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Foreword

National Electrical Installation Standards™ are intended to improve communication among specifiers, purchasers, and suppliers of electrical construction services. They define a minimum baseline of quality and workmanship for installing electrical products and systems. NEIS™ are intended to be referenced in contract documents for electrical construction projects. The following language is recommended:


Use of NEIS is voluntary, and the National Electrical Contractors Association assumes no obligation or liability to users of this publication. Existence of a standard shall not preclude any member or non-member of NECA from specifying or using alternate construction methods permitted by applicable regulations.

This publication is intended to comply with the edition of the National Electrical Code (NEC) in effect at the time of publication. Because they are quality standards, NEIS may in some instances go beyond the minimum requirements of the NEC. It is the responsibility of users of this publication to comply with state and local electrical codes when installing electrical products and systems.

Suggestions for revisions and improvements to this standard are welcome. They should be addressed to:

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1. Scope

This standard describes installation procedures for closed-circuit television system equipment installed for protection of building interiors, building perimeter, and surrounding property. This publication applies to closed-circuit television systems for security and monitoring activities in nonhazardous locations both indoors and outdoors. It also covers periodic routine maintenance procedures for closed-circuit television systems.

1.1 Products and Applications Included

This publication applies to the following:

1. Closed-circuit television camera
2. Monitors, switchers, multiplexers, and recording devices
3. Electronic hardware components
4. Conductor and cable installation
5. Security of data, software, or computer systems
6. Transmission of video images to remote locations
7. Remote supervising locations that receive signals from premises CCTV systems
8. Alternate or back-up sources of power

1.2 Products and Applications Excluded

This publication does not apply to the following:

1. One and two family dwellings
2. Installation of lighting fixtures or lighting design
3. Branch circuit wiring methods
4. Security of data, software, or computer systems
5. Transmission of video images to remote locations
6. Remote supervising locations that receive signals from premises CCTV systems
7. Alternate or back-up sources of power

1.3 Regulatory and Other Requirements

a) All information in this publication is intended to conform to the National Electrical Code (ANSI/NFPA 70). Installers should always follow the NEC, NESC, applicable state and local codes, manufacturer’s instructions, and contract documents when installing building grounding and bonding systems.

b) Only qualified persons familiar with the installation of grounding and bonding systems should perform the work described in this publication.

c) General requirements for installing electrical products and systems are described in NECA 1-2000, Standard Practices for Good Workmanship in Electrical Contracting (ANSI). Other National Electrical Installation Standards provide additional guidance for installing particular types of electrical products and systems. A complete list of NEIS is provided in Annex A.
## 2. Definitions

<table>
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<th>Term</th>
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<td><strong>Blanking</strong></td>
<td>Electrical signal produced at the end of each scanning line.</td>
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<td><strong>C-Mount</strong></td>
<td>Former industrial standard lens mounting format. C-mounts can be adapted to CS-mounts using a CSA, or a CS to C adapter, but CS-mounts cannot be adapted to C-mounts.</td>
</tr>
<tr>
<td><strong>Closed-Circuit Television (CCTV)</strong></td>
<td>Closed-circuit television is a system which, unlike normal television that is available to anyone with a suitable receiver, operates on a “closed loop” basis where pictures and images are only available to those directly connected to the “loop.”</td>
</tr>
<tr>
<td><strong>Coaxial Cable</strong></td>
<td>Cable commonly used to transmit video signals. It consists of a metallic shield with one or more center conductors that are isolated from each other and from the shield.</td>
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<tr>
<td><strong>Composite Video</strong></td>
<td>Video signal that contains the picture signal, with vertical and horizontal blanking and sync pulses.</td>
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<tr>
<td><strong>CS-Mount</strong></td>
<td>New standard lens mounting format.</td>
</tr>
<tr>
<td><strong>Depth of Field</strong></td>
<td>Front-to-back area that is focused in the camera view. The better the lighting, the greater the depth of field possible.</td>
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<tr>
<td><strong>Duplex or Multiplexer</strong></td>
<td>A multiplexer allows viewing of multiple “pictures” during recording.</td>
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<tr>
<td><strong>Dwell</strong></td>
<td>Length of time a video switcher holds a camera’s “picture” before switching to the next camera’s “picture.”</td>
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<tr>
<td><strong>Fiber Optics</strong></td>
<td>Flexible glass fibers used to conduct signals.</td>
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<tr>
<td><strong>Field of View</strong></td>
<td>The horizontal or vertical picture size at a given distance from a camera to the subject.</td>
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<tr>
<td><strong>f-Stop</strong></td>
<td>Lens speed. Lower f-stop means the lens remains open longer, resulting in more light passing through the lens and better low light camera performance.</td>
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<tr>
<td><strong>Gen-Lock</strong></td>
<td>Method used to synchronize one or more cameras by external means. Typical methods are composite video, composite sync, and horizontal or vertical sync.</td>
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<tr>
<td><strong>Image Intensifier</strong></td>
<td>Electronic device used to provide a brighter output image than the input image.</td>
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<tr>
<td><strong>Incident Light</strong></td>
<td>Amount of light directly over an object.</td>
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<tr>
<td><strong>Looping</strong></td>
<td>Term used when a high impedance device is connected in parallel to a video source.</td>
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<tr>
<td><strong>Matrix Switcher</strong></td>
<td>Normally used in larger camera systems, a matrix switcher allows any of the system's cameras to be routed to any of the system's monitors.</td>
</tr>
<tr>
<td><strong>Multiplexer</strong></td>
<td>Device which allows the recording/playback of multiple cameras on a single time lapse recorder with little loss of information.</td>
</tr>
<tr>
<td><strong>Pinhole Lens</strong></td>
<td>Lens with a very small front, easily concealed, for use in covert applications.</td>
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<tr>
<td><strong>Quad</strong></td>
<td>Device that simultaneously places the pictures from four cameras onto one video monitor.</td>
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<tr>
<td><strong>Resolution</strong></td>
<td>Measure of the ability of a CCTV system, or one of its components, to produce detail.</td>
</tr>
<tr>
<td><strong>Roll</strong></td>
<td>Result of the loss of vertical sync which causes the picture on a monitor to move up or down.</td>
</tr>
<tr>
<td><strong>Sync</strong></td>
<td>Electronic pulses inserted in a video signal for assembling picture information in the proper position.</td>
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**Time Lapse VCR**

VCR that can record for extended periods of time on a single video tape by using frequent tape “pausing.” The longer the time of recording, the fewer number of “pictures” recorded per second.  

NOTE: Each state separately defines the minimum number of frames per second for recordings to be considered “real time” for law enforcement purposes.
3. Delivery, Handling, and Storage

3.1 Delivery
a) Upon delivery of equipment and accessories, visually inspect packaging for physical damage. If physical damage is evident, notify the shipper and the manufacturer in writing immediately.

b) Compare equipment and accessories received with the bill of materials, to verify that the shipment is complete. If the shipment is not complete, notify the manufacturer in writing immediately.

c) Verify that the equipment and accessories received conform with approved submittals and manufacturer quotations. If they do not, notify the manufacturer in writing immediately.

d) Upon delivery, carefully unpack equipment and accessories sufficiently to inspect for concealed damage resulting from shipping and handling. If damage has occurred, notify the shipper in writing immediately.

e) If CCTV equipment and accessories are to be stored prior to installation, restore original packing materials to protect from exposure to environmental conditions. When conditions permit, leave the packing materials intact until equipment and accessories are ready for installation.

3.2 Handling
a) Handle CCTV equipment and accessories in accordance with manufacturer recommendations. Avoid impact, jolting, jarring, rough handling, etc.

b) Ensure that equipment and components are within the rated capacity of the handling equipment.

3.3 Storage
a) Store CCTV equipment and accessories in accordance with manufacturer recommendations.

b) Store in a clean, dry, environmentally controlled space.

c) Store in an area to discourage vandalism and theft, and out of the way of construction traffic.
4. Pre-Installation Considerations

4.1 General

a) Survey the project site for conditions prior to installation. Inspect for seasonal and environmental conditions such as average, maximum, and minimum temperatures, fog, rain, snow, ice, humidity, condensing moisture, corrosion, salt water exposure, heat, cold, vibration, radio frequency interference, electrical discharge, AC induction, dust, smoke, animal or insect infestation, vegetation, decorations, marketing aids, hazardous or volatile atmospheres, vandalism, tampering, theft, etc. Survey outdoor camera locations when trees, shrubs, etc., are in full foliage.

b) Select equipment and components suitable for the physical and environmental conditions that the site may present.

4.2 Documentation

a) If required, notify the Authority Having Jurisdiction (AHJ) prior to the installation or alteration of CCTV equipment or wiring.

b) Upon the AHJ’s request, submit information regarding the system or system alterations, including project drawings and specifications and battery calculations, if applicable.

c) If required by the AHJ and prior to requesting final approval of the installation, furnish a written statement that the system has been:

1. Installed in accordance with specifications, and
2. Tested in accordance with the manufacturer’s specifications and appropriate NFPA requirements.

4.3 Compatibility and Integration

a) Ensure that CCTV system components are compatible as a system. Ensure that the CCTV system is compatible with collateral systems when integrated into other systems. NOTE: CCTV systems can be installed as an independent, stand-alone system, as an integral system combining other detection, notification, and auxiliary functions, or integrated as a component subsystem that is coordinated with other systems.

b) Where integrated with other systems, arrange systems to function as a single system. NOTE: CCTV systems may share control equipment with other systems or function as a stand-alone subsystem. Ensure that simultaneous operation of all system components does not degrade overall system operation and performance.

c) Where integrated with central station premise security systems, comply with applicable codes and requirements for central station premise security systems.

4.4 Voltage Considerations

a) CCTV systems operating at 120 Volts AC typically have cameras supplied with a 6-foot standard power cord, which necessitates locating a suitable receptacle within 6 feet of the camera location. Cameras operating at 120 Volts AC are typically used for installations requiring power-intensive accessories such as wiper/washers, heaters, blowers, etc., such as in outdoor locations.

b) CCTV systems typically operate at 24 Volts AC. Cameras can be powered by external, plug-in type power supplies using smaller-gauge conductors at each location, or from remote or centrally-located power supplies. Alternatively, siamese cable, which
contains video coax and power cable under one jacket, can be used for both power and video cabling requirements.

c) CCTV systems operating at 12 Volts DC are typically used in vehicles or other locations where power is derived from one or several large batteries to power the system. Twelve Volt DC systems are supplied power in the same manner as 24 Volt AC systems with the additional restriction that cable length is limited by voltage drop.

4.5 Camera Selection and Location

Camera performance depends upon several factors including area and image illumination, reflectance and glare, f-stop, color temperature, etc. Consequently, camera performance is somewhat subjective and may require a live demonstration or mock-up to determine suitability.

a) Ensure that camera selections and locations comply with manufacturer recommendations, drawings, and specifications, considering access for maintenance, repairs, and future replacement.

b) Use color cameras in locations where color and details are important to distinguish characteristics or for object recognition.

c) Use cameras that are appropriately designed and adjusted for light levels and sensitivity. NOTE: Supplemental lighting, including infrared lighting, may be required for acceptable camera performance.

d) Use cameras and lenses with the appropriate level of resolution for the intended application. NOTE: In any situation, a higher resolution picture is more desirable than a lower resolution camera.

e) Select cameras and lenses considering depth of field and field of view. Consider how wide or how tall an object is in comparison to surroundings when related to recognition of that object on a system monitor. Two cameras may be required for a given application, one for an overall view, and another to view fine details.

f) Select cameras, lenses, enclosures, and accessories that are physically compatible with the installed location and mounting methods, such as concealed locations or dome enclosures. Size enclosures for cameras, lenses, and ancillary equipment.

g) Use optically-corrected domes. Typically, clear domes are used for outdoor locations and smoked domes are used indoors.

h) Select enclosures considering discretion, aesthetics and serviceability. Domes afford a great deal of discretion by prohibiting an observer from determining which way the camera is looking at any given time. Certain enclosures, including domes, afford greater serviceability due to built-in features, electronics or modularity. Other enclosures tend to “blend in” more with their environment for purely aesthetic reasons.

i) Select cameras and/or systems that allow cameras to be synchronized for roll-free video switching, using either cameras with synchronizing capabilities, or using systems with external phase adjustment features. NOTE: External phase adjustment capabilities is recommended because it allows more flexibility in system set-up and does not require cameras with phase line-lock capabilities.

j) Select fixed cameras where focusing on one point or feature, such as doors, hallways, alcoves, very small areas, etc.

k) Select dome-mounted or pan/tilt/zoom cameras where the area to be protected has an unobstructed line of sight with no hidden alcoves.

l) Select dome-mounted cameras for 360-degree coverage.
Guidelines for installing cabling, conductors, and conduits are contained in various *National Electrical Installation Standards*. The following requirements modify or supplement those requirements with respect to conduits, cabling, and conductors installed for CCTV systems.

5.1 General

a) Install wiring and cable in accordance with manufacturer recommendations and the NEC requirements.

b) Solder and heat-shrink-wrap electrical connections to device manufacture supplied leads, or use high-quality insulating crimp connectors.

c) Provide strain relief for all connections to ensure that tension is not transmitted to joints or terminals and will not damage or break connections.

d) Provide a minimum of 2 inches of separation between conductors of lighting and power circuits and those of Class 3 circuits, unless one of the circuits is installed in metallic raceway.

e) Use conductors and cables of the appropriate gauge, strands, insulation, and electrical properties as specified by the manufacture of the device to be connected.

f) Install conductors and cables to provide access to equipment for maintenance and repairs.

g) Prepare cable and conductors in accordance with manufacturer instructions. *NOTE: Some manufacturers provide unique instructions for their products. Stripping of sheathing as described in h) and i) below may not be an acceptable practice with products such as coaxial cable or category-rated network cable.*

h) Strip cables and conductors to the length prescribed by the manufacture of the device to which they should be connected. Do not damage or remove any strands of stranded conductors.

i) Remove the outside protective sheathing of cables a minimum of 2 inches from the end to expose the internal insulated conductors for making connections. Removal of the outside sheathing in excess of 2 inches to facilitate inserting the cable back into the opening is acceptable. Do not damage the insulation of the internal conductors of the wires or cables.

j) Ensure that wires and cables extend at least 6 inches beyond the finished surface at the point of device installation.

k) Use separate cables for power, control, and video, unless using one cable listed as suitable for combined use.

l) Identify circuits within control panels, enclosures, pull boxes, etc. Identify circuits at field terminations and all accessible locations.

5.2 Video Cable and Conductors

a) Use standard coaxial video cables with a solid copper center conductor and a braided copper shield with 95 percent coverage, or mini-coaxial video cables with a stranded copper center conductor and a braided copper shield with 89 percent coverage.

b) Do not use coaxial cables with an aluminum or copper-clad steel center conductor. Do not use cables with an aluminum braid or foil shield. *NOTE: Cables with a foil shield may be used if the foil shield is combined with, and in addition to, a copper braid shield.*
c) Do not exceed manufacturer’s recommendations for cable length.

d) Use cable with a stranded center conductor cable specifically manufactured for the application for pan/tilt/zoom cameras between the camera and junction box.

e) Use coaxial cable with a nominal impedance of 75 ohms. Do not use coaxial cable rated for any other nominal impedance.

5.3 Control Wiring

The purpose of low-voltage control cabling is to carry control signals to devices within the CCTV system. Such devices include, but are not limited to, remote positioning devices such as pan/tilt/zoom cameras, scanner units, and domes, zoom lenses, and auxiliary devices such as wipers and washers, heaters, blowers, and remote relays.

a) Size control wiring to deliver the manufacturer’s optimum operating voltage from the power supply or controller to the device being driven. Use the manufacturers’ data sheets specifying the operating voltage range, maximum distance versus wire gauge, and power consumption.

b) Use a minimum of 18 AWG, stranded copper conductors for control wiring.

5.4 Data Cable

The purpose of data cable is to carry digital data communications between various devices within the system. Such devices include, but are not limited to, receivers, drivers, keyboards, controllers, multiplexers, and recording devices.

a) Use data cable in accordance with manufacturer recommendations.

5.5 Fiber Optic Cabling

Fiber optic transmission of both video and data presents distinct advantages over standard copper-based cabling. Higher quality and longer distance transmission characteristics, inherent noise resistance, greater flexibility for usage and reduced cabling diameters are a few of these advantages. Installation and design of fiber optic systems are subject to the requirements and demands of both the application and the manufacturers’ specifications. Fiber optic cable installations should be completed by an approved and certified fiber optics installer.

a) Install fiber optic cables in accordance with manufacturer recommendations.

b) Protect fiber optic cables against mechanical damage.

c) Install a service loop at control panels and enclosures used for terminations and at all field terminations. Conform to manufacturer’s specifications for the bending radius of the service loop, but not less than 10 times the cable diameter. Provide mechanical protection of service loops.

5.6 Coaxial Connectors, Splices, and Terminations

a) Use BNC crimp-on style connectors. Do not use screw-on or twist-on connectors or adapters.

b) Make direct connections within the CCTV system. Do not make connections using any type of adapter.

c) Use a standard female-to-male BNC splice when splicing coaxial cable. Do not use “F” connectors or barrels. NOTE: Although a female-to-female splice using a barrel adapter is acceptable, there is more signal loss with this type of splice.

d) Use connection terminals that are insulated either by the manner of their construction and use, or by adding heat shrink insulation over the connection for each individual connector.

e) Ensure that all terminations are properly made. NOTE: Examples of improper connections include, but are not limited to, connections that do not include all of the strands of the conductor, are bent or misshapen, and do not properly fit the terminal on the device.
f) Use terminals for more than one conductor that are identified as suitable for that purpose. Connect only conductors of the same size and composition under common terminals.

5.7 Grounding and Bonding

a) Ground and bond equipment and components in accordance with manufacturer recommendations.

b) Bond all metallic components together. *NOTE:* The NEC does not require pullboxes to be bonded if the highest voltage in the pullbox is 50 volts or less. However, it is recommended that equipment and conduit systems be bonded together.

5.8 Conduits and Raceways

a) Install bushings at all conduit and raceway connections to junction boxes and at all open ends of raceways or flexible conduits. Secure raceways and install bushings for conduits and raceways that are not terminated on an appropriate back box. Position conduits and raceways to provide mechanical protection for the wires or cables to the device.

b) Limit distance between devices and raceways, conduits or flexible conduits to no more than 3 inches.

c) Size raceways to protect any device manufacturer provided leads and connectors, along with any conductors from the wires or cables.

d) Install raceways and conduits relative to devices to facilitate removal, reinstallation, and reconnection without damaging finished surfaces or extended time fishing for wires or cables. Generally, install raceways and conduits perpendicular to the device.
6. Installation

6.1 General

a) Install cameras, equipment, and accessories in accordance with manufacturer installation instructions and recommendations.

b) Ensure that components are fully compatible as a system, ensuring that equipment is compatible with wiring methods, system voltage, etc. Use equipment listed for the purpose for which it is used, where applicable nationally recognized standards exist.

c) Integrate system components with support equipment and software into a fully operational, functional video control system.

d) Construct pole and tower foundations and install poles and towers in accordance with drawings, specifications, and manufacturer recommendations.

e) Ensure that cameras mounted on poles or towers are accessible for maintenance using vehicles or bucket trucks, or provide a camera lowering system with dome enclosures.

f) Install, conceal, and disguise covert cameras in accordance with manufacturer recommendations.

g) Locate equipment and components so that accidental operation or failure is not caused by vibration or jarring.

h) Locate and install equipment and components in accessible locations for service personnel.

6.2 Mounting and Supports

a) Mount and support equipment in accordance with manufacturer recommendations.

b) Use anchoring devices that are approved for the mounting surface, and for the weight and wind-loading, where applicable, of the equipment used.

c) Tighten mounting bolts and hardware snug to the mounting surface.

d) Use mounts and supports that provide for adequate support and do not inhibit camera operation or field of view.

e) Use parapet mounts that are designed to allow equipment to be swiveled in toward the roof for maintenance access.

f) Provide supports to structures for all ceiling mounted cameras.

6.3 Camera Installation

a) Prior to installation, check the dimension of all camera housing assemblies to ensure that cameras, lenses, mounting brackets, heaters, where required, blowers, where required, washer/wiper assemblies, where required, and all other required components will fit into the housing.

b) Install cameras in locations that avoid a direct view of sources of light. Picture quality is degraded when a camera looks directly into a light source, or has a relatively high contrast between objects being viewed and the background scene.

c) Ensure that proposed camera locations afford the necessary field of view of the areas to be monitored.
d) Verify that the field of view of ceiling-mounted cameras is not obstructed by light fixtures, fire suppression sprinklers, HVAC diffusers or return air grills, breaks in ceiling height, etc. If such conflicts exist, coordinate with the building owner, general contractor, engineer of record, etc., prior to installation.

e) Install spot filters for cameras with fixed lenses, where necessary. Install asymmetrical wide-angle lenses to correct for distortion.

### 6.3.1 External Cameras

a) Install external cameras such that icing, sunlight angles, extreme temperature, and wind loading do not affect their operation. **NOTE:** Pan/tilt/zoom cameras may be required to start up in icing conditions.

b) Use weather-tight housings were exposed to elements.

c) Install accessories for external conditions such as heaters, blowers, and defrosters or defoggers, as required.

d) Install external CCTV equipment and components that are vandal and tamper resistant.

e) Install sun-shield or hoods to reduce glare when the sun is low on the horizon, or if the camera has a direct view of the sun, where applicable.

### 6.4 Control Cabinet and Equipment

a) Install CCTV equipment, components, cameras, transmitters, receivers, matrix switchers, collectors, digital recorders, video cassette recorders, programmable logic controllers, computers, routers, monitors, pan/tilt/zoom controls, etc., in accordance with manufacturer recommendations.

b) Ensure that equipment is installed and connected to function as intended, designed, and manufactured.

c) Ensure that transmitters and receivers are capable of transmitting and receiving video, data, and control signals for pan/tilt/zoom controls, where applicable.

d) Install console-mounted monitors on consoles or cabinets. Install overhead monitors mounted on steel support brackets. Use brackets capable of supporting up to 40 pounds that are adjustable in height and width to accommodate the required monitor dimensions.

e) Provide 75-ohm terminations for all unused video amplifier outputs that are not source-terminated.

### 6.5 Software

a) Provide and configure custom software, if necessary, to complete system installation.

b) Use software provided with a premise security system that is listed for use with the equipment on which it is installed.

c) Maintain a record of installed software version numbers at the location of the premise security system.

d) Protect software from unauthorized changes.

### 6.6 Power Supplies

a) Connect power supplies for CCTV equipment to NEC compliant branch circuiting.

b) Provide and install listed power supplies with performance characteristics compatible with unique requirements of the equipment being supplied.

c) Size power supplied in accordance with manufacturer recommendations and with the application. Ensure that loads connected to power supplies do not exceed 80 percent of the power output rating of the power supply.

d) Provide individual fusing for each camera.

e) Consider power source redundancy with at least two independent and reliable power supplies, one primary and one secondary or standby source, each of which with adequate capacity for the application.

f) Install transient voltage surge protection devices at the primary power supply for CCTV equipment.
6.7 Storage Batteries

a) When installing batteries as a secondary source for CCTV systems, locate storage batteries such that the premise security equipment, including overcurrent devices, are not adversely affected by battery gases. Conform to the NEC.

b) Use battery racks that are suitably protected against deterioration.

c) Permanently identify the location of remote batteries and battery charger at the premise security control panel.

d) Secure storage batteries from unauthorized access.

e) Provide automatic battery charging in accordance with manufacturer recommendations.

f) Provide a battery charger capable of maintaining the battery fully charged under normal operating conditions and to recharge batteries after fully charged batteries have been subject to a single discharge cycle.

g) Ensure that batteries are protected from excessive charging current by overcurrent devices or by automatic current-limiting design of the charging source.

h) Use battery charging equipment with voltage and charging current metering either by integral meters or by readily accessible terminals for the connection of portable meters.

i) Provide supervision of the battery charger to detect a failure of the battery charger and initiate a trouble signal.

6.8 Site Cleanup

a) Upon completion of the work, remove excess debris, materials, equipment, apparatus, tool and the like and leave the premises clean, neat, and orderly.

b) Provide signage for buildings and areas under CCTV surveillance, unless covert CCTV is used.
7. Commissioning

7.1 Field Adjustments

Some CCTV equipment and components contain automatic controls to adjust for in-service conditions such as brightness control of video monitors, frequency control for synchronizing cameras, gain control to adjust signal strength, and light control for cameras to automatically adjust for proper light levels.

a) Make field adjustments to cameras to improve the field of view of the area being monitored. For cameras monitoring doors, the top of the field of view should be the top of the door.

b) Set pan and tilt limits in accordance with manufacturer recommendations and as required for the project.

c) Set camera back-focus such that cameras remain in focus while zooming all the way out or zooming all the way in.

d) As applicable, set all pan/tilt/zoom cameras to automatically adjust, using set points, to view the intended target, when the cameras call-up switching signal is generated.

e) Synchronize all cameras to prevent rolling when switching on each monitor. Adjust cameras to optimize the presentation at the display.

f) Ensure that the recording speed of the multiplexer is compatible with the time-lapse speed of the recording device. NOTE: Most multiplexers require the video signal to be delivered in three-hour mode to prevent lost information or picture interference.

g) Adjust variable focal lenses during final acceptance testing.

7.2 Acceptance Testing

a) Test CCTV systems, equipment, and components in accordance with manufacturer recommendations.

b) Visually inspect monitors to ensure system monitors are working properly and that cameras are properly aimed and focused.

c) Verify proper operation of remote controls, such as pan/tilt/zoom cameras.

d) Verify proper operation of ancillary device operation, such as heaters, blowers, defrosters, washer/wipers, etc.

e) Verify proper operation of matrix switchers, multiplexers, quads, etc., that sequence and cycle between cameras and monitors.

f) Verify that the various camera images are displayed on the appropriate monitors.

g) Verify proper operation of recording devices such as digital video recorders, video cassette recorders, etc.

h) Correct system defect and malfunctions in accordance with manufacturer recommendations.

7.3 Documentation

a) Deliver owner’s and user’s manuals and installation instructions covering all system equipment to the owner or responsible party upon final acceptance of the system.

Owners or responsible parties include, but are not necessarily limited to, the owner of the protected property, the leaseholder of the tenant space where the system is installed, or an employee or agent of the owner or the leaseholder.
Documentation should include the following:

1) Detailed narrative description of the system inputs, signaling, ancillary functions, annunciation, intended sequence of operation, expansion capability, and application considerations and limitations.

2) Operator instructions for basic system operations, including system start-up and reset, operation of manual ancillary function controls such as pan/tilt/zoom cameras, operation of recording devices, etc.

3) Detailed description of routine maintenance and testing as required and as would be provided under a maintenance contract. Include testing and maintenance instructions for each type of device installed.

4) Listing of the individual system components that require periodic testing and maintenance.

5) Schedule of testing and maintenance procedures and intervals for each type of device installed.

6) Detailed troubleshooting instructions for each trouble condition generated from monitored field wiring, including opens, grounds and loop failures, including a list of all trouble signals annunciated by the system, a description of the conditions that cause such trouble signals, and step-by-step instructions describing how to isolate such problems and correct them, or how to call for service, as appropriate.

7) Service directory that included a list of names and telephone numbers of those who provide service for the system.

b) Where required by code or regulation, provide a Premise Security Record of Completion form to the owner or responsible party.

c) Protect documentation that may compromise the premise security system to prevent the unauthorized release of critical system locations, operations and functions.

7.4 Training

a) Provide training for all systems users. Coordinate this with the owner or responsible party.

b) Base training on the level of user involvement with the system, using owner’s and operator’s manuals as references materials.

c) Make documentation of training available to the AHJ upon request, and include it with the owner’s and user’s manuals. Include the names of attendees, the date of the training, the scope of the training, and the lesson plan of the training in the documentation.
8. Maintenance

8.1 General

a) Inspection, testing, or maintenance may be performed by a person or organization other than the owner if conducted under a written contract.

b) To prevent unnecessary response, notify all persons affected by CCTV systems, including supervisory personnel and building occupants, before proceeding with any testing or maintenance.

c) Notify the owner or responsible party that the system or a part of the system may not be fully functional during the testing or maintenance procedure and that appropriate safeguards should be taken, based upon the perceived risk.

d) Notify the owner or responsible party that information may be lost during the time the system is under maintenance or testing.

e) Coordinate maintenance and testing to prevent interruption of critical building systems or equipment.

f) Review information regarding the system and system alterations, including record of completion, owners manual and installations instructions, if available from the owner or responsible party prior to maintenance and testing.

g) Notify all affected parties upon the conclusion of inspections, maintenance, and testing.

h) If a defect or malfunction is not corrected at the conclusion of system inspection, testing, or maintenance, provide written notice to the system owner or responsible party. Maintain a written record for a period of 1 year from the date the impairment is corrected.

8.2 Routine Inspection, Maintenance, and Testing

a) Inspect, maintain, and test CCTV equipment and components in accordance with manufacturer recommendations.

b) Use replacement components that are fully compatible with existing equipment and components. NOTE: For example, do not replace a CS-mount lens with a C-mount lens. A C-mount lens requires a greater distance between the lens and the camera sensor than a CS mount lens. It would not be possible to focus the camera without the aid of a CSA, or CS-to-C adapter. On occasion, installing a C-mount lens on a CS-mount camera without an adapter can damage the camera sensor.

c) Clean equipment and components using manufacturer recommended materials and methods.

d) Inspect equipment and components for evidence of moisture. Consult manufacturer for recommendations to protect against moisture.

e) Periodically measure the voltage of power supplies to ensure proper equipment operating voltage. Replace deficient or degraded power supplies. Voltage regulation problems can cause camera mis-operation.

f) Inspect equipment with air filters. Clean or replace dirty filters as required.

g) Measure the temperature of rooms containing CCTV equipment and components. Ensure that equipment ambient temperatures are within operational limitations of equipment. Notify owner or responsible party when ambient temperatures exceed equipment operating limits.
h) Perform Acceptance Testing in accordance with 7.2.

i) Provide training for all users when inspection, maintenance, or testing results in a change in system operation.

8.3 Making Repairs or Modifications to an Existing System

a) Upon notification of a CCTV system malfunction, effect repairs within 24 hours, unless it is determined that there is no risk to the protected property or the occupants. In such case, notify the owner or responsible party in writing that repairs may be completed outside of 24 hours.

b) Inspect and test all systems upon completion of installation, adding or deleting system components, any modification, repair, or adjustment to system hardware or wiring, change in site-specific software, or change in the structure being protected.

c) Fully test all components, circuits, systems operations, or site-specific software functions known to be affected by changes.

d) Complete routine system maintenance in accordance with Section 8.2.
(This annex is not part of the standard)

Annex A: Reference Standards

This publication, when used in conjunction with the National Electrical Code and manufacturers’ literature, provides sufficient information to install and maintain CCTV systems. The following publications may also provide useful information:

National Fire Protection Association
1 Batterymarch Park
Quincy, MA  02169-7471
(617) 770-3000 tel
(617) 770-3500 fax
www.nfpa.org

ANSI/NFPA 70-2005, National Electrical Code (ANSI)

Current National Electrical Installation Standards™ published by NECA:
NECA 90-2004, Recommended Practice for Commissioning Building Electrical Systems (ANSI)
NECA 100-1999, Symbols for Electrical Construction Drawings (ANSI)
NECA 101-2001, Standard for Installing Steel Conduits (Rigid, IMC, EMT)
NECA 102-2004, Standard for Installing Aluminum Rigid Metal Conduit (ANSI)
NECA/AA 104-2000, Recommended Practice for Installing Aluminum Building Wire and Cable (ANSI)
NECA/NEMA 105-2002, Recommended Practice for Installing Metal Cable Tray Systems (ANSI)
NECA 111-2003, Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC) (ANSI)
NECA 200-2002, Recommended Practice for Installing and Maintaining Temporary Electrical Power at Construction Sites (ANSI)
NECA 202-2001, Recommended Practice for Installing and Maintaining Industrial Heat Tracing Systems (ANSI)
NECA/FOA 301-2004, Standard for Installing and Testing Fiber Optic Cables (ANSI)
NECA 331-2004, Standard for Building and Service Entrance Grounding and Bonding
NECA 400-1998, Recommended Practice for Installing and Maintaining Switchboards (ANSI)
NECA 303  Standard for Installing Closed-Circuit Television (CCTV) Systems

NECA 402-2001, Recommended Practice for Installing and Maintaining Motor Control Centers (ANSI)
NECA/EGSA 404-2000, Recommended Practice for Installing Generator Sets (ANSI)
NECA 405-2001, Recommended Practice for Installing and Commissioning Interconnected Generation Systems (ANSI)
NECA 406-2003, Standard for Installing Residential Generator Sets (ANSI)
NECA 407-2002, Recommended Practice for Installing and Maintaining Panelboards (ANSI)
NECA 408-2002, Recommended Practice for Installing and Maintaining Busways (ANSI)
NECA 409-2002, Recommended Practice for Installing and Maintaining Dry-Type Transformers (ANSI)
NECA/IESNA 500-1998, Recommended Practice for Installing Indoor Commercial Lighting Systems (ANSI)
NECA/IESNA 501-2000, Recommended Practice for Installing Exterior Lighting Systems (ANSI)
NECA/IESNA 502-1999, Recommended Practice for Installing Industrial Lighting Systems (ANSI)
NECA 503-2005, Standard for Installing Fiber Optic Lighting Systems
NECA/BICSI 568-2001, Standard for Installing Commercial Building Telecommunications Cabling (ANSI)
NECA/MACSCB 600-2003, Recommended Practice for Installing and Maintaining Medium-Voltage Cable (ANSI)
NECA/NEMA 605-2005, Recommended Practice for Installing Underground Nonmetallic Utility Duct (ANSI)