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DIVISION 27 - COMMUNICATIONS

SECTION 27 54 00.00 20

COMMUNITY ANTENNA TELEVISION (CATV) SYSTEMS

04/06

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Use Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM,
for empty conduit CATV systems instead of this
section. Include the backboard, outlet, faceplate,
and other special requirements in that section.

NOTE: As a minimum, the Designer shall provide the
CATV system loss and tilt compensation calculations
using manufacturer's data and including the
amplifier sizes and system requirements to the
EFA/EFD. Project drawings shall show the cable
system, grounding, homeruns, and passive and active
devices in a one-line diagram. Where television
mounting brackets are required on a job, provide
bracket requirements and details in architectural
drawings and specifications.

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the
publications cited in the text of the guide
specification. The publications are referred to in
the text by basic designation only and listed in
this paragraph by organization, designation, date,
and title.

Use the Reference Wizard's Check Reference feature
when you add a RID outside of the Section's
Reference Article to automatically place the
reference in the Reference Article. Also use the
Reference Wizard's Check Reference feature to update
the issue dates.

References not used in the text will automatically
be deleted from this section of the project
specification when you choose to reconcile
references in the publish print process.

The publications listed below form a part of this specification to the
extent referenced. The publications are referred to within the text by the
basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2007; Errata 2007; INT 2008) National
Electrical Safety Code

IEEE C62.41.1 (2002) IEEE Guide on the Surges
Environment in Low-Voltage (1000 V and
Less) AC Power Circuits

IEEE C62.41.2 (2002) IEEE Recommended Practice on

Characterization of Surges in Low-Voltage
(1000 V and Less) AC Power Circuits

NATIONAL CABLE AND TELECOMMUNICATIONS ASSOCIATION (NCTA)

NCTA RP (2003) NCTA Recommended Practices for
Measurements on Cable Television Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2007; AMD 1 2008) National Electrical
Code - 2008 Edition

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 76.605 Technical Standards

UNDERWRITERS LABORATORIES (UL)

UL 1581 (2001; Rev thru Jul 2008) Reference
Standard for Electrical Wires, Cables, and
Flexible Cords

UL 1666 (2007) Test for Flame Propagation Height
of Electrical and Optical-Fiber Cables
Installed Vertically in Shafts

UL 969 (1995; Rev thru Nov 2008) Marking and
Labeling Systems

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS, applies to
this section with the additions and modifications specified herein.

1.3 DEFINITIONS

1.3.1 CATV

Community antenna television (CATV) system, commonly referred to as cable
television, is a network of cables, headend, electronic and passive
components that process and amplify television (TV) signals for
distribution from the headend equipment to the individual television
outlets.

1.3.2 Headend

The connection point between CATV system equipment and equipment provided
by the local CATV company.

1.3.3 Distribution System

Distribution system transports and delivers adequate signals to each
receiver. Provides distortion-free signal to TV sets by isolating each
receiver from the system and by providing proper amount of signal to each
set.

1.3.4 Cable

NOTE: Delete the first bracketed item for single housing units and small systems where trunk and feeder cables are not used. Edit the last sentence accordingly.

[Trunk and feeder cables are low-loss cables used to transport the desired signal from the headend equipment to the communications closet in the area to be served. These cables are used to transport signal from the [communications closet][headend equipment] into close proximity to a number of user locations in excess of 60 meters 200 feet from the [communications closet][headend equipment].]Drop cables are used to transport the desired signal used from the [communications closet][headend equipment] to the wall outlet.

1.4 SYSTEM DESCRIPTION

1.4.1 Headend

Contractor shall provide interior equipment up to headend [and including the main amplifier] located at the interior CATV [backboard][cabinet].

1.4.2 Distribution System

NOTE: Choose the bracketed item depending on the CATV system design.

[Distribution system shall be star topology with each outlet connected to a communications closet with a feeder cable or a drop cable and each communications closet connected to the headend equipment with a trunk cable][Distribution system shall be star topology with each outlet connected to headend equipment with the drop cable].

1.4.3 Cable

NOTE: Delete the first bracketed item for single housing units and for small systems where trunk and feeder cables are not used. Edit the last sentence accordingly.

[Provide trunk cables to transport the desired signal from the headend equipment to the communications closet in the area to be served.][Provide [trunk] [feeder] cables to transport signal from the [headend equipment][communications closet] to user locations in excess of 60 meters 200 feet from the [headend equipment][communications closet].] Provide drop cables to transport the desired signal from the [communications closet][headend equipment] to the outlet.

1.4.4 System Components

System shall provide high quality TV signals to all outlets with a return path for interactive television and cable modem access. Provide any

combination of items specified herein to achieve required performance, subject to approvals, limitations, acceptance test, and other requirements specified herein. System shall include amplifiers, splitters, combiners, line taps, cables, outlets, tilt compensators and all other parts, components, and equipment necessary to provide a complete and usable system.

1.4.4.1 System Bandwidth

- a. Downstream: 50-750 MHz minimum.
- b. Upstream 5-40 MHz minimum.

1.4.5 System Performance

System shall be in compliance with 47 CFR 76.605.

1.4.5.1 Receiver Termination Signal Level

Each termination for a TV receiver must have a minimum signal level of 0 decibel millivolts (dBmV) (1000 microvolts) at 55 MHz and of 0 dBmV (1000 microvolts) at 750 MHz and a maximum signal of 15 dBmV or a level not to overload the receiver for the entire system bandwidth.

1.4.5.2 Distribution System

- a. Modulation distortion at power frequencies: 4 percent or less hum distortion;
- b. Composite third order distortion for:
 - (1) CW carriers: 53 dB.
 - (2) Modulated carriers: 59 dB.
- c. Subscriber terminal isolation: 18 dB or greater.
- d. Carrier to second order beat ratio: 60 dB.
- e. Amplitude characteristic shall be within a range of plus or minus 2 decibels from 0.75 MHz to 5.0 MHz above the lower boundary frequency of the cable television channel, referenced to the average of the highest and lowest amplitudes within these frequency boundaries.
- f. Visual, aural carrier level - 24-hour variation: 47 CFR 76.605, subpart (a), rules (4), (5), and (6).
- g. Frequency determination: 47 CFR 76.605, subpart (a), rules (1), (2), and (3).

1.4.5.3 All New System Tolerance

The system shall not show a serious loss of carrier to noise when the system levels are lowered 3 dB below normal or a significant distortion when the levels are increased 3 dB above normal, as observed on a TV set located at the far end extremities of the system.

1.5 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

CATV system wiring diagrams and installation details; G

CATV system components; G

SD-03 Product Data

Attenuators; G

Amplifiers, including [headend,]trunk, bridging, and distribution; G

Cables, including [trunk, feeder, and]drop; G

Terminators; G

Splitters/combiners; G

Line Taps; G

Outlets; G

Connectors; G

Tilt compensator; G

Grounding block; G

Submittals for each manufactured item shall be the current manufacturer's descriptive literature of catalog products, equipment drawings, diagrams, performance and characteristics curves, and catalog cuts.

SD-05 Design Data

CATV System Loss Calculations; G

SD-06 Test Reports

Operational test plan; G

Operational test procedures; G

System pretest; G

Acceptance tests; G

SD-08 Manufacturer's Instructions

Connector Installation; G

1.6 QUALITY ASSURANCE

1.6.1 Wiring Diagrams and Installation Details

Illustrate how each item of equipment functions in the system and include an overall system schematic indicating the relationship of CATV units on one diagram. Drawings shall include wiring diagrams and installation details of equipment indicating proposed locations, layout and arrangements, and other items that must be shown to ensure coordinated installation.

1.6.2 CATV System Loss Calculations

NOTE: Use second bracketed option in the first sentence for systems that include amplifiers.

Calculations shall verify that the system does not exceed the loss values specified in dBmV at the [receiver terminations][input of all active devices and the receiver terminations]. Provide a drawing displaying all distribution network calculations. The drawing should accurately show taps, splitters, outlets, and the type and length of all [trunk, feeder,

and drop cables. The drawing shall show how many taps, splitters, or outlets are served by each tap or splitter.

1.6.3 Operational Test Plan

NOTE: The test methods in Parts I and II of the NCTA recommended practices are used to establish proper operating parameters during initial setup and alignment. They are also used to verify proper operation of a unit following a needed repair. Only a few of the tests can be used during normal operations of a CATV system without interruption to the system or the specific channel under test.

Test plan shall define tests required to ensure that the system meets technical, operational, and performance specifications. Test plan shall be based on NCTA RP and be in accordance with FCC proof of performance requirements. Test plan shall include plan for testing for signal leakage. Provide test requirements and guidelines.

1.6.4 Operational Test Procedures

Use test plan and design documents to develop test procedures. Procedures shall consist of detailed instructions for a test setup, execution, and evaluation of test results.

1.6.5 Connector Installation

Provide manufacturer's instructions for installing connectors.

PART 2 PRODUCTS

NOTE: This specification is written for bidirectional devices operating from 5 to 40 MHz and from 50 to 1000 MHz. The lower end, 5 to 40 MHz provides an active return path and allows ordering of pay-per-view, cable modem and communication back to the CATV system provider. The 50 to 1000 MHz provides one-way communication to the user's service. Passive devices are rated 1000 MHz since they require more work if upgrading of the system is required in the future. Active devices such as amplifiers are easier to change out, and thus are rated for the current normal operating requirement of a minimum of 750 MHz. Coordinate with the cable service provider to ensure these specifications meet their minimum requirements for CATV service.

2.1 ELECTRONIC EQUIPMENT

Electronic components of similar type shall be produced and designed by the same manufacturer as major components of the equipment and shall have the manufacturer's name and model permanently attached. Equipment shall function properly as a complete integrated system. Equipment shall be shielded. The system shall be designed to operate within 5 to 1000 MHz

bandwidth using 1000 MHz passive devices and a minimum of 750 MHz active devices.

2.2 HEADEND EQUIPMENT

NOTE: Use the headend equipment paragraphs when the headend equipment is provided by the Contractor. Delete when provided by local cable television company.

2.2.1 Headend Amplifiers

NOTE: Broadband amplifiers are used to amplify a number of TV channels. Single-channel amplifiers are used to amplify a single TV channel.

Provide broadband distribution amplifiers. Amplifiers shall amplify broadband signals from 40 to 750 MHz and provide an amplified return path for signals from 5 to 40 MHz for 75 ohms impedance. Amplifiers shall be bidirectional with variable slope and gain control.

2.2.2 Attenuators

Provide attenuators to equalize signal levels, when required. Variable attenuators are not permitted.

2.2.3 Power Supplies

Power supplies shall contain a current limiter circuit to protect against short circuits on the radio frequency (RF) line. Provide overvoltage protection to protect solid state equipment from line surges and induced voltages, in accordance with IEEE C62.41.1 and IEEE C62.41.2.

2.3 DISTRIBUTION EQUIPMENT

NOTE: Delete paragraphs for distribution amplifiers when design calculations indicate they are not required.

2.3.1 Distribution Amplifiers

Distribution amplifiers shall be equipped for 75 ohms input and output impedance. Electronic equipment exposed to weather shall be equipped with weatherproof housings. Amplifiers shall be bidirectional with variable slope and gain control and shall amplify broadband signals from 50 to 750 MHz and provide an amplified return path for signals from 5 to 40 MHz for 75 ohms impedance.

2.3.1.1 Trunk Amplifiers

Trunk amplifiers shall have automatic level and slope control features.

2.3.1.2 Bridging Amplifiers

Bridging amplifiers shall be used to connect feeder cables to trunk cables.

2.3.2 Cables and Associated Hardware

NOTE: For cable subject to moisture from flooding or to atmospheric contamination such as cable near coastal areas or in cities with significant air pollution, specify the same cable protected by a black polyethylene jacket with a flooding or other water migration deterrent compound between the jacket and the aluminum shield. When this type of cable is required, add the requirement to the item specifying the jacket and insulation in the applicable cable paragraph(s).

For systems under 90 meters 295 feet from headend equipment to communications closet or from communication closet to communication closet, provide RG-11 coaxial trunk cable. For systems exceeding 90 meters 295 feet from headend equipment to communication closet or from communication closet to communication closet, consideration should be given to utilizing 625 series cable to reduce system losses. Edit paragraphs for type of cable required in job. Delete paragraphs for trunk and feeder cable for single family housing units and for small systems where only drop cables are used.

Cabling shall be UL listed for the application and shall comply with NFPA 70. Provide a labeling system for cabling as required by UL 969. Cabling manufactured more than 12 months prior to date of installation shall not be used.

2.3.2.1 Trunk Cable

UL 1666. Provide trunk cable with an NFPA 70 rating of CATVR.

a. Provide RG-11 coaxial cable with the following characteristics:

- (1) #14 AWG copper-clad steel center conductor.
- (2) Gas injected foam polyethylene dielectric with nominal 7.11 mm 0.28 inches outer diameter.
- (3) Bonded foil inner-shield and 60 percent aluminum braid or quad shield.
- (4) 75 ohms impedance.
- (5) 82 to 85 percent nominal velocity of propagation.
- (6) Black PVC jacket
- (7) Maximum attenuation characteristics:

MHz	DB/100 m	MHz	DB/100 m
5	1.25	600	10.43
55	3.15	750	11.97
300	7.38	1000	14.27
350	7.94		
450	9.02		
500	9.51		

MHz	DB/100 ft	MHz	DB/100 ft
5	0.38	600	3.18
55	0.96	750	3.65
300	2.25	1000	4.35
350	2.42		
450	2.86		
500	2.90		

- b. Provide 625 Series cable with an NFPA 70 rating of CATVR and the following characteristics:
- (1) Copper-clad aluminum center conductor
 - (2) Seamless aluminum tubing shield
 - (3) Expanded polyethylene dielectric
 - (4) 75 ohms impedance
 - (5) Nominal diameter over outer conductor: 15.88 mm 0.625 inches.
 - (6) Maximum attenuation at 20 degrees C and 1000 MHz: 6.79 dB/100m 2.07 dB/100 feet
 - (7) Black medium density polyethylene jacket
 - (8) Nominal 87 percent velocity of propagation

2.3.2.2 Feeder Cable

NOTE: CATVP is plenum rated cable. Provide type CATVP plenum rated cabling in ducts, plenums and other air-handling spaces. Choose the first bracketed option for CATV cable and the second bracketed option for CATVP cable throughout. Delete feeder cable paragraphs for single family housing units and for small systems where only drop cables are used.

UL 1581, provide RG-11 coaxial trunk cable with an NFPA 70 rating of [CATV][CATVP] and the following characteristics:

- a. #14 AWG copper-clad steel center conductor.

- b. [Gas injected foam polyethylene][Foam FEP] dielectric with 7.11 mm .28 inches nominal outer diameter.
- c. Bonded foil inner-shield and a minimum of 60 percent aluminum braid or quad shield.
- d. 75 ohms impedance.
- e. 81 to 84 percent nominal velocity of propagation.
- f. [Black PVC][PVC low smoke polymer or FEP] jacket.
- g. Maximum attenuation characteristics:

CATV	
MHz	DB/100 m
50	3.1
100	4.2
200	5.7
400	8.85
700	11.0
1000	14.26

CATV	
MHz	DB/100 ft
50	.95
100	1.3
200	1.9
400	2.7
700	3.9
1000	4.8

CATVP	
MHz	DB/100 m
50	3.9
100	5.6
200	8.2
400	11.5
700	15.1
900	17.4
1000	18.4

CATVP	
MHz	DB/100 ft
50	1.2
100	1.7
200	2.5
400	3.5
700	4.6
900	5.3

MHz	DB/100 ft
1000	5.6

]2.3.2.3 Drop Cable

NOTE: CATVP is plenum rated cable. Provide type CATVP plenum rated cabling in ducts, plenums and other air-handling spaces. Choose the first bracketed option for CATV cable and the second bracketed option for CATVP cable throughout.

UL 1581. Provide RG 6 coaxial cable with an NFPA 70 rating of [CATV][CATVP] and with the following characteristics:

- No. 18 AWG copper-clad steel center conductor.
- Bonded foil inner-shield and 90 percent aluminum braid.
- Characteristic impedance of 75 ohms.
- [Gas injected foam polyethylene][Foam FEP] dielectric
- Nominal capacitance, conductor to shield, of 53 pf per 100 m 16.2 pf per 100 ft .
- Maximum operating voltage of 350 V RMS.
- Maximum attenuation:

[

CATV			
MHz	DB/100 m	MHz	DB/100 m
10	2.59	700	19.02
50	5.08	1000	22.74
100	7.19		
200	10.17		
400	14.38		
500	15.48		

CATV			
MHz	DB/100 ft	MHz	DB/100 ft
10	0.81	700	6.0
50	1.46	1000	7.3
100	2.05		
200	2.83		
400	4.0		
500	4.53		

][

CATVP			
MHz	DB/100 m	MHz	DB/100 m
10	2.3	900	22.6
50	4.9	1000	23.9

MHz	DB/100 m	MHz	DB/100 m
100	6.9		
200	10.2		
400	14.8		
700	19.7		

CATVP

MHz	DB/100 ft	MHz	DB/100 ft
10	0.7	900	6.9
50	1.5	1000	7.3
100	2.1		
200	3.1		
400	4.5		
700	6.0		

] h. [Black polyvinyl chloride (PVC)][PVC low smoke polymer or FEP] jacket.

i. 100 percent sweep testing from 5 MHz to a minimum of 1000 MHz.

2.3.3 Terminators

Terminators shall be rated for 75 ohms and 1/4 watt.

2.3.4 Splitters/Combiners

NOTE: Slope is the straight line of the average response between 54 MHz and 450 MHz. Return loss is a measure of impedance matching.

Use splitters/combiners with characteristics equal to or exceeding the characteristics listed in this paragraph over the entire operating band. All unused outlets must be terminated with 75-ohm terminators.

a. Peak to Valley: Not to exceed 1 dB across bandwidth of device.

b. Return loss: 18 dB minimum.

c. Bandwidth: 5-1000 Mhz

2.3.5 Line Taps

Line taps shall have 18 dB minimum isolation from each tap to the thru-line. Pressure tapoffs are not permitted. Taps shall be rated from 5 to 1000 MHz and shall have a peak to valley not to exceed 1 dB to 1 GHz.

NOTE: Designer has the option to provide a combination convenience receptacle and CATV outlet in one outlet box. If used, provide detail on drawings indicating combined outlet with isolation barrier between power and communication sections.

2.3.6 Outlets

Provide flush mounted, 75-ohm, F-type connector outlets rated from 5 to 1000 MHz in standard electrical outlet boxes[with isolation barrier].

2.3.7 Connectors

NOTE: Delete trunk and feeder cable connectors for
housing units and when trunk cable and feeder cable
are not used in job.

Provide one piece connectors. [Trunk and feeder cable connectors shall be pin type.]Drop cable connectors shall be feed thru type.

2.3.8 Tilt Compensator

Provide tilt compensators as required.

2.4 GROUNDING AND BONDING

Provide ground rods and connections in accordance with Section 26 20 00, "Interior Distribution System".

2.4.1 Grounding Block

Provide [corrosion-resistant] grounding block suitable for [outdoor][indoor] installation.

2.5 BACKBOARDS

Provide void-free, fire rated interior grade plywood, 19 mm 3/4 inch thick, [1200 by 2400 mm][4 by 8 feet][as indicated]. Backboards shall be painted with a gray, nonconductive fire-resistant overcoat. Do not cover the fire stamp on the backboard.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Distribution System

NOTE: Show cable routing and equipment locations on
the drawings.

Distribution system shall conform to requirements specified herein. Installation shall be in accordance with IEEE C2 and NFPA 70.

3.1.1.1 Raceway

NOTE: Use the bracketed option when conduit stubout
is provided for the local cable television company.

Provide cable installed in raceways such as conduit and cable trays in

compliance with NFPA 70. Raceway shall comply with Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM. [Provide 78 mm 3 inch, minimum, PVC from interior headend location to exterior CATV company connection location. Coordinate location and requirements with the local cable television company.]

3.1.1.2 Grounding System

NOTE: Show location of grounding blocks on drawings. Grounding blocks may be used either inside or outside. Since they are intended to protect equipment from foreign currents, they are most frequently placed inside, close to the cable entrance.

Provide the grounding block [at the main CATV backboard][_____]. Ground this device according to the requirements of IEEE C2 and NFPA 70.

3.1.1.3 Trunk, Feeder, and Drop Cable

NOTE: Delete Trunk and Feeder from the title for housing units and when trunk and feeder cable are not used in the job.

Provide cable to grounding blocks, to line taps, and to outlets.

3.2 FIELD QUALITY CONTROL

3.2.1 System Pretest

NOTE: Use the first bracketed item requiring the Contractor to align and balance the system, where amplifiers are provided. For single family housing units, delete second bracketed item requiring testing at 151 and 547 MHz. Testing at these frequencies is required for other applications.

Use option for testing at each outlet instead of random sampling and at furthest outlet when a small number of outlets are provided in the job.

Upon completing installation of the CATV system, the Contractor [shall align and balance the system and]shall perform complete pretesting. During the system pretest, Contractor, utilizing the approved spectrum analyzer or signal level meter, shall verify that the system is fully operational and meets all the system performance requirements of the specification. Contractor shall test the signal loss in dBmV at 55[, 151, 547,] and 750 MHz. The signal levels shall be 0 dBmV (1000 microvolts), minimum. The signal shall not exceed 15 dBmV over the entire system bandwidth. Any deficiencies found shall be corrected and revalidated by follow up testing. Contractor shall measure and record the video and audio carrier levels at each of the frequency levels specified at each of the following points in the system:

- a. Furthest outlet from [each communication closet][service entrance point of connection].
- b. A random sampling of 25 percent of the [outlets[from each communication closet]][housing units].
- [c. At each outlet.]
- [d. [Headend and]Distribution amplifier inputs and outputs.]

3.2.2 Acceptance Tests

NOTE: Use option for testing at each outlet instead of random sampling and at furthest outlet when a small number of outlets are provided in the job.

Contractor shall notify the Contracting Officer of system readiness 10 days prior to the date of acceptance testing. Contractor shall also coordinate with the local CATV provider and allow them to attend witness tests. CATV system shall be tested in accordance with the approved test plan in the presence of the Contracting Officer's representative to certify acceptable performance. System test shall verify that the total system meets all the requirements of the specification and complies with the specified standards. Contractor shall verify that no signal leakage exists in conformance with **NCTA RP** and **47 CFR 76.605**. System leakage shall also be tested at the headend location with signal applied to system. Deficiencies revealed by the testing shall be corrected [on the [housing units][outlets] sampled as well as on the [units][outlets] not sampled]and revalidated by follow-up testing. Contractor shall conduct testing at each of the following points in the system:

- a. Furthest outlet from [each communication closet][service entrance point of connection].
 - b. A random sampling of 25 percent of the [outlets[from each communication closet]][housing units] as designated by the Contracting Officer.
 - [c. At each outlet.]
 - [d. [Headend and]Distribution amplifier inputs and outputs.]
- End of Section --