to rely on other test results, whether by Verizon, Staff, or anyone else. Liberty notes that proper grounding procedures require removal of the paint in any area where a ground clamp is installed, a procedure which Verizon did not dispute in its July 1 memorandum. Without removing the paint, there is no assurance that a reliable contact to a metal surface has been made or that any contact made will continue over time or be sufficient to provide an adequate ground during a power surge. Liberty's inspectors found no evidence that the paint had been removed at the grounding sites for the six locations Verizon noted, which is confirmed by the photographs taken by Liberty's inspectors. It is possible that the ground contact in these cases was made because there was a small patch of paint that had been scraped away but was not visible.²¹ If so, Liberty cannot independently verify this or whether such contact, if it occurs, is sufficient to form a robust ground path over time.

Regardless of the accuracy and sufficiency of Verizon's continuity tests, Liberty believes that these locations are not compliant with the appropriate grounding practices. As noted in Section III.C, there are locations where Verizon's installers have not complied with the proper grounding practices but where the ONT may still be grounded in some way. Such locations must still be considered non-compliant. The *NEC 2008 Handbook*, Article 250 states, "Nonconductive coatings (such as paint lacquer and enamel) on equipment to be grounded shall be removed from threads and other contact surfaces to ensure good electrical continuity or be connected by means of fittings designed so as to make such removal unnecessary."²²

3. Inadequacies in the Electrical Grounding System at the Customer's Premises (5 locations: Verizon location numbers 31, 75, 103, 105, and 107).

In these cases, Verizon noted that the defect Liberty identified was with the grounding source itself (*e.g.*, an electrical meter panel or a multi-ground neutral (MGN)) rather than Verizon's grounding procedures and that Verizon should not be responsible for assuring that the grounding

²¹ Verizon also claims that grounding clamps may have dug sufficiently into the paint surface to make contact with the metal, but the clamps Verizon used in these cases were all strap-type clamps that are unlikely to dig far into the painted surface. Liberty notes that its inspectors encountered many locations where Verizon's installers made use of a meter panel corner clamp on painted meter panels. Liberty found all instances of these locations to be compliant installations because, as opposed to the strap-type clamp, the meter panel corner clamp is designed to "bite" into the painted surface to make contact with the metallic surface below the paint.

²² This is also consistent with Verizon's methods and procedures documentation. Verizon's *FiOS Single Family Unit ONT Grounding Practices Issue F* states on page 20, "When making grounding connections the Technician must ensure that the surface of the grounding point is free from debris, corrosion, paint or any other current impeding material."

source is itself properly grounded. After reviewing Verizon's claims and reviewing the inspector notes and photographs, Liberty agrees that the Verizon installers followed all the appropriate grounding procedures up to the point of the connection to the supposed external ground source. Therefore, Liberty has changed the status of these locations to compliant.

Nevertheless, Liberty notes that the problems with the grounding sources were clearly visible to the installer and other grounding options were available at all of these locations. In two of these cases (Verizon location numbers 105 and 107), the grounding wire was connected to an outdoor meter panel but the meter panel itself was connected to non-metallic cables without the presence of the rigid metallic conduit that is typically found on outdoor electric meters. In another case (Verizon location number 103), Verizon's installer attached the ONT ground wire to the MGN conductor, but the clamp that was used to connect the MGN conductor to the ground rod immediately below the ONT was clearly broken and unattached to the ground source. In another case (Verizon location number 75), the Verizon technician connected the ONT ground wire to the braided MGN conductor, but the braided MGN conductor was connected to a cold water pipe that was clearly too far (more than 30 feet) from the service entrance, in violation of the NEC rule requirement that such connections be no more than five feet from the service entrance. In the last case (Verizon location number 31), the ONT ground wire was clamped to a 6-gauge wire that was connected to a cold water pipe more than five feet from the service entrance, but it is unclear whether connection of the 6-gauge wire to the cold water pipe occurred at the time of the Verizon FiOS installation or was an existing connection; in either case, the violation of the grounding rules should have been clear to the installer.

4. Excessive Conductor Lengths (21 locations: Verizon location numbers 4, 21, 22, 24, 36, 38, 39, 47, 61, 71, 74, 76, 87, 90, 93, 112, 121, 129, 133, 137, and 146).

The NEC grounding rules require the primary protector grounding conductor to be less than 20 feet and require connections to cold water pipes to be no more than five feet from the point of entrance of the water pipe into the premises. Liberty's inspectors measured the connection lengths to determine whether these conditions were met. The locations Verizon identified were of three types:

- (1) Locations that have ONT grounding conductors with lengths greater than 20 feet connected to TII-442 devices (3 locations).²³ Verizon claims the 20-foot rule does not apply to grounding such devices because they are used in Inside Installations.
- (2) Locations that have ONT grounding conductors wire with lengths between 20 and 24 feet (13 locations).²⁴ Verizon claims that the excess length is minimal and should be considered immaterial.
- (3) Locations where a cold water pipe connection was greater than five feet from the service entrance (5 locations).²⁵ Verizon claims that this is an unnecessary requirement as long as there are no non-conductive interruptions visible in the cold water pipe.

²³ Verizon location numbers 4, 36, and 47.

²⁴ Verizon location numbers 21, 22, 24, 38, 39, 61, 71, 74, 90, 93, 112, 137, and 146.

²⁵ Verizon location numbers 76, 87, 121, 129, and 133.

The *NEC 2008 Handbook* in Article 800.100 states, “The primary protector grounding conductor shall be as short as practicable. In one- and two-family dwellings, the primary protector grounding conductor shall be as short as practicable, not to exceed 6.0M (20 feet) in length.” The *NEC 2008 Handbook* also notes that this article “provides guidance for the treatment of the cable and primary protector grounding conductor length at apartment and commercial buildings that is consistent with the 20 foot rule for one-and two-family dwellings. However, a specific length is not specified in the Code because such a limitation may not be practical in some installations.” Liberty therefore concludes that some flexibility should be used in applying the 20-foot rule to apartment and commercial buildings.²⁶ The three locations noted above with greater than 20-foot connections to TII-422 devices were all in apartment buildings; Liberty has changed the status of these locations (Verizon location numbers 4, 36, and 47) to compliant. The other 13 locations subject to the 20-foot rule were all either Outside Installations²⁷ or were Inside Installations in single-family residences;²⁸ Liberty therefore declined to change its determination of non-compliance for these locations.²⁹ There is also no basis for Verizon’s assertion that the deviations are immaterial. The *NEC 2008 Handbook* in Article 250.4(A)(1) FTN states, “An important consideration for limiting the imposed voltage is the routing of bonding and grounding conductors so that they are not any longer than necessary to complete the connection without disturbing the permanent parts of the installation and so that unnecessary bends and loops are avoided.” The NEC rules were adopted to assure that this is the case.³⁰

²⁶ This exception is also noted in Staff’s letter to Mr. Thomas McCarroll, Verizon’s Executive Director of Public Affairs, Policy and Communications, dated August 5, 2008. It is also consistent with Verizon’s methods and procedures documentation. Verizon’s *FiOS Single Family Unit ONT Grounding Practices Issue F* states on page 6, “A grounding wire cannot exceed twenty (20’) feet, regardless of gauge, between the ONT and the primary grounding electrode. The only scenario where the grounding wire is permitted to be greater than twenty (20’) feet is in the MDU environment when utilizing the TII 442.” In Verizon’s Draft Report Comments (page 12), the company quotes this exception as justification for flexibility in the 20-foot rule for all locations. As noted, the exception applies only to apartment and commercial dwellings, not to one- and two-family dwellings, as is the case for all the other locations for which Verizon has raised an objection to the use of the 20-foot rule.

²⁷ Verizon location numbers 21, 22, 61, 71, 74, 93, 112, and 137.

²⁸ Verizon location numbers 24, 38, 39, 90, and 146.

²⁹ In Verizon’s July 1, 2010 memorandum (pages 9 and 10), the company also reiterates an argument that the NEC requirements only apply to Outside Installations. The Commission in its January 14, 2009 Order acknowledged the validity of some of Verizon’s arguments regarding the applicability of the NEC standards. Nevertheless, that order concluded that the NEC requirements should be relied on for all ONT grounding with the exception of allowing TII-442 devices for Inside Installations when the use of the “conventional direct ground” (*i.e.*, NEC-approved grounding methods) is impractical or unsafe. The order certainly does not dispense with the NEC requirements entirely for Inside Installations, and certainly does not authorize ignoring the specific ground conductor length rules Verizon is contesting in these cases. Furthermore, there is no basis for concluding that the grounding at these locations is compliant with the Commission’s rules simply because violating the rules is unlikely to affect the grounding or because of an arbitrary determination of the immateriality of the violation.

³⁰ Furthermore, even using the NRP’s definition of materiality that the non-compliance “has no significant impact on the overall safety and reliability of a FiOS installation” (NRP paragraph 1, footnote 1), excessive length is a concern because, as the *NEC 2008 Handbook* in Article 800.100 states, “For one- and two-family dwellings, 800.100(A)(4) restricts the length of the primary protector grounding conductor to 20 ft. This restricted conductor length reduces the impedance of the grounding conductor, resulting in lower potential difference between the communications system conductors and equipment and the electrical conductors and equipment in the building. The low impedance bonding connection will reduce the fire hazard and shock hazard to persons in the event that electric utility power lines come in contact with communications conductors.”

Regarding the use of the cold water pipe as a ground source, Article 250.52 of the *NEC 2008 Handbook* states, “Interior metal water piping located more than 1.52 m (5 feet) from the point of the service entrance to the building shall not be used as part of the grounding electrode system or as a conductor to interconnect electrodes that are part of the grounding electrode system.” The NEC makes clear that the only exception to the cold water pipe grounding rule is for commercial buildings where the conditions for maintenance and supervision ensure that only metal interior water piping will be installed, which ensures continuity of the ground at points more than five feet from the service entrance. Accordingly, Liberty declined to change its determination of non-compliance for these locations.

5. *Connections to Basic Armored (BX) Shields of MGN Conductors (4 locations: Verizon location numbers 29, 30, 35, and 80).*

Verizon objected that the installations at these locations were connected to the MGN conductor supplied by a BX cable, which is a permissible grounding source.³¹ After reviewing the inspector notes and photographs of these installations, Liberty concluded that Verizon’s argument is valid. Therefore, Liberty determined that these four locations (Verizon location numbers 29, 30, 35, and 80) are compliant.³²

6. *“Just Inside” ONTs Grounded Through a Three-Prong Plug (14 locations: Verizon location numbers 14, 15, 25, 27, 28, 32, 37, 41, 72, 73, 78, 96, 115, and 132).*

These locations consisted of Inside Installations that are also Past Installations.³³ Verizon claims that the Commission’s January 14, 2009 Order on grounding methods, which approved the use of TII-442 devices for Inside Installations where a practical or safe alternative is not available, does not apply to such Past Installations. Verizon claims that such Past Inside Installations are compliant if they are grounded using a three-prong plug. Verizon also provided Liberty a copy of an April 3, 2009 letter to Staff in which the company made this argument.³⁴ Liberty finds no basis in the Commission’s January 14, 2009 Order to support this contention.³⁵ Because there is

³¹ During the interview on December 29, 2009, Verizon indicated that its methods and procedures do not include this grounding method and therefore the company did not believe it was used by Verizon’s installers. Nevertheless, it is compliant with the Commission’s grounding and bonding rules.

³² Liberty notes that in one of these locations (Verizon location number 29) the BX MGN conductor was connected to a cold water pipe at a distance greater than five feet from the service entrance. However, consistent with the determination in Section III.B.3 that such inadequacies are not the responsibility of the Verizon installer, Liberty agrees that this location should also be considered compliant.

³³ Verizon’s July 1, 2010 memorandum (page 8) indicated that the installations at these locations were before September 1, 2008. The cutoff date for Past Installations in the NRP approved by the Commission is actually August 1, 2008. However, none of these 14 locations had installation dates after August 1, 2008. Therefore, the one-month discrepancy in the dates is immaterial.

³⁴ This letter is also Exhibit A to Verizon’s Draft Report Comments.

³⁵ As noted in Verizon’s Draft Report Comments (pages 13-15 and Exhibit A), the company appears to base its argument on whether the locations were compliant with Verizon’s methods and procedures at the time the installations were made and that the Commission implicitly approved the use of different criteria for Past Installations by approving the NRP, which defines such methods and procedures as changing “from time to time.” As noted, Liberty’s compliance criteria are not based on Verizon’s methods and procedures but instead on the Commission’s grounding criteria, derived from discussions with Staff and Verizon and a reading of the

no ground wire leaving the ONT that directly connects it to any of the approved grounding sources at any of these locations, Liberty considers the ONT installations at all these locations to be non-compliant with the Commission's grounding rules and also to lack a direct external ground.³⁶

7. *Ground Blocks Not Connected to ONTs (2 locations: Verizon location numbers 1 and 10).*

These two locations are Outside Installations with grounding blocks but no ground wire connecting the ONT to the ground blocks. In effect, Verizon contends that the appropriate devices are grounded at these locations through the coaxial cable connection to the grounding block. Even if this were true, Liberty understands, based in part on the initial meetings and interviews Liberty held with Staff and Verizon, that the Commission intended Verizon, in addition to the connection of the coaxial cable to the grounding block, to make a direct connection between the ONT and the grounding block so that there would be a direct external ground for the ONT.³⁷ In fact, in the numerous other cases like this that Liberty inspected, Verizon installers provided the ground connection from the ONT to the grounding block, which strongly suggests that Verizon recognizes that this is the grounding requirement.³⁸

Despite Verizon's arguments, Liberty considers these to be cases without a direct external ONT ground. Even if the coaxial cable is grounded, there may be other devices connected to the ONT that are not. Liberty understands the grounding rules to require an external grounding connection for the ONT in any case. Therefore, Liberty declined to change its determination of non-compliance for these locations and considers them to be without an external ground.

Commission's orders and the documented communications between Staff and Verizon. Liberty cannot find any clear indication from Staff and the Commission's orders that those criteria should be applied differently depending on the time the installation was performed. Liberty shared its compliance criteria with Staff and Verizon in the Audit Work Plan prior to the start of the inspections. This plan did not call for the application of different compliance criteria depending on the date of the installation. Verizon did not raise with Liberty the issue of the need for different criteria to be applied depending on the timing of the installation after reading the Audit Work Plan or at any other time until after the inspections were complete.

³⁶ Liberty also notes that Verizon's *FiOS Single Family Unit ONT Grounding Practices Issue F* states on page 5 that its technicians must "[p]roperly ground **every** ONT in accordance with the guidelines contained within this document." [Emphasis in the original.] Verizon's "guidelines" referred to in this quotation require direct external grounding of the ONT. Although as noted in Verizon's Draft Report Comments (page 15 and Exhibit B), this version of the Verizon's methods and procedures went into effect after August 1, 2008, the cutoff date for Past Installations, it is interesting that of the 144 locations in Liberty's final inspection sample that are Inside Past Installations, 94 had failed Verizon's inspection and required remediation. In 93 of these 94 remediated locations, Verizon has used other grounding methods instead of a three-prong plug, including 21 that use a TII-442 device. This is a surprisingly large fraction if Verizon is correct that a three-prong plug is sufficient to meet the grounding requirements.

³⁷ Liberty does not recall Verizon raising the issue of the lack of need for directly grounding the ONT until Verizon's July 1 and 7 memoranda, after Liberty's inspections were complete and Verizon had reviewed the results. Liberty clearly indicated that direct grounding of the ONT would be a criterion of compliance in the Audit Work Plan that both Staff and Verizon reviewed before the inspections began. Verizon did not object to this criterion at that time.

³⁸ As noted in the previous footnote, Verizon's methods and procedures specifically require direct external grounding of every ONT.

8. *Simultaneous Appearance of Red and Green Lights on a TII-442 Device (2 locations: Verizon location numbers 48 and 136).*

Verizon contends that in such cases a ground exists and therefore these installations should not be considered materially non-compliant. In reply, Liberty notes that the manufacturer's instructions for the TII-442 devices clearly indicate that the simultaneous appearance of red (no ground) and green (good ground) lights indicates a problem with the electrical connections at that outlet. This probably indicates, as Verizon states, that the load and neutral sides of the outlet are reversed and that there is a ground nevertheless. However, the TII-442 device is designed to be used only when a green light appears and not when both are lit. Therefore, Liberty concludes that these locations are non-compliant, although they are probably grounded

The need to avoid using TII-442 devices when both the red and green lights are present is also recognized and clearly stated in Verizon's own methods and procedures. Issue F of Verizon's *FiOS Single Family Unit (SFU) ONT Grounding Practices* states that when testing an outlet for use with a TII-442, the technician should, "[v]erify that the Green lamp is lit solid. **If the Green lamp is not lit or both the Green and Red lamps are lit, DO NOT continue with this test. Locate either a suitable outlet that is properly wired/grounded or use method 1 for ground verification.**" [Bold and underlined text in the original.] Additionally, Verizon's *TII-442 Grounding Module* method and procedure document states, "**If the red lamp or both lamps are lit, a technician is not to use the TII 442 module as a single grounding source for the ONT. If no visible single grounding option exists, a technician is not to install the FiOS service and refer the issue to their immediate supervisor.**" [Bold and underlined text in the original.]

9. *Findings Related to Loose Connections (13 locations: Verizon location numbers 7, 20, 53, 63, 69, 89, 95, 111, 125, 126, 127, 131, and 135).*

These are all cases where Liberty found the grounding to be non-compliant because the connections of the grounding wires to the grounding points were loose. Verizon presented the results of continuity tests indicating the presence of a ground for six of these locations³⁹ and therefore claims that the non-compliance is "immaterial" for these. For the remaining seven locations,⁴⁰ the Verizon escorts found the ground wires to be disconnected because, Verizon claims, the Liberty inspectors pulled out the ground connection in the course of the inspection and that "it is clear there was an actual ground" before this happened.

As already mentioned, Liberty's inspectors did not perform any continuity testing. To test for loose connections, the inspectors tugged the ground wire slightly. When the connections were very loose, this sometimes caused the wire to become entirely dislodged from the connection point. Liberty's inspectors were instructed to make certain that such physical examination of the wires was gentle, and Liberty's inspection team leader performed observations of the inspectors to help ensure that this was happening. There is no basis for Verizon's implication that anything but a gentle tugging of the wires occurred.

³⁹ Verizon location numbers 7, 63, 95, 126, 131, and 135,

⁴⁰ Verizon location numbers 20, 53, 69, 89, 111, 125, and 127.

Liberty agrees with Verizon that ONTs with loose ground connections should not be considered definitely ungrounded. At best, the ground has to be considered uncertain in such cases, based solely on a physical rather than electrical test.⁴¹ Nevertheless, even if there might be sufficient contact to produce a ground, the connections must be tight in order to be compliant with the grounding rules regardless of whether Verizon considers such non-compliance to be “material.” The *NEC 2008 Handbook* Article 250.68(B) states, “The connection of a grounding electrode conductor or bonding jumper to a grounding electrode shall be made in a manner that will ensure an effective grounding path.” Therefore, Liberty concludes that these locations are non-compliant.

Verizon’s methods and procedures documentation also specifically stresses the need for tight connections. Verizon’s *FiOS Single Family Unit ONT Grounding Practices Issue F* states on page 20, “When making grounding connections Technicians must ensure that the connections are tightened properly.” Appendix B of the same document provides a matrix of the torque that should be used for each of various types of ground connections that can be made to ensure tightness of the connection.

10. Miscellaneous Findings (9 locations: Verizon location numbers 33, 45, 56, 57, 58, 92, 104, 139, and 144).

Verizon objected to the Liberty’s non-compliance determination for five locations⁴² in the July 1 memorandum with miscellaneous conditions not addressed in the other nine categories mentioned above. Based on a photograph that Liberty subsequently provided, Verizon concurred in its July 7 memorandum that one⁴³ of these five locations is non-compliant. Verizon moved another⁴⁴ of the locations into the “Interference by Third Parties” category in the July 7 memorandum; this case is addressed above in the discussion of that category. In addition, Liberty pointed out that Verizon had objected to the non-compliance of six other locations⁴⁵ but did not provide a rationale for the objections in the July 1 memorandum; the company provided the rationale for these locations in its July 7 memorandum.

Of the three remaining miscellaneous locations from the Verizon July 1 memorandum,

- (1) At Verizon location number 33, the ONT ground wire was connected to a metallic electrical conduit that used compression fittings rather than a threaded metallic conduit. Verizon contends that this is allowed by the NEC code. After review of the code,⁴⁶ Liberty agrees and has changed the status of this location to compliant.
- (2) At Verizon location number 92, Liberty had considered the ground connection non-compliant because the connection was made using a ground clamp that was not known to be listed by Underwriters’ Laboratories’ (*UL*). Verizon provided

⁴¹ As noted in Section III.B.2, Liberty’s examination is meant to be an independent review. Therefore, the compliance determination cannot be based on any Verizon test results.

⁴² Verizon location numbers 33, 67, 92, 94, and 144.

⁴³ Verizon location number 94.

⁴⁴ Verizon location number 67.

⁴⁵ Verizon location numbers 45, 56, 57, 57, 104, and 139.

⁴⁶ *NEC 2008 Handbook* Article 344 “Rigid Metal Conduit: Type RMC,” Article 344.43 “Couplings and Connectors,” and Article 344.60 “Grounding.”

evidence that the clamp is, in fact, UL-listed. Therefore, Liberty agrees with Verizon that the location is compliant.

- (3) At Verizon location number 144, Liberty found the ONT ground to be non-compliant because of a bend in the grounding wire that is greater than 90 degrees.⁴⁷ Liberty provided photographic evidence of this to Verizon showing that the bend appears to be about 135 degrees, but the company continues to disagree with Liberty's finding.⁴⁸

Of the six additional miscellaneous locations discussed in the Verizon July 7 memorandum,

- (1) Verizon locations 56, 57, and 58 contained rack-mounted ONTs with the rack grounded by a ground wire connection to an outlet faceplate screw. There is no basis in the grounding rules for such a grounding connection.⁴⁹ Verizon contends in its July 7 memorandum that the locations should not be treated as "materially non-compliant." In any case, Verizon appears to agree that they are non-compliant.
- (2) At Verizon location number 45, the ONT is grounded using a sheet metal screw to a "Leviton S-One cabinet," which Verizon claims is a compliant connection. Liberty finds no basis for this claim based on examination of the NEC rules, which are the primary basis of the Commission's grounding and bonding requirements.⁵⁰
- (3) At Verizon location number 139, the ONT ground wire is attached to a lug bolt on the side of an auxiliary electrical service panel, a connection which Verizon

⁴⁷ The *NEC 2008 Handbook* Article 800.100(A)(5) states, "The grounding conductor shall be run to the grounding electrode in as straight a line as practicable." As a way to quantify "straight as possible," Liberty used the criterion that the bend be no larger than 90 degrees. This is consistent with Verizon's methods and procedures documentation. The "Grounding Basics" section Verizon's *FiOS Single Family Unit ONT Grounding Practices Issue F*, which states on page 3, "Technicians must run a grounding wire as straight as possible avoiding any sharp bends (any bends made must be sweeping)." The "Ground Protection Laminated Job Aid" used by the Verizon technicians states, "Technicians must run a ground wire as **straight as possible** avoiding any bend greater than 90 degrees (*bends must be sweeping*)." [Emphasis in the original.]

⁴⁸ Liberty also examined Verizon's photograph of the same location and did not find anything in that photograph to change the designation of non-compliance. In any case, the non-compliance determination was based primarily on the inspector's physical observation and notation of his conclusions. The photographs are merely corroborating evidence of this determination.

⁴⁹ The *NEC 2008 Handbook* Article 800.100(B) "Electrodes" does not include an electrical outlet faceplate in the list of acceptable grounding electrodes for the connection of the ground wire. Additionally, Verizon's methods and procedures do not include electrical outlet faceplates as an acceptable grounding point.

⁵⁰ The *NEC 2008 Handbook* Article 800.100(B) "Electrodes" does not include these cabinets in the list of acceptable grounding electrodes for the connection of the ground wire. Article 250.8 recognizes the use of machine screws and thread-forming machine screws as methods to connect grounding and bonding conductors under certain special conditions. However, this article states, "Limited recognition to these types of screws as acceptable methods of connection also says that no other type of screw, such as sheet metal screw or wood screw, is permitted as a connection method." Verizon's methods and procedures also do not include these cabinets as an acceptable grounding point nor do they allow for the use of a sheet metal screw to attach the ground wire to the grounding source.

claims should not be treated as “materially non-compliant.” It is nevertheless non-compliant.⁵¹

- (4) At Verizon location number 104, Liberty found the ground connection to be loose. Verizon therefore contends that any non-compliance should be considered as “immaterial.” As discussed already above in Section III.B.9, such connections should be considered non-compliant.

The net result of these additional considerations after Verizon’s input is that Liberty determined that three locations (Verizon location numbers 52, 97, and 99) should be dropped from the sample and 14 other locations (Verizon location numbers 4, 29, 30, 31, 33, 35, 36, 47, 75, 80, 92, 103, 105, and 107) should be changed from non-compliant to compliant.

In Verizon’s July 1 memorandum, the company also objected to Liberty’s designation of which non-compliant locations are ungrounded. As noted above, Liberty provided Verizon numbers in this category which included both those with no external ground at all and those for which the ground is uncertain because of such conditions as painted surfaces and loose connections. Liberty agrees that these two types of conditions (no external ground and uncertain ground) should be distinguished and does so in the analysis described below.

C. Liberty’s Final Inspection Findings

After the initial review of the data and the discussions with Verizon about the company’s objections, Liberty made a final determination of the findings from the inspections. The following table shows the overall compliance results after this final determination.

⁵¹ The *NEC 2008 Handbook* Article 250.70 states, “The grounding or bonding conductor shall be connected to the grounding electrode by exothermic welding, listed lugs, listed pressure connectors, listed clamps, or other listed means.” Verizon’s methods and procedures also do not list lug bolts as an acceptable apparatus for attaching a grounding wire to the ground source.

Table III
Final Inspection Results

Relevant Area	Total Location Sample Size	Invalid Locations	Locations Not Inspected or Dropped from Sample	Completed Inspections	Fully Compliant Locations
Bronx	112	3	20	89	85
Brooklyn	112	1	22	89	81
Capital North	112	2	33	77	73
Capital South	112	4	33	75	65
Central	137	3	55	79	69
Manhattan	462	19	334	109	96
North Nassau	112	4	23	85	81
South Nassau	112	3	15	94	90
Queens	132	0	59	73	63
Staten Island	112	1	20	91	75
North Suffolk	112	3	5	104	94
South Suffolk	112	1	11	100	94
Rockland	112	2	15	95	91
North Westchester	112	2	27	83	76
South Westchester	112	0	35	77	65
Western	142	0	64	78	70
Total	2,217	48	771	1,398	1,268

In this table the locations listed as “Not Inspected or Dropped from the Sample” include both the locations Liberty did not inspect for the reasons noted in Section III.A and the three locations that Liberty dropped from the sample after examining evidence from Verizon that the grounding connections had been tampered with. In addition, this table reflects the change of 14 other locations from non-compliant to compliant based on evidence provided by Verizon.

Non-Compliant Locations

It is convenient to place the non-compliant locations in three different categories: i) ungrounded ii) uncertain ground, and iii) technically non-compliant.

Locations for which there is no apparent external direct grounding connection from the ONT to one of the approved grounding sources specified in Appendix A comprise the “ungrounded” category. This occurs because one of the following conditions:

- There is no ground wire exiting the ONT⁵²
- The ground wire was not connected to anything

⁵² In Verizon’s Draft Report Comments (pages 22 and 23), the company objects to Liberty’s inclusion of locations in the “no ground” category for which Verizon claims the installations are grounded through the ONT’s three-prong plug and those locations without a connection between the grounding block and the ONT. Verizon asserts that “three-prong plug” locations do not fall within any of the three conditions noted here. In fact, for such installations there is no separate ground wire exiting the ONT connecting it directly to one of the approved grounding sources, which Liberty understands to be a necessary condition of the Commission’s grounding requirements. This is also true of installations without a connection between the grounding block and the ONT.

- Only the red light was illuminated on the TII-442 device (Liberty found only one example of this).

Locations with ONTs having the following types of connections comprise the “uncertain ground” category:

- The ground connection was loose or open because:
 - A clamp was loose
 - The ground wire was loose
- The wire was connected to an unapproved device whose grounding is uncertain without a complete trace of the connectivity to an approved grounding source.⁵³ These include:
 - BX distribution cables
 - Water spigots
 - Cold water feeds to a hot water heater
 - Painted surfaces⁵⁴
 - AC conduits for internal or external house wiring (*e.g.*, conduits for outdoor lighting or conduits to junction boxes)
 - Telephone company network interface devices (NIDs)⁵⁵
 - Cable company NIDs
 - “T” beam supports for a building’s wooden main support beams
 - Faceplates of electrical outlets
 - Faceplates of AC junction boxes.

Such connections may be grounded, and in some cases, Verizon has provided evidence of connectivity tests demonstrating that a ground existed at the time Verizon performed that test; however, there is no way to determine that a ground necessarily exists based solely on the visual and physical inspections Liberty performed.

⁵³ The tracing of such unapproved ground points to a possible grounding source was outside the scope of the inspections and would be extremely difficult to perform in most cases. In Verizon’s July 1 memorandum (page 14) and in Verizon’s Draft Report Comments (pages 20, 21, 23, and 24), the company contended that a number of such types of connections should be considered to be merely technically compliant because they are grounded, but Liberty disagrees that a ground in such cases can be asserted without a full trace of the connectivity.

⁵⁴ This also includes the six instances at which Verizon provided continuity testing results. As noted, Liberty was requested to perform an independent audit and not to rely on tests by other parties. Because Liberty cannot independently confirm Verizon’s test results and because of poor quality of connection to painted surfaces and the uncertainty of any ground connectivity for such surfaces over time, Liberty has classified all instances of attachments to painted surfaces as having uncertain ground.

⁵⁵ It should be noted that in Verizon’s Draft Report Comments (pages 20 and 21), the company incorrectly objected to the classification of Verizon Location number 18 as having uncertain ground based on its belief that the ground wire was connected to the telephone company NID. In fact, this is not the case. There is no grounding connection at this location and Liberty has appropriately classified it as having no ground.

Locations with ONTs that appear currently to have some form of ground but for which the grounding connection is not compliant with the Commission’s grounding requirements comprise the “technically non-compliant” category. Included in this category are cases in which:

- The ground wire was longer than allowed by the NEC code (*i.e.*, greater than 20 feet)
- The ground wire had a bend greater than 90 degrees
- The ground wire was connected to a water pipe more than five feet from the service entrance
- A TII-442 device was used when a direct ground option was available
- A TII-442 device showed both a red and green light
- Non-bonded ground rods were used
- An improper ground clamp was used
- There were two ground connections on the same ground clamp.

The next table shows the number of non-compliant locations that fall into these three categories.

**Table IV
Non-Compliant Locations**

Relevant Area	Completed Inspections	Total Non-Compliant Locations	Ungrounded	Uncertain Ground	Technically Non-Compliant
Bronx	89	4	1	0	3
Brooklyn	89	8	1	5	2
Capital North	77	4	2	0	2
Capital South	75	10	4	2	4
Central	79	10	5	1	4
Manhattan	109	13	6	2	5
North Nassau	85	4	0	3	1
South Nassau	94	4	0	0	4
Queens	73	10	0	5	5
Staten Island	91	16	1	6	9
North Suffolk	104	10	1	7	2
South Suffolk	100	6	0	6	0
Rockland	95	4	1	1	2
North Westchester	83	7	2	1	4
South Westchester	77	12	1	8	3
Western	78	8	1	1	6
Total	1,398	130	26	48	56
Statewide Weighted Average Percentage⁵⁶		9.8%	1.3%	4.1%	4.5%

As noted, these determinations are based only on the Liberty inspectors’ visual and physical inspections; Liberty’s inspectors made no attempt to measure the electrical connectivity. In

⁵⁶ Weighted using the fractions of all FiOS locations in each Relevant Area shown Table I.

Verizon's July 1 and July 7 memoranda and reiterated in Verizon's Draft Report Comments, the company indicated that some but not all of the locations Liberty has classified in both the "uncertain ground" and "technically non-compliant" categories should be considered cases where the non-compliance is "immaterial." Liberty sees no basis for determining that the non-compliance is "immaterial" for these cases. The determination of non-compliance was based on Liberty's understanding of the Commission's grounding and bonding requirements, and Liberty is aware of nothing in the Commission's determination of grounding requirements that suggests that connectivity measurements should determine whether the grounding is compliant or that conditions close to but not exactly conforming to the rules should be considered "immaterial." It is certainly possible to achieve some form of a ground even if the NEC rules are not followed; however, Liberty understands that whether or not these rules are followed is the primary determination of compliance for the Commission.⁵⁷ Verizon also considers 16 of the 26 "ungrounded" locations to be compliant. These locations include: i) the 14 Inside Past Installations discussed in Section III.B for which Verizon claims the Commission's grounding rules related to the use of the TII-442 devices do not apply, and ii) the two ground blocks not connected to ONTs discussed in the same section.. As noted in that section, Liberty knows of no basis for that conclusion.

Poor Grounding Practices for Compliant Locations

Although Verizon claims that a number of the Liberty's non-compliance determinations are immaterial, Liberty's inspectors also noted a number of instances for which the connections might be considered "immaterially compliant." Despite being technically compliant with the Commission's rules, these locations demonstrated poor grounding practices. For a number of these locations, Liberty's inspectors found evidence that the way the installations were performed makes them particularly subject to future failures. These include cases where:

- A TII-442 device was not secured as specified in Verizon's methods and procedures by screwing the unit's dog-ear connector to the electrical outlet⁵⁸

⁵⁷ As noted in Verizon's Draft Report Comments (pages 4-6), the NRP refers at various points to "material" non-compliance with the "Grounding M&Ps" as a criterion for the inspections of the New Installations by the ONQAT (e.g., NRP paragraph 7) and that remediation of Past Installations would be for those installations determined after inspection to have "material non-conformities" (NRP, paragraph 15). However, Liberty's review, as noted above, is based on the Commission's grounding and bonding rules rather than Verizon's methods and procedures. Liberty also attempted to use criteria that were as objective as possible and to avoid subjective determinations of the "materiality" of non-compliance. Nevertheless, it is worth noting that the NRP's definition of a material deviation is one "that is purely technical in nature and that **has no significant impact on the overall safety and reliability of a FiOS installation.**" (NRP paragraph 1, footnote 1, emphasis added) In fact the NEC rules that are the basis for the Commission's requirements and the criteria for Liberty's compliance determinations were specifically written to address safety concerns. As the *NEC 2008 Handbook* Article 250.4(A)(1) states, "Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line-surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operation." The Commission also noted in its November 3, 2008 Order, on page 18, "We expect Verizon to apply the [material deviation] standard liberally, especially in light of the fact that these are safety requirements, requiring that the company err on the side of protecting consumers."

⁵⁸ In the Audit Work Plan, Liberty indicated the intention to find such locations to be non-compliant with the grounding rules. Liberty reconsidered that intention during the course of the audit. Nevertheless, not securing the

- The ground wire was connected to a dissimilar metal (e.g., a copper wire to an aluminum or aluminum-clad MGN) and no anti-oxidant compound was used to prevent corrosion
- A ground wire was strung with too much slack across an active outdoor hose bib, making it vulnerable to breaking.

The following table shows the number of these locations, which Liberty estimates represent approximately 3.6 percent of all locations across New York State.

Table V
Compliant Locations Subject to Potential Future Failure

Relevant Area	Completed Inspections	Fully Compliant Locations	Compliant Locations Subject to Potential Future Failure	Percent of Locations Subject to Future Failures
Bronx	89	85	1	1.1%
Brooklyn	89	81	4	4.5%
Capital North	77	73	3	3.9%
Capital South	75	65	0	0.0%
Central	79	69	4	5.1%
Manhattan	109	96	45	41.3%
North Nassau	85	81	1	1.2%
South Nassau	94	90	2	2.1%
Queens	73	63	3	4.1%
Staten Island	91	75	0	0.0%
North Suffolk	104	94	0	0.0%
South Suffolk	100	94	0	0.0%
Rockland	95	91	0	0.0%
North Westchester	83	76	5	6.0%
South Westchester	77	65	2	2.6%
Western	78	70	1	1.3%
Total	1,398	1,268	71	
Statewide Weighted Average⁵⁹				3.6%

The most common of these situations (65 of 71) was the presence of an unsecured TII-442 device. This condition occurred for 92 percent of the locations subject to potential failure. When the TII-442 is unsecured, it can become loose or it is easy for a customer to unplug the unit without realizing that this has removed the grounding. Liberty found 36 percent of all inspected locations with a TII-442 device did not have the device secured. This percentage varied across Relevant Area as the following table shows.⁶⁰ However, the number of TII-442 devices in the sample for most Relevant Areas is very small; therefore, the differences may not be significant in all cases.

TII-442 device is certainly a very poor installation practice and is not approved in Verizon's methods and procedures.

⁵⁹ Weighted using the fractions of all FiOS locations in each Relevant Area shown Table I.

⁶⁰ This table includes two locations with unsecured TII-442 devices where the grounding failed to comply with the Commission's grounding requirements for other reasons.

Table VI
Condition of TII-442 Installations

Relevant Area	Total TII-442	Total Unsecured	Percent Unsecured
Bronx	15	1	7%
Brooklyn	6	4	67%
Capital North	11	3	27%
Capital South	2	0	0%
Central	14	1	7%
Manhattan	82	46	56%
North Nassau	1	1	100%
South Nassau	3	1	33%
Queens	10	4	40%
Staten Island	6	0	0%
North Suffolk	3	0	0%
South Suffolk	2	0	0%
Rockland	7	0	0%
North Westchester	4	4	100%
South Westchester	9	2	22%
Western	10	0	0%
Total	185	67	
Statewide Weighted Average⁶¹			30%

Table V shows that the largest fraction of locations subject to future failures is in Manhattan. The numbers for that Relevant Area are large enough to be statistically significant. The preponderance of failures in Manhattan is not surprising, given the prevalence of the TII-442 installations in Manhattan and the frequency with which Liberty found these to be unsecured, as shown in Table VI.

In addition to the observations of installations with significant potential for future failure, Liberty’s inspectors observed several other installation practices that are potentially problematic. Liberty did not attempt to quantify the number of installations with such practices; however, the types of problematic installation practices observed were:

- Bonding a Verizon installed ground to the power company’s multi-ground neutral by running the 6-gauge bonding wire over the roof of the building
- Attaching the ground clamp to extremely rusted surfaces (*e.g.*, strap clamps on a very rusted rigid metallic conduit)
- Running the ONT ground wire through the frame of a building without using an insulating sleeve
- Removing minimal insulation from a grounding electrode under an ONT ground clamp
- Allowing too much slack in the ONT ground wire, causing it to hang in front of a basement window.

⁶¹ Weighted using the fractions of all FiOS locations in each Relevant Area shown Table I.

Additional Unusual Grounding Conditions

Liberty encountered two additional unusual conditions among the sample locations:

- Rack-mounted ONTs
- Desktop ONTs.

The rack-mounted ONTs were found at the Manhattan apartment building mentioned above, where Verizon requested that Liberty not complete the inspections. According to Verizon, rack-mounted ONTs are installed by the Verizon construction department rather than the standard FiOS installation group. The three sample ONTs at this location were each in a separate rack on different floors of the building in telephone closets in the hallway. Although there was evidence of some grounding, Liberty found all three ONTs to be non-compliant with the Commission grounding requirements. In all three cases, a common copper bus that used the frame ground was used to ground the ONT. The frame ground wire for each of the three inspected ONT frames was attached by a screw to the metallic cover of the power receptacle. For these installations both the grounding point (the metallic power receptacle cover) and the ground connector (a screw) were not approved methods for grounding an ONT or an equipment frame. In all three cases, Liberty found that the rigid metallic power service conduit was readily available to ground the ONT frame wire using a strap or similar clamp but that this approved option was not used by the Verizon installer.

Liberty observed nine installations at which Verizon used newer desktop ONT models. These ONTs do not have an external ground wire and, according to Verizon, the units are UL-listed and grounded through the three-prong power cord.⁶² Verizon also indicated that when coaxial cable wiring is present, a ground block should be installed and then grounded either to an approved primary power ground or by using the TII-442 option. Liberty found this latter condition in six of the nine desktop ONT installations. It is not clear that the grounding of such desktop ONT models is addressed in the Commission's orders to date. Liberty had no reason to doubt Verizon's representation of the grounding requirements of the desktop ONT models, and thus determined them to be properly grounded.

Types of Observed Grounding Conditions

Liberty found that Verizon used a variety of grounding methods in its installations. The most common methods were i) grounding to the power company's grounding electrode conductor (grounding option #2 in Appendix A), ii) grounding to grounded rigid metallic power service conduit (option #3), and iii) grounding to the power company's meter box (option #4). The next most common option was using the TII-442 device, as described above. Liberty's inspectors found 60 cases in which the company used a cold water pipe as a grounding method (option #6). Although the Commission's rules allow for this method, it is somewhat surprising that Verizon used this method so frequently because the company's methods and procedures documents discourage its use. Liberty also found significant regional variation in the grounding methods,

⁶² Verizon May 10, 2010 response to a Liberty data request.

suggesting regional variations in Verizon’s procedures. For example, Liberty found little to no use of grounding option #2 in Brooklyn, Queens, Rockland, Staten Island, and South Westchester, although this method was commonly used in most of the other Relevant Areas.⁶³ In fact, it appears to be the dominant option used in the Central, Capitol North, and Western Relevant Areas. Similarly, there are a number of areas where option #3 and option #4 are rarely used, although they are dominant options used in other areas. The following table shows this variation.

Table VII
Most Common Grounding Methods Used

Relevant Area	Completed Inspections	Option #2 Power Co. Conductor	Option #3 Rigid Metallic Conduit	Option #4 Meter/Service Panel	Other Approved Grounding Option
Bronx	89	0	71	0	18
Brooklyn	89	0	70	10	9
Capital North	77	35	2	22	18
Capital South	75	23	3	42	7
Central	79	33	6	8	34
Manhattan	109	0	16	0	93
North Nassau	85	14	28	34	9
South Nassau	94	10	40	28	16
Queens	73	0	47	5	21
Staten Island	91	0	62	13	16
North Suffolk	104	31	15	46	12
South Suffolk	100	28	18	45	9
Rockland	95	6	6	63	20
North Westchester	83	19	1	45	18
South Westchester	77	3	20	32	22
Western	78	47	4	0	27

Compliance with Grounding Block Requirements

Liberty also analyzed the inspection results to determine compliance with the requirement in the Commission’s January 14, 2009 Order for the implementation of grounding blocks for the ONTs on a prospective basis. This order and Verizon’s compliance letter on January 29, 2009 require that Verizon implement the grounding block for future new installations and on existing installations if Verizon has any reason to make a premises visit for maintenance or remediation. Accordingly, Liberty examined whether the grounding block existed in locations where, after Verizon had completed implementation of processes to comply with the order, the company i) completed the installation or ii) had to make a premises visit to remediate an existing installation.⁶⁴ Verizon informed Liberty that the company began implementing procedures to comply with the order on March 1, 2009 and completed implementation by mid-April of that

⁶³ Liberty also found no evidence this method was used in Manhattan, but this is not surprising, given the dominance of the use of TII-442 devices in that Relevant Area.

⁶⁴ The database Verizon provided Liberty for choosing locations for the inspection sample contains the dates of the installation and the most recent remediation activity. However, it does not contain the dates of maintenance activity.

year.⁶⁵ To test for compliance, Liberty analyzed the locations in the inspection sample for which either the installation or last remediation date was after this time period. Liberty restricted the analysis to only those locations for which Liberty was definitely able to determine that a coaxial cable was present, given that the grounding block should not be required if no coaxial cable is present.⁶⁶ The results are shown in the table below.

Table VIII
Coaxial Cable Grounding Block at Locations with Installation or Remediation on or after
May 1, 2009

Relevant Area	Total Installations with Grounding Block	Total Installations with a Coaxial Cable Present	Percent Installations with Grounding Block
Bronx	24	24	100%
Brooklyn	37	40	92.5%
Capital North	26	27	96.3%
Capital South	16	17	94.1%
Central	36	38	94.7%
Manhattan	31	46	67.4%
North Nassau	25	26	96.2%
South Nassau	21	21	100.0%
Queens	32	34	94.1%
Staten Island	19	20	95.0%
North Suffolk	22	22	100.0%
South Suffolk	40	40	100.0%
Rockland	20	20	100.0%
North Westchester	24	26	92.3%
South Westchester	14	15	93.3%
Western	42	44	95.5%
Total	429	460	
Statewide Weighted Average⁶⁷			95.0%

Liberty estimates that Verizon’s overall compliance rate with the grounding block requirement is 95.0 percent across New York State. However, there is a notable deviation from the statewide rate in the Manhattan, where the compliance rate is approximately 67 percent. Excluding the results in Manhattan, the weighted statewide compliance rate is 96.3 percent.

D. Statistical Analysis

Using the final master results sheet, Liberty performed statistical analyses of the data. The primary objectives of the analysis were to:

⁶⁵ Verizon’s April 10, 2010 response to a Liberty data request.

⁶⁶ The percentage of locations without cable present vary somewhat across the state, presumably because of variations in service availability, but Liberty found that percentage to be around five percent on average.

⁶⁷ Weighting using the fractions of all FiOS locations in each Relevant Area shown Table I.

- Estimate the Verizon’s overall grounding compliance rate in New York State for those installations for which Verizon has been able to successfully complete the NRP process
- Determine whether differences exist in the compliance rates among the 16 Relevant Areas.

Full Compliance Estimates and Results

Based on the inspection results described in Section III.C above, Liberty estimated the percentage of fully compliant installations (according to the Commission’s grounding rules) for each Relevant Area and overall. Table IX shows these estimates by Relevant Area and overall, as well as the corresponding 95 percent confidence bounds for these estimates.

Table IX
Estimates of Locations Fully Compliant with the Commission’s Grounding Rules

Relevant Area	Percent of Fully Compliant Installations	Lower 95 Percent Confidence Bound	Upper 95 Percent Confidence Bound
Bronx	95.5%	88.9%	98.8%
Brooklyn	91.0%	83.1%	96.0%
Capital North	94.8%	87.3%	98.6%
Capital South	86.7%	76.9%	93.4%
Central	87.3%	78.0%	93.8%
Manhattan	88.1%	80.5%	93.5%
North Nassau	95.3%	88.4%	98.7%
South Nassau	95.7%	89.5%	98.8%
Queens	86.3%	76.3%	93.2%
Staten Island	82.4%	73.1%	89.6%
North Suffolk	90.4%	83.1%	95.3%
South Suffolk	94.0%	87.4%	97.8%
Rockland	95.8%	89.6%	98.8%
North Westchester	91.6%	83.4%	96.5%
South Westchester	84.4%	74.4%	91.7%
Western	89.7%	80.8%	95.5%
Statewide Weighted Average⁶⁸	90.2%	88.4%	91.9%

The confidence bounds for individual areas in Table IX were calculated using the binomial distribution. This approach is an exact method of calculating such bounds when the installations reviewed in each area are a random sample.⁶⁹ The “Statewide Weighted Average” is calculated using weights based on the fraction of statewide installations in each Relevant Area (shown in

⁶⁸ Liberty also calculated the simple average compliance rate (weighting each Relevant Area equally). The result was 90.6 percent. Given how close this is to the weighted average, Liberty decided to use the weighted rather than the simple average in stating New York State-wide results for this and the other quoted measurements, because these provide a more logical estimate of the statewide conditions.

⁶⁹ While the installations selected in each area were a random sample, the installations completed were not due to no-access conditions, and thus Liberty also considered the effect of the no-access conditions on the sample estimates.

Table I). The confidence bounds for this weighted average are calculated using the statistical variance by area (calculated assuming the binomial distribution) to compute a total statewide statistical variance, and then using a normal distribution to determine the bounds.

Estimates of the Results of Other Observations

Liberty also developed estimates and confidence bounds for other observations noted in Section III.C. These include: (i) the percentage of locations that appeared to be without any grounding (from Table IV), (ii) the percentage of locations for which the presence of a ground is uncertain (from Table IV), (iii) the percentage of compliant locations which are subject to potential future failures (from Table V), and (iv) the percentage compliant with implementation of the Commission’s order requiring installations of coaxial cable grounding blocks (from Table VIII). Liberty also developed estimates for the percentage of locations that either have no ground or for which the grounding condition is uncertain based on the visual and physical observations performed during the inspections, that is, the combination of the first two quantities (i and ii) listed above. Tables X through XIV below show the estimates and confidence bounds for these observed quantities. The estimates and confidence intervals in this table were calculated in the same manner as estimates and confidence intervals in Table IX.

Table X
Estimates of Ungrounded Locations

Relevant Area	Percent of Ungrounded Installations	Lower 95 Percent Confidence Bound	Upper 95 Percent Confidence Bound
Bronx	1.1%	0.1%	6.1%
Brooklyn	1.1%	0.1%	6.1%
Capital North	2.6%	0.4%	9.1%
Capital South	5.3%	1.5%	13.1%
Central	6.3%	2.1%	14.2%
Manhattan	5.5%	2.1%	11.6%
North Nassau	0.0%	0.0%	4.2%
South Nassau	0.0%	0.0%	3.8%
Queens	0.0%	0.0%	4.9%
Staten Island	1.1%	0.1%	6.0%
North Suffolk	1.0%	0.1%	5.2%
South Suffolk	0.0%	0.0%	3.6%
Rockland	1.1%	0.1%	5.7%
North Westchester	2.4%	0.3%	8.4%
South Westchester	1.3%	0.1%	7.0%
Western	1.3%	0.1%	6.9%
Statewide Weighted Average	1.3%	0.7%	1.9%

Table XI
Estimates of Uncertain Ground Locations

Relevant Area	Percent of Uncertain Ground Installations	Lower 95 Percent Confidence Bound	Upper 95 Percent Confidence Bound
Bronx	0.0%	0.0%	4.1%
Brooklyn	5.6%	1.9%	12.6%
Capital North	0.0%	0.0%	4.7%
Capital South	2.7%	0.4%	9.3%
Central	1.3%	0.1%	6.9%
Manhattan	1.8%	0.3%	6.5%
North Nassau	3.5%	0.8%	10.0%
South Nassau	0.0%	0.0%	3.8%
Queens	6.8%	2.3%	15.3%
Staten Island	6.6%	2.5%	13.8%
North Suffolk	6.7%	2.8%	13.4%
South Suffolk	6.0%	2.3%	12.6%
Rockland	1.1%	0.1%	5.7%
North Westchester	1.2%	0.1%	6.5%
South Westchester	10.4%	4.6%	19.4%
Western	1.3%	0.1%	6.9%
Statewide Weighted Average	4.1%	2.9%	5.2%

Table XII
Estimates of Ungrounded or Uncertain Ground Locations

Relevant Area	Percent of Ungrounded or Uncertain Ground Installations	Lower 95 Percent Confidence Bound	Upper 95 Percent Confidence Bound
Bronx	1.1%	0.1%	6.1%
Brooklyn	6.7%	2.6%	14.1%
Capital North	2.6%	0.4%	9.1%
Capital South	8.0%	3.0%	16.6%
Central	7.6%	2.9%	15.8%
Manhattan	7.3%	3.3%	14.0%
North Nassau	3.5%	0.8%	10.0%
South Nassau	0.0%	0.0%	3.8%
Queens	6.8%	2.3%	15.3%
Staten Island	7.7%	3.2%	15.2%
North Suffolk	7.7%	3.4%	14.6%
South Suffolk	6.0%	2.3%	12.6%
Rockland	2.1%	0.3%	7.4%
North Westchester	3.6%	0.8%	10.2%
South Westchester	11.7%	5.5%	21.0%
Western	2.6%	0.4%	9.0%
Statewide Weighted Average	5.4%	4.1%	6.7%

Table XIII
Estimates of Locations with Potential for Future Failure

Relevant Area	Percent of Ungrounded or Uncertain Ground Installations	Lower 95 Percent Confidence Bound	Upper 95 Percent Confidence Bound
Bronx	1.1%	0.1%	6.1%
Brooklyn	4.5%	1.3%	11.1%
Capital North	3.9%	0.9%	11.0%
Capital South	0.0%	0.0%	4.8%
Central	5.1%	1.4%	12.5%
Manhattan	41.3%	32.0%	51.1%
North Nassau	1.2%	0.1%	6.4%
South Nassau	2.1%	0.3%	7.5%
Queens	4.1%	0.9%	11.5%
Staten Island	0.0%	0.0%	4.0%
North Suffolk	0.0%	0.0%	3.5%
South Suffolk	0.0%	0.0%	3.6%
Rockland	0.0%	0.0%	3.8%
North Westchester	6.0%	2.0%	13.5%
South Westchester	2.6%	0.4%	9.1%
Western	1.3%	0.1%	6.9%
Statewide Weighted Average	3.6%	2.7%	4.4%

Table XIV
Coaxial Cable Grounding Block at Locations with Installation or Remediation on or after May 1, 2009

Relevant Area	Percent Installations with Grounding Block	Lower 95 Percent Confidence Bound	Upper 95 Percent Confidence Bound
Bronx	100%	85.8%	100.0%
Brooklyn	92.5%	79.7%	98.4%
Capital North	96.3%	81.1%	99.9%
Capital South	94.1%	71.4%	99.9%
Central	94.7%	82.3%	99.4%
Manhattan	67.4%	52.0%	80.5%
North Nassau	96.2%	80.4%	99.9%
South Nassau	100.0%	83.9%	100.0%
Queens	94.1%	80.4%	99.3%
Staten Island	95.0%	75.2%	99.9%
North Suffolk	100.0%	84.6%	100.0%
South Suffolk	100.0%	91.2%	100.0%
Rockland	100.0%	83.2%	100.0%
North Westchester	92.3%	74.9%	99.1%
South Westchester	93.3%	68.1%	99.8%
Western	95.5%	84.6%	99.4%
Statewide Weighted Average	95.0%	92.8%	97.2%

Statistical Analysis of Factors Affecting Compliance Rates

In order to better understand the factors leading to compliance and to possibly adjust the estimates for situations in which Liberty encountered a no-access situation, Liberty performed a statistical analysis of variance (ANOVA) on whether certain factors affected the compliance rates shown in Table IX. An ANOVA, which involves an assumption that the data follow a normal distribution, was not appropriate for the data in Tables X through XIII, where the rates were very low and even zero for some Relevant Areas. For the ANOVA used to analyze the data in Table IX, the following factors were used:

- Whether the installation was prior to or after August 1, 2008 (Past versus New Installation)
- Whether the installation was an Inside or Outside Installation
- Installation geographic location (considering both the Relevant Area and central office as variables)
- Inspections made on the first access attempt versus those made on the second attempt.

Because each central office falls within a single Relevant Area, the factor of where the installation took place was considered as part of two ANOVAs, one that included only Relevant Area and one that included central office within Relevant Area. The other three factors were included in each ANOVA. Thus, for example, Liberty determined whether the compliance rate was different when the installation was prior to August 1, 2008, after accounting for Relevant Area in one ANOVA and after accounting for central office in a second ANOVA.

Liberty indicated in the Audit Work Plan that it would also examine the differences between installations in single-family dwellings and multiple dwelling units; however, during its inspections, Liberty observed that there was generally no difference in the type of installations made in single-family and multiple dwelling units, aside from the very small number of cases in which rack-mounted ONTs were used in a multiple dwelling unit. Therefore, Liberty did not attempt to analyze this issue further.

The results of the ANOVA with respect to each factor can be expressed using a statistic called a p-value. The p-value is an indication, on a probability scale from 0 to 1, of the frequency of obtaining the observed results when the factor is irrelevant with respect to compliance rate, and after accounting for all the other factors. Thus, a low p-value can be thought of as indicating that the factor is not likely to be irrelevant (or equivalently, a low p-value indicates the factor is likely relevant). A standard cut-off in statistical analysis is 0.0500, or 5 percent. Factors with p-values below 0.0500 are thus considered related to compliance and factors with p-values above 0.0500 are considered unrelated to compliance.

The following table (Table XV) summarizes the important factors for compliance percentages shown in Table IX. The highlighted cells in the table are factors that were statistically significant in determining compliance. The table shows that whether locations had an Inside or an Outside Installation appears to be the main factor related to the percentage of compliant locations. Relevant Area also appears to be a significant factor in overall compliance, although much less

significant than whether a location had an Inside or Outside Installation. Table XV indicates that whether a locations is a Past Installation or a New Installation is not a significant factor in overall compliance (once inside versus outside is considered)..

Table XV
Analysis of Factors Related to Observed Results⁷⁰

Factor Tested	Overall Compliance (Table IX) Analysis with Central Office p-value	Overall Compliance (Table IX) Analysis with Relevant Area p-value
Inside versus Outside Installation	<u>0.0048</u>	<u>0.0155</u>
Past versus New Installation	0.4481	0.1868
Site Required Revisit	0.3810	0.3882
Relevant Area	NA	<u>0.0278</u>
Central Office	0.4868	NA

Because Inside versus Outside Installation and Relevant Area appear to be the important factors in determining compliance, Liberty made adjustments for the no-access situations using these two factors. To provide some idea of the magnitude of these differences, the table below shows the full compliance rate for Inside and Outside Installations, by area.

⁷⁰ The full ANOVA tables are shown in Appendix B.

Table XVI
Inside vs. Outside Installation Compliance

Relevant Area	Inside Installations			Outside Installations		
	Number of Fully Compliant Installations	Total	Percent Fully Compliant	Number of Fully Compliant Installations	Total	Percent Fully Compliant
Bronx	20	20	100.0%	65	69	94.2%
Brooklyn	10	10	100.0%	71	79	89.9%
Capital North	47	51	92.2%	26	26	100.0%
Capital South	12	15	80.0%	53	60	88.3%
Central	55	64	85.9%	14	15	93.3%
Manhattan	96	109	88.1%	-	-	-
North Nassau	6	6	100.0%	75	79	94.9%
South Nassau	4	4	100.0%	86	90	95.6%
Queens	13	18	72.2%	50	55	90.9%
Staten Island	24	31	77.4%	51	60	85.0%
North Suffolk	4	6	66.7%	90	98	91.8%
South Suffolk	3	3	100.0%	91	97	93.8%
Rockland	22	23	95.7%	69	72	95.8%
North Westchester	27	32	84.4%	49	51	96.1%
South Westchester	21	26	80.8%	44	51	86.3%
Western	67	75	89.3%	3	3	100.0%
Statewide Weighted Average			86.0%			92.1%

As shown in the table, the percentage fully compliant was somewhat higher, in general, for Outside Installations than for Inside Installations.

Adjustments of Compliance Rates for Potential No-Access Bias

Thus, Liberty concludes that the only significant evidence of potential no-access bias comes from the different rates at which the inspectors were able to access and inspect Inside as opposed to Outside Installations and the different compliance rates observed for Inside versus Outside Installations in each Relevant Area. In order to adjust for this potential bias, Liberty performed a regression analysis to predict the compliance rate based on Relevant Area and whether the installation was an Inside or Outside Installation. Liberty then used the predicted results of this regression to estimate compliance rates and associated confidence bounds adjusting for this potential bias.⁷¹ The adjusted results are shown in the next table.

⁷¹ The regression results and confidence interval calculations are detailed in Appendix B.

Table XVII
Estimates of Locations Fully Compliant with the Commission’s Grounding Rules Adjusted for Potential No-Access Bias⁷²

Relevant Area	Percent of Fully Compliant Installations	Lower 95 Percent Confidence Bound	Upper 95 Percent Confidence Bound
Bronx	94.8%	87.9%	98.3%
Brooklyn	90.2%	82.0%	95.4%
Capital North	94.3%	86.6%	98.3%
Capital South	85.5%	75.4%	92.5%
Central	87.0%	77.6%	93.5%
Manhattan	88.1%	80.5%	93.5%
North Nassau	94.7%	87.6%	98.3%
South Nassau	95.2%	88.8%	98.5%
Queens	85.0%	74.7%	92.2%
Staten Island	82.0%	72.6%	89.3%
North Suffolk	90.1%	82.8%	95.1%
South Suffolk	93.6%	86.9%	97.5%
Rockland	95.2%	88.8%	98.5%
North Westchester	90.7%	82.3%	95.9%
South Westchester	83.4%	73.2%	90.9%
Western	89.6%	80.7%	95.4%
Statewide Weighted Average	89.5%	87.7%	91.3%

The estimates for each Relevant Area were calculated using a weighted average of the estimated compliance rate for the accessed and no-access locations. The estimated compliance rate for accessed locations is simply the percent compliant at these locations, weighted by the percent of locations attempted where access was obtained and an inspection was completed. The estimated compliance rate for no-access locations was determined by estimating a statistical regression model that included Relevant Area and whether the installation was an Inside or Outside Installation. This model allowed a forecast of compliance.

The confidence intervals for each Relevant Area were calculated using the Binomial Distribution.⁷³ The Statewide Weighted Average is a weighted average of compliance rates for each Relevant Area, its confidence interval was calculated using the normal distribution and calculating the variance as a weighted average of the variances for the estimates in the Relevant Areas.

⁷² These results, which show 6 out of 16 areas having 95 percent compliance outside the upper confidence bound, would occur only once in about 12,361 tests if the true compliance of each installation was 95 percent.

⁷³ The ANOVA was used to calculate the estimated number in compliance. When this was an integer, the Binomial confidence interval was calculated directly. When this was not an integer, Liberty used a weighted average of the confidence intervals of the two nearest integers. This method generally produced confidence intervals wider than those that would have been produced using the ANOVA and a normal approximation. Even in the absence of missing data, it is common in statistical sampling to employ a ratio or regression estimate, which uses information known about the entire population to improve the estimate. Here, the type of installation, known for the entire sample, is used to improve the estimate of compliance only for no access items. Thus, the precision improves with this additional information, but not substantially.

Comparing Tables IX and XVII shows that the bias adjustment has generally lowered the compliance percentages by a small amount, which results from Liberty's finding that Inside Installations generally have a lower compliance rate than Outside Installations.

IV. Conclusions

The following summarizes Liberty's conclusions from analyzing the FiOS installation inspection results.

Conclusion #1: Verizon's average rate of compliance with the Commission's grounding and bonding rules across New York State is 89.5 percent for locations at which the company has been able to apply the procedures adopted in the Network Review Plan. This rate is considerably better than that reported prior to the adoption of the Network Review Plan but is somewhat below the stated objective of the plan. (See Recommendation #1.)

Based on the results of its installation inspections, Liberty estimates, after adjusting for possible no-access bias, that 89.5 percent of the FiOS installations in New York State that have been subject to the NRP comply with the Commission's grounding and bonding rules. (The statistical analysis indicates that, with 95 percent confidence, the true percentage lies between 87.7 and 91.3 percent.) Stated differently, Liberty estimates that 10.5 percent of locations are out of compliance with the Commission's rules (with the true percentage lying with 95 percent confidence between 8.7 and 12.3 percent).

Liberty sampled installation locations for inspection from the universe of FiOS locations for which Verizon had, by March 1, 2010, been able to complete inspections and remediations. Thus, Liberty's estimate only applies to locations for which the company has been able to complete the processes adopted in the NRP (nearly 92 percent of all installations). However, it is appropriate to focus principally on these locations because this provides a measure of how well the NRP is working. In this regard, it appears that the NRP has been very successful. Verizon indicated to Liberty that the company's inspectors found a compliance rate of 34.5 percent for locations with FiOS installations made before the NRP was implemented.⁷⁴ The difference between the two numbers indicates a very substantial improvement in Verizon's performance since the implementation of the NRP. Nevertheless, it should be noted that the stated objective of the NRP was for Verizon to achieve 95 percent compliance.⁷⁵ This means that there is still some room for Verizon to improve its performance.⁷⁶ Liberty noted a number of cases where the

⁷⁴ Verizon's February 19, 2010 response to Liberty's data request.

⁷⁵ More precisely, paragraph 7 of the NRP states the objective as "ensur[ing] that 95% or more of the New Installations included in each sample inspected [by the ONQAT] conform to the Grounding M&Ps in all material respects." It is important to note that Liberty's results are based on somewhat different criteria. In particular, Liberty's inspections were of a sample of all installations, not just New Installations, and the criteria for compliance was Liberty's understanding of the Commission's grounding and bonding rules as specified in the Audit Work Plan and Appendix A of this report. Furthermore, as noted above, Liberty avoided making arbitrary determinations of the materiality of any non-compliance.

⁷⁶ Although Liberty does not agree with Verizon's proposed reclassification of the non-compliance findings in Verizon's Draft Report Comments, it is interesting to note that even with these reclassifications, the upper 95

installations did not conform to Verizon's methods and procedures. Better adherence by Verizon's technicians to these methods and procedures would likely have improved the compliance rate.

Conclusion #2: The FiOS installations are missing any direct ground at 1.3 percent of locations and the ground is uncertain at 4.1 percent of locations in New York State where the company has been able to apply the procedures adopted in the Network Review Plan. (See Recommendation #1.)

Based on the results of its installation inspections, Liberty estimates that 1.3 percent of the FiOS installations in New York State that have been subject to the NRP are likely to be ungrounded. (The statistical analysis indicates, with 95 percent confidence, that the true percentage lies between 0.7 and 1.9 percent.) Furthermore, Liberty's analysis indicates that the FiOS ground is uncertain at 4.1 percent of other locations. (The true percentage lies with 95 percent confidence between 2.9 and 5.2 percent.) The remaining locations that Liberty found to be out of compliance with the Commission's grounding and bonding rules are locations for which the FiOS grounding is not in compliance with the Commission's rules but nevertheless appear to have some form of ground. Liberty made these determinations based solely on visual and physical observations rather than electrical measurements.

The large number of grounding conditions Liberty observed that are either ungrounded or for which the grounding is uncertain (5.4 percent, with the true value lying with 95 confidence between 4.1 and 6.7 percent) indicates that some Verizon installers appear to be still incompletely applying the company's procedures, thereby leaving the installation ungrounded. The lack of a ground represents a potentially hazardous condition for the FiOS customer. The stated objective of the NRP was to achieve a condition of 100 percent of the installations with some grounding. This suggests that Verizon needs to work more on achieving this goal.

Conclusion #3: The grounding of a number of FiOS installations, although technically compliant with the Commission's rules, is at significant risk of future disconnection, thereby leaving the installation ungrounded. (See Recommendations #2 and #3.)

Based on its installation inspection observations, Liberty estimates that 3.6 percent of the locations are at significant risk of disconnection, although they are technically compliant with the Commission's rules. (The true value lies with 95 percent confidence between 2.7 and 4.4 percent.) This risk arises for various reasons. The most important cause is an unsecured TII-442 installation. This device is plugged into an electrical socket, which makes it easy to inadvertently disconnect the device without necessarily disconnecting the FiOS ONT, which would allow the FiOS service to continue but it would be ungrounded. Verizon's methods and procedures documentation requires that TII-442 devices be secured when they are installed by permanently attaching them to the power outlet using the molded dog-ear connection on the device. Other less

percent confidence bound of Verizon's restated statewide compliance rate, although very close, still falls below 95 percent compliance (see Verizon's Draft Report Comments, page 26 and Exhibit J).

common causes include connections of the ground wire to a dissimilar metal and stringing of ground wires with too much slack.

Conclusion #4: The rate of Verizon's compliance with the Commission's grounding and bonding rules varies somewhat across New York State. (See Recommendation #3.)

Liberty's statistical analysis indicates that Verizon's compliance rate with the Commission's rules (Conclusion #1) varies somewhat from Relevant Area to Relevant Area. Table XV above shows that this difference is statistically significant (*i.e.*, the p-value is below the typical p-value cutoff of 0.05). Liberty also found evidence of geographical variation in other quantities observed during the inspections, including the percentage of locations that are compliant with the Commission's rules for installing coaxial cable grounding blocks (see Conclusion #6) and locations that are technically compliant with the Commission's rules but at significant risk of future ground disconnection (see Conclusion #3).

The existence of such variability suggests potential variations in the Verizon technicians' adherence to its methods and procedures across the state.

Conclusion #5: The rate of Verizon's compliance with the Commission's grounding and bonding rules is greater for Outside Installations than for Inside Installations. (See Recommendation #4.)

Liberty's statistical analysis indicates that Verizon's compliance rate with the Commission's rules (Conclusion #1) vary significantly between Inside and Outside Installations. The statewide average compliance rate for Inside Installations is 86.0 percent; for Outside Installations, the compliance rate is 92.1 percent. Table XV above shows that this difference is statistically significant (*i.e.*, the p-value is below the typical p-value cutoff of 0.05). Because of this effect and the lower access rates for inside inspections (compared to outside), Liberty adjusted the estimates of the overall compliance rate to account for potential no-access bias. These differences also suggest that Verizon should explore the reasons for the differences and adjust the methods and procedures accordingly.

Conclusion #6: The rate of Verizon's compliance with the Commission's requirement to install grounding blocks on an on-going basis after implementation of the January 2009 order is 95.0 percent. (See Recommendation #3.)

Based on the results of its installation inspection observations, Liberty estimates that 95.0 percent of the FiOS installations in New York State that have coaxial cables and for which Verizon had completed installations or repairs on or after May 1, 2009 had installed coaxial cable grounding blocks. (The statistical analysis indicates that, with 95 percent confidence, the true percentage lies between 92.8 and 97.2 percent.) Liberty chose the May 1, 2009 date for the analysis to allow time for Verizon to implement the Commission's January 2009 order, and

corresponds to a date after Verizon indicated the company had completed implementation of the coaxial cable grounding block installations procedures. This is a good overall compliance rate, but it does show some room for improvement. In particular, it is noteworthy that the compliance rate is significantly lower in Manhattan.

Conclusion #7: In addition to the grounding conditions that are at significant risk of losing ground, Liberty found other grounding conditions that, although technically compliant with the Commission's rules, are potentially problematic. (See Recommendation #2.)

During its inspections, Liberty encountered some other grounding conditions which could be significantly improved, although technically compliant with the Commission's rules. These conditions include:

- Bonding a Verizon installed ground to the power company's multi-ground neutral by running the 6-gauge bonding wire over the roof of the building
- Attaching the ground clamp to extremely rusted surfaces (e.g., strap clamps on a very rusted rigid metallic conduit)
- Running the ONT ground wire through the frame of a building without using an insulating sleeve
- Removing minimal insulation from a grounding electrode under an ONT ground clamp
- Allowing too much slack in the ONT ground wire, causing it to hang in front of a basement window.
- .

Verizon can significantly improve the security of the grounding and bonding of the FiOS installations by eliminating such conditions. Verizon's methods and procedures discourage the use of such practices; this is another case where better adherence by the Verizon technicians to the methods and procedures would improve the company's performance.

V. Recommendations

Based on its conclusions, Liberty makes the following recommendations to Verizon.

Recommendation #1: Examine the reasons why a significant number of installations are missing a ground or are wired in such a manner that the ground is uncertain, and take action to eliminate the cause for these.

As noted in Conclusion #2, Liberty estimates that 5.4 percent of FiOS installations in New York State either have no ground or have an uncertain ground. Liberty estimates that 1.3 percent show no evidence of any ground. As noted, the lack of a ground represents a potentially hazardous condition for the FiOS customer. Liberty's estimates also indicate that eliminating these situations would allow Verizon to meet both the NRP objective of 100 percent of locations with

some ground and the NRP objective of 95 percent of locations fully compliant with the Commission's grounding and bonding rules.

Recommendation #2: Examine the reasons for the grounding conditions that leave a number of installations at significant risk of losing ground in the future or otherwise are problematic and take action to eliminate them.

As noted in Conclusion #3, Liberty estimates that, although currently technically compliant with the Commission's grounding and bonding rules, 3.6 percent of FiOS installations in New York State are at risk of losing ground. Most of these correspond to unsecured TII-442 installations. Conclusion #7 notes some other grounding conditions which should be eliminated. Although Verizon's methods and procedures documentation already discourages many of these practices, it is possible that improvements in Verizon's methods and procedures documentation or training could eliminate or significantly reduce the frequency of these conditions.

Recommendation #3: Examine the reasons for the geographic variability in grounding compliance and compliance with coaxial grounding block installation requirements and take action to eliminate them.

As noted in Conclusion #4, Liberty found evidence of differences in grounding compliance across New York State. Conclusion #6 also noted that the compliance with the Commission's coaxial grounding block installation requirements was lower in Manhattan than in other areas of New York State. Liberty found similar geographic variability in the securing of the TII-442 devices. These findings may be due to different standard practices or rates of compliance with Verizon's methods and procedures across the state. If so, the company should investigate this and take action to eliminate such causes.

Recommendation #4: Examine the reasons for the difference in grounding compliance between Inside and Outside Installations and take action to eliminate them.

As noted in Conclusion #5, Liberty found evidence of significant differences in grounding compliance between Inside and Outside Installations. It is not clear why this occurs, but it could represent an inadequacy in the methods and procedures documentation or training, particularly for Inside Installations, for which the compliance rate is lower than for Outside Installations.

Appendix A: Detailed Inspection Process

A. Inspection Process and Schedule

1. *Identifying and clustering sampled locations*

At the start of the inspections, each inspector was assigned a Relevant Area and in most cases completed all inspections in that area before moving to another Relevant Area. Liberty provided each inspector a list of the locations in the Relevant Area to be visited for inspections, which Liberty created by sampling from the universe of FiOS locations that Verizon provided. The list contained all the information that the inspector needed, including the location's address and the customer's name. Once the sample was drawn, the location list was organized within each Relevant Area for efficiency of driving or otherwise traveling between locations. Specifically, all locations were listed in order of their proximity to each other to minimize travel time between locations (*i.e.*, location #2 was the closest to location #1, location #3 was the closest to location #2, *etc.*). Using this ordered arrangement of the sample locations, the inspectors determined the daily schedule by visiting the sample locations in the order they were given. In no case, did the inspectors reveal the list of locations to the Verizon escorts. The escort followed the inspector from location to location, only learning the address of the next location when necessary (*i.e.*, when the inspector was ready to leave the current location and move on to the next location).

To maintain the integrity of the sample, Liberty treated equally all 112 sample locations provided within each of the Relevant Areas. Specifically, the inspectors attempted to inspect all locations provided to them regardless of the number of inspections actually achieved. If the assumed 35 percent no-access rate had been exactly correct, 73 completed inspections would have resulted from the 112 location visits. In the event that the no-access rate was less than 35 percent, the inspector did not stop after completing 73 locations and continued until an attempt had been made to inspect each of the remaining locations. In Relevant Areas where the 35 percent no-access rate was exceeded, the inspector received another list of additional sample locations for that Relevant Area. The number of locations on this second list was based on the number of actual inspections the inspector was able to accomplish from the original list of locations (*i.e.*, the closer to the 73 target inspections that were achieved, the smaller the second sample needed to be). This second sample was drawn using the same random selection process that was used to select the original locations. However, in drawing this second sample, the original locations were removed from the sample population prior to selecting the second sample to prevent duplication. As was the case with the first list, all locations on the second list were treated equally and an attempt to inspect all of them was made even if this results in accomplishing more than the required 73 inspections.

To minimize the potential bias to the sample that might be caused by the locations where the inspector experienced a no-access condition, every attempt was made to inspect all the locations provided on the list. For the initial list of 112 locations, after the inspectors had made one visit to all locations on the list, they made a second attempt to inspect those no-access locations where, during the first visit, the inspectors found no one at the location or where there was not an adult present to grant permission to enter. Second attempts to inspect an installation were not made to

i) no-access locations where the inspector was refused entry during the first visit, ii) locations determined by the inspector to be potentially unsafe during the first visit, or iii) a location that had to be skipped for some other reason not already mentioned (e.g., because the FiOS installation had been disconnected). These second attempts to the no-access locations generally followed the same order in which the list was provided to minimize travel times between locations. However, the inspectors sometimes scheduled the visits at a different time of day or day of the week from the original attempt to increase the probability of finding someone at the location. If the inspectors were unable to achieve access to the interior of a location during their second attempt, they noted this on the tracking sheet and made no further attempts to inspect that location. These second attempts were made regardless of the number of successful inspections completed during the first pass through the list of locations.

Based on Verizon's inspection experience, inspectors developed their individual schedules on the assumption that they would be able to make 20 location visits per day, with a visit defined as a combination of attempted inspections (no access) and inspections accomplished.⁷⁷ When developing daily schedules, the inspectors allowed for the time necessary at the end of each day to transcribe their inspection results onto the electronic tracking sheet and transmit the tracking sheet to the centralized collection point.

2. Inspection process and Verizon's role in the inspection

Before beginning the inspections, each inspector was provided a Verizon escort who accompanied the inspector during the course of inspections. The principal role of the Verizon escorts was to use their Verizon credentials as an aid to gain access to the locations and thus minimize the no-access conditions that would otherwise be experienced by unescorted location visits. To maintain the confidentiality of Liberty's inspection results, the Liberty inspectors conducted their inspections unobserved by the Verizon escorts. Once a Liberty inspector fully completed an inspection, the Verizon escort had the opportunity to go to the ONT and perform a separate inspection. The Liberty inspectors and Verizon escorts did not share with each other either a verbal assessment of the results of any of their inspections or any of their written inspection notes. The separate Verizon inspections were performed expeditiously

It was the inspectors' responsibility to contact their Verizon escorts to make arrangements about when and where to meet. The inspectors did not provide their Verizon escorts with the list of addresses that were to be visited. To maintain the integrity and independence of the inspections, the inspectors provided the locations to be visited to the Verizon escort one location at a time, only providing the next location when an inspector was ready to move to that location. When the Verizon escort was contacted for the first time, the inspector had the Verizon escort suggest the meeting place for the first day of the inspections. However, when establishing this meeting point with Verizon, the inspectors did not provide the specific area where they intended to begin the inspections, only the general vicinity. This was done to maintain the anonymity of the inspection locations from Verizon as much as possible. Once the initial meeting place has been established, the subsequent meeting places were established at the end of each day based on the location of

⁷⁷ Verizon interview, December 29, 2009.

the next cluster of locations to be inspected. Because of insurance restrictions, Liberty's inspectors did not ride in the same vehicle as their Verizon escorts.

On the advice of Verizon and Staff based on their inspection experiences, Liberty's inspectors did not make appointment calls to customers prior to the start of the inspections; that is, all inspections were attempted by inspectors going to the sampled FiOS locations without a prior appointment.⁷⁸ The Verizon escorts had proper Verizon identification to show customers. Liberty provided a photo identification badge to its inspectors, indicating their association with Liberty Consulting. This identification was visibly displayed, either clipped to the inspector's outerwear or hung on a lanyard around the inspector's neck. Each inspector was given a communications card containing NYSDPS contact information to provide if challenged by someone at the location.

Upon arrival at a location, the Liberty inspectors allowed their Verizon escorts to make the initial contact with anyone that might be present at the location. If someone was present at the location, the Verizon escorts displayed their credentials, explained the purpose for the visit, and asked permission to conduct the inspections. If permission was not granted, the location was noted as a no-access location on the tracking sheet with a note indicating that the permission to access the location was refused. To the extent possible, Liberty's inspectors had minimal contact with persons at the location to be inspected. However, if someone at the location asked the Liberty inspector why the inspection was being conducted, the inspectors were careful not to give any indication that there were problems with the quality of the FiOS installation at that location or that problems had been found in the past and the inspection was to verify Verizon's remediation. For their own protection against the potential of a false claim of abuse, inspectors never entered the interior of a location unless an adult was present and granted permission to enter. Unless an adult at the location granted such permission, the inspector considered this a no-access situation and moved to the next location. Inspections of Outside Installations without an adult present proceeded as long as the minor did not object.

In cases where no one was present or responded, the inspector and the Verizon escort walked around the outside of the location to determine if the ONT was an Outside Installation. Verizon's installation inventory did not provide information on whether the installations are Outside or Inside Installations; therefore, this information was not available prior to arriving at the location. When checking the location for an Outside Installation, extreme care was taken not to damage the property at the location and to note any situation that might be dangerous for the inspector or the Verizon escort (*e.g.*, fenced-in dog, hostile neighbor). If there was any doubt whether the ONT search or inspection at a location was safe, the inspector and escort immediately abandoned that location.

⁷⁸ Verizon interview, December 29, 2009. Verizon indicated that calling the FiOS customers to attempt to schedule inspections in advance typically resulted in negative responses by the customers, thus increasing the number of no-access locations. Verizon indicated that inspectors had better success by simply showing up at the locations to conduct the inspections without a prior appointment. Staff confirmed that the NYSDPS inspectors had similar experiences.

In cases where the ONT was found on the exterior of the location and the situation was deemed safe, the Verizon escort left the immediate area around the ONT to allow the inspector to proceed with the inspection even if no one was present at the location to provide permission to proceed with the inspection.⁷⁹ Inspectors recorded instances when the ONT could not be located or the conditions were deemed to be unsafe as no-access conditions with a note explaining the reason (*e.g.*, no one at the location, could not locate ONT on outside of building, dog on grounds). If the customer (or a neighbor) challenged the inspector during the inspection (*e.g.*, the customer arrived home while the inspection was in progress), the Verizon escorts showed their credentials and explained what was being done. The inspection continued to completion unless someone at the location asked the inspector to leave. If this occurred, the inspector noted the location as a no-access location indicating that the inspection could not be completed due to a request to leave.⁸⁰

The data from which Liberty choose the sample locations did not always identify locations at which FiOS service was recently disconnected. If someone at the location informed the Liberty inspector and the Verizon escort that this location no longer has FiOS service or the inspector and escort otherwise determined that the service has been disconnected, they thanked the people at the location and proceeded to the next location. The inspector indicated in the inspection notes that the location was skipped because the service has been disconnected.⁸¹

For multiple dwelling units and other locations where multiple ONTs were installed, the inspectors were instructed to make every effort to distinguish the ONT associated with the apartment identified on the sample list. This was typically not a problem for large apartment buildings, as the ONT is generally installed within the apartment itself. However, when the inspectors encountered a situation for which there were multiple ONTs installed at a location, the inspector tried to identify the one targeted for the inspection by looking for apartment identification on the ONT or ground tag or by attempting to trace the coaxial cable to the apartment unit. The inspectors also attempted to identify the ONT from its serial number; however, the serial numbers in the Verizon database were not always current and the serial numbers were typically not visible on the exteriors of the ONTs. Whenever the ONT chosen in the sample could not be identified, the inspector inspected all the ONTs present at that location and recorded on the tracking sheet that multiple ONTs were installed and the inspection results for each.⁸²

During the course of the inspection, using the standardized tracking sheet provided, the inspector took notes of what was observed (*e.g.*, installation compliant with ONT properly grounded to power company ground rod, installation non-compliant with ONT improperly grounded to

⁷⁹ Customer-provided access to the location is typically not required for inspections of outside ONT installations.

⁸⁰ An inspection did not count unless it was fully completed.

⁸¹ Liberty only excluded locations for which the inspector could determine at the time of the inspection that service had been disconnected. There are likely to be a few locations remaining in the inspection sample at which service was disconnected but that fact was not apparent to the inspector at the time of the inspection. These are typically locations with Outside Installations, where the inspection could be completed without the presence of the resident.

⁸² Although the inspectors recorded all the inspection results in such situations, Liberty only counted the results as a successful inspection if the grounding condition of all the ONTs were the same (*i.e.*, either all grounded properly or all not) and only counted the results once.

painted conduit without paint scraped off). The inspector also took digital photographs of all grounding conditions found (both compliant conditions and non-compliant conditions). The inspectors were instructed to take care that the notes accurately reflected the address inspected and the condition found at that address, and that the photographs were properly aligned with the location (*i.e.*, photograph number is recorded and associated with house number).

Most inspections required only a visual verification of compliance with the Commission's grounding rules. The only physical check an inspector made was a slight tug on the ground wire in cases for which it appeared that the wire might not be securely connected to a clamp or there was doubt that it was connected within the ONT. Prior to touching any wired connection, however, the inspector scanned it with a voltage-detection meter to make sure the connection was not hot. There were also some instances for which an inspector needed to tug on the ground wire coming out of the ONT to be able to trace it to its ground connection point; when such a procedure was necessary, the inspector performed it with the great care. Inspectors recorded any loose ground connection as a non-compliant condition. Liberty's inspectors performed no electrical tests of the ground source used by Verizon to ensure it was a suitable ground.

To conduct the inspections, the inspectors were instructed to use the following tools and equipment:

1. Photo identification card provided by Liberty Consulting
2. A Global Positioning System device (alternatively, detailed driving directions between locations)
3. Maps of the area
4. Cell phone
5. Digital camera
6. Pen light or flashlight
7. Tape measure
8. Voltage-detection meter
9. Person computer with Microsoft Excel™ software – needed for maintaining and transmitting tracking sheet.

When conducting inspections, the inspectors were instructed to dress comfortably and appropriate for the weather conditions but not to wear tattered or soiled jeans and sneakers.

B. Acceptable Grounding Methods

1. Background

The purpose of Liberty's inspections was to verify Verizon's conformance with the Commission's rules for proper grounding of the ONT. Liberty is not aware that there has been any validation that Verizon's FiOS installation methods and procedures (M&Ps) conform to the Commission's grounding rules. As such, Liberty's focus when conducting its inspections was on

compliance with the Commission's grounding rules only and not compliance with the Verizon M&Ps. Following is a summary of the acceptable ONT grounding methods based on the Commission's rules⁸³:

1. Buildings or structures with an Intersystem Bonding Termination (IBT).
 - a. In such cases, the grounding conductor shall be connected to the intersystem bonding termination.
2. Buildings or structures with other grounding means.
 - a. In such cases, the grounding conductor shall be connected to the nearest accessible location on the following:
 - i. The building or structure grounding electrode system as covered in Article 250.50 of the *NEC 2008 Handbook*
 - ii. The grounded interior metal water piping system within 1.5 meters (5 feet) from its point of entrance to the building, as covered in Article 250.52 of the *NEC 2008 Handbook*
 - iii. The power service accessible means external to enclosures as covered in Article 250.94 of the *NEC 2008 Handbook*
 - iv. The metallic power service raceway
 - v. The service equipment enclosure
 - vi. The grounding electrode conductor or the grounding electrode conductor metal enclosure
 - vii. The grounding conductor or the grounding electrode of a building or structure disconnecting means that is grounded to an electrode as covered in Article 250.32 of the *NEC 2008 Handbook*.⁸⁴

In addition to the acceptable grounding methods outlined in the Staff's letter to Verizon, as listed above, in its January 14, 2009 Order the Commission accepted an additional method for use on Inside Installations only. In this order the Commission states:

In light of the unique features of the TII 442 and its demonstrated ability to resolve potential hazards and in view of the reduced likelihood of potential electrical hazards associated with inside installations, we conclude that the alternative TII 442 approach is an acceptable grounding method. However, in terms of achieving a safe and appropriate ground, absent a good reason not to use the more robust direct ground, Verizon will be required to continue to adhere to its commitment to use the TII 442 only where it would be impractical or unsafe to use the conventional direct ground. We expect that approach, where practical, should not add any material cost to installations. Where use of the direct ground

⁸³Staff letter to Mr. Thomas McCarroll, Verizon's Executive Director of Public Policy and Communications, dated August 5, 2008.

⁸⁴During the interview on December 29, 2009, Verizon indicated that methods vi and vii of the acceptable Commission grounding rules are not included in its M&Ps and therefore, are not used by Verizon's installers. Nevertheless, Liberty found instances of the use of these methods during its inspections.

approach would add material costs to inside installations, we will allow use of the TII 442.

2. Inspection Requirements for Compliant Installations

For Outside Installations of the ONT, the following lists provide the only acceptable grounding methods that the inspector were instructed to consider compliant with the Commission's grounding rules. Any deviation from these methods or alternate method for grounding the ONT was considered a non-compliant condition.

General rules that apply to all the acceptable grounding methods described below:

1. The length of ground wire from the ONT to the connection at the primary ground point cannot exceed 20 feet.
2. With the exception of the approved deviations described below, the ground wire must be one continuous length with no splices. In some cases,⁸⁵ Verizon should have installed a coaxial cable grounding block. In these cases the ground wire from the ONT is connected to the grounding block via one of two screw-down connections. On the other screw-down connection, a ground wire is run from the grounding block to one of the primary grounding sources described below. This is an approved arrangement and is an acceptable instance for which the ground wire from the ONT to the primary ground source will not be a single contiguous wire for an outside installation. The inspectors were instructed to check for the presence of these grounding blocks and record on the tracking sheet whether or not one was installed. The inspectors were not required to determine whether or not the grounding block should have been present at a location. That determination was made as part of the data analysis after the inspections were complete.
3. The ground wire must be run as straight as possible. Bends in the wire must be sweeping; no wire bends shall be more acute than 90 degrees. The ground wire must never be coiled.
4. The ground wire from the ONT must be a minimum of 10 American Wire Gauge (AWG).
5. Ground tags should be attached to the ground wire at the point where the wire attaches to the grounding point. Installations without ground tags were considered compliant as long as all other requirements were met. The inspectors were instructed only to note missing ground tags in the inspection notes.
6. Appropriate clamps must be used for attaching ground wire to the primary ground. According to the *NEC 2008 Handbook*, Article 250.70, clamps must be UL-listed and be of cast bronze, brass, or plain or malleable iron. When viewing clamps for proper application, the inspectors were instructed to let common sense

⁸⁵ This applies to locations for which, after the effective date of the Commission's January 14, 2009 Order, Verizon completed any installation, remediation, or repair visit of a location. Verizon indicated in an April 10, 2010 response to a Liberty data request that the company completed implementation of this process by mid-April 2009.

be the guide. If the clamp appeared to be appropriate for the connection, the installation was deemed to be compliant and recorded as such.

7. All connections to the primary ground source must be single-wire connections (*i.e.*, the ONT ground wire is connected to the primary ground source with its own clamp having no other wires connected to the same ground wire termination point on that clamp). The only exception to this rule is use of the meter panel corner clamps, which are allowed to have screw down connectors for up to three separate ground wires (see #5 under “Acceptable Grounding Methods for Outside Installation of ONT” below).
8. The inspectors were instructed to use common sense judgment in all aspects of the inspections. For example, if the inspector found the ONT to be properly grounded using one of the methods described below but determined that the ground wire used to make the connection could easily be broken or damaged, the installation was considered non-compliant with proper photographic evidence and written documentation explaining why. Examples of conditions where the ground wire might be vulnerable to damage include, but are not limited to, ground wires that are run across a walk path, ground wires that are run through a doorway or window, and ground wires with too much slack dangling from a basement ceiling that can easily be accessed and damaged. Conversely, installation conditions that may not have met the individual inspector’s installation standards but did not expose the ground wire to a threat of easy breakage, such as running the wire through a hole drilled in a window or door frame, were considered compliant as long as all the other grounding requirements were properly satisfied.

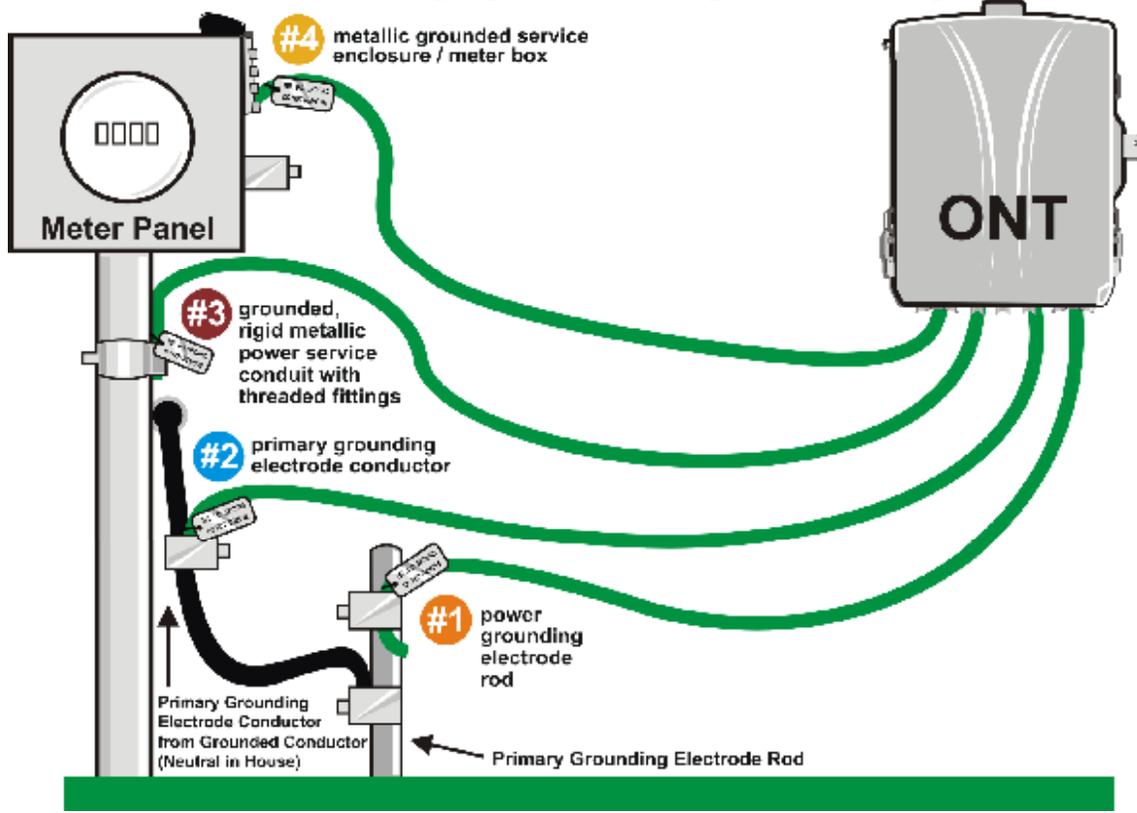
Acceptable Grounding Methods for Outside Installation of ONT:

1. For buildings with an installed Intersystem Bonding Termination (IBT), the ground wire exiting the ONT must be connected to the IBT. An IBT provides a way to interconnect and terminate grounding conductors from power, telephone, cable television or radio and television antennas using a single device. It is also used to bond grounding conductors from cable television or satellite dish conductors, security systems, landscape lighting controls, and lightning protection systems.
2. The ground wire exiting from the ONT is connected directly to the power company’s ground rod with a ground rod clamp. See grounding option #1 in the diagram shown below. The power company ground clamp cannot be used; the ground wire must have its own ground rod clamp.
3. The ground wire exiting from the ONT is connected to the power company’s grounding electrode conductor (the power company’s bare grounding wire running from the ground rod to the service panel inside the house) with a ground wire clamp. See grounding option #2 on the diagram shown below.
4. The ground wire exiting the ONT is connected to the power company’s grounded, rigid metallic power service conduit with threaded fittings leading to the power company’s metallic grounded service enclosure/meter box. Connection must be made with threaded metallic conduit clamps, u-bolt ground clamps, or similar

clamping devices attached to the power service conduit either above or below the power meter. In situations where conduit is painted, the paint where the conduit clamp is attached to the conduit must be scraped away; if not, the installation is non-compliant. See grounding option #3 on the diagram shown below.

5. The ground wire exiting the ONT is connected to the location's metallic grounded power service meter box using a corner clamp attached to a non-movable portion of the meter box (*i.e.*, the clamp cannot be attached to the hinged portion of the meter box). In many cases corner clamps can accommodate more than a single ground connection. This is the only exception to the general rule above where there can only be a single ground wire per ground clamp. See grounding option #4 on the diagram shown below.
6. For installations where the ONT is mounted too far away from the power company ground source to allow the installer to use one of the four non-IBT grounding methods described above, a ground rod placed by the Verizon installer can be used. For this method to be compliant, the ground rod must be driven into the ground within 20 feet of the ONT. Additionally, the ground rod cannot be within six feet from any other ground rod or lighting protection system that may be found at the location. The 10 AWG wire exiting the ONT must be clamped to the newly installed ground rod. Using a separate clamp, the new Verizon-installed ground rod must be bonded to the primary (power company) ground rod using 6 AWG ground wire and clamped to the primary ground rod with a separate clamp. This is an acceptable grounding arrangement where the ONT is not connected to ground with one continuous length of ground wire. Additionally, the 6 AWG ground wire used to bond the ground rods together is not restricted by the 20 foot limitation rule. This wire can exceed 20 feet in length and does not need to be insulated. This is the only scenario in which the ground wire can exceed 20 feet.

Some Available Grounding Options for Proper Grounding of the ONT



There may be instances where the ONT is installed on the outside of the location and the ground wire is run into the interior of the building. For these installations, access to the location was required to determine whether the ground wire is properly terminated to one of the power company grounds as described above or to the cold water pipe as described in the Inside Installation section below. For such installations, in addition to verifying that the ground wire was properly terminated on an approved ground source, the inspectors were also instructed to verify that the ground wire did not exceed 20 feet in length and that it ran as straight as possible. Ground wire that runs through the frame of a building must be insulated and should be encased by a tube sleeve. For instances where the ground wire was insulated but no insulating sleeve was installed by the Verizon technician, the Liberty inspectors were instructed to consider the installation to be compliant with the Commission’s grounding rules and note the missing sleeve in the inspection notes.

Acceptable Grounding Methods for Inside Installations of the ONT:

1. According to the Commission’s August 14, 2009 order, Verizon will use a conventional direct connection grounding method for Inside Installations unless it is impractical or unsafe to do so. These conventional direct connection grounding methods are the six methods described above for grounding an outside ONT installation and the use of the cold water pipe as described in #2 below. When using one of the six direct connection methods, in cases where the ground wire from the ONT is run through a wood-frame to be connected to the primary ground

on the exterior of the building, the ONT's ground wire should run through a noncombustible, insulating tube/sleeve, to the exterior of the building. As previously noted, instances where the ground wire was insulated but there was no insulating sleeve were considered to be compliant with the Commission's grounding rules; the inspectors were instructed to simply document the missing sleeve in the inspection notes.

2. The ground wire exiting the ONT is connected to the cold water pipe using an appropriate clamp at a point that is no greater than five feet from where the service entrance water pipe enters the building. (The clamp must also not be greater than 20 feet from the ONT.) This pipe can be identified by the water meter and/or service shut-off valves at the point where the service enters the building. An installation with a connection to the cold water service entrance pipe that is greater than five feet from the pipe's entrance to the building, a connection to any other cold water pipe, or a connection to any other pipe (*e.g.*, hot water, black gas pipe) is a non-compliant installation. In cases where the length of the ground wire exceeds 10 feet to connect from the ONT to the cold water pipe, the ground wire should either be protected using BX metallic sheathing or protective molding. Instances where such protection is not used were considered compliant with the Commission's rules as long as the ground wire was insulated. In cases where the Verizon technician deemed it impractical or unsafe to use one of the six direct ground connection methods or a cold water pipe attachment when doing an inside installation, the Commission's order allowed the use of a TII-442 grounding module.⁸⁶ This grounding module is only acceptable for Inside Installations of the ONT and only when one of the direct grounding options or a cold water pipe within 20 feet is not available to the installer. It must never be used when the ONT is installed on the exterior of the building. In cases where the inspectors found that the TII-442 was used when it was practical or safe to use one of the direct ground connection options, they were instructed to note the installation as failing to comply with the Commission's grounding rules. If the ONT was installed inside the building but the conductive coaxial cable leaving the ONT runs to the exterior of the building (*e.g.*, to get to the second floor of a building the installer ran the coaxial cable from the ONT in the basement to the second floor on the exterior of the building) the TII-442 module cannot be used. For installations where the conductive cable leaves the interior of the building only one of the direct grounding methods or the cold water pipe grounding method is acceptable. When the ONT was grounded via the TII-442 module the inspectors were instructed to verify that the following conditions exist. Unless noted otherwise, any deviation to these conditions⁸⁷ was considered to constitute an installation that is not in conformance with the Commission's rules:

⁸⁶ The Commission's January 14, 2009 Order.

⁸⁷ In addition, a ground tag should be placed in close proximity of either the ground wire transition point (where the ONT ground is connected to the TII-442) or at the TII-442 attachment (the dog-ear). However, missing ground tags were not considered to constitute a non-compliant condition and the inspectors were instructed simply to note such cases.

- a. No direct ground connections or water pipe service entrance are available for grounding the ONT or it is not practical and safe to use such an alternative
 - b. Green lamp **only** is lit on the TII-442 module
 - c. The device must be permanently attached to the power outlet using the molded dog-ear connection on the device⁸⁸
 - d. The ground wire cannot be longer than 20 feet
 - e. Ground wire must be run as straight as possible – bends in the wire must be sweeping, no wire bends should be more acute than 90 degrees
 - f. The ground wire used must consist of 10 AWG wire and the wire must be insulated.⁸⁹
3. The Commission’s grounding rules permit grounding of the ONT by connecting the ground wire to the structural steel of the building that is properly grounded according to the NEC guidelines.⁹⁰ However, Verizon has indicated that this option is not used by its installers because of the uncertainty of the suitability of the ground.⁹¹ Because of the difficulty in determining whether the structural steel is grounded properly, Liberty’s inspectors were instructed to clearly document in detail in the inspection tracking notes with supporting photographs of the grounding arrangements for any installation where the ONT ground wire terminates on the structure of the building.

C. Tracking Inspection Results

Because this inspections involved multiple inspectors conducting simultaneous inspections throughout New York it was important that, for consistency of results compiling and reporting, inspection results were tracked in a consistent manner. To help ensure this consistency all inspectors used an Excel tracking sheet, the instructions for which are shown in Appendix C, and the inspectors were instructed to explicitly follow the instructions for recording their inspection results. During the course of the inspections it was impractical to electronically record each location’s results and findings directly onto the spreadsheet. Given this impracticality, for ease of

⁸⁸ Liberty originally intended to consider TII-442s without such attachments to be non-compliant. However, Liberty later decided that this requirement is not clearly in violation of the Commission’s rules. Nevertheless this is an important requirement to assure that the ONT remains grounded in the future. Therefore, Liberty has classified all such cases as compliant conditions that are subject to potential future failures.

⁸⁹ In cases where the ONT is installed greater than 10 feet from the TII-442 device, the ground wire should be protected with either BX metallic sheathing or protective molding. Instances where such protection was not used were considered compliant with the Commission’s rules as long as the ground wire was insulated. Alternatively, the 10 AWG connected to the TII-442 device can be connected by using an appropriate compression type clamp with 6 AWG wire running from the same clamp to the ONT. In this case, the 6 AWG wire does not require the BX metallic sheathing or protective molding, as the 10 AWG does. This is another acceptable scenario that allows for a non-contiguous run of the ground wire. However, for installations grounded in this manner, both the 6 AWG wire and the 10 AWG ground wire must be insulated. The total length of the wire must also not exceed 20 feet. The use of non-insulated ground wire for inside installations is a non-compliant arrangement.

⁹⁰ *NEC 2008 Handbook*, Article 250.52(A)(2) and Exhibit 250.22

⁹¹ Verizon interview, December 29, 2009.

transposing the results onto the electronic form at the end of the day, the inspectors were instructed to use a hard copy facsimile of this tracking spreadsheet to manually record each location's results. If the inspectors found the need to record their detailed inspection notes of what was observed in a separate pad or notebook, they were instructed to use care to help ensure that the inspectors could relate these notes to the proper address when transposing the information onto the electronic tracking form. The inspectors were instructed to record all locations visited on the tracking sheet, including instances of no access to conduct the inspection.

The inspectors were instructed to exercise care to help ensure that the photograph number(s) were properly associated with the address of the inspection location and were recorded appropriately on the tracking sheet. To help make this relationship and to have a back-up source for recording the proper photograph numbers on the tracking sheet, the inspector were instructed, upon arrival at a location, to take a photograph of the location's address written on post-it notes affixed to the ONT. Subsequent photographs of the grounding condition were then easily related to the address of the location. The series of photographs for a given location stopped upon arrival at the next location where a photograph of that address, also written by the inspector on post-it note attached to the ONT at that location, was taken. Inspectors were instructed not to take photographs of the address as it appears on the building at the location or a mailbox, as these types of photographs might have made the resident or neighbors uncomfortable and could have resulted in unnecessary challenges to the inspector.

The notes section of the tracking sheet is a free form section that allowed the inspectors to provide comments on what they encountered at the inspection site. The inspectors were instructed to make these notes detailed enough to provide critical information that might be required for results analysis. For no-access situations, the instructors were instructed to state the reason for lack of access in the notes section (*e.g.*, no one responded to a doorbell, potentially dangerous situation, could not find location). For any inspection that was found to be non-compliant, the inspectors were instructed to add notes that would help explain the reason for the non-compliance. Conversely, for all compliant installations the inspector was instructed to indicate which of the approved methods was used to ground the ONT. See the instructions found in Appendix C for more information on how to complete this template and the information required in the notes section.

The inspectors were instructed to complete the electronic tracking form at the end of each day and transmit the completed forms to the Liberty inspection team leader. The inspectors were also instructed to back up all photographs taken onto a flash drive or other transportable storage medium, to ship copies of the photographs to the inspection team leader, and to maintain an electronic copy of all their tracking sheets and photographs until the project is completed and all records were received and acknowledged by Liberty Consulting. All manual worksheets used to record inspection results were also preserved as audit work papers. The inspectors were instructed to mail all of the manual work sheets used to the inspection team leader after the completion of inspections in each Relevant Area. These work sheets were also used to conduct spot check audits of the electronic tracking sheets for consistency of information and quality control.

Appendix B: Statistical Approach

Liberty assumed that the required sample sizes are determined by two conditions:

- The NYSDPS Staff would like to determine whether Verizon is meeting a compliance rate for all installations that is at least 95 percent, regardless of whether they are New or Past Installations. Furthermore, Staff expects that the actual compliance rate is close to 95 percent and should be determined for each of the 16 relevant areas and at a statewide level with a 95 percent confidence level and 5 percent margin of error (*i.e.*, at most 5 percentage points more than the sample percentage).
- The Staff would like to find out whether Verizon's compliance rate varies across the 16 Relevant Areas. For this purpose, Staff would like to assume the same 95 percent compliance rate for each of the 16 Relevant Areas as at the statewide level, and that the actual compliance rate should be determined in each of the 16 areas with a 95 percent confidence level and 5 percent margin of error (*i.e.*, an absolute 5 percentage points from the sample percentage).

The second requirement provides the most stringent condition on sample size.⁹² As a result, Liberty approached each of the 16 areas separately and did not assume that the compliance rates were the same by area; however, Liberty did not attempt to achieve any specified precision separately for New or Past Installations within each area. Thus, Liberty's sample size calculations below are for each Relevant Area, without regard to when Verizon installed FiOS in the sampled locations. Liberty used the samples described below to make projections by area, but also used standard statistical techniques to combine these projections for an estimate of overall compliance rate.

The precision of the overall statewide compliance rate was far better than the 5 percent precision for the individual area compliance rates described below. In general, Liberty estimated statewide compliance rates by weighting each area by the number of FiOS installations in the sampled population from which the sample was taken. This weighting implies that each individual installation has equal importance in the overall compliance. Liberty also examined the impact of calculating overall compliance by weighting each area equally. This weighting implies that each area is of equal importance in the overall compliance. Because the two approaches led to similar results, Liberty decided to use the first approach as the primary measure of statewide compliance.

Using the requirements described above, Liberty determined the appropriate sample size to be 73 inspections per Relevant Area, with a total statewide sample size of 1,168. Liberty performed the analysis and projections using standard statistical theory and a 95 percent confidence interval for each measure of compliance.

⁹² The first requirement implies a one-sided 95 percent confidence interval, which, at the same 5 percent precision as the two-sided interval implied by the second requirement, would require a smaller sample size, since a 95 percent one-sided interval allows all 5 percent of uncertainty to be in a single direction and a 95 percent two-sided interval typically requires 2.5 percent of the uncertainty in each of two directions.

Technical Calculations for Sample Size Determinations

The specific technical calculations follow here. Assume **p** is the compliance rate (95 percent), **m** is the margin of error (5 percent), **C** is the confidence in percentage terms (95 percent), $z(\alpha/2)$ is the normal distribution critical value for **C** of $1-\alpha$, and **n** is the sample size. Then:

$$m = z(\alpha/2) * \sqrt{p * (1 - p) / n}$$

The value of **n** which solves this for an **m** of 5 percent, a **C** of 95 percent (α of 5 percent), and a **p** of 95 percent is 72.99. To determine the required sample size, Liberty rounded this number to deal with the discrete nature of the data, resulting in a sample size of 73. For the purpose of this calculation, Liberty assumed an absolute rather than relative margin of error.

When the binomial distribution is used instead of a normal approximation, a sample size of 73 and a compliance rate of 95 percent (69 out of 73) produces a 95 percent confidence interval of between 86.5 percent and 98.5 percent, indicating that use of the binomial distribution produces about a plus or minus 6 percent interval (the actual interval depends on the results). To see the binomial interval bounds, the following two commands can be issued in “R”: 1) `pbinom(69,73,.985)` shows that 2.4 percent of results are less than or equal to 69 out of 73 when the true percentage is 98.5; and 2) `1-pbinom(68,73,.865)` shows that 2.4 percent of results are greater than or equal to 69 when the true percentage is 86.5. To produce a 95 percent balanced interval, both of these percentages should be about (but less than) 2.5 percent, and the figures shown are the closest percentages to the 2.5 percent bound using one decimal percent precision on the interval.

Technical Formulas for Calculation of Results

Notwithstanding adjustments that may be required due to no access, sample results by area were calculated as the number of improperly grounded FiOS installations divided by the total number of installations. Two-sided 95% confidence intervals by area were calculated using the binomial distribution. In particular, the following function, created in “R,” or the equivalent, was used:

```
> binomCI
function( numer, denom, confper=.95) {
# calculates to within 1/2 of a percent
# can change range of variable a for greater precision
# x percent two-sided interval
# default is 95% but can be changed
taill<-(1-confper)/2
a<-(1:2001)*.0005-.0005
lower<-1-pbinom( numer, denom, a)+dbinom( numer, denom, a)
upper<-pbinom( numer, denom, a)
upper<-max(a[upper>=taill & !is.na(upper)])
lower<-min(a[lower>=taill & !is.na(lower)])
CI<-list(lower, upper)
names(CI)<-c("Lower CI", "Upper CI")
return(CI)
}
```

In order to calculate the overall results, a mean and variance for each area was first computed using the binomial distribution. Then the weights were applied and the results calculated, with the confidence interval calculated according to the normal distribution.

Mathematically, this can be expressed as follows:

Let

g_A = the number in the sample that were properly grounded in Relevant Area A.

n_A = the total number of locations checked for grounding in Relevant Area A.

$p_A = g_A / n_A$ = the sample percentage of installations that are properly grounded in Relevant Area A.

w_A = the weight for Relevant Area A. (This will be 1/16 when areas are weighted equally and the percent of all FiOS installations in the area when areas are weighted by the number of FiOS installations.)

P = the estimated overall percent of properly grounded installations.

Then, the overall result is calculated as:

$$P = \sum w_A p_A, \text{ where the sum is taken over all 16 Relevant Areas A.}$$

The 95% confidence interval for this result is calculated as:

$$P \pm 1.96s$$

In the above confidence interval, s is the standard error of P and is calculated as the square root of the variance:

$$s^2 = \sum w_A^2 p_A (1-p_A) / n_A, \text{ where the sum is taken over all 16 Relevant Areas A.}$$

In order to examine the factors leading to compliance and to possibly adjust the estimates for situations in which Liberty was unable to complete the inspections, mainly because the inspectors encountered a no-access situation, Liberty performed a statistical analysis of variance (ANOVA) on whether certain factors affected the compliance. The summarized results of the two ANOVA calculations Liberty ran are shown in Table XV of the report. The full ANOVA table from the *Stata* program for the two ANOVA calculations is shown in the following tables. In these tables, the following variables were used to explain the observed compliance results for the locations at which inspections were completed, with the compliance result treated as a binary variable taking the value of “1” if the inspection found compliance and “0” if not:

Area_cat is a categorical variable that takes on one of 16 values, identifying each of the 16 Relevant Areas.

Area_co_cat is an analogous categorical variable that takes on different values for each Relevant Area-Central Office combination (136 in all).

Insideind is a binary variable that is “1” if the installation is an Inside Installation and “0” if not.

Installprioraug108 is a binary variable that takes on the value of “1” if the installation occurred before August 1, 2008 (Past Installation) and “0” if not.

Revisitind is a binary variable that takes on the value of “1” if the Liberty inspector made a revisit before the inspection was completed and a “0” if not.

Table B1
ANOVA of the Observed Compliance Using the Variables Insideind, Installprioraug108, Area_co_cat, and Revisitind

Source	Partial SS	df	MS	F	Prob > F
Model	12.2923189	138	.089074775	1.06	0.3049
insideind	.670929491	1	.670929491	8.00	0.0048
install~108	.048295815	1	.048295815	0.58	0.4481
area_co_cat	11.3233479	135	.083876651	1.00	0.4868
revisitind	.064440379	1	.064440379	0.77	0.3810
Residual	105.618983	1259	.08389117		
Total	117.911302	1397	.084403223		

Table B2
ANOVA of the Observed Compliance Using the Variables Area_cat, Insideind, Installprioraug108, and Revisitind

Source	Partial SS	df	MS	F	Prob > F
Model	3.23520374	18	.179733541	2.16	0.0032
area_cat	2.26623274	15	.151082182	1.82	0.0278
insideind	.488132268	1	.488132268	5.87	0.0155
install~108	.145079319	1	.145079319	1.74	0.1868
revisitind	.061964007	1	.061964007	0.75	0.3882
Residual	114.676098	1379	.083158882		
Total	117.911302	1397	.084403223		

The results shown in these two tables indicate that only two variables, *area_cat* and *insideind*, are statistically significant in the ANOVA because these are the only variables with p-value (“Prob > F”) less than the standard cutoff of 0.0500. After determining these to be the statistically significant variables in explaining the compliance, Liberty ran a regression to formulate predictions using *area_cat* and *insideind*. Using the regression command in *Stata*, Liberty obtained these results:

Table B3
Regression Results

```
xi: regress formulal i.area_cat insideind
i.area_cat      _Iarea_cat_1-16      (naturally coded; _Iarea_cat_1 omitted)
```

Source	SS	df	MS	Number of obs = 1398		
Model	3.04196949	16	.190123093	F(16, 1381) = 2.29		
Residual	114.869332	1381	.083178372	Prob > F = 0.0026		
-----				R-squared = 0.0258		
Total	117.911302	1397	.084403223	Adj R-squared = 0.0145		
-----				Root MSE = .28841		

formulal	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
_Iarea_cat_2	-.0513121	.0433033	-1.18	0.236	-.1362595	.0336354
_Iarea_cat_3	-.0897905	.0452098	-1.99	0.047	-.1784778	-.0011033
_Iarea_cat_4	.0177989	.04589	0.39	0.698	-.0722227	.1078206
_Iarea_cat_5	-.048459	.0463728	-1.04	0.296	-.1394277	.0425098
_Iarea_cat_6	-.0303812	.0445365	-0.68	0.495	-.1177477	.0569854
_Iarea_cat_7	-.0108508	.0438686	-0.25	0.805	-.0969071	.0752055
_Iarea_cat_8	-.0606767	.0418049	-1.45	0.147	-.1426846	.0213312
_Iarea_cat_9	-.0302785	.0441479	-0.69	0.493	-.1168826	.0563257
_Iarea_ca~10	-.0908037	.0455439	-1.99	0.046	-.1801464	-.001461
_Iarea_ca~11	.003824	.0425475	0.09	0.928	-.0796409	.0872888
_Iarea_ca~12	-.0079341	.0428398	-0.19	0.853	-.0919721	.0761039
_Iarea_ca~13	-.0260924	.0422422	-0.62	0.537	-.1089582	.0567734
_Iarea_ca~14	-.104499	.0449543	-2.32	0.020	-.1926852	-.0163128
_Iarea_ca~15	-.1243091	.04307	-2.89	0.004	-.2087989	-.0398194
_Iarea_ca~16	-.0158591	.0475303	-0.33	0.739	-.1090986	.0773803
insideind	-.0566776	.0218061	-2.60	0.009	-.0994543	-.0139009
_cons	.9677927	.0309613	31.26	0.000	.9070565	1.028529

Here the model used for the regression to explain compliance (“Formula 1”) is:

$$\text{Compliance} = \text{Coef}_{\text{cons}} + \text{Coef}_{\text{insideind}} * \text{insideind} + \sum \text{Coef}_{\text{area_cat } i} * \text{area_cat } i$$

In this equation, the sum is taken over all area categories *i* from 2 to 16. The “Coef.” column of Table B3 shows the coefficient to apply and the subscript denotes the row. For example, $\text{Coef}_{\text{cons}}$ is equal to .9677927.

To estimate the impact of the Liberty inspectors’ inability to complete all the inspections in the original sample, Liberty used the “predict” command in *Stata*, which takes the following form:

```
predict formlpred
```

This command created predicted values for each location in the full location sample, whether or not the inspection was completed. That is, Liberty estimated the impact of inability to complete the inspections by using the regression model to predict the likely result of an inspection for those locations in the original location sample at which an inspection could not be completed. The following table, based on the results shown in Table III, provides the number of sample locations that either were or were not inspected.

Table B4
Inspection Sample Locations

Relevant Area	Total Location Sample	Invalid Locations	Valid Locations	No Inspection	Completed Inspections	Percent Missing Inspections	Percent with Inspections
Bronx	112	3	109	20	89	18.3%	81.7%
Brooklyn	112	1	111	22	89	19.8%	80.2%
Capital North	112	2	110	33	77	30.0%	70.0%
Capital South	112	4	108	33	75	30.6%	69.4%
Central	137	3	134	55	79	41.0%	59.0%
Manhattan	462	19	443	334	109	75.4%	24.6%
North Nassau	112	4	108	23	85	21.3%	78.7%
South Nassau	112	3	109	15	94	13.8%	86.2%
Queens	132	0	132	59	73	44.7%	55.3%
Staten Island	112	1	111	20	91	18.0%	82.0%
North Suffolk	112	3	109	5	104	4.6%	95.4%
South Suffolk	112	1	111	11	100	9.9%	90.1%
Rockland	112	2	110	15	95	13.6%	86.4%
North Westchester	112	2	110	27	83	24.5%	75.5%
South Westchester	112	0	112	35	77	31.3%	68.8%
Western	142	0	142	64	78	45.1%	54.9%
Total	2,217	48	2,169	771	1,398	35.5%	64.5%

Based on the regression results, Liberty recalculated compliance percentages in each Relevant Area, using predicted values in cases where compliance could not be determined because the inspection could not be completed. These predictions relied on the observations of Liberty’s inspectors as to whether the locations at which the inspections could not be completed were Inside or Outside Installations (because this information is not in Verizon’s database from which the inspection sample was derived). The results are shown in the following table:

Table B5
Condition of TII-442 Installations

Relevant Area	Sample Compliance Rate for Inspected Locations	Estimated Compliance Rate for Uninspected Locations
Bronx	95.5%	91.4%
Brooklyn	91.0%	86.8%
Capital North	94.8%	93.1%
Capital South	86.7%	82.7%
Central	87.3%	86.5%
Manhattan	88.1%	88.1%
North Nassau	95.3%	92.3%
South Nassau	95.7%	92.1%
Queens	86.3%	83.4%
Staten Island	82.4%	80.1%
North Suffolk	90.4%	85.0%
South Suffolk	94.0%	90.0%
Rockland	95.8%	91.5%
North Westchester	91.6%	88.1%
South Westchester	84.4%	81.1%
Western	89.7%	89.5%

To arrive at the adjusted compliance percentages shown in Table XVII, Liberty took the observed compliance percentage for the inspected locations multiplied by its weight and added the estimated compliance percentage for the uninspected locations multiplied by its weight, where the weights are “Percent with Inspections” and “Percent Missing Inspections,” respectively, as shown in Table B4. For example, for Brooklyn, Liberty took the product of the compliance percentage for the inspected locations from Table B5 (91.0%) and the fraction of the inspected locations in the Brooklyn sample from Table B4 (0.802) and then added the equivalent product for the uninspected locations (86.8%*0.198), yielding 90.2% (91.0%*0.802 + 86.8%*0.198 = 90.2%), which is shown in Table XVII in the row for Brooklyn.⁹³

While it would be possible simply to use the regression model and its standard error to compute confidence intervals for these adjusted values, Liberty did not do so for three reasons:

1. The high compliance percentage combined with the small sample size by Relevant Area means that the standard normal approximations do not hold very well; this led Liberty to use binomial confidence intervals for the initial analysis
2. Liberty believes that an appropriate comparison with the original confidence intervals can only be made if these intervals are approximated using a binomial distribution
3. Most of the intervals would not have been very different with a normal approximation substituted.

⁹³ The actual calculations were performed using four decimal places and then rounding to the results shown in Table XVII.

The confidence intervals were thus calculated substituting the adjusted compliance percentage for the calculated compliance percentage from the inspected locations. When this procedure resulted in a non-integer number of complying locations, Liberty interpolated between the two closest integer confidence intervals. Again using Brooklyn as an example, the adjusted compliance percentage of 90.2% translates to 80.25 out of 89 compliant locations. However, a binomial confidence interval cannot be computed for the non-integer number of successes of 80.25. Thus, Liberty computed the confidence interval for 80 successes as 81.7 to 95.3 percent and computed the confidence interval for 81 successes as 83.1 to 96.0 percent. In order to interpolate, Liberty weighted the first interval by 0.75 (because 80.25 is 75% of the distance from 81 down to 80) and the second interval by 0.25. This resulted in a final adjusted confidence interval of 82.0% to 95.4%.⁹⁴

The confidence intervals for the statewide weighted average results were computed the same way as in Table IX, with the new, adjusted percentages in Table XVII substituted for the percentages in Table IX.

⁹⁴ Again, the calculations were performed to four decimal places, and the numbers in Table XVII show the results of such calculations after rounding.

Appendix C: Inspection Results Tracking Sheet Instructions

Column	Column Name	Instructions for filling in data	Entry in "Notes" section required
A	Full address of inspection location	Insert full address of location visited. All locations visited, whether inspected or not, need to be recorded on tracking sheet. In the event a location could not be found it should also be recorded and identified in the notes that it could not be found.	Optional
B	Date and time of location visit	Insert the date and the time inspector arrived at location	Optional
C	Inside or outside installation	Indicated with an "I" if the ONT was installed inside the location or with an "O" if the ONT was installed on the exterior of the location. In cases where no access was available and it could not be determined if the ONT was installed on the exterior of the location (e.g., locked gate) field should be populated with a "U" for unknown.	Optional
D	Coaxial Grounding Block Installed	Indicated with a "Y" for yes for locations that had a grounding block installed and a "N" for no for locations where no grounding block was present.	Optional
E	No access	Insert an X for locations visited that could not be inspected due to no access to the location. No access is defined as any condition where access to either the ONT or the ground termination was denied to the inspector for any reason. The reason for the no access must be described in the "notes" field. No access conditions include, but are not limited to, i) entry to location was necessary and no one was present or entry was denied by persons at the location, ii) entry to the interior was necessary but only a minor was present, iii) outside inspection started but could not complete because inspector was asked to leave, iv) dangerous or unsafe condition prevented inspection, or v) installation had been disconnected.	Required
F	Properly grounded (passed inspection)	Insert an "X" in this field for all inspections where the ONT was found to be compliant with the Commission's grounding rules. Also, provide a description in the notes field of the grounding arrangement observed (e.g., ONT grounded to power company ground rod with proper clamp).	Required
G	No ground	Insert an "X" in this field if ONT is found to have no ground connection, i.e., no ground wire exiting the ONT or ground wire is open (not terminated).	Required
H	Attached to unbonded driven electrode	Insert an "X" in this field if ONT ground wire is attached to Verizon-installed ground rod that is not properly bonded to the power company primary ground.	Required

Column	Column Name	Instructions for filling in data	Entry in "Notes" section required
I	Loose ground conductor connection	Insert an "X" in this field if ONT ground wire is found to be loose either at the ONT or at the ground wire termination point.	Required
J	Multiple ground conductors under same connection point	Insert an "X" in this field if ONT ground wire is attached to a clamp or other connection point that contains another ground connection.	Required
K	Improper grounding point	Insert an "X" in this field if ONT ground wire is attached to a point other than one of the approved ground points as described in the work plan and the job aid.	Required
L	Spliced ground conductor	Insert an "X" in this field if ONT ground wire is found to be spliced or joined with something other than a compression type clamp.	Required
M	Improper clamp/clamp usage	Insert an "X" in this field if ONT ground wire is attached to the ground source with an improper clamp, sheet metal screw, or other non-approved device.	Required
N	Improper conductor or conductor length	Insert an "X" in this field if ONT ground wire is not at least 10 AWG and if it is not insulated. Also, should be marked with an "X" if the ground wire exceeds 20 feet in length.	Required
O	Improper use of TII 442	Insert an "X" in this field if inspector finds a TII 442 module was used inappropriately to ground the ONT.	Required
P	Other	Insert an "X" in this field for any non-compliant condition not covered by one of the previously identified reason for failure categories. Explain situation found in detail in the notes section of the tracking sheet.	Required
Q	Photo number(s)	Enter the photo number(s) for the photos taken at the premises	Optional
R	Detailed notes	Field must be filled in with detailed notes of the conditions found anytime an X is populated any of the fields in columns D through O. Examples of information that needs to be included include, but are not limited to: a) Reason for no access (e.g., no answer, refusal of entrance by persons at the location, unfriendly dog, inspection started but could not be completed - with explanation of why inspection could not be completed). b) Type of compliant grounding arrangement found (e.g., connected to power company ground rod, properly connected to cold water service entry pipe, proper use of TII 442 module). c) A brief description of any non-compliant grounding condition found (e.g., TII 442 used when direct ground source was available, ground wire loose on clamp, double terminations of ground wires on same clamp, sheet metal screw used in lieu of ground clamp). d) Where necessary a brief description of any other condition worth noting (e.g., ground wire run greater than 10 feet without protective conduit, insulated ground wire run through building without protective sleeve).	Required

Appendix D: Final Inspection Schedule

Relevant Area	Start date	End Date	Notes
Staten Island	4/15/2010	4/22/2010	
Brooklyn	4/5/2010	4/13/2010	
Queens	3/22/2010	4/8/2010	1) Liberty suspended inspections during the week of March 29 through April 4 to avoid conflicts with Passover and Holy Week observances. 2) Liberty drew an additional sample of 20 locations in Queens and visited all of them to ensure that the target number of inspections was met.
Bronx	4/14/2010	4/21/2010	
Manhattan	4/5/2010	5/10/2010	1) Liberty drew an additional sample of 350 locations in Manhattan and visited all of them to ensure that the target number of inspections was met. 2) Except for one day of no-access revisits to locations on Saturday, April 7, Liberty suspended inspections in Manhattan after April 13 until inspections in all other Relevant Areas were complete and additional inspectors were available. Inspections resumed on April 29 with three inspectors working in Manhattan, segmenting the island by the south, east, and west areas.
N. Suffolk	4/5/2010	4/14/2010	
S. Suffolk	3/22/2010	4/5/2010	Liberty suspended inspections during the week of March 29 through April 4 to avoid conflicts with Passover and Holy Week observances.
N. Nassau	4/8/2010	4/15/2010	
S. Nassau	4/5/2010	4/13/2010	
Western	4/5/2010	4/21/2010	1) Liberty drew an additional sample of 30 locations in the Western Relevant Area and visited all of them to ensure that the target number of inspections was met. 2) Liberty assigned an additional inspector to this Relevant Area during the week of April 19 to help with the no-access revisits and the additional sampled locations.
Central	4/6/2010	4/15/2010	1) To avoid travel on Easter Sunday for inspectors and escorts, the start date was delayed by one day. 2) A sample of 25 more locations was added to ensure that the target number of inspections was met.
Capitol North	4/6/2010	4/14/2010	To avoid travel on Easter Sunday for inspectors and escorts, the start date was delayed by one day.
Capitol South	4/19/2010	4/28/2010	
S. Westchester	4/6/2010	4/13/2010	To avoid travel on Easter Sunday for inspectors and escorts, the start date was delayed by one day.
N. Westchester	4/13/2010	4/27/2010	To minimize cost by eliminating the need for air travel and hotel stays, inspections were suspended in North Westchester after April 16 and were resumed on April 26, when a local inspector became available.
Rockland	4/19/2010	4/27/2010	