DISTRICT CABLEVISION
CABLE TELEVISION SYSTEM
TECHNICAL AUDIT

VOLUME ONE

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May 31, 2000

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EXECUTIVE SUMMARY:

This report is a Technical Audit of District Cablevision Limited Partnership's (District Cablevision) cable television system and associated Public, Educational, and Governmental (PEG) Access production facilities. The report was prepared by William F. Pohts, who was retained to consult and advise on this matter and on other technical issues relating to District Cablevision's obligations under its franchise agreement with the District.

Updated excerpts from my 1996 publication entitled: "Telecommunications & FCC Cable TV Technical Standards" are included in the following (Cable Television Basics) section of this report. Further explanations of cable television system and telecommunications technologies and a glossary of technical terms may be found in the publication.

Few cable television systems in the United States have had the degree of national media coverage of its problems, as does the District Cablevision system.

As examples:

- The May 4, 1998 issue of ***Broadcasting & Cable*** magazine said - "One year after TCI President Leo Hindery promised an audience at the Washington Metro Cable Club that he would revamp Washington's much-maligned cable system, Hindery says he has approved a system upgrade to go along with the new manager brought in at the end of last year."
- ***Multichannel News*** has published such information as - "Hindery said the District Cablevision plant was a "dinosaur," and he was

committed to making whatever investment was necessary to improve the system's performance."

The objectives of this Technical Audit were to evaluate the technical characteristics of the current District Cablevision plant in terms of:

- Does it meet Franchise requirements?
- Does it meet FCC Technical Standards?
- Has the cable system been built to serve all residents in the District?
- What sort of performance can subscribers expect from the current plant?
- Is there a basis for all the complaints about problems with receiving the local broadcast television station programming? and
- Are there any recommendations for improving the performance?

The approach followed to meet the above stated objectives for this report were the following:

- Review the system design;
- Review performance measurement records;
- Review signal leakage records;
- Review recent technical performance complaints filed with the Office of Cable Television and Telecommunications and follow up with a site visit, if indicated; and
- Conduct site visits throughout the District to evaluate plant construction, maintenance, and performance.

The report summarizes tests and observations made of the design, construction, and performance during the period of 1994 to currently and review of numerous documents from as far back as 1988. Earlier tasks were performed under direct contract to the Office of Cable Television and

Telecommunications, while some of the more recent tasks were performed as a sub-contractor to Thompson, Cobb, Bazilio and Associates, P.C.

Maintenance records show that severe, frequent and prolonged signal leakage has been common. Signal leakage can occur within the cable plant outside subscribers' homes when a cable becomes damaged or a connector becomes loose. Signal theft frequently causes these conditions to occur.

Signal leakage can also occur within subscribers' homes for several reasons. Three of the most common are that one or more connectors are loose, inferior cable is being used to extend service to several television receivers and VCRs, and that the wrong type of cable and connectors are being used to interconnect VCRs and television receivers.

When a condition occurs that permits signal leakage, this same condition permits signal ingress into the system. Since District Cablevision distributes the local VHF television station programming from Channels 4, 5, 7, and 9 at the same frequencies used by the stations, ghosting occurs.

Depending upon the degree of ingress, the amount of ghosting will vary. Slight ingress can distort pictures to producing only a faint image displaced to the side. Medium ingress results in prominent multiple images; severe ingress can cause enough interference to completely obliterate the pictures.

Signal ingress affects much more than just the local television station reception; it can have an even more profound effect upon digital signal transmissions such as the high-speed data and telephony services, as well as the digital compressed television services. Intermittent losses of signals and overall poor transmission reliability are common symptoms of ingress problems.

Records showed that the current plant has suffered from intermittent severe ingress problems for the entire past number of years that I was able to review. While significant improvements in correcting ingress problems has occurred during the past year, it is very doubtful that they can be fully corrected to the point of being able to consistently support two-way high-speed data and similar transmissions in all areas of District without a system rebuild. My review showed that the remarks which then TCI President Leo Hindery was said to have made in 1998 classifying the system as a “dinosaur” were quite appropriate.

The observations, tests performed, and records reviewed for this technical audit show clear indications of a plant that was designed and is maintained and operated under severe restraints. Throughout the technical review, major portions of the system were always missing from the records; District Cablevision was never able to provide complete “as-built” system drawings for review.

The current cable television system resulting from these restraints is one with a design that is less than optimum, operates below optimum, is in need of considerably more preventative maintenance, lacks sufficient test equipment and technical personnel to use them, has incomplete and flawed records, and provides technical performance that many subscribers have come to expect to be good some days and poor the next.

The system is not what would presently be considered “state-of-the-art” technology. While a system major rebuild would appear to me to be clearly indicated, I have not seen any formal reports or plans for the District Cablevision system upgrading or rebuild.

Until such time as the system is rebuilt, performance of the current system could be greatly improved by significantly greater efforts and resources being devoted to preventative maintenance and repairs.

The appearance and signal quality of the PEG channels were also reviewed in this technical audit. Much of the television camera and video tape recording equipment is quite old and should be replaced with “state-of-the-art” equipment. Generally, it is considered necessary to replace such equipment about every five to seven years to maintain quality performance. The review revealed that District Cablevision’s maintenance of the Public Access studio facility’s equipment needed to be improved.

The transmission links that District Cablevision provided for programming from OCTT at 2217 14th Street, NW and Public Access Playback Master Control at 1325 W Street, NW to the headend use old equipment and old coaxial cable technology. District Cablevision technicians are not able to operate the links at optimum performance because of the lack of adequate monitoring and test equipment at the headend.

The transmission links from UDC and Penn Center to the headend and between OCTT and One Judiciary and the District Building use fiber optic technology and are leased from Bell Atlantic.

As a part of any rebuild, District Cablevision should be able to provide high quality fiber optic links for PEG programming transmission to replace the coaxial cable links and those leased from Bell Atlantic. These, together with replacement of all old cameras, video tape recorders, and associated necessary equipment with state-of-the-art equipment and preventative maintenance of the retained equipment should provide a considerable improvement to PEG programming technical quality.

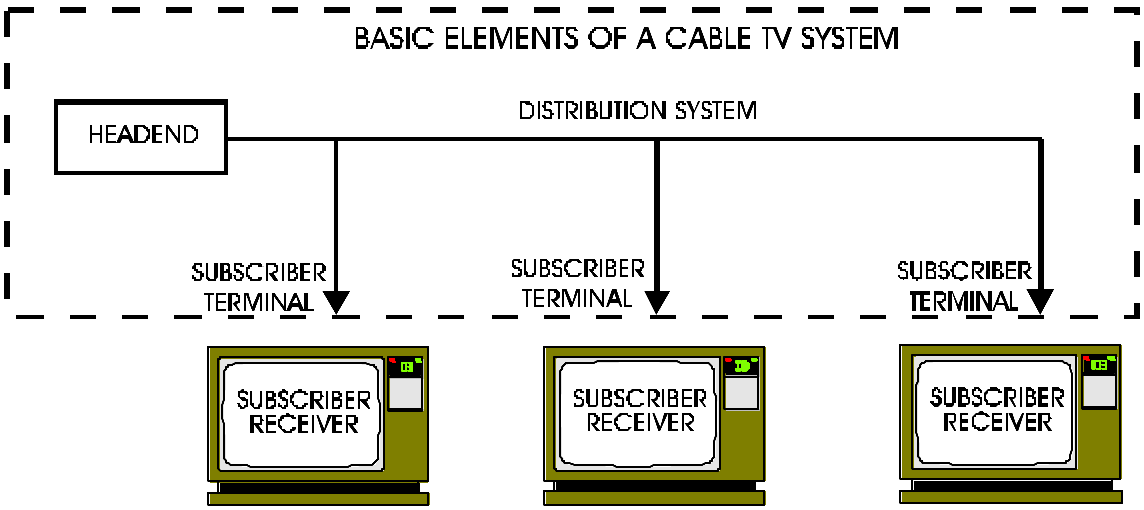
In conclusion, the review of past records, tests performed, and observations made as a part of this technical audit found the following:

1. The system did not meet all Franchise requirements in such areas as not providing an Institutional Network, emergency override not being provided, upgrading, and grounding and safety considerations.
2. The system can be shown to meet an FCC Proof-of-Performance, but many subscribers will still experience performance below FCC Technical Standards.
3. The system has been built to physically be able to serve all residents in the District. However, the current system is not able to provide the advanced services such as high-speed data and other digital based services on a consistently reliable basis to all residents without a major rebuild.
4. Although District Cablevision has increased its maintenance efforts during the past year, many subscribers can expect to experience poor performance until a major rebuild is completed.
5. Several reasons for complaints about problems with receiving the local broadcast television station programming include: signal ingress into the system causing ghosting; poor or loose connections within subscribers' homes allowing ingress causing ghosting; frequent intermittent outages or damages caused by falling tree limbs; and signal theft damaging the cables and allowing ingress into the system.
6. Some recommendations for improving performance include: much greater preventative maintenance; additional test and monitoring equipment; replacement of malfunctioning and out-of-date equipment

with state-of-the-art equipment; and a major system rebuild are indicated.

CABLE TELEVISION BASICS:

The basic elements of a cable television system are the headend, a distribution system, and subscriber terminals.

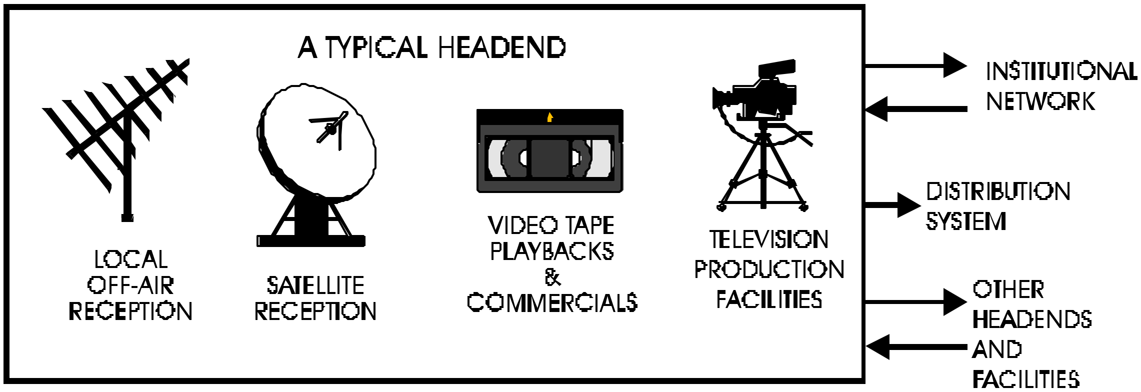


THE HEADEND

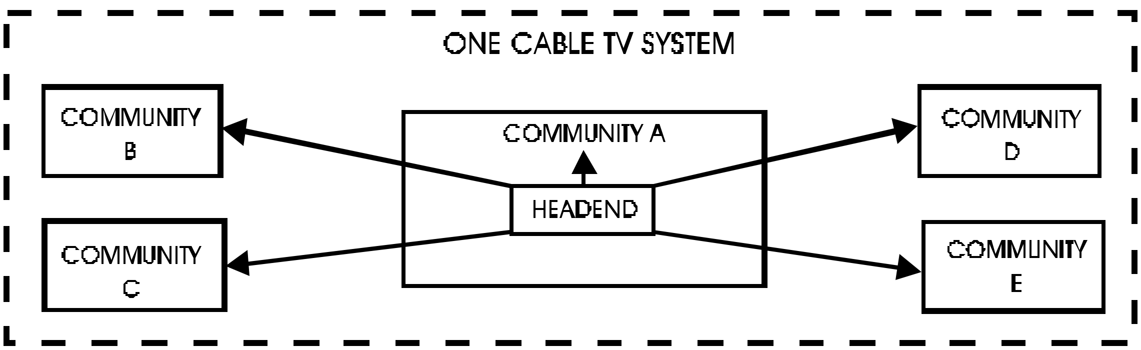
The headend is like the "Brains" of the cable television system. A typical headend is a combination of equipment used to receive local off-the-air radio and television stations, receive satellite transmitted programming, has television production facilities, and playback facilities for video taped programming and commercial inserts. Video, audio, and data signals may be interconnected with an institutional network and other headends and facilities.

The headend may contain equipment such as a tower, antennas, receivers, processors, demodulators, decoders (descramblers), amplifiers, switchers, patch panels, cameras, video tape recorders, character generators, encoders (scramblers), modulators, and associated equipment.

Sometimes, the off-the-air and satellite receiving antennas are located at a site remote from the headend. The signals are transferred to the headend on coaxial cables, microwave, or fiber optic cables.



One headend may be used to serve several communities. Each community may have a separate franchise agreement with the cable operator. However, the FCC considers the composite of all the equipment used for Community A, B, C, D, and E to be one cable television system, for technical standards purposes.



THE DISTRIBUTION SYSTEM

All cable television systems have at least one fundamental distribution network with the main purpose of providing television programming to households; some also provide an audio (sound) service such as FM radio stations or digital music, and yet others also provide data services such as stock quotations. Common labels for this network are the **Subscriber Network**, the Residential Network, Home Subscriber Network, and other similar names. This network usually also provides its programming services to businesses such as offices, hotels, and restaurants.

Some cable television systems also have a second network which provides television (also simply called video), data (typically computers), and voice (another name for telephone) transmission links for institutions and businesses with interconnecting transmission links from Public, Educational, and Governmental (PEG) Access Production Facilities (studios, video tape playback master control, etc.) and the cable television system Subscriber Network (typically the headend). A common label for this network is the **Institutional Network**. Typical institutional users are local governments; schools; libraries; colleges and universities; and hospitals. Some cable companies might use the Institutional Network for both Institutional and Business Services. Typical business users are banks, corporate offices, hotels, and convention centers.

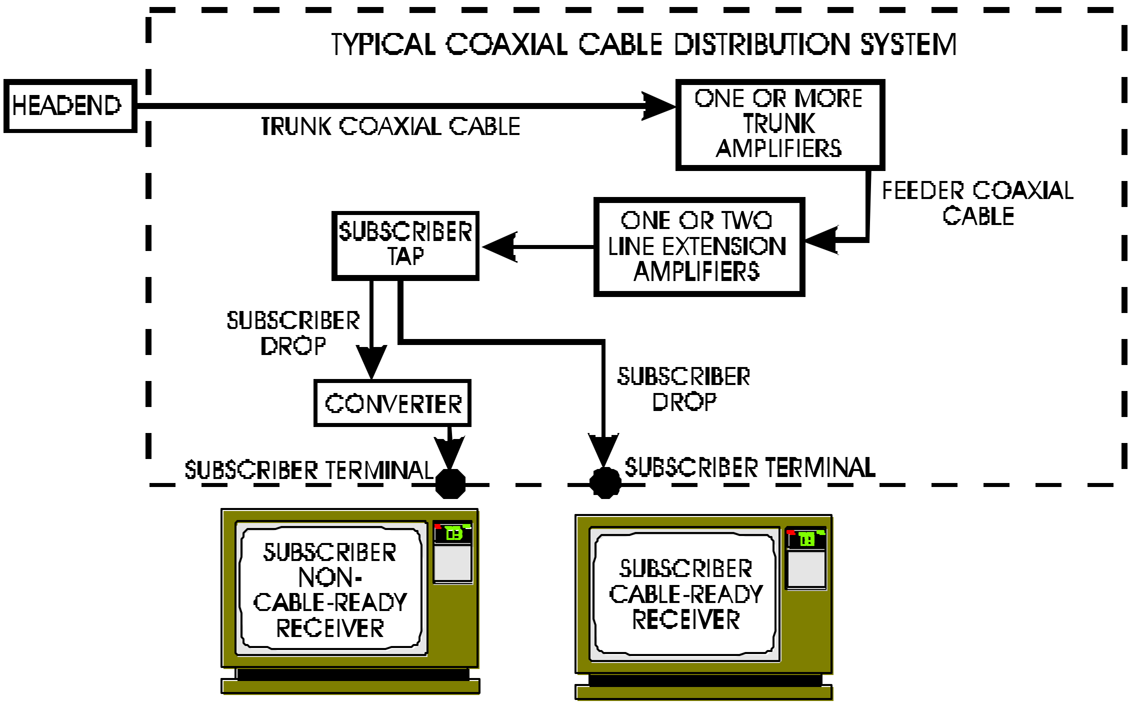
Some cable television systems have additional dedicated transmission links, which are, strictly speaking, neither a Subscriber Network, nor an Institutional Network, nor a Business Network. These are generally short links connecting two or more locations and do not share the transmission medium with other users. For example, a cable might exist between two offices or between a production studio and the cable system headend.

Most television programming distributed to subscribers on cable television systems today is transported as NTSC (National Television Standards Committee) signals in the analog format. NTSC signals are the same as what VHF and UHF broadcast television stations use for their transmissions.

An increasing number of cable television systems are transporting television signals in various digital formats, utilizing digital comparison technologies. However, even if transported in a digital format, they are delivered to subscribers in an analog NTSC signal.

Cable Television Subscriber and Institutional Network distribution systems take many different forms. Most existing systems use coaxial cable to some degree. Many use additional transmission technologies, such as fiber optics and microwave. Cable Television Subscriber and Institutional Network distribution systems being upgraded and/or rebuilt today are making heavy use of fiber optic technologies.

A typical Subscriber Network distribution system using all coaxial cable is depicted in the following simplified diagram. It utilizes coaxial cable for the larger trunk cables (generally ranging from 3/4 to 1 1/8 inch diameter), smaller feeder cables (generally about 1/2 inch diameter), and subscriber drop cables (generally about 1/4 inch diameter). The number of trunk amplifiers in cascade between the headend and the furthermost subscriber may be as high as 30 or 40 in some systems. However, the number of line extension amplifiers is usually not more than one or two, primarily because they tend to degrade the transmitted signals faster than trunk amplifiers. [1] Subscriber taps are available with a number of output ports (usually up to eight) to serve multiple subscriber drops.



Signals can be distributed in two directions on some cable television systems. All cable television systems distribute television programming signals "**downstream**" from the headend to subscribers. Some also include FM radio station and digital music programming downstream to subscribers.

Some cable television systems can also distribute signals "**upstream**" from subscribers to the headend. Upstream transmission frequencies are in the range from 5 to 30 MHz in older systems and 5 to 40 MHz in currently being upgraded/rebuilt systems.

Cable distribution systems are classified in terms of what frequencies are used for transmission, where the upstream and downstream transmission frequency split occurs, and their upper transmission frequency limit. The following table shows the classification based upon the upstream and downstream split.

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[1] Some new types of amplifiers being used in cable television system rebuilds utilize amplifiers being called "system amplifiers."

Type	Upstream Bandwidth (MHz)	Number of Upstream Channels	Downstream Bandwidth (MHz)
Sub-Split	5 to (30 or 40)	4 to 6	54 to upper limit
Mid-Split	5 to 108	17	150 to upper limit
High-Split	5 to 175	28	225 to upper limit

The following table shows the number of standard television channels[2] that can be distributed on the most common systems used to distribute to subscribers' homes. [3] The table is based upon a two-way sub-split or one-way distribution system with the downstream portion beginning at about 54 MHz.

Upper Frequency Limit (MHz)	Approximate Number of TV Channels
300	35
330	42
400	54
450	60
550	80
750	115
860/870	135

Television signals are distributed in cable television systems at some transmission frequencies that are different than those used by standard VHF and UHF television stations. Cable-ready television receivers have a switch that permits them to tune the cable television system frequencies instead of the standard broadcast television station frequencies. Older cable-ready receivers were only able to tune 35 cable television channels. Modern cable-ready receivers are able to tune as many as 80 and more cable channels.

USE OF FIBER OPTICS

Cable television systems are increasingly using fiber optic technology in their distribution systems. The following drawings will show the basics of how fiber optic cables are used to nodes placed throughout the area to be served; at the nodes, the signals from the fiber optic cable is transformed into electrical signals and continue to subscribers over the traditional coaxial cables as was shown earlier in a typical coaxial cable plant.

[2] A standard television channel is one utilizing 6 MHz (6 Megahertz or 6,000,000 Hertz) of spectrum.

[3] The actual number of channels can vary slightly depending upon whether FM signals are distributed and if some channels may not be used due to interference from and to other services.

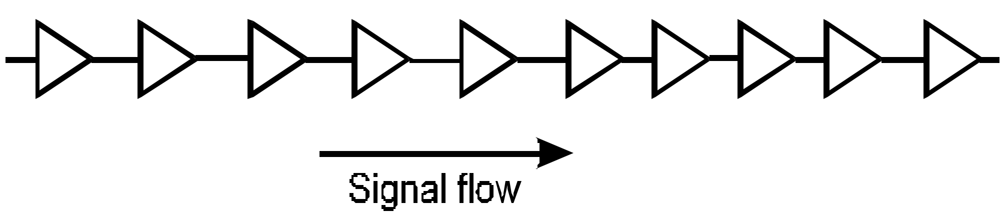
The quantity and placement of nodes is dependent upon mostly marketing reasoning rather than technical reasons. The cable company tries to predict how much demand there will be for pay-per-view movies and events, replays of the evening news and other programs, high-speed data transmission services like internet and stock networks, and traditional pay services. Each node is designed and equipped to serve from 100 to 1500 homes passed.

Initially, a node may be designed to serve far fewer homes passed then for which all-necessary equipment has been provided. For example, the node may be placed with the necessary equipment to serve 1000 homes passed. However, later, because of the way the node was designed, equipment is added, and distribution from the node is subdivided, resulting that each segment of the same node now being able to serve 250 homes passed.

One of the main reasons for installing fiber to fiber/coaxial cable nodes are to have short amplifier cascades[4] or to break up the long cascades of trunk amplifiers. The signal transmission **performance and overall reliability increase** as the number of amplifiers in cascade decreases.

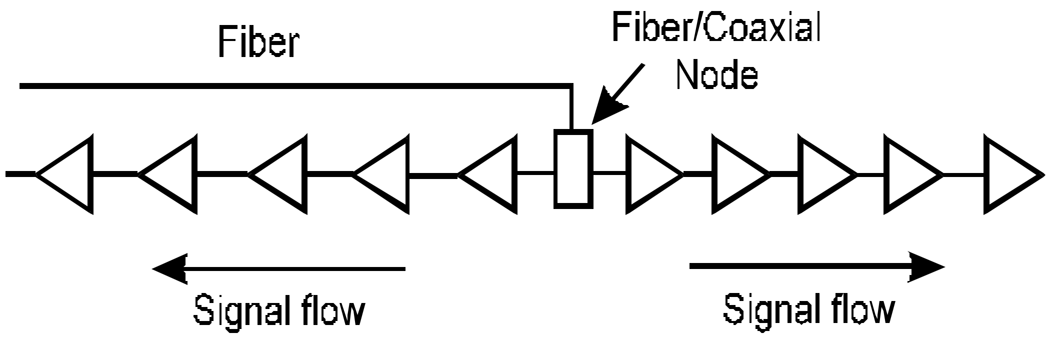
Modern system upgrades and rebuilds are based on from a maximum of a total of from 3 to 12 coaxial amplifiers between the node and the furthermost subscriber. 550 MHz systems tend to use up to 12; 1GHz systems used 3 as maximum; and most 750 and 860 MHz systems use a maximum of about 4 coaxial amplifiers in cascade following a node. One cable company, just up the road from my home, has rebuilt major sections in their system with no additional coaxial cable amplifiers following the node.

The following drawing shows 10 amplifiers in series (cascade). Performance for subscribers served off of the first amplifier is significantly better than those served off of the tenth amplifier. Also, any disruption or signal loss anywhere along the line will affect those subscribers down the line.

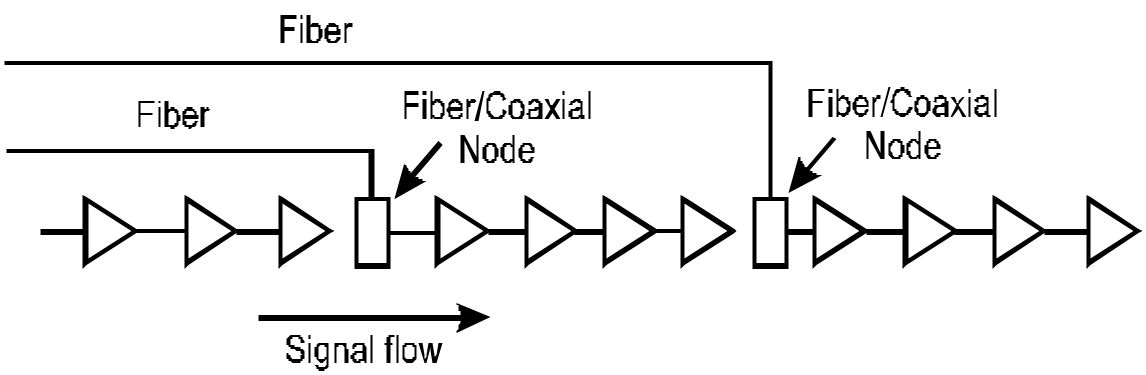


[4] Number of amplifiers in line to the most distant subscriber.

The next two drawings show two common ways of installing fiber nodes to break up the long cascade. In the first drawing, a node is inserted midway in the ten amplifier cascade and five of the amplifiers are turned.



In the following drawing, the cascade is broken into sections with smaller numbers of amplifiers, fiber optic cable is installed to each of the locations, and a fiber node is inserted at the beginning of each new section; amplifiers are not turned. This is also frequently called a type of **fiber backbone** system.



It used to be common for cable television systems serving large geographic areas to have some very long amplifier cascades and break up the plant into smaller sections served from **Hubs**. They frequently used special high performance amplifiers (as a super trunk or transportation trunk) or microwave transmissions from the Headend to the Hubs to reduce the number of needed regular amplifiers. In today's system rebuilds and upgrading such special trunks and microwave systems are being replaced with fiber optic cables to the Hubs.

SUBSCRIBER TERMINALS

A subscriber terminal is the **interface point** between the cable television system (cable operator owned equipment, such as drop cable and converters) and subscriber owned equipment. It is usually the input terminal of the subscriber's television receiver or VCR. It is **never** the converter input, **unless** someone other than the cable operator provides the converter.

The term **subscriber terminal** is **sometimes mistaken** for similar sounding terms such as: subscriber set-top terminal, set-top terminal, set-top, or subscriber set-top. These are merely other names for a converter and **not** the term subscriber terminal as defined in FCC Cable Television Technical Standards.

SIGNAL SECURITY

Several different methods and equipment are currently being used for signal security to control access to pay programming such as HBO, pay-per-view programming such as first run movies, and various programming tiers. These include: positive trapping, negative trapping, scrambling, interdiction, addressable traps, and addressable converters.

Positive trapping utilizes an encoder at the headend to insert an interference signal into the programming signal. For a monthly fee, the cable operator installs a trap to remove the interference signal at the subscriber's home. Unfortunately, not all receivers respond the same way to the interference signal; some receivers will produce a viewable picture and the sound portion of the programming may be heard without any interference. Programming carried on positive trapped channels frequently tend to have reduced resolution or sharpness; this is because when the trap removes the interference signal it also removes some of the picture video signal.

Negative trapping utilizes a trap at the subscriber's home that removes the programming signal. For a monthly fee, the cable operator removes the trap at the subscriber's home permitting the programming signal to be received. Unfortunately, not all receivers respond to the trapped signal the same way; some receivers will produce a viewable picture and the sound portion of the programming may be heard.

Scrambling takes several different forms. The most common form utilizes an encoder or signal scrambler [5] at the headend. The encoder may scramble the picture or both the picture and sound programming signals.

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[5] Similar to the encoder used for positive trapping, but not the same.

Descrambling is accomplished at the subscriber's receiver by either a descrambler located within a converter or an external descrambling/decoding device.[6]

Interdiction utilizes interference generators located at subscribers' homes. The programming signals are distributed from the headend free of any interference signals. At the subscriber's home, interference signals are inserted in accordance with whatever programming the subscriber is not authorized to receive. Interdiction systems contain an addressable feature controlled from the headend without the need for a technician to go to the home. The main subscriber advantage of an interdiction system is that the signals can be fed directly to a cable-ready television receiver without the need for a converter. However, interdiction systems are limited to the number of channels or combinations of channels, which they can control or provide sufficient interdiction interference.

Addressable traps can also be installed at subscribers' homes to permit control of inserting positive and negative traps controlled from the headend without the need for a technician to go to the home. Addressable traps are usually limited to only a few (about four) at any location.

Addressable converters contain a decoder/descrambler section, which can be controlled from the headend without the need for a technician to go to the home. Addressable converters can usually control many channels and many combinations of channels.

CABLE TELEVISION SYSTEM EVOLUTION

Cable television systems are in the midst of radical changes and technology evolution. Major multiple system operators (MSO) have announced that they are either rebuilding or will be rebuilding most of their major systems. The reasons are to be able to provide more television programming services, high-speed data services, and telephony – and the need to compete with those who want to overbuild an existing system - whether it is current state-of-the-art or not, and those who want to provide programming by other means - such as direct broadcast satellites, OVS (Open Video Systems) replacing video dialtone, or wireless cable.

[6] Various external decoders have been considered for connecting to the television receiver without the need for a converter. The most common of these were those associated with the Multiport Connector installed on some television receivers.

The state-of-the-art for cable television systems has advanced greatly in the last few years. Currently, the state-of-the-art is to rebuild to either 750 MHz or 860 MHz systems. [7]

Digital compression of television signals has opened a whole new set of opportunities for cable television systems as well as competing emerging technologies. Instead of transmitting only one television program in a 6 MHz bandwidth, we now transmit four to twelve.

However, following an overall rule of life of not getting something for nothing, the greater the compression - the greater the degradation of the signal. The amount of degradation is also affected by the program content and may not be visible or objectionably noticeable to the "average" viewer. [8] Basically, the degradations tend to be seen as loss of picture sharpness and details for lettering and for moving objects.

In order for a cable television system to distribute television programming using digital compression technology, standard television signals need to be converted to digital signals and compressed at the headend or they could also be received in the proper digitally compressed format via satellite transmissions from a service such HITS (Headend in the Sky), which was established by TCI around 1996. To view digitally compressed television programming, subscribers must be provided with a special type of converter capable of decoding the compressed signals; such converters cost about $400 each depending upon the options and quantity purchased.

The use of digital compression technology has resulted in considerable confusion with the term **"channel."** Until recently, a cable television system or broadcast television station television channel has meant only one standard NTSC television signal occupying 6 MHz of bandwidth.

Some cable television system operators are claiming that their systems can distribute 500 or 750 or even 1000 television channels to subscribers. To distribute 500 television **"channels"** would require a bandwidth of over 3000 MHz; 750 television channels would require a bandwidth of over 4500 MHz; and 1000 television channels would require a bandwidth of over 6000 MHz. What these operators are talking about are **"television signals"** or perhaps better described, to avoid confusion, as **"video services" – not "channels."**

Some of the first claims that cable television systems would be able to carry 500 channels to subscribers were based upon the use of 6 to 1 digital compression technology. The 6 to 1 compression permitted six video services

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7 Some manufacturers are expanding the 860 to 870 MHz or further.
8 Whatever an "average viewer" is?

to be carried in a 6 MHz bandwidth. Therefore, a 550 MHz system (which can be loosely described as having 500 MHz of downstream bandwidth from 50 to 550 MHz) could carry 500 **"video services."**

Currently in use digital compression of television programming signals is twelve television signals carried in 6 MHz of bandwidth. Therefore, if all television programming signals on a cable television system were carried using this 12 to 1 level of digital compression, a 750 MHz system (which can be loosely described as having 700 MHz of downstream bandwidth from 50 to 750 MHz) could carry 1,400 **"video services."**

For the foreseeable future, cable television systems will be distributing **"video services"** in various combinations. Some will continue to use standard NTSC television programming signals, with each requiring 6 MHz of bandwidth, while others will use digital compression technologies with many different compression ratios.

HIGH-SPEED DATA

As cable television systems are upgraded to greater bandwidth transmission capacity and made into two-way systems, they are a natural choice for the transmission of high-speed data such as Internet and similar services. High-speed modems being manufactured today have downstream transmission capabilities of up to around 30,000,000 bits/second. Cable operators are currently using several transmission data rates.

Basically, high-speed data (generally up to 1,500,000 bits/second) is being sent downstream to homes and low speed (generally up to 256,000 bits/second) upstream from the homes, based upon the assumption that homes mostly send low quantity data control and request transmissions rather than large amounts of graphic material.

Some cable television companies are using an interim approach of using the telephone line to the home for the return path (limited to slightly less than 56,000 bits/second) until such time as they can upgrade their cable system to two-way for upstream signals.

Whichever approach is chosen, the modem in the home is a box about the size of a small converter; it will be interconnected to the home computer by means of installing an Ethernet networking type card in the computer or connecting to one of the computer's external ports.

CABLE TELEVISION TELEPHONY

A lot of cable television systems are planning or at least considering providing telephone service to homes. Any system providing telephone service will have to become a two-way system and be highly reliable to be successful at the telephone business; these could also provide huge benefits to cable television service subscribers.

The basic plan is that the cable television system would be upgraded to a two-way 750 or 860 MHz system fed by a number of fiber nodes. Transmissions from the cable television system headend downstream to the homes would be in the 50 to 750 or 860 MHz part of the spectrum and upstream from the homes to the headend in the 5 to 40 MHz region. Some systems use other combinations of frequencies for downstream and upstream transmissions.

An interface box (NIU or Network Interface Unit) attached to the side of the house would provide interconnection to the coaxial cable inside the home for television transmissions and to telephone wires inside the home for telephone service. Various options would also provide connections to utility meters. Power for the electronic equipment in the NIU could come from either inside the home being served or from the cable television system distribution plant.

SYSTEM RELIABILITY

Probably everyone has seen the documentaries and heard the stories of how the early cable television systems were established to basically only pick up and distribute distant television stations; very few, if any, such systems still exist.

Cable television systems now distribute many distant television stations, satellite delivered signals, and local programming around-the-clock 24 hours a day and seven days a week. I doubt that there is any time of the day or night that a transmission outage will not affect some subscriber.

As cable television systems begin distributing high-speed data services and telephony services to subscribers, there has been an increased concern regarding the reliability of the systems.

Telecommunication and cable television system reliability is commonly referred to as ***"the number of nines."***

The number of nines defines the percentage of time that a system is providing acceptable service, or on the other hand, when an outage condition does **not** exist.

The following table lists the operational and outage times for some of the more commonly cited number of nines.

RELIABILITY %	OPERATIONAL (MINUTES/YEAR)	OUTAGE (MINUTES/YEAR)	OUTAGE (HOURS/YEAR)	OUTAGE (DAYS/YEAR)
90.000	473,040.00	52,560.00	876.0000	36.5000
99.000	520,344.00	5,256.00	87.6000	3.6500
99.900	525,074.40	525.60	8.7600	0.3650
99.990	525,547.44	52.56	0.8760	0.0365
99.999	525,594.74	5.26	0.0877	0.0037

60 minutes/hour x 24 hours/day x 365 days/year = 525,600 minutes/year

Companies tabulate their outages in many different ways. Some may consider an outage to occur only when all subscribers lose all programming services; others will consider certain percentages of subscribers to be the deciding point; many exclude “acts of God;” and most exclude all scheduled outages.

Two design features of cable television systems that greatly affect reliability are standby power and status monitoring.

STANDBY POWER

One of the most definite conditions that can cause outages in a cable television system is the loss of electrical power. To deal with these common happenings, cable television systems utilize several forms of standby power equipment in different degrees.

At the Headend and Hubs, electrical power generators and some form of UPS (uninterruptible power supplies) are usually always provided. The generators are powered by propane gas, diesel or gasoline engines and come on automatically a few seconds after the loss of regular electrical power company power. Sufficient fuel is stored to allow for continued operations for from a day to several days.

Also, UPS equipment is frequently provided for computer and memory-based equipment that cannot tolerate any interruptions. Many of the best Headends and Hubs are using battery based UPS style equipment for practically all of their equipment so that no interruptions will occur.

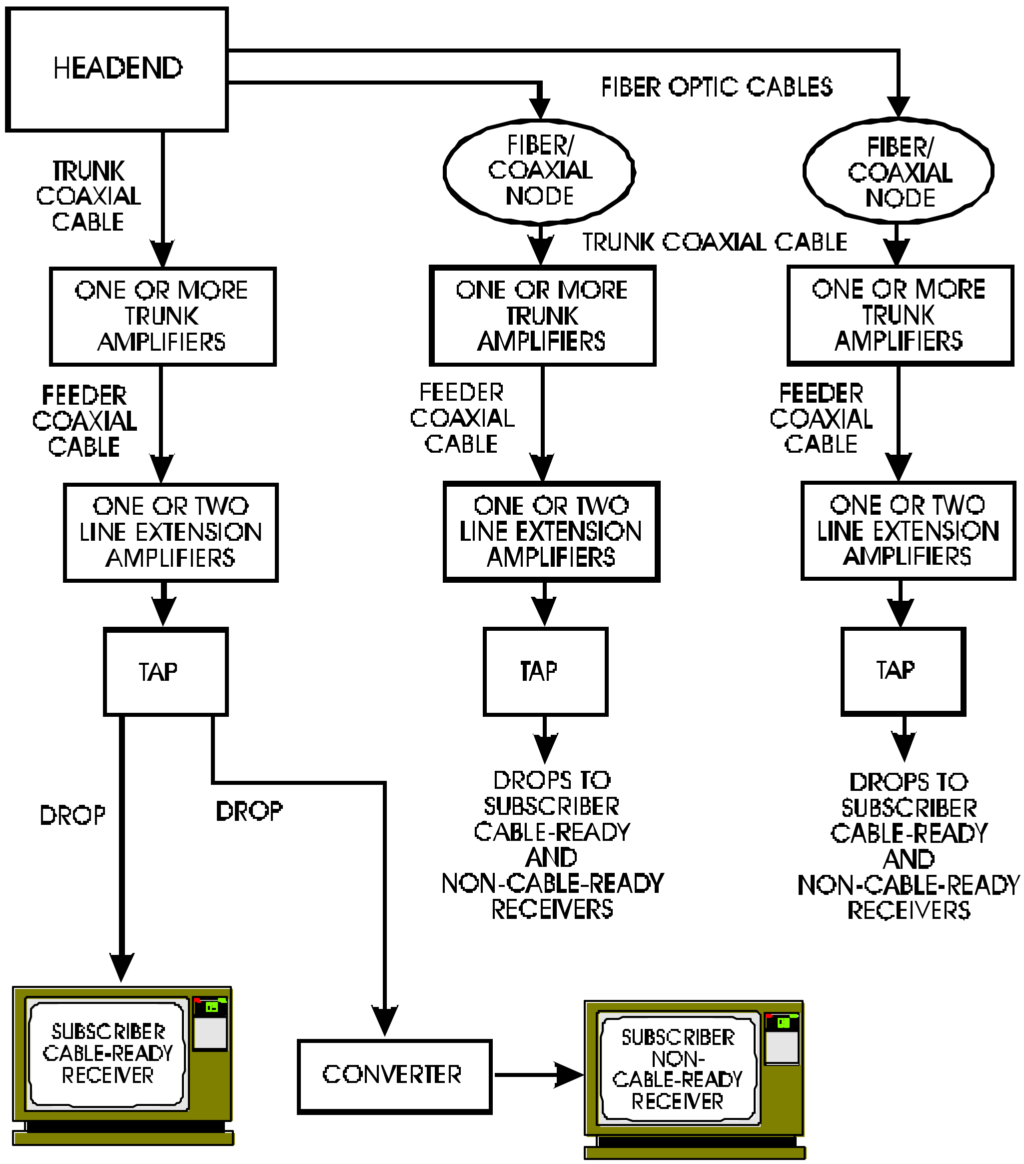
The power supplies at the fiber optic nodes and for the coaxial cable amplifiers throughout the distribution system are backed up with batteries capable of providing from 2 to 6 hours of continued operation. Some of these power supplies are being installed with combinations of batteries and fuel-powered generators to allow for longer back up times.

STATUS MONITORING

The main reason for having a status monitoring system is to alert personnel that something has happened or is about to happen **before** it has caused an outage or affected performance to where subscribers will be affected.

Good status monitoring systems alert such conditions as: that signal levels have changed; the charge conditions of batteries in standby power equipment; utility electrical power has been lost and that section of the system is operating on batteries; temperatures within equipment have changed; or a door has been opened.

SUBSCRIBER NETWORK:



DISTRICT CABLEVISION SUBSCRIBER NETWORK DISTRIBUTION PLANT

District Cablevision's Subscriber Network distribution system utilizes coaxial cables and fiber optic cables. The coaxial cable portions use coaxial cable known as "trunk" and "feeder" cables. For the fiber optic portions of the plant, fiber optic cables go from the Headend to three fiber/coaxial nodes, where the distribution continues via traditional coaxial cable plant methodology. The portion of the system utilizing the combination of fiber optic cables to nodes and then distribution via coaxial cable is typically refered to as a hybrid fiber coaxial (HFC) configuration or plant.

Distribution within the District is divided along the following six general areas:

1. One trunk leaves the Headend, branches out, and serves the area to the Northwest;
2. One trunk leaves the Headend, branches out, and serves the area to the Southwest between Rock Creek and the Southern boundry of the Potomac River;
3. One trunk leaves the Headend, branches out, and serves the area to the North to the Northern border;
4. A fiber optic cable leaves the Headend, goes to a fiber node near the Capitol, and serves the business/central area between Benning Road Bridge to the North and the Washington Channel to the South;
5. A fiber optic cable leaves the Headend, goes to a fiber node near the Sousa Bridge, and serves the Northeast area; and
6. A fiber optic cable leaves the Headend, goes to a fiber node near the Douglas Bridge, and serves the Southeast area.

Obtaining complete and accurate information from District Cablevision during this Technical Audit was much more difficult than I normally encounter. Many of the system plant drawings were always "in the process" of being drawn or otherwise incomplete or could not be found. Most of the monthly reports, which District Cablevision submitted over the years, were plagued with erroneous data regarding system technical details.

However, District Cablevision estimated that the total Subscriber Network plant length is about 1,055 miles. Of these 1,055 miles, about 772 miles are aerial (above ground) plant and 283 miles are underground plant.

For the most part, the Subscriber Network is a one-way 450 MHz system capable of providing to subscribers about 63 standard television channels of programming and digital music in the FM Band.

My understanding is that a small portion of the Subscriber Network distribution plant was upgraded to two-way 750 MHz and two fiber nodes were added to provide high-speed internet serves to AT&T DC office and to the National Cable Television Association headquarters at 1724 Massachusetts Avenue, NW around the beginning of 1999.

In 1998, District Cablevision began installing equipment shown in photographs A – 11, A – 12, and A – 22 to receive digitally compressed programming being distributed via satellite from the Headend in the Sky (HITS) transmission center near Denver. Currently, digital compression permits twelve television programs to be distributed in a 6 MHz portion of spectrum in place of one standard analog television channel.

District Cablevision is currently distributing the “four pack” which provides up to 48 television programming options or “video services” in place of four regular standard analog television channels. The options included pay and pay-per-view programming, as well as additional regular programming.

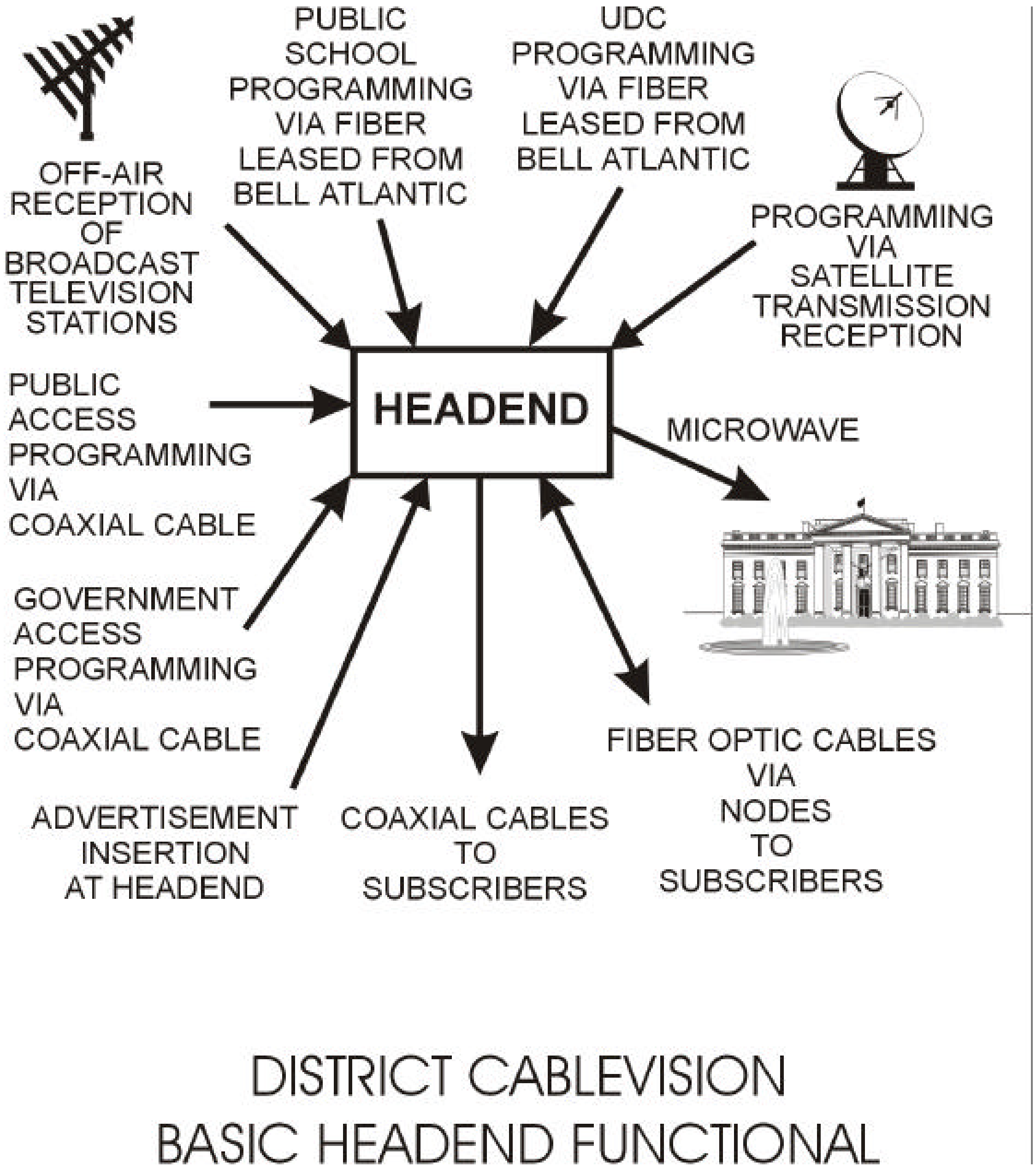
Digital compression is mostly suited for distribution of motion picture film programming, due to the fact that the sharpness of the pictures are more noticeably reduced on standard non-film programming. However, depending upon the size and quality of the television receiver, many subscribers will not see the reduced sharpness.

Utilizing the HITS “four pack” with 12 to 1 compression increased the number of television programs or “video services” which can be carried to about 107 (59 standard analog plus 48 digitally compressed). **These numbers can vary greatly depending upon how many standard channels are converted and the programming actually carried on each of the digitally compressed lineups.**

A subscriber must use a special piece of equipment to receive and the decode programming transmitted by digital compression. The new digital converter box and its remote control are shown in photographs A – 82 and A – 83.

The new digital converter boxes replaces any converter and the addressable converter shown in photograph A – 84, which may have been being used previously.

SUBSCRIBER NETWORK HEADEND:



Photographs A – 1 through A – 36 show views and descriptions of the equipment and facilities of the current headend located at 1351 Florida Avenue, NW and the previous headend, which was located at 1328 Florida Avenue, NW.

The current Headend is located at 1351 Florida Avenue, NW at the intersection of Florida Avenue and 14th Street. This location is effectively across the street of Florida Avenue from the Office of Cable Television and Telecommunications production and office facilites on 14th Street.

In 1995, 1351 Florida Avenue, NW served as only the remote reception site for local broadcast stations, and the remote reception site for satellite transmitted programming, and a television production studio. The actual Headend was located about a half block away at 1328 Florida Avenue, NW. Coaxial cables transmitted signals received at the remote reception (current Headend location) to that Headend.

Although the records are somewhat sketchy, records indicate that in 1988 there was an additional Headend located in the Southeastern portion of the District. The remote reception site at 1351 Florida Avenue, NW was interconnected to the second Headend site via the microwave antennas shown on the tower photograph A - 3. This Southeastern Headend location has since been replaced and signals for the area are distributed from the current Headend to the area via fiber optic cables.

The current location of the Headend at 1351 Florida Avenue, NW will probably not be the Headend location for this system very much longer. For about the past two years, TCI and District Cablevision officials have been saying publicly that they plan to upgrade the system to a 750 MHz system.

As a part of the expected upgrade, I have come to understand that many more fiber nodes would be deployed throughout the District and the current Headend would be re-located. The current Headend at 1351 Florida Avenue, NW could become only one of several Hubs used for fiber optic deployment. Photograph A – 18 shows some of the new modulators and processing equipment being prepared for installation at 1351 Florida Avenue, NW.

Several sites have been under consideration for the new Headend, including: the District Cablevision offices area at 900 Michigan Avenue, NE as well as outside the District somewhere between the District and Baltimore.

Photographs A – 9 and A – 10 show the Emergency Alert System (EAS) equipment installed in the fall of 1998. This equipment has the capability to provide the emergency override Franchise requirements. **Present District Cablevision personnel had no knowledge of emergency override equipment, as required by the Franchise, ever having been installed.**

Not withstanding expected re-location of the current Headend, I found the receiving and processing equipment that have been being used at the Headend to be of good quality but old and limited in quantity. **Although there is sufficient equipment to receive and process the signals currently being distributed on the system, equipment which would be used to monitor the quality and permit optimization of the quality of the signals are practically non-existant at the Headend.** Equipment such as program routing switchers, high quality video monitors, waveform monitors, vectorscopes, sound level meters, high quality stereo amplifiers and speakers, patch panels, and associated equipment are typically used for these monitoring and optimization functions.

Also, the lack of sufficient test equipment was a continued problem throughout the technical audit, making it difficult, and many times impossible, for District Cablevision personnel to make accurate measurements of equipment performance. **The lack of adequate and appropriate test equipment, along with insufficient monitoring equipment cited above have made it virtually impossible for District Cablevision personnel to be able to optimize the performance.**

DISTRICT CABLEVISION DEDICATED COAXIAL CABLE LINKS:

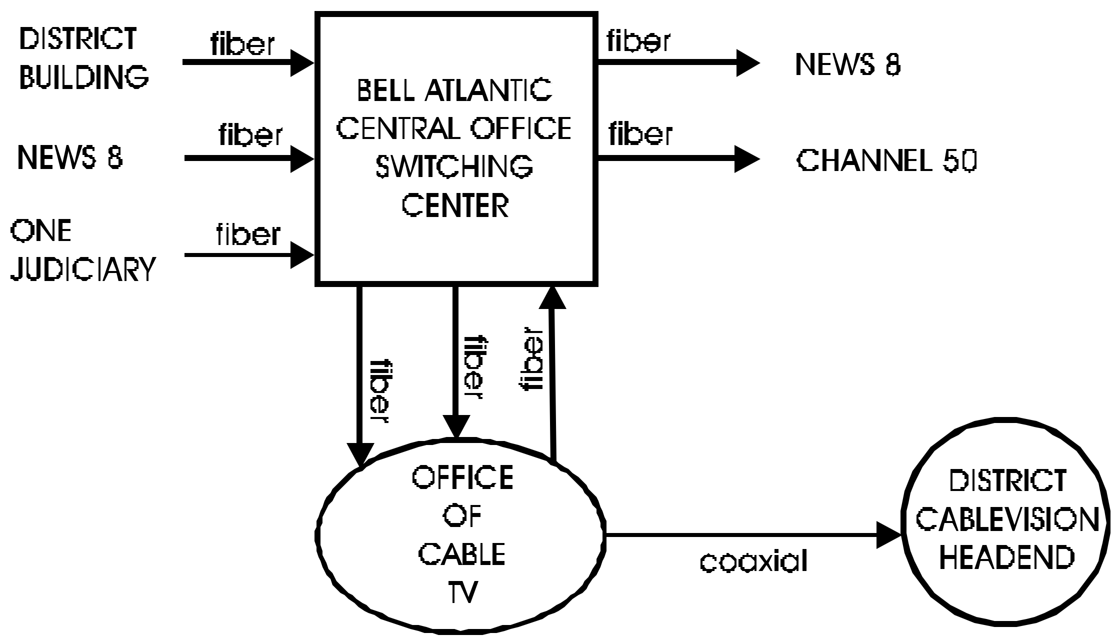
Public Access provides television programming on the Subscriber Network for Channels 25 and 26. District Cablevision uses a dedicated coaxial cable separate from the Subscriber Network coaxial cables to transmit programming from the Playback Master Control at 1325 W Street, NW to the Headend.

Governmental Access television programming for the Subscriber Network Channels 13 and 16 are controlled and played back from the Office of Cable Television production facilities at 2217 14th Street, NW. Programming from various sources are transmitted to the Office of Cable Television production facilities on transmission links/lines leased from Bell Atlantic. Programming from the Office of Cable Television production facilities at 2217 14th Street, NW is combined with the programming from the Public Access Playback Master Control at 1325 W Street, NW in the 2217 14th Street, NW basement on the same dedicated coaxial cable and transmitted to the Headend.

The equipment used for transmission on this dedicated cable is old technology. The lack of adequate and appropriate test equipment, along with insufficient monitoring equipment have made it virtually impossible for District Cablevision personnel to be able to optimize performance.

TRANSMISSION LINKS LEASED FROM BELL ATLANTIC:

Programming from the District Building and Judiciary Square have used fiber optic links, leased from Bell Atlantic, to bring television and to the Office of Cable Television production facilities at 2217 14th Street, NW. Fiber links have also interconnected with Television Channel 50 (WFTY) and Newschannel 8.



The DC Public Schools' Cable Channel 28 is programmed from a television production facility at Penn Center at 1709 Third Street, NE.

Signals are transmitted directly to the Headend via a leased Bell Atlantic fiber optic link.

The UDC Cable Channel 28 is programmed from the UDC television production facility at 4400 Connecticut Avenue, NW. Signals are transmitted directly to the Headend via a leased Bell Atlantic fiber optic link.

SUBSCRIBER NETWORK DISTRIBUTION SYSTEM:

Photographs A – 37 through A – 84 show views and descriptions of the equipment and facilities which are a part of the distribution system.

Basically, the distribution system accepts the signals from the headend and transmits them to subscribers. For some services, such as ordering pay programming, high-speed data and telephony, signals can also be transmitted from the subscribers to the headend on the distribution system.

Fiber optic nodes, coaxial cable amplifiers, splitters, subscriber taps, and filters can be seen in photographs such as A – 37, A – 38, A – 39, A – 41, A – 45, A – 46, A – 48, and A – 61.

Cables comprising a drop can be seen in photographs such as A – 40, A – 45, A – 47, A – 48, and A – 50. Photograph A – 39 provides a special view of the tags used to identify the classification of the of drop; white signifies an active drop, while orange indicates the the drop has been disconnected.

Boxes used to contain ground blocks and splitters at homes and Multiple Dwelling Units can be seen in photographs such as A – 49, A – 51, A – 53, A – 54, A – 57, A – 59, A – 60, A – 62, A – 64, A – 66, A – 67, A – 69, A – 70, A – 71, A – 72, and A – 78. The box shown in photographs A – 54 and A – 55 is an example of a location not in accordance with the current National Electrical Code because the ground wire is not connected. Boxes in such photographs as A – 49, A – 50, A – 57, A – 58, and others may be in accordance with the current National Electrical Code, but the connection to electrical ground could not be fully determined.

Power supplies used for aerial and underground sections of the plant can be seen in photographs such as A – 42, A – 43, and A – 44.

Cables hanging down in public areas, as shown in photographs A – 74 and A – 75 are a safety hazard and violate several codes.

Open boxes, wiremold, and cables, as shown in photographs A –59, A – 60, A – 62, A – 63, A – 65, A – 68, A – 69, A – 70, A – 71, A – 72, and A – 73 are examples of poor maintenance, possible safety hazards, and conditions inviting signal theft.

Photographs A – 82, A – 83, and A – 84 show views of the digital and analog addressable converter boxes and a remote control as currently being used by subscribers.

PUBLIC ACCESS PRODUCTION FACILITIES:

Photographs A – 85 through A – 114 show views of facilities used by Public Access to produce, edit, and playback television programming for the Subscriber Network.

Views of the studio facilities at 900 Michigan Avenue, NE are shown in photographs A – 85 through A – 91. The equipment is quite old. Replacement of camera and video tape recording equipment is normally recommended about every five to seven years for a high quality operation. During the site visit, I was told that some of the lighting fixtures have not been operational for some time.

The storage room, shown in photograph A – 91, was over-crowded and too small for such a facility. As a result, a large part of the studio had to be used for storage, as can be seen in photograph A – 86. It is normally recommended that the studio storage area be about three times the studio size.

Views of the playback master control facilities at 1325 W Street, NW are shown in photographs A – 92 through A – 100. The equipment is quite old and several pieces were either out for repair or in need of repair at each of my site visits. Replacement of video tape recording and playback equipment is normally recommended about every five to seven years for a high quality operation.

Views of the production and editing facilities at 1400 20th Street, NW are shown in photographs A – 101 through A – 114. Much of the equipment is quite old and several pieces were either out for repair or in need of repair at each of my site visits. Replacement of camera, video tape recording, and playback equipment is normally recommended about every five to seven years for a high quality operation.

During the site visits to the Public Access production facilities, I reviewed a few video tape recordings and was surprised at how good the technical quality was for the age of the equipment when personnel were able to control the number of generations of editing and overall production and editing procedures. However, some other video tape recordings prepared under less controlled conditions had substantially greater noise in the pictures, appearing like snow, and displayed unstable synchronization signals resulting in jittery pictures. Consideration should be given to acquiring equipment that could improve the noise and synchronization conditions for some programming that Public Access seems to always need to accept for playback.

OCTT PRODUCTION FACILITIES:

Views of the Office of Cable Television and Telecommunications production and editing facilities at 1400 20th Street, NW are shown in photographs A – 115 through A – 138. Much of the old equipment was replaced about December 1999. Replacement of camera, video tape recording, and playback equipment is normally recommended about every five to seven years for a high quality operation.

At different site visits to the facilities I have observed interference and noise in pictures on some monitors/receivers. Indications were that some of these disturbances were due to defective monitors/receivers and/or problems with the internal distribution system in the building. At other times, many of the noisy pictures were being originated from the Judiciary Square Building facility with noticeably noisy pictures. As additional old equipment is being replaced, consideration should be given to acquiring equipment that could improve the noise conditions.

D.C. COUNCIL PRODUCTION FACILITIES:

Views of the District of Columbia Council production facilities in Judiciary Square at 441 4th Street, NW are shown in photographs A – 139 through A – 150. Most of the equipment is quite old and several pieces were either out for repair or in need of repair at of my site visits. Replacement of camera, video tape recording, and playback equipment is normally recommended about every five to seven years for a high quality operation.

The noisy pictures cited above were clearly visible on the monitors shown in photograph A – 143. The degree of noise is due to an old camera being operated with maximum video gain, as a means of dealing with the low lighting levels in the Council meeting room, with the particular equipment available. As old equipment is being replaced in this facility, particular consideration should be given to acquiring equipment that could improve the noise conditions.

Photographs A – 146 through A – 150 show views of the transmission equipment located in the basement. As can be seen by the photographs, the equipment installation is very poorly done and preventative maintenance would appear to be non-existant, which is inviting unreliable and intermittent performance.

D.C. PUBLIC SCHOOLS PRODUCTION FACILITIES:

Views of the D.C. Public Schools television production and editing facilities in Penn Center at 1709 Third Street, NE are shown in photographs A – 151 through A – 173. Much of the old equipment was recently replaced. Replacement of camera, video tape recording, and playback equipment is normally recommended about every five to seven years for a high quality operation.

Reception of the Subscriber Network has appeared poor at each of my site visits to this facility. This condition was called to District Cablevision's attention, but no improvement has been seen.

At the last site visit in October, I spent some time observing outgoing and return performance in the master control area shown in photograph A – 169. I noted that audio levels varied considerably between different video tapes being played and the operator was unable to correct the variance. Except for this audio level problem, the overall technical performance looked very good.

Programming from this facility is transmitted to the headend over a fiber optic link leased from Bell Atlantic, shown in photograph A – 168.

UDC PRODUCTION FACILITIES:

Views of the UDC television production and editing facilities at 4400 Connecticut Avenue, NW are shown in photographs A – 1741 through A – 184. Most of the equipment is quite old. Replacement of camera, video tape recording, and playback equipment is normally recommended about every five to seven years for a high quality operation.

Programming from this facility is transmitted to the headend over a fiber optic link leased from Bell Atlantic, shown in photograph A – 183.

FCC PROOF OF PERFORMANCES REVIEW:

In preparation for the Subscriber Network phase of the Technical Audit in 1998, District Cablevision provided several technical performance measurement documents to the District for my review. These documents included the most recent: FCC Proof of Performance; FCC Form 320 Signal Leakage Report; and Signal Leakage Records.

In 1999, some additional performance related documents were provided to me for review. These included a smattering of **partially** complete: Headend Proof of Performance; FCC Proof of Performance; listing of various System Test Points; and 24 Hour Level Variation Test results dating from 1988 and with **gaps** through 1997.

Many of the critical information test results values were **faint** to the point of being unreadable. Details of how the measurements were made were only **partially** provided. A review of the readable numbers indicated that **many of the measurements could not have been done correctly.**

For example, carrier to noise (C/N) performance at several locations in the District were listed as being in the high 50s and even the 60s.

Carrier to noise is a measure of how much random noise, looking like snow, is introduced into the pictures by the cable television system equipment.

Typical headend equipment are capable of producing C/N performance of about 54 dB. The FCC Technical Standards require a minimum getting to subscribers of 43 dB.

The **only** way that I have found that C/N measurements in the distribution plant and at subscribers exceeds the performance at the output of the headend is by making an **incorrect** measurement.

I have found incorrect measurement of C/N, as well as a few other parameters, to be quite common in the cable television industry. Therefore, I **always insist** beginning a review of measurement results with a thorough review of the **precise** method(s) that were used in making the measurements with those who made the measurements, if these details are not already contained in the report of test results.

Although District Cablevision technical managers and technicians remembered generally how many of the measurements were made, none could recall precise details of the methodology for all measurements.

Therefore, it was impossible to determine which results in addition to the obvious ones were in error.

However, the results are indicative of a cable television system plant that has been and continues to be in need of considerably greater efforts devoted towards preventative maintenance.

Signal level measurements show variations between channels and across the system bandwidth with conditions technically described as "standing waves" and "suck outs."

Many of the variations across the system bandwidth would normally be correctable through "sweeping and balancing" preventative efforts. However, for sweeping and balancing to be able to be successfully done, the overall design of amplifier spacing and the passive equipment must be correct.

Based upon the limited amount of design drawings which I was able to review, there are indications that the design limits of optimum amplifier spacing and the passive equipment may have been exceeded in several sections of the District's plant.

Also, before sweeping and balancing can be successfully done, conditions causing the standing waves and suck outs must be corrected. These are frequently due to damaged cable. Such corrections would require replacement of the cable.

SIGNAL LEAKAGE RECORDS REVIEW:

The following information was part of the intial documentation supplied by District Cablevision for my review. The examples are **excerpts** from the "Leaks Repaired During the Span" section of a CLI Report dated 3/20/98. The report listed the Time Span of Tests as being from 9/19/97 to 12/18/97. The report lists that during the time span 475 leaks were detected; 439 leaks were listed as being repaired; 36 leaks were listed as not being being repaired and were used in the calculations to claim that the system passed CLI requirements.

EXAMPLE #	ADDRESS OF LEAK	LEAKAGE LEVEL @ 10 FT.	DATE DETECTED	DATE REPAIRED
1	B ST SE 3400-3500	250	9/30/97	1/5/98
2	57th ST SE 118	2000	12/19/97	1/8/98
3	RANDOLPH St NW 1836	2000	12/19/97	1/10/98
4	MORSE ST NE 1280	200	1/22/98	1/13/98
5	21ST ST NE 865	300	1/23/98	1/13/98
6	21ST ST NE 843	1600	1/23/98	1/13/98
7	9TH & ALABAMA AVE SE	647	1/24/98	1/13/98
8	RAUM ST NE 1213	347	1/14/98	1/13/98
9	DELAFIELD PL NW 1202	469	1/3/98	1/15/98

10	7TH ST NW 1915	871	1/17/98	1/15/98
11	NEWTON ST NW 1367	1000	1/21/98	1/16/98
12	14TH ST NW 4000	3000	1/6/98	1/17/98
13	2ND ST NW 2022	1746	1/6/98	1/20/98
14	MICHIGAN AVE NE 37	1500	1/17/98	1/21/98
15	QUINCY PL NE 24	1000	1/17/98	1/21/98
16	R ST NW 210	2189	1/21/98	1/24/98
17	21ST ST NE 208	1000	1/2/98	1/27/98
18	MARYLAND AVE NE 2014	1000	1/13/98	1/27/98
19	9TH ST NW 5619	1000	2/12/98	2/3/98
20	9TH ST NW 5517	2000	1/27/98	2/6/98
21	XENIN ST SE 839	2000	2/13/98	2/6/98
22	KEEFER PL NW 647	1500	2/11/98	2/6/98
23	HARVARD ST NW 1466	1000	3/13/98	3/7/98

At the initial April 1998 review meeting with District Cablevision officials, including the technical manager who prepared the report through the general manager of District Cablevision, I expressed my concern over the potential **safety hazards**, **damaging effects** to technical performance, and the obvious **erroneous** nature of the entries.

Some leaks were permitted to leak for a **substantial** amount of time before they were repaired: examples 1, 2, 3, 12, 13, 14, 15, 16, 17, 18, and 20. **Many leaks were listed as having been repaired before they were detected:** examples 4, 5, 6, 7, 8, 9, 10, 11, 19, 21, 22, and 23.

In May 1998, District Cablevision provided some new data for some of the above entries. The data showed that the larger valued leaks were usually repaired the same day they found. They claimed the errors occurred because of the difficulty in reading the technicians' logs. I was still concerned that several lower valued leaks were not repaired until several months after they were detected.

In an attempt to assess the degree of the potential safety hazards, damaging effects to technical performance, and the erroneous nature of the entries, I reviewed as many of the leakage records from 1994 to the present that could be obtained or reviewed.

The examples in the following table are excerpts from the records that are **representative** of entries which are **indicative** of leakage and leakage record **problems** that occurred during that period.

EXAMPLE #	ADDRESS OF LEAK	LEAKAGE LEVEL @ 10 FT.	DATE DETECTED	DATE REPAIRED
1	SAVANNAH SE 2020	75	9//22/94	?
2	SAVANNAH TERR 1900	250	8/23/94	3/30/95

3	UPSAL ST SE 755	100	2/23/95	?
4	SOUTHERN AVE 5736	100	9/07/94	?
5	VALLEY AV SE 515	250	2/23/95	2/25/95
6	COLORADO NW 4869	50	7/3/96	3/23/97
7	400 BLK 6TH NE	700	8/24/96	9/30/96
8	60TH ST NE 5	98	10/23/96	3/23/97
9	MLK AVE SW 4100	50	10/23/96	4/14/97
10	CALL PL SE 5100	1000	4/30/97	4/30/97
11	15TH ST NW 1325	1000	6/8/97	6/8/97
12	14TH PL NE 243	2000	7/1/97	7/1/97
13	24TH ST NE 502	75	7/1/97	10/6/97
14	1820 MISS AVE SE	2100	8/15/97	9/6/97
15	1858 FREDRICK PL	3000	8/15/97	8/15/97
16	13TH ST NW 3422	2459	9/28/97	9/28/97
17	13TH ST SE 1025 3RD FLOOR	2239	9/30/97	9/30/97
18	HARTFORD 2300 BLK	170	8/16/97	10/6/97
19	K ST SE 1427	1952	9/30/97	10/7/97
20	50TH ST NE 321	2400	10/20/97	10/20/97
21	V ST SE 1340	243	11/5/97	11/5/97
22	MERIDIAN PL NW 1342	2000	12/5/97	12/5/97

For many (although only three are listed) leaks, it was **unknown** if they were **ever** repaired: examples 1, 3, and 4. Some leaks were permitted to leak for a **substantial** amount of time before they were repaired: examples 2, 6, 7, 8, 9, 13, 18, and 19. The intensity of the largest leaks **increased** starting in 1997: examples 10, 11, 12, 14, 15, 16, 17, 19, 20, and 22. Was this an indication that previous to 1997 they were not being measured **correctly**?

The Cumulative Leak Index Report dated 7/25/94 for the test dates from 6/21/94 to 9/20/94 lists a total of only 84 leaks found, with **only one** above 350 µV/m.

A **second** Cumulative Leak Index Report for the same test dates from 6/21/94 to 9/20/94, but dated 7/08/94 lists a total of only 80 leaks found, with **none** above 350 µV/m.

The highest detected leak that I found referenced in the 1995 leakage logs was 350 µV/m. Most were in the 50 to 100 µV/m range, and most were not listed as when they were repaired.

The FCC Form 320 Exhibit B (CLI report) dated 12/23/96 for the test dates from 9/21/96 to 12/20/96 lists a total of only 124 leaks found, with all below 250 µV/m.

The 1997 FCC Form 320 Exhibit B and accompanying records are **drastically** different than the earlier reports and records. First, the entries from the technicians' logs have been entered into tables and are easy to read. Second, the quantity of found and repaired leaks has increased many times previous years records. Third, the value of the discovered leak has also increased many times previous years' records.

For example, the FCC Form 320 Exhibit B dated 12/24/97 for the test dates from 9/19/97 to 12/18/97 and accompanying records are drastically different than the earlier reports and records. The highest detected leak that I found referenced in the 12/24/97 leakage report was 2459 µV/m. A total of 467 leaks were listed as being detected. 421 detected leaks ranging from 50 to 2459 µV/m were repaired. 20 of those repaired ranged evenly from 1295 to 2459 µV/m. 46 detected leaks ranging from 50 to 317 µV/m were not yet repaired at the time of the report.

I consider signal leakage issues to be perhaps the most important findings of this technical audit, and that they may be some of the main reasons for the poor performance of the District Cablevision system cited by so many subscribers.

I believe the most important concern for District Cablevision's **signal leakage problems is a safety issue**. Some of the programming distributed on the system operate at or near the same frequencies used by aircraft, fire, and police communications. **If these signals "leak" from the cable system, they could interfere with communications.**

The District is uniquely subject to some of the highest concern for aircraft communications because of the presence of Reagan National Airport and the White House.

What qualifies as sufficient intensity to cause interference has been the subject of widely differing engineering opinions and is dependant upon many factors. Some of these factors include: the type of modulation and signals being used (amplitude modulated, frequency modulated, pulse code modulated, analog, digital, and spread spectrum to mention a few); the intensity of the desired signal compared to the undesired interfering signal at receiving location; and the specific communications equipment being used.

FCC Technical Standards limit cable television system signal leakage for most applicable frequencies to **20 µV/m** as measured at 3 meters (roughly 10 feet) from the source. Also, **if any value of signal leakage is causing interference to communications services, the cable television system operator is required to repair the condition at any level even below 20 µV/m.**

Until recently, **many** cable television system operators paid little attention to the 20 μV/m standard and were **allowing their systems to leak like a proverbial sieve.** As a result, the **FCC added additional requirements commonly referred to as CLI** (Cumulative Leakage Index) to the technical standards.

CLI standards require the annual submission of a report (Form 320) to the FCC listing the method used and the result of tests made to show that the system met a minimum CLI Standard. The cable operator is permitted to utilize the results of either an airplane flying over the area measuring and plotting the leakage (the fly-over test) or driving through the area (the drive-out method) measuring and making a mathematical computation.

District Cablevision has chosen to use the drive-out method in its CLI reports to the FCC. Under this method, they compute a number based upon the intensity values of leaks equal to or greater than **50 μV/m** which they **found but have not yet repaired over a three month period**.

With regard to the **effects of signal leakage on performance:** the most common complaint that I have heard regarding District Cablevision's technical performance is that subscribers have trouble receiving the local VHF television station on channels 4, 5, 7, and 9: that the pictures and sound are distorted to varying degrees some places all the time and other places only some of the time.

District Cablevision distributes the local VHF television station channels 4, 5, 7, and 9 signals to subscribers at the **same** transmission frequencies as the stations transmit the programming into the air for non-cable reception. This makes it possible for cable subscribers to tune their television receiver to the same channel number as the station channel number without the need for a converter.

Some cable television system operators distribute local VHF television station programming at **different** frequencies than those used by the stations to transmit their programming into the air for non-cable reception. In such systems, the cable operator may use a converter with "mapping" capabilities.

Mapping capable converters will display the station's channel number, even though the signal is actually being distributed at some other channel frequency. If the converter being used does not have mapping capabilities, the subscriber must tune their television receiver to some other number than the station channel number to receive it. Also, if the subscriber does not have a converter, they must tune their television receiver to some other number than the station channel number to receive it.

Signal leakage issues are of particular importance to performance in systems using District Cablevision' s method of "on frequency" distribution in areas where strong signals exist from local VHF television stations, such as in the District.

If signals are leaking from a cable television system, other signals outside the system can also leak into the system; this is called signal ingress.

When signals from strong local television stations leak into a cable television system carrying the stations on the same frequencies, the **ingress signal combines** with the cable distributed signal creating a **"ghost"** type picture. Depending upon several technical factors, the ghosting may be more or less severe and various other effects may occur to distort the pictures and sound.

The strong local station ingress signals can get into the cable television system distributed signal by, basically, four major areas: (1) the cable television system distribution plant outside the home in the street; (2) the drop from the subscriber tap in the street to the home; (3) the coaxial cable wiring within the home to various outlets; or (4) the wiring, splitters, amplifiers, and other devices that the subscriber may be using to interconnect between the outlets and VCRs and television receivers in the home.

The District Cablevision leakage records and the site visits clearly show that leaks within all of the above four areas are quite common. They also show that very intense leaks are quite common, which means large amounts of ingress would be expected. They show that large amounts of time (several months in many cases) were allowed to elapse between the time leaks were detected and when they were repaired; how much time elapsed between when the leak occurred and when it was detected cannot be defined.

Detecting and repairing signal leakage conditions requires adequate personnel. I was unable to discover how many technicians District Cablevision had been **assigned** to this work previous to 1997. However, my understanding is that in 1997 about 6 technicians were assigned for awhile, which dropped to only two until the fall of 1998; since the fall of 1998, up to 15 technicians have been devoted to this work.

Although I did not do a count of the causes of the leaks, it appears that at least half of them are labeled as either disconnected or illegal.

ON-SITE SYSTEM REVIEW:

Dozens of locations throughout the District were visited to review the system's construction and technical performance. Visited areas included: Sixth Street, SE; East Capitol Street, SE; 4th & G Street, SW; (TP#9) at 6th & Southern, SE; (TP#107) at 19th Street, SE; (TP#91) at Kentucky Avenue, SE; (TP#36) at Bladensburg Road, NE ; (TP#31) at Eastern Avenue, NE; (TP#1) at Oregon Avenue, NW; (TP#43) at Colorado Avenue, NW; 1100 Block Chicago Street, SE; 930 "M" Street, NW; 9th Street, SE; (TP#4) at 4500 Clark Place, NW; Potomac & Newark Street, NW; (TP#5) at Potomac & Norton Street, NW; 3514 Com. Joshua Barney Drive, NE; Decatur Street, NW; 8300 Block East Beech Drive, NW; 1824 Upshur Street, NW; 1850 Calvert Street, NW; (TP#32) at 1400 Block Roxanna Road, NW; 1200 Block Florida Avenue, NW; 1325 W Street, NW Public Access playback facility; 48th Street & Brandywine, NW;

39th & Langley Court, NW; 47th Street & Brandywine, NW; Penn Center at 1709 Third Street, NE DC Public Schools' production facility; the Headend at 1351 Florida Avenue, NW; W Street and Shanon Place, SE; Chicago Street and Railroad Avenue, SE; 13th Street and Lawrence Street, NE; 33rd Street between N and O Streets, NW; 3248 O Street, NW;1257 Lawrence Street, NE; 3326 13th Street, NE; 3316 13th Street, NE; 1301 Lawrence Street, NE; 624 Mississippi Avenue, SE; 3618 Connecticut Avenue, NW; 3620 Connecticut Avenue, NW; 3622 Connecticut Avenue, NW; 4660 MLK Avenue, SW; 58 Galveston Street, SW; 101 Galveston Street, SW; 63 Galveston Street, SW; 59 Galveston Street, SW; 62 Galveston Street, SW; 1305 Lawrence Street, NE; Fort Lincoln Townhouses, NE; 900 Michigan Avenue, NE; 2217 14th Street, NW; Judiciary Square at 441 4th Street, NW; and UDC at 4400 Connecticut Avenue, NW.

A variety of observations and tests were conducted at the locations listed above. General construction was observed at all sites. Many of the above sites were photographed and their conditions are shown and described in photographs A – 37 through A – 84. Further explanations of the sites can be found throughout the body of this report.

At the sites described in this section, additional tests and observations were done at each visited area. Where homes were available, several additional homes were checked for Electrical Code and general system construction. Signal levels on all channels were measured by District Cablevision personnel. Channels were tuned through all available on either the home television receiver (when inside the home) or the test television receiver which was carried in a service van.

In addition to a television receiver, the signal level meter and spectrum analyzer, shown in photographs A – 76 and A - 77, were used.

In the early morning hour of about 12:30 AM on April 23, 1998, we began the technical performance testing of the Subscriber Network at the headend.

Levels and performance on all channels were observed and tested to have as a basis for tests to be done at other locations throughtout the District.

Levels and performance on all channels were good except for the observed conditions listed in the following table:

CHANNEL NUMBER	PROGRAMMING	CONDITION

13	City Cable	Varying amounts of periodic noise (wavy lines) and random noise (snow) on different cameras
14	WTMW	Severe ghosting in pictures.
17	CH32 from Howard U	Low audio levels. Headend uses processor; can not adjust.
27	WNVT	Pronounced displaced Chroma Delay in pictures
28	DC Public Schools	High Chroma level in pictures (vivid colors)
36	Home Team Sports	Impulse noise (flases like dropouts) and interference in pictures
46	Cartoon Network ?	Slight random noise in pictures
54	Bravo ?	Slight random noise in pictures

We next tested across from 4612 Sixth Street, SE (also known as 6th & Southern and Test Point #9 in the records). Signal levels were within specifications, but many channels exhibiting very poor performance with observed conditions listed in the following table:

CHANNEL NUMBER	CONDITION
2	Medium random noise in pictures
3	Medium random noise in pictures
9	Slight ghosting and slight random noise in pictures
11	Pronounced ghosting and random noise in pictures
12	Slight random noise in pictures
13	Severe random and periodic noise in pictures
19	Slight ingress visible in pictures
21	Slight random noise in pictures
25	Severe random noise in pictures
29	Pictures not sharp
31	High chroma level (vivid colors)
35	Medium random noise in pictures
40	Very High chroma level
49	Slight random noise in pictures

I asked District Cablevision to measure the carrier to noise (C/N) on Channel 2 because the pictures were exhibiting significant amounts of noise. They measured it as having a C/N of **32 dB**. This was **considerably below FCC minimum standards of 43 dB.**

The measurements were made on the **only** spectrum analyzer that District Cablevision had available: a Hewlett Packard model 8590A, which they believed was last calibrated **7/3/95**. Annual calibration is the recommended practice for spectrum analyzers.

The C/N of the pictures on Channel 2 were definitely below FCC minimum standards. However, I did not feel that they were as bad as a 32 dB C/N would cause. At the time, I was unable to determine whether something about the test setup was solely causing the poor reading or just the spectrum analyzer being out of calibration was to blame.

That night, we also visited a test point location at 4th & G, SW known as Test Point #3 in District Cablevision records. Performance was very poor on several channels.

Ingress was visible on Channel 19; **intermodulation distortion**, appearing as bars in the picture, was **severe** on Channels 49, 50, 63, and 64. Operation on these channels was clearly **significantly below** FCC minimum standards.

I expressed my concern with the poor performance that we were seeing at these locations. District Cablevision personnel told us that the **poor performance was due to problems with the fiber optic transmission equipment** that interconnected the headend to the nodes, and that the equipment was **being replaced shortly**.

I was unable to discover how long the fiber optic transmission had been malfunctioning. The **affected nodes served most of the eastern portion of the District.** My understanding was that the **new equipment** was not **installed** until a few months later: somewhere **around July**.

During a site inspection in September 1998, I asked that we return to Test Point #9. Perforance was much better. C/N was measured with a new spectrum analyzer and found to be in the 44 to 45 dB area.

In October 1998, we returned to Test Point #3. Ingress interference was still visible on Channel 19, but the severe intermodulation distortion on Channels 49, 50, 63, and 64 was corrected.

At some locations throughout the District, a connection point was mounted on a pole to facilitate testing. Photograph A – 79 shows such a test point location.

At the Roxanna Road Test Point #32, ingress into the system was visible and pictures on the higher channels were slightly noisy. C/N on Channel 51 was measured to be 43 dB and Channel 54 was measured to be 41 dB.

The signal level variation across the bandwidth at the Oregon Avenue Test Point #1 showed indications of the need for sweeping.

Performance in a home on Chicago Street, SE displayed a severe ghost on Channel 4 and signal levels were below minimum standards. Checking outside the home at the subscriber tap revealed adequate signal levels and no ghosting was visible on Channel 4. Further checking showed that several splitters were being used to feed to multiple VCRs and television receivers in the home.

While at the Chicago Street, SE home, its drop and eight homes were checked for proper grounding. Of the nine checked, three were properly grounded according to Electrical Code, three were not properly grounded, and the remaining three may have been either way because we were unable to fully trace the ground wire.

We attempted to check on a complaint from a subscriber in Mount Vernon Plaza at 930 M Street, NW. Access to the building was difficult to achieve. The conditions were described an varying from one day to the next with considerable noise and interference visible in the pictures from time to time. The subscriber appears to be served via a modified master antenna distribution network built into the walls. Details of the network were not available. Levels were checked and performance on the day of our visit. It was thought that District Cablevision should arrange to come back to trace the cause of the intermittent performance.

Complaints from a subscriber at 9th St, SE area were also checked. Signal levels were low at the subscriber tap, as well in the building. An illegal connection to a neighbor was found and removed by District Cablevision. They planned to return to clean up the cabling and increase the levels in the area..

An attempt was made to determine why PEG Access Programming does not look good all the time. During various facets of my work with regard to the Institutional Network review and this Technical Audit, I have been able to observe PEG programming over a span of several years. During that time, I have reviewed the programming from the source production facilities, studied the transmission links to the headend, and reviewed the equipment at the headend.

Based upon that review, I have observed several reasons that lead to poor technical performance, including: some cameras had noticeably more noise visible indicating the need for adjustment or repair; some of the source video tape recordings being played have excessive noise in the pictures due to the tape or the video tape recorder; some of the source video tape recordings being played have excessive noise in the pictures due to many generations of editing; at one time, the coaxial cable link from the Public Access playback facility needed repairing; picture and sound levels from the PEG Access facilities are not maintained within proper standards at all times; and it is almost impossible for headend technicians to optimize their equipment's performance due to the lack of proper monitoring and test equipment at the headend.

Even during this Technical Audit, District Cablevision technical staff attempted for several months to borrow some of the needed optimization and test equipment from another system, but was never able to complete the arrangements.

Performance was checked at several locations at Clark Place, including Test Point #4. Performance at the test point was good. Grounding was checked at six homes in the area: three met Electrical Code; three did not meet the current Code.

While at the Clark Place area, we were able to check performance within a home, where the subscriber said they had severe ghosting. The ghosts were there and signal levels at the receiver were way below minimums (-13 dBmV). Signal performance and levels were good at the subscriber tap outside. Problems were traced to the internal cabling within the home.

While traveling in the area near Potomac and Newark St, NW, a leak of 700 µV/m was detected and traced to the damaged cables shown in photograph A - 81.

Checking a complaint from a subscriber at Com. Joshua Barney Drive, NE, the pictures looked good, but the levels were too high for the receiver. Indications were that an amplifier feeding or in the building complex was operating past its design and was probably the reason for distorted pictures from time to time. District Cablevision later told me they found and made the necessary corrections for the area.

Checking a complaint from a subscriber at Decatur St., NW about ghosting and bars on several channels lead to finding that signal levels in the home were considerably below minimum standards. Performance at the subscriber tap outside was good, which indicated that the problem was due to internal wiring in the home.

A subscriber's complaint about ghosting on local channels at East Beech Drive, NW was checked. Moving cabling at the television receiver caused severe distortion and ghosting to come and go in the pictures. A type of "push on" was being used between the VCR and receiver. District Cablevision planned to return to make the necessary changes.

In response to a complaint about noisy pictures from a subscriber at Upshur St, NW, the home was visited. Signal levels were found to be very low at the oulets in the home, the drop was not grounded outside, and indications were that there was a defect in the internal wiring somewhere. Some outlets in the home were left unterminated, which permited them to act as antennas to pick up local channels and add to the interference.

The 48th St & Brandywine area was checked because of ghosting claimed to be visible at several homes in the area. Performance was checked at a subscriber tap outside and ghosting was clearly visible on Channel 4. Leakage had been detected in the area. This was an example of the local station ingressing into the cable distribution plant, causing the ghosted Channel 4 pictures to be distributed to all subscribers from the point of the leaking cable out in the street.

The above descriptions of the types of complaints received about performance from subscribers; reasons for the problems; and tests, findings, and observations are representative of all the areas and homes that were visited during the on site inspections of the District Cablevision plant.

INSTITUTIONAL NETWORK:

The District Cablevision Institutional Network currently consists of a cumulative amount of about 32 miles of bits and pieces of coaxial cable at various locations underground in the District.

The District's Cable Franchise Agreement ("CFA") with District Cablevision includes the following technical related requirements for an Institutional Network as well as provisions for institutional services: (1) coaxial cable for an Institutional Network was to be installed where Subscriber Network underground trunk coaxial cable was being installed, and (2) capacity for the carriage of institutional services was to be provided on the Institutional and Subscriber Networks. Section 5.6.01 stipulates that District Cablevision shall "install trunk cable for a separate institutional network wherever it installs trunk cable for the underground residential [subscriber] network."

District Cablevision estimated that the total plant length of coaxial cables in the District is about 1,055 miles. Of these 1,055 miles, about 772 miles is aerial (above ground) cable and 283 miles is underground cable. Of the 283 underground miles, about 47 miles are trunk cables and the remaining 236 miles are feeder cables.

At the outset of my Institutional Network study in 1994 to review the status of the Institutional Network, it became clear that complete and accurate maps of the current residential system trunk cable and Institutional Network cable locations did not exist. **Formal file construction drawings were never prepared for the Institutional Network cable nor was the information ever added to the Subscriber Network plant (residential system) drawings at the Michigan Avenue office.**

However, according to District Cablevision, as of April 1994 only 26.9 miles, or 57.4 percent, of the cable stipulated for Institutional Network in the CFA had been laid. This figure is based upon data included in a report provided to District Cablevision by Bell Atlantic-DC, the company with whom District Cablevision had a conduit leasing agreement.

To ascertain the extent of the Institutional Network construction, information was obtained from the only known to exist summary map of residential system **trunk** cable locations. It consists of a base summary map (approximately 1990 era) of the residential system trunk cable upon which the cable contractor drew lines to indicate approximately where it had installed the Institutional Network cable. It is believed that the Bell Atlantic Telephone Company provided the map to District Cablevision in 1991. The map, which was quite faded and difficult to read, had to be copied and enhanced along the lines corresponding to my understanding of the locations of the Institutional Network cable resulting in a new draft map. District Cablevision reviewed this draft map and agreed with these interpretations and issued a confirming letter. The draft maps, dated 6/24/94 & 7/5/94, were provided to the Office of Cable Television.

The map supports a 32.19 mile listing of bits and pieces of cable claimed to have been installed between various identified manholes. District Cablevision had been reporting that it had installed 26.9 miles of bits and pieces. As a check, District Cablevision sent its crew to check four locations from the 32.19 mile list, which were not on the 26.9 mile list; they found that the cables were there.

While the 32.19 mile list probably represents a good listing of what cable was actually installed, it may no longer be of much use for Institutional Network planning. The ends of the cables were not sealed, so many could have been damaged by moisture. District Cablevision has indicated that it knows that some pieces were used to replace damaged Subscriber Network Trunk Cables, however, the locations of these pieces were not recorded in their records. In addition, some pieces most certainly have been used as pull lines for other cables being installed by other contractors. **Only a very small portion of the 32.19 miles of pieces are in correct location for an Institutional Network; considerably more coaxial cable would need to be added to make an operational network. However, the technology of fiber optic transmission has advanced to where an Institutional Network system constructed today would probably be mostly fiber rather than more coaxial cable.**

DCLP MONTHLY REPORTS REVIEW:

I reviewed a group of technical performance reports dated from July 1995 through January 1999, which District Cablevision had provided to the District.

Based upon my initial review, I felt that at least many dozens of the entries provided were incorrect. The quantity of incorrect entries and the possibility of the number reaching hundreds was discussed at a meeting with District Cablevision officials in February 1999.

District Cablevision asked that I submit a written list of my questions and concerns regarding these reports.

A copy of the questions with accompanying documents and District Cablevision's reply are contained in the Appendix of this report.

Based upon the answers, the reports which District Cablevision had submitted to the District did contain hundreds of errors.

FRANCHISE COMPLIANCE:

Several technical conditions do not appear to be in compliance with Franchise requirements.

Section 5.1 indicates that the Subscriber Network should have been expanded to 550 MHz operation: "Grantee shall expand the initial channel capacity of such system as soon as 550 MHz technology has been reasonably perfected to ensure high performance and quality throughout the distribution system and as soon as reasonably practicable pursuant to its finding that such additional channel capacity is needed and economically feasible." Those conditions would have been met several years ago. It has been reported that even Leo Hindery, as the president of TCI, refered to the system as a "dinosaur."

Section 5.6.01 required a certain initial amount of cable be installed to be used towards an Institutional Network: "Grantee shall install trunk cable for a separate institutional network wherever it installs trunk cable for the underground residential network." Only 32.19 miles of the required 47 miles were installed in bits and pieces. Nothing further was done to develop an operational network. Some of the bits and pieces have been used for other purposes, and those remaining have not been maintained.

Section 5.8 required: "Grantee shall provide the system capability to transmit an emergency alert signal to all participating subscribers. Grantee shall also provide an emergency audio override capability to permit the District to interrupt and cablecast an audio message on all channels simultaneously in the event of disaster or public emergency." My understanding is that **since at least 1991 until about July 1998 there has not been an operational emergency override system of any type.** However, in response to the Federal Communications Commission's requirement that all cable television systems of District Cablevision's size install an Emergency Alert System (EAS) by December 31, 1998, an EAS system with override capabilities was installed about July 1998. However, District officials had not yet been given the code numbers because of some sort of mis-understandings.

Section 4.1 requires compliance with FCC, the National Electric Code, and additional provisions: “Grantee agrees to construct, operate, and maintain the cable television system subject to the supervision of and inspection by the Office and in full compliance with the regulations, including applicable amendments, of the Federal Communications Commission and all other applicable federal or District laws and regulations, including the latest editions of the National Electrical Safety Code and the National Fire Protection Association National Electrical Code.”

Previous discussions described the Grantee’s **failure to operate and maintain** the system in full compliance with signal leakage standards of the Federal Communications Commission.

Also, “Full Compliance” is subject to some degree of further explanation in regard to the National Electric Code. The National Electric Code and related codes have changed over the years. Clearly, some indications were observed during the site visits which should be corrected as soon as possible, such as low hanging cables over streets and loose lashing wires for other cables. Other conditions, such as bringing the grounding of drop cables at homes up to current should have been being checked and brought up to current code any time a technician visited a subscriber for any reason and as part of any system upgrade. **Further attention to bringing the system and all drops up to current codes should be a major condition as a part of the system upgrade and rebuild.**

District Cablevision appears to have been quite negligent in these matters.

Have a tremendous day!

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APPENDIX