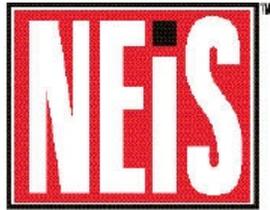


NECA 303

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Standard for Installing and Maintaining Closed-Circuit Television (CCTV) Systems

ANSI ~~Recirculation~~^{view} Draft
December 2017~~July 2016~~

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17 (This foreword is not a part of the standard)
18

19 Foreword

20
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23 of quality and workmanship for installing electrical products and systems. *NEIS*® are intended to be
24 referenced in contract documents for electrical construction projects. The following language is
25 recommended:

26
27 Closed-circuit television (CCTV) systems shall be installed and maintained in accordance with
28 NECA 303-2XXX, *Standard for Installing and Maintaining Closed-Circuit Television (CCTV)*
29 *Systems* (ANSI).
30

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35

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37 quality standards, *NEIS* may in some instances go beyond the minimum safety requirements of the NEC.
38 It is the responsibility of users of this publication to comply with state and local electrical codes and
39 Federal and state OSHA safety regulations as well as follow manufacturer installation instructions when
40 installing electrical products and systems.
41

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

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45 Bethesda, MD 20814
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47 (301) 215-4500 Fax
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50

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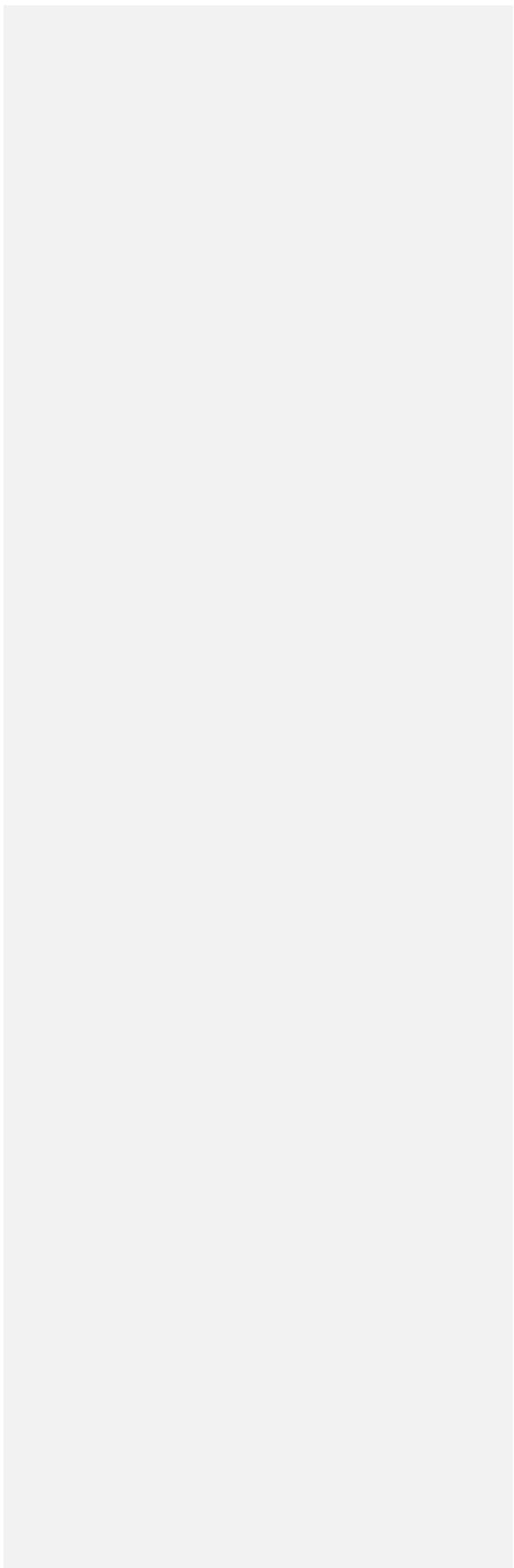
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63

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1. Scope

This Standard describes installation procedures for new closed-circuit television (CCTV) system equipment installed for video surveillance and for protection of building interiors, building perimeter, and surrounding property. This publication applies to CCTV systems, equipment, components, and accessories as required for a complete and functional CCTV system for security and monitoring activities in non-hazardous locations both indoors and outdoors. It also covers periodic routine maintenance procedures for CCTV systems.

1.1 Products and Applications Included

This Standard applies to the following:

- Video cameras, controls, enclosures and accessories, including pan-tilt-zoom and fixed-mounted cameras
- Monochrome or color monitors, video controllers, video switches, remote switchers, quad switchers, signal processing equipment, combiners, amplifiers, control stations, video multiplexers, recording devices (tape or DVR), distribution components, power supplies, and accessories
- Electronic hardware components
- Conductor and cable installation

1.2 Products and Applications Excluded

This Standard does not apply to:

- One and two family dwellings
- Design or installation of lighting fixtures or security lighting
- Branch circuit wiring methods.
- Security of data, software, or computer systems
- Transmission of video images to remote locations
- Remote supervising locations that receive signals from premises CCTV Systems
- Commercial Monitoring Stations
- Alternate or back-up sources of power

1.3 Regulatory and Other Requirements

All information in this publication is intended to conform to the NEC (ANSI/NFPA 70TM). Installers shall follow the NEC, applicable state and local codes, manufacturer instructions, and contract documents when installing CCTV systems.

Only qualified persons as defined in the NEC familiar with the construction and installation of CCTV systems shall perform the technical work described in this publication. Administrative functions such as receiving, handling, and storing CCTV system parts, components, and equipment and other tasks may be performed under the supervision of a qualified person. All work shall be performed in accordance with NFPA 70E, *Standard for Electrical Safety in the Workplace*.

173 General requirements for installing electrical products and systems are described in NECA 1, *Standard*
174 *Practices for Good Workmanship in Electrical Construction (ANSI)*. Other *NEIS* provide additional
175 guidance for installing particular types of electrical products and systems. A complete list of *NEIS* is
176 provided in Annex A.

177
178
179 **1.4 Mandatory Requirements, Permissive Requirements, Quality and Performance**
180 **Instructions, Explanatory Material, and Informative Annexes**

181
182 Mandatory requirements in manufacturer instructions, or of Codes or other mandatory Standards that may
183 or not be adopted into law, are those that identify actions that are specifically required or prohibited and
184 are characterized by the use of the terms “must” or “must not,” “shall” or “shall not,” or “may not,” or
185 “are not permitted,” or “are required,” or by the use of positive phrasing of mandatory requirements.
186 Examples of mandatory requirements may equally take the form of, “equipment must be protected . . .,”
187 “equipment shall be protected . . .,” or “protect equipment . . .,” with the latter interpreted (understood) as
188 “(it is necessary to) protect equipment . . .”

189
190 Permissive requirements of manufacturer instructions, or of Codes or other mandatory Standards that may
191 or not be adopted into law, are those that identify actions that are allowed but not required, or are
192 normally used to describe options or alternative means and methods, and are characterized in this
193 Standard by the use of the terms “may,” or “are permitted,” or “are not required.”

194
195 Quality and performance instructions identify actions that are recommended or not recommended to
196 improve the overall quality or performance of the installation and are characterized by the use of the
197 terms “should” or “should not.”

198
199 Explanatory material, such as references to other Codes, Standards, or documents, references to related
200 sections of this Standard, information related to another Code, Standard, or document, and supplemental
201 application and design information and data, is included throughout this Standard to expand the
202 understanding of mandatory requirements, permissive requirements, and quality and performance
203 instructions. Such explanatory material is included for information only, and is identified by the use of
204 the term “NOTE,” or by the use of italicized text.

205
206 Non-mandatory information and other reference standards or documents relative to the application and
207 use of materials, equipment, and systems covered by this Standard are provided in informative annexes.
208 Informative annexes are not part of the enforceable requirements of this Standard, but are included for
209 information purposes only.

210
211

212 **2. Definitions**

213
214 **Approved.** Acceptable to the Authority Having Jurisdiction.

215
216 **Authority Having Jurisdiction (AHJ).** An organization, office, or individual responsible for enforcing
217 the requirements of a code or standard, or for approving equipment, materials, an installation, or a
218 procedure.

219
220 **Blanking.** Electrical signal produced at the end of each scanning line.

221

222 **C-Mount.** Former industrial standard lens mounting format. C-mounts can be adapted to CS-mounts
223 using a CSA, or a CS to C adapter, but CS-mounts cannot be adapted to C-mounts.
224

225 **Closed-Circuit Television (CCTV).** A video system in which an analog or digital video signal travels
226 from the camera to video monitoring stations at the protected premises.
227

228 **Coaxial Cable.** Cable commonly used to transmit video signals. It consists of a metallic shield with one
229 or more center conductors that are isolated from each other and from the shield.
230

231 **Combination System (as related to premises security).** A system that provides premises security as a
232 portion of a single control unit, or multiple control units that work together to provide one integrated
233 control.
234

235 **Composite Video.** Video signal that contains the picture signal, with vertical and horizontal blanking
236 and sync pulses.
237

238 **Control Unit.** A system component that monitors inputs and controls outputs through various types of
239 circuits.
240

241 **CS-Mount.** Newer standard lens mounting format.
242

243 **Depth of Field.** Front-to-back area that is focused in the camera view. The better the lighting, the greater
244 the depth of field that is possible.
245

246 **Digital Imaging System (DIS).** A video system in which a digital video signal travels from the camera
247 and can be viewed by any authorized user at or away from the protected premises.
248

249 **Digital Video Recorder (DVR).** Electronic device used to store video images on an internal hard drive
250 with a specific memory capacity.
251

252 **Dwell.** Length of time a video switcher holds a camera's scene before switching to the next camera's
253 scene.
254

255 **Fiber Optics.** Flexible glass fibers used to conduct signals.
256

257 **Field of View.** The horizontal or vertical picture size at a given distance from a camera to the subject.
258

259 **f-Stop.** Lens speed. Lower f-stop means the lens remains open longer, resulting in more light passing
260 through the lens and better low light camera performance.
261

262 **Gen-Lock.** Method used to synchronize one or more cameras by external means. Typical methods are
263 composite video, composite sync, and horizontal or vertical sync.
264

265 **Image Intensifier.** Electronic device used to provide a brighter output image than the input image.
266

267 **Incident Light.** Amount of light directly over an object.
268

269 **Labeled.** Equipment or materials to which has been attached a label, symbol, or other identifying mark
270 of an organization that is acceptable to the AHJ and concerned with product evaluation, that maintains

271 periodic inspection of production of labeled equipment or materials, and by whose labeling the
272 manufacturer indicates compliance with appropriate standards or performance in a specified manner.

273
274 **Listed.** Equipment, materials, or services included in a list published by an organization that is
275 acceptable to the AHJ and concerned with evaluation of products or services, that maintains periodic
276 inspection of production of listed equipment or materials or periodic evaluation of services, and whose
277 listing states that either the equipment, material, or service meets appropriate designated standards or has
278 been tested and found suitable for a specified purpose.

279
280 **Looping.** Term used when a high impedance device is connected in parallel to a video source.

281
282 **Matrix Switcher.** Normally used in larger camera systems, a matrix switcher allows any of the system's
283 cameras to be routed to any of the system's monitors.

284
285 **Multiplexer.** Device which allows the recording or playback of multiple cameras on a single time
286 recorder with little loss of information.

287
288 **Network Video Recorder (NVR).** A digital device and software within an internet protocol (IP) video
289 surveillance system that receives live images/video streams and records them in a digital format to a disk
290 drive or other mass storage device. *NOTE: Many NVRs permit real-time video monitoring in addition to*
291 *recording, and allows remote access for one or more personnel can view cameras simultaneously using*
292 *secure logins.*

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293
294 **Open Network Video Interface Forum (ONVIF).** Open standard protocol that allows compliant
295 network video devices to communicate regardless of manufacturer.

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296
297 **Pinhole Lens.** Lens with a very small front, easily concealed, for use in covert applications.

298
299 **Power Over Ethernet (POE).** Standard that allows data (Ethernet) cables to simultaneously transmit
300 data and power using a single network cable. POE permits powering electronic devices via Ethernet
301 cabling without the need for a separate power source.

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302
303 **Quad.** Device that simultaneously places the scenes from four cameras onto one video monitor.

304
305 **Record of Completion.** A document that acknowledges the features of installation, operation
306 (performance), service, and equipment with representation by the property owner, system installer, system
307 supplier, service organization, and the AHJ.

308
309 **Resolution.** Measure of the ability of a CCTV system, or one of its components, to produce detail.

310
311 **Roll.** Result of the loss of vertical sync which causes the picture on a monitor to move up or down.

312
313 **Strain Relief.** Cable termination that provides structural rigidity of conductors under conditions of
314 flexure.

315
316 **Sync.** Electronic pulses inserted in a video signal for assembling picture information in the proper
317 position.

318
319 **Video Cassette Recorder (VCR).** Electronic device used to store video images on a removable cassette
320 tape. VCRs that can record for extended periods of time on a single video tape by using frequent pausing
321 of the tape. The longer the time of recording, the fewer number of frames or pictures recorded per

322 second. Each state separately defines the minimum number of frames per second for recordings to be
323 considered “real time” for law enforcement purposes.
324
325

326 **3. Delivery, Handling, and Storage**

327 **3.1 Delivery**

328 Upon delivery of equipment and accessories, visually inspect packaging for physical damage. Carefully
329 unpack equipment and accessories sufficiently to inspect for concealed damage resulting from shipping
330 and handling. If damage has occurred, notify the shipper and the manufacturer in writing immediately.
331
332

333 Compare equipment and accessories received with the bill of materials, to verify that the shipment is
334 complete. If the shipment is not complete, notify the manufacturer in writing immediately.
335
336

337 Verify that the equipment and accessories received conform with approved submittals and manufacturer
338 quotations. If they do not, notify the manufacturer in writing immediately.
339

340 If CCTV equipment and accessories are to be stored prior to installation, restore original packing
341 materials to protect from exposure to environmental conditions. When conditions permit, leave the
342 packing materials intact until equipment and accessories are ready for installation.
343
344

345 **3.2 Handling**

346 Handle CCTV equipment and accessories in accordance with manufacturer instructions. Avoid impact,
347 jolting, jarring, and rough handling.
348
349

350 Ensure that equipment and components are within the rated capacity of the handling equipment.
351
352

353 **3.3 Storage**

354 Store CCTV equipment and accessories in accordance with manufacturer instructions.
355
356

357 Store in a clean, dry, environmentally controlled space.
358
359

360 Store in an area to discourage vandalism and theft, and out of the way of construction traffic.
361

362 **4. Pre-Installation Considerations**

363 **4.1 General**

364 Survey the project site for conditions prior to installation. Inspect for seasonal and environmental
365 conditions such as average, maximum, and minimum temperatures, fog, rain, snow, ice, humidity,
366 condensing moisture, corrosion, salt water exposure, heat, cold, vibration, radio frequency interference,
367 electrical discharge, AC induction, dust, smoke, animal or insect infestation, vegetation, decorations,
368
369

370 marketing aids, hazardous or volatile atmospheres, vandalism, tampering, and theft. Survey outdoor
371 camera locations when trees and shrubs are in full foliage.

372
373 Consider the areas to be covered by the CCTV system, such as, but not limited to, entrances, exits,
374 entrance ramps, elevators, stairwells, walkways, and parking areas. Select equipment and components
375 suitable for the physical and environmental conditions that the site may present. Verify that lighting
376 levels are suitable with video cameras. Use low-light cameras or increase light levels as needed for
377 proper operation of CCTV systems.

378
379 The level of tamper resistance shall be determined by a security vulnerability assessment or by the
380 requirements of the AHJ.

381
382

383 4.2 Documentation

384
385 Upon the AHJ's request, submit documentation regarding the system or system alteration design,
386 including project drawings and specifications and battery calculations, if applicable.

387
388 If required by the AHJ and prior to requesting final approval of the installation, furnish a written
389 statement that the system has been:

- 390 • Installed in accordance with all applicable specifications, and
- 391 • Tested in accordance with the manufacturer's specifications and appropriate NFPA™
392 requirements.

393
394

395 4.3 Compatibility and Integration

396
397 CCTV systems can be installed as an independent, stand-alone system, or can be either integrated systems
398 combining detection, notification, and auxiliary functions in a single system or a combination of
399 component subsystems.

400
401 Ensure that CCTV system components are compatible as a system. Ensure that the CCTV system is
402 compatible with collateral systems when integrated with other systems. Systems other than electronic
403 premises security systems are permitted to share components, equipment, circuitry, and installation wiring
404 with premises security systems.

405
406 Where integrated with other systems, arrange systems to function as a single system. CCTV systems may
407 share control equipment with other systems, or be able to operate as stand-alone subsystems arranged to
408 function as a single system. Ensure that the simultaneous operation of all system components does not
409 degrade overall system operation and performance. IP systems should be compliant with ONVIF
410 protocol.

411
412 When a CCTV system connects to a fire alarm system or other life safety systems, the requirements of
413 other codes and standards pertaining to those systems shall be followed.

414
415 When CCTV systems are integrated with central station premise security systems, comply with applicable
416 codes and requirements for central station premise security systems.

417
418

419 4.4 Voltage Considerations

420
421 CCTV systems operating at 120 Volts AC typically have cameras supplied with a 1.8 m (6-foot) standard
422 power cord, which necessitates locating a suitable receptacle within 1.8 m (6 feet) of the camera location.
423 Cameras operating at 120 Volts AC are typically used for installations requiring power-intensive
424 accessories such as wiper/washers, heaters, and blowers, such as in outdoor locations.

425
426 CCTV systems typically operate at 24 Volts AC. Cameras can be powered by external, plug-in type
427 power supplies using smaller-gauge conductors at each location, or from remote or centrally-located
428 power supplies. Alternatively, Siamese cable, which contains video coax and power cable under one
429 jacket, can be used for both power and video cabling requirements.

430
431 CCTV systems operating at 12 Volts DC are typically used in vehicles or other locations where power is
432 derived from one or more batteries used to power the system. 12 Volt DC systems are supplied power in
433 the same manner as 24 Volt AC systems with the additional restriction that cable length is more limited
434 due to voltage drop. Power Over Ethernet (POE) systems should conform to the following Standards;
435 IEEE 802.3AF from 44VDC-57VDC and 15 Watts maximum, and IEEE 802.3 from 44VDC-57VDC and
436 30 Watts maximum.

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437 438 **4.5 Camera Selection and Location**

439
440 Camera lenses are typically furnished separately from the camera body. Exercise care in selecting
441 cameras and lenses to ensure compatibility and proper performance. Camera performance depends upon
442 several factors including area and image illumination, reflectance and glare, f-stop, and color temperature.
443 Consequently, camera performance is somewhat subjective and may require a live demonstration or
444 mock-up to determine suitability for a given application.

445
446
447 Ensure that camera selections and locations comply with manufacturer instructions, drawings, and
448 specifications, considering access for maintenance, repairs, and future replacement.

449
450 Use color cameras in locations where color and details are important to distinguish characteristics or for
451 object recognition.

452
453 Use cameras that are appropriately designed and adjusted for light levels and sensitivity. Supplemental
454 lighting, including infrared or ultraviolet lighting, may be required for acceptable camera performance.
455 Locate cameras such that light sources are either behind the camera or are perpendicular to camera field
456 of view. Where the camera field of view has bright illumination behind the main subject, or for scenes
457 with extreme contrast, use cameras and accessories having electronic compensation, such as backlight
458 compensation or high dynamic range cameras.

459
460 Use cameras and lenses with the appropriate level of resolution for the intended application. In general, a
461 higher resolution camera is more desirable than a lower resolution camera.

462
463 Select cameras and lenses considering focal length for depth of field and field of view. Consider how
464 wide or how tall an object is in comparison to surroundings when related to recognition of that object on a
465 system monitor. Two cameras may be required for a given application, one for an overall view, and
466 another to view fine details.

467
468 Select cameras, lenses, enclosures, and accessories that are physically compatible with the installed
469 location and mounting methods, such as concealed locations or dome enclosures. Size enclosures for

470 cameras, lenses, ancillary equipment, and any other required equipment, such as connectors, other
471 electronic devices, and transformers.
472
473 Use optically-corrected domes. Typically, clear domes are used for outdoor locations and smoked domes
474 are used for indoor locations.
475
476 Select enclosures considering discretion, aesthetics and serviceability. Domes afford a great deal of
477 discretion by prohibiting an observer from determining which way the camera is looking at any given
478 time. Certain enclosures, including domes, afford greater serviceability due to built-in features,
479 electronics or modularity. Other enclosures tend to “blend in” more with their environment for purely
480 aesthetic reasons.
481
482 Select cameras and/or systems that allow cameras to be synchronized for roll-free video switching, using
483 either cameras with synchronizing capabilities, or using systems with external phase adjustment features.
484 External phase adjustment capabilities are recommended because they allow more flexibility in system
485 set-up and do not require cameras with phase line-lock capabilities.
486
487 Select fixed cameras where focusing on one point or feature, such as doors, hallways, alcoves, and very
488 small areas.
489
490 Select dome-mounted or pan/tilt/zoom cameras where the area to be protected has an unobstructed line of
491 sight with no hidden alcoves.
492
493 Select dome-mounted cameras for 360-degree coverage.
494
495 Position and mount cameras to discourage vandalism.
496
497

498 **5. Cabling and Conductors**

499
500 Guidelines for installing cabling, conductors, and conduits are contained in various *National Electrical*
501 *Installation Standards*. The following requirements modify or supplement those requirements with
502 respect to conduits, cabling, and conductors installed for CCTV systems.
503

504 505 **5.1 General**

506
507 Install wiring and cable in accordance with manufacturer instructions and the NEC requirements. Install
508 low-voltage cables in accordance with Federal State and local low-voltage Codes, specifications,
509 standards and practices. Install plenum-rated cable where cable is installed in an air handling plenum.
510
511 Ensure that CCTV system wiring and cables are of the appropriate gauge, strands, insulation, and
512 electrical properties as specified by the manufacture of the device to be connected.
513
514 Splice or join conductors using mechanical splicing devices approved for the purpose. Mechanically join
515 splices intended to be soldered before soldering. Cover each splice and joint with insulation equivalent to
516 that of the conductors or wrap with a minimum of two layers of electrical tape. Seal splices located in
517 damp or wet locations with an approved sealant or equivalent treatment.
518

519 Solder and heat shrink wrap electrical connections to device manufacture supplied leads, or use high-
520 quality insulating crimp connectors.
521
522 Use connection terminals that are insulated either by the manner of their construction and use, or by
523 adding heat shrink insulation over the connection for each individual connector.
524
525 Ensure that all terminations are properly made. Examples of improper connections include, but are not
526 limited to, connections that do not included all of the strands of the conductor, are bent or misshapen, and
527 do not properly fit the terminal on the device.
528
529 Use terminals for more than one conductor that are identified as suitable for that purpose. Connect only
530 conductors of the same size and composition under common terminals. Mark or color code terminals
531 where necessary to indicate the proper connections.
532
533 Provide strain relief for all connections, including connections to device manufacturer supplied leads, to
534 ensure that tension is not transmitted to joints or terminals and will not damage or break connections.
535 Provide strain relief for wiring leaving control panels and junction boxes not utilizing raceways.
536
537 Make connections to terminal parts using pressure connectors, wire binding screws or splices to flexible
538 leads.
539
540 Provide a 150 mm (6-inch) service loop at field terminations, control panels and enclosures used for
541 wiring terminations. Provide physical protection of service loops. See Section 5.5 for fiber optic service
542 loop requirements.
543
544 Provide a minimum of 50 mm (2 inches) of separation between conductors of lighting and power circuits
545 and those of Class 3 circuits, unless one of the circuits is installed in a metallic or non-metallic raceway.
546 Bond metallic raceways to ground. Size raceways in accordance with the NEC.
547
548 Install conductors and cables to provide access to equipment for maintenance and repairs. Do not block
549 access panels or removable coverplates with conductors or cables.
550
551 Prepare conductors and cables in accordance with manufacturer instructions. *NOTE: Some*
552 *manufacturers provide unique instructions for preparing their products for connection or termination.*
553 *Additionally, stripping of sheathing as described below may not be an acceptable practice with products*
554 *such as coaxial cable or category-rated network cable. Strip cables and conductors to the length*
555 *prescribed by the manufacturer of the device to which they should be connected. Do not damage or*
556 *remove any strands of stranded conductors.*
557
558 Remove the outside protective sheathing of cables a minimum of 50 mm (2 inches) from the end to
559 expose the internal insulated conductors for making connections. *NOTE: Removal of the outside*
560 *sheathing in excess of 50 mm (2 inches) to facilitate inserting the cable back into the opening is generally*
561 *acceptable. Do not damage the insulation of the internal conductors of the wires or cables while*
562 *stripping.*
563
564 Ensure that wires and cables extend at least 150 mm (6 inches) beyond the finished surface at the point of
565 device installation. Provide excess cabling at each camera installation point to allow for repositioning of
566 the camera in the future, when possible.
567
568 Use separate cables for power, control, and video, unless using one cable listed as suitable for combined
569 use, such as a Siamese cable.

570
571 Bundle, lace and neatly train wiring within enclosures to terminal points with no excess. Provide and use
572 lacing bars and distribution spools as needed.

573
574 Identify circuits within control panels, enclosures, and pull boxes. Identify circuits at field terminations
575 and all accessible locations. Ensure that identification is not visible to the public.

576
577 Do not exceed manufacturer's recommended pulling tension. Do not install bruised, kinked, scored,
578 deformed or abraded cable. Do not splice cable between termination, tap, or junction points. Remove
579 and discard cable where damaged during installation and replace with new cable.

580
581 Install exposed cable parallel and perpendicular to building lines, follow surface contours, and support as
582 recommended by the manufacturer.

583

584

585 **5.2 Video Cable and Conductors**

586

587 Use standard coaxial video cables with a solid copper center conductor and a braided copper shield with
588 95 percent coverage, or mini-coaxial video cables with a stranded copper center conductor and a braided
589 copper shield with 89 percent coverage. Use coaxial cable with a nominal impedance of 75 ohms. Do
590 not use coaxial cable rated for any other nominal impedance.

591

592 Do not use coaxial cables with an aluminum or copper-clad steel center conductor. Do not use cables
593 with an aluminum braid or foil shield. Cables with a foil shield may be used if the foil shield is combined
594 with, and in addition to, a copper braid shield.

595

596 Do not exceed manufacturer's recommended maximum cable length. Do not exceed 4.5 m (15 feet) for
597 mini-type cables. Do not exceed 230 m (750) feet for RG-59/U-type cables. Do not exceed 365 m (1,200
598 feet) for RG-6/U-type cables. Do not exceed 760 m (2,500) feet for RG-11/U-type cables. Where cables
599 exceed the manufacturer's recommended maximum length, use a larger cable, use a different mode of
600 transmission such as fiber optics, or install a video amplification system to ensure signal strength.

601

602 Use flexible cables with a stranded center conductor cable specifically manufactured for the application
603 for pan/tilt/zoom cameras between the camera and junction box to accommodate camera movement.

604

605 Use moisture proof, gel-filled direct burial type cable in raceways located outdoors.

606

607 Do not use MATV (Master_Antenna TeleVision) cable for CCTV applications.

608

609

610 **5.3 Control Wiring**

611

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

616

617 Size control wiring in accordance with controls manufacturer instructions. Size control wiring to deliver
618 the manufacturer's optimum operating voltage from the power supply or controller to the device being

619 driven. Size control wiring based on the current and voltage needs of the controlling system and the
620 length of the wire run, but not less than 18 AWG, stranded copper conductors.

621
622

623 **5.4 Data Cabling**

624

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

628

629 Provide data cable in accordance with manufacturer instructions.

630

631

632 **5.5 Fiber Optic Cabling**

633

634 Fiber optic transmission of both video and data presents distinct advantages over standard copper-based
635 cabling, including higher quality and longer distance transmission characteristics, inherent noise
636 resistance, greater flexibility for usage, and reduced cabling diameters. Installation and design of fiber
637 optic systems are subject to the requirements and demands of both the application and the manufacturer
638 specifications. Fiber optic cable installations should be completed by an approved and certified fiber
639 optics installer.

640

641 Install fiber optic cables in accordance with manufacturer instructions.

642

643 Protect fiber optic cables against physical damage.

644

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

648

649

650 **5.6 Coaxial Connectors, Splices, and Terminations**

651

652 Use three-piece BNC crimp-on style connectors for coaxial cable connections. Do not use screw-on or
653 twist-on connectors or adapters. Use suitable tools and methods for stripping coaxial cables and for
654 crimping three-piece BNC connectors.

655

656 Make direct coaxial cable connections within the CCTV system. Use appropriate connectors as dictated
657 by the equipment when terminating coaxial cable on terminals for other than BNC connectors. Do not
658 make connections using any type of in-line adapter.

659

660 Use a standard female-to-male BNC splice when splicing coaxial cable. Do not use type "F" connectors
661 or barrels. Although a female-to-female splice using a barrel adapter is generally acceptable, there is
662 more signal loss with this type of splice.

663

664

665 **5.7 Grounding and Bonding**

666

667 Ground and bond equipment and components in accordance with NEC requirements and manufacturer
668 instructions.

669
670 Bond all metallic components together. The NEC does not require pullboxes to be bonded if the highest
671 voltage in the pullbox is 50 volts or less. However, it is recommended that equipment and conduit
672 systems be bonded together.

673
674
675 **5.8 Conduits and Raceways**

676
677 Install bushings to protect conductors from abrasion at all conduit and raceway connections to junction
678 boxes and at all open ends of raceways or flexible conduits. Secure raceways and install bushings for
679 conduits and raceways that are not connected to an appropriate back box. Position conduits and raceways
680 to provide physical protection for the wires or cables to the device.

681
682 Limit the distance between devices and raceways, conduits or flexible conduits to no more than 75 mm (3
683 inches).

684
685 Size raceways to protect any device manufacturer-provided leads and connectors, along with any
686 conductors from the wires or cables.

687
688 Install raceways and conduits relative to devices to facilitate removal, reinstallation, and reconnection
689 without damaging finished surfaces or extended time fishing for wires or cables. Generally, install
690 raceways and conduits perpendicular to the device.

691
692

693 **6. Installation**

694
695 **6.1 General**

696
697 If required, notify the AHJ prior to the installation or alteration of CCTV equipment or wiring. Obtain
698 AHJ approval of system design prior to installation.

699
700 Install cameras, equipment, and accessories in accordance with the standards and specifications approved
701 by the AHJ, if required, manufacturer installation instructions, and in accordance with NFPA standards,
702 the NEC, and other applicable state and local codes. Comply with all federal, state, and local privacy
703 laws when installing CCTV systems. Notify the AHJ prior to the start of installation, if required.

704
705 Ensure that components are fully compatible as a system and that equipment is compatible with wiring
706 methods, and system voltage. Use equipment listed or labeled for the purpose for which it is used, where
707 applicable nationally recognized standards exist.

708
709 Integrate system components with support equipment and software into a fully operational and functional
710 video monitoring and control system.

711
712 Construct pole and tower foundations and install poles and towers in accordance with drawings,
713 specifications, and manufacturer instructions. Ensure that cameras mounted on poles or towers are
714 accessible for maintenance using vehicles or bucket trucks, or provide a camera lowering system with
715 dome enclosures.

716
717 Install, conceal, and disguise covert cameras in accordance with manufacturer instructions.
718

719 Locate equipment, components, devices, appliances, and control units so that accidental operation or
720 failure is not caused by vibration or jarring.

721
722 Ensure that equipment is suitable for the voltage, temperature, vibration, and humidity conditions in
723 accordance with manufacturer instructions.

724
725 Locate CCTV controls and system components within a secured area, such as within the area being
726 monitored by the system. When this is not possible, locate controls and components where continuously
727 under the notice of assigned personnel, in an area accessible only to authorized personnel, or supervised
728 to annunciate tampering.

729
730 Locate and install equipment and components in accessible locations for service personnel.

731
732 Install rack-mounted CCTV equipment in suitable component racks sized for the equipment and equipped
733 with accessories as needed for proper equipment operation, such as power supplies, power distribution
734 units, power conditioners, and cooling fans.

735
736 Set stops for pan-tilt-zoom cameras to suit final position, mounting, and required field of view.

737
738

739 **6.2 Mounting and Supports**

740
741 Mount and support equipment in accordance with manufacturer instructions and in consultation with the
742 owner. Cameras are typically mounted to provide as wide a field of view as possible, such as ceiling-
743 mounting in the corner of a room.

744
745 Use anchoring devices that are approved for the weight of the equipment used, mounting surface, and
746 wind-loading, where applicable.

747
748 Install tamper resistant fasteners, nuts, bolts, screws, locks or similar equipment, or install fasteners in
749 such a fashion that they cannot be removed without the use of tools.

750
751 Torque anchors, mounting bolts, and hardware in accordance with manufacturer instructions.

752
753 Use mounts and supports that provide for adequate support and do not inhibit camera operation or field of
754 view. Support ceiling-mounted cameras from structure.

755
756 Use parapet mounts that are designed to allow equipment to be swiveled in toward the roof for
757 maintenance access.

758
759 Mount control units, power supplies and batteries in a vertical, upright position, unless indicated
760 otherwise in manufacturer instructions.

761
762 Provide adequate headroom below cameras and their mountings. Where necessary, change the type of
763 mounting to provide adequate headroom below.

764

765 766 **6.3 Camera Installation**

767

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

771
772 Install cameras in locations that avoid a direct view of sources of light. Picture quality is degraded when
773 a camera looks directly into a light source, or has a relatively high contrast between objects being viewed
774 and the background scene.

775
776 Ensure that proposed camera locations afford the necessary field of view of the areas to be monitored.

777
778 Verify that the field of view of ceiling-mounted cameras is not obstructed by light fixtures, fire
779 suppression sprinklers, HVAC diffusers or return air grills, or breaks in ceiling height. If such conflicts
780 exist, coordinate the camera location with the building owner, general contractor, and engineer of record,
781 prior to installation.

782
783 Install spot filters for cameras with fixed lenses, where necessary. Install asymmetrical wide-angle lenses
784 when needed to correct for distortion.

785
786 Provide individual fusing for each camera.

787 788 789 **6.3.1 External Cameras**

790
791 Install external cameras such that icing, sunlight angles, extreme temperatures, wind loading, rain, and
792 external moisture do not affect their operation. Keep in mind that pan/tilt/zoom cameras may be required
793 to start up in icing conditions.

794
795 Use weather-tight housings for cameras exposed to the elements.

796
797 Install accessories for external conditions such as heaters, blowers, washers/wipers, and defrosters or
798 defoggers, as required for proper operation.

799
800 Install external CCTV equipment and components that are vandal and tamper resistant.

801
802 Install sun-shields or hoods to reduce glare when the sun is low on the horizon, or if the camera has a
803 direct view of the sun, where applicable.

804 805 806 **6.4 Control Cabinets and Equipment**

807
808 Install CCTV equipment, components, transmitters, receivers, matrix switchers, collectors, DVRs or
809 VCRs, programmable logic controllers, computers, routers, monitors, and pan/tilt/zoom controls, in
810 accordance with manufacturer instructions.

811
812 Ensure that equipment is installed and connected to function as intended, designed, and manufactured.

813
814 Ensure that transmitters and receivers are capable of transmitting and receiving video, data, and control
815 signals for pan/tilt/zoom controls, where applicable.

816

817 Install console-mounted monitors on consoles or cabinets. Install overhead monitors mounted on steel
818 support brackets. Use brackets capable of supporting up to 18 kg (40 pounds) that are adjustable in height
819 and width to accommodate the required monitor dimensions.

820
821 Provide 75-ohm terminations for all unused video amplifier outputs that are not source-terminated.

822
823

824 **6.5 Software**

825
826 Provide and configure custom software, if necessary, to complete the system installation.

827
828 When CCTV systems are installed as part of a premises security system, use software provided with the
829 premise security system that is listed for use with the equipment on which it is installed. Maintain a
830 record of installed software version numbers at the location of the premise security system.

831
832 Protect software from unauthorized changes.

833
834

835 **6.6 Power Supplies**

836
837 Connect power supplies for CCTV equipment to NEC-compliant branch circuiting. Connect power
838 supplies to a dedicated branch circuit or the unswitched portion of a branch circuit.

839
840 Provide and install listed power supplies with performance characteristics compatible with the unique
841 requirements of the equipment being supplied.

842
843 Size power supplies in accordance with manufacturer instructions and with the application. Ensure that
844 loads connected to power supplies do not exceed 80 percent of the power output rating of the power
845 supply. Keep in mind that additional devices and accessories may necessitate increasing the size of
846 power supplies and associated conductors.

847
848 Consider power source redundancy with at least two independent and reliable power supplies, one
849 primary source and one secondary, or standby, source, each with adequate capacity for the application.

850
851 Install surge protection devices at the primary power supply for CCTV equipment and for all
852 microprocessor-based control units and equipment.

853
854 Provide a power supply disconnecting means with a distinctive marking that is accessible only to
855 authorized personnel and identified as "PREMISES SECURITY CIRCUIT." The location of the circuit
856 disconnecting means shall be permanently identified at the premises security control unit.

857
858 Primary power supplies to equipment that include Class 2 or Class 3 plug-in transformers utilizing
859 receptacles shall be mechanically secured to prevent inadvertent disconnection.

860
861

862 **6.7 Storage Batteries**

863
864 When installing batteries as a secondary source for CCTV systems, locate storage batteries such that the
865 premise security equipment, including overcurrent devices, are not adversely affected by battery gases.
866 Conform to NEC requirements.

867
868 Use battery racks that are suitably protected against deterioration.
869
870 Permanently identify the location of remote batteries and battery charger at the premises security control
871 panel.
872
873 Secure storage batteries from unauthorized access.
874
875 Provide automatic battery charging in accordance with manufacturer instructions that is capable of
876 maintaining the battery fully charged under normal operating conditions and to recharge batteries after
877 fully charged batteries have been subject to a single discharge cycle.
878
879 Ensure that batteries are protected from excessive charging current by overcurrent devices or by
880 automatic current-limiting design of the charging source.
881
882 Use battery charging equipment with voltage and charging current metering either by integral meters or
883 by readily accessible terminals for the connection of portable meters.
884
885 Provide supervision of the battery charger to detect a failure of the battery charger and initiate a trouble
886 signal.
887

888
889 **6.8 Site Cleanup**
890
891 Upon completion of the work, remove excess debris, materials, equipment, apparatus, and tools, and leave
892 the premises clean, neat, and orderly. Separate, sort, and recycle materials to the greatest extent possible.
893
894 Clean all system components, including camera housing windows, lenses and monitor screens. Use
895 methods and materials recommended by the manufacturer.
896
897 Provide signage for buildings and areas under CCTV surveillance, unless covert CCTV is used.
898
899

900 **7. Commissioning**

901 902 **7.1 Field Adjustments**

903
904 Some CCTV equipment and components contain automatic controls to adjust for in-service conditions
905 such as brightness control of video monitors, frequency control for synchronizing cameras, gain control to
906 adjust signal strength, and light control for cameras to automatically adjust for proper light levels.
907
908 Make field adjustments to cameras to improve the field of view of the area being monitored. For cameras
909 monitoring doors, for example, the top of the field of view should be the top of the door.
910
911 Set pan and tilt limits in accordance with manufacturer instructions and as required for the project.
912
913 Use the proper filters and tools necessary to perform step-by-step back focus and depth of field
914 adjustments for each camera in accordance with manufacturer instructions. Set camera back-focus such
915 that cameras remain in focus while zooming all the way out or zooming all the way in.
916

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

919
920 Synchronize all cameras to prevent rolling when switching on each monitor. Adjust cameras to optimize
921 the presentation at the display.

922
923 Ensure that the recording speed of the multiplexer is compatible with the time-lapse speed of the
924 recording device. Some multiplexers require the video signal to be delivered in three-hour mode to
925 prevent lost information or picture interference.

926
927 Adjust variable focal lenses during final acceptance testing.

928
929 Perform set up procedures on dual chip technology color cameras in accordance with manufacturer
930 instructions to provide proper color temperature during high light situations and proper Black/White
931 (B/W) sensitivity during low light situations.

932
933 Adjust the lens iris, electronic iris, digital rendering, and all other electronic or mechanical devices so that
934 analog camera video output is approximately 1 Volt Peak to Peak (VPP) or 140 Institute of Radio
935 Engineers (IRE) units composite signal. The minimum acceptable video output level is 0.85 VPP with
936 the automatic gain control engaged in lower light situations.

937
938

939 **7.2 Testing Cables and Conductors**

940
941 Test conductors with a voltmeter to verify that there are no stray (unwanted) voltages between installation
942 conductors or between installation conductors and ground. Unless a different threshold is specified in the
943 system per the installed equipment manufacturer's specifications, the maximum allowable stray voltages
944 shall not exceed 1 Volt AC/DC.

945
946 Test conductors other than those intentionally and permanently grounded for isolation from ground per
947 the installed equipment manufacturer's specifications.

948
949 Test conductors other than those intentionally connected together for conductor-to-conductor isolation per
950 the installed equipment manufacturer's specifications. The same circuits also shall be tested conductor-
951 to-ground.

952
953 Test the fiber-optic transmission line in accordance with the manufacturer instructions by the use of an
954 optical power meter or by an optical time domain reflectometer used to measure the relative power loss of
955 the line. Record this relative figure for each fiber-optic line in the control panel. If the power level drops
956 to below the manufacturer's instructions, repair or replace the transmission line, section thereof, or
957 connectors to bring the line back into compliance with the accepted transmission level in accordance with
958 manufacturer instructions.

959
960 Test supervised or monitored circuits for integrity by opening one connection for not less than 10 percent
961 of the controlled devices. Introduction of a fault in any monitored circuit should result in a trouble
962 indication at the control unit.

963
964

965 **7.3 Acceptance Testing**

966

967 Test CCTV systems, equipment, and components in accordance with manufacturer instructions and AHJ
968 requirements, if applicable.

969
970 Visually inspect monitors to ensure system monitors are working properly and that cameras are properly
971 aimed and focused. Verify that the various camera images are displayed on the appropriate monitors.
972 Verify that the final image meets the design requirements.

973
974 Verify proper operation of remote controls, such as pan/tilt/zoom cameras.

975
976 Verify proper operation of ancillary devices, such as heaters, blowers, defrosters, and washer/wipers.

977
978 Verify proper operation of matrix switchers, multiplexers, and quads, that sequence and cycle between
979 cameras and monitors.

980
981 Verify proper operation of recording devices such as DVRs and VCRs.

982
983 Correct system defects and malfunctions in accordance with manufacturer instructions.

984
985

986 **7.4 Documentation**

987
988 Deliver operation and maintenance manuals and installation instructions covering all system equipment to
989 the owner or responsible party upon final acceptance of the system. The owner or responsible parties
990 include, but are not necessarily limited to, the owner of the protected property, the leaseholder of the
991 tenant space where the system is installed, or an employee or agent of the owner or the leaseholder.

992
993 Documentation should include a general description, safety precautions, and installation procedures for
994 the system, in addition to the following:

- 995 • Detailed narrative description of the system inputs, signaling, ancillary functions, annunciation,
996 intended sequence of operation, expansion capability, and application considerations and
997 limitations.
 - 998 • Detailed operating instructions covering operation under both normal and abnormal conditions.
 - 999 • Operator instructions for basic system operations, including system start-up and reset, operation
1000 of manual ancillary function controls such as pan/tilt/zoom cameras, and operation of recording
1001 devices.
 - 1002 • Detailed description of routine maintenance and testing as required and as would be provided
1003 under a maintenance contract.
 - 1004 • Listing of the individual system components that require periodic testing and maintenance.
1005 Include step-by-step testing and maintenance instructions for each type of device installed, along
1006 with a schedule of testing and maintenance intervals for each type of device installed.
 - 1007 • Detailed troubleshooting instructions for each trouble condition generated from monitored field
1008 wiring such as opens, grounds and loop failures, including a list of all trouble signals annunciated
1009 by the system, a description of the conditions that cause such trouble signals, and step-by-step
1010 instructions describing how to isolate such problems and correct them, or how to call for service,
1011 as appropriate.
 - 1012 • Service directory that includes a list of names and telephone numbers of those who provide
1013 service for the system along with a list of spare parts and replacement components recommended
1014 to be stored at the site for ready access.
- 1015

1016 Where required by code or regulation, provide a Premise Security Record of Completion form to the
1017 owner or responsible party.

1018
1019 Protect documentation that may compromise the CCTV system to prevent the unauthorized release of
1020 critical system locations, operations, and functions.

1021
1022 Provide documentation of all inspections and testing completed during installation in accordance with
1023 NFPA 731.

1024

1025

1026 **7.5 Training**

1027

1028 Provide training for all systems users. Coordinate training with the owner or responsible party.

1029

1030 Base training on the level of user involvement with the system, using owner's and user's manuals as
1031 references materials.

1032

1033 Document user training. Maintain a record of the training for a minimum of one year. Make
1034 documentation of training available to the AHJ upon request, and include it with the owner's and user's
1035 manuals. Include the names of attendees, the date of the training, the scope of the training, and the lesson
1036 plan of the training in the documentation.

1037

1038

1039 **8. Maintenance**

1040

1041 **8.1 General**

1042

1043 Inspection, testing, or maintenance may be performed by a person or organization other than the owner if
1044 conducted under a written contract. Inspection, testing, and maintenance must be performed by qualified
1045 personnel.

1046

1047 To prevent unnecessary response, notify all persons affected by CCTV systems, including the system
1048 user, parties responsible for the protected premises, and facilities receiving alarm, supervisory, or trouble
1049 signals before proceeding with any testing or maintenance.

1050

1051 Notify the owner or responsible party that the system or a part of the system may not be fully functional
1052 during the testing or maintenance procedure and that appropriate safeguards should be taken, based upon
1053 the perceived risk.

1054

1055 Notify the owner or responsible party that information may be lost during the time the system is
1056 undergoing maintenance or testing.

1057

1058 Coordinate maintenance and testing to prevent interruption of critical building systems or equipment.

1059

1060 Review information regarding the system and system alterations, including the Record of Completion,
1061 owner's manual, and installation instructions prior to maintenance and testing, if available from the owner
1062 or responsible party.

1063

1064 Notify all affected parties upon the conclusion of inspections, maintenance, and testing.

1065

1066 If a defect or malfunction is not corrected at the conclusion of system inspection, testing, or maintenance,
1067 provide written notice to the system owner or responsible party within 24 hours. Maintain a written
1068 record for a period of one year from the date the impairment is corrected.
1069
1070

1071 **8.2 Routine Inspection, Maintenance, and Testing**

1072
1073 Inspect, maintain, and test CCTV equipment and components in accordance with manufacturer
1074 instructions. Perform inspections, maintenance, and testing periodically in accordance with a security
1075 vulnerability assessment for the protected premises, and in accordance with the manufacturer's published
1076 instructions for the devices and appliances that are used. In general, inspect, maintain, and test CCTV
1077 systems, devices, and equipment not less than annually.
1078

1079 Use replacement components that are fully compatible with existing equipment and components. For
1080 example, do not replace a CS-mount lens with a C-mount lens. A C-mount lens requires a greater
1081 distance between the lens and the camera sensor than a CS mount lens. It would not be possible to focus
1082 the camera without the aid of a CSA, or CS-to-C adapter. Also, installing a C-mount lens on a CS-mount
1083 camera without an adapter may damage the camera sensor.
1084

1085 Clean equipment and components using manufacturer recommended materials and methods.
1086

1087 Inspect equipment and components for evidence of moisture. Consult the manufacturer for instructions to
1088 protect against moisture.
1089

1090 Periodically measure the voltage of power supplies to ensure proper equipment operating voltage.
1091 Replace deficient or degraded power supplies. Voltage regulation problems can cause camera
1092 misoperation.
1093

1094 Inspect equipment with air filters. Clean or replace dirty filters as required.
1095

1096 Measure the temperature of rooms containing CCTV equipment and components. Ensure that equipment
1097 ambient temperatures are within operational limitations of equipment. Notify the owner or responsible
1098 party when ambient temperatures exceed equipment operating limits.
1099

1100 Perform Acceptance Testing in accordance with Section 7.3.
1101

1102 Provide training for all users when inspection, maintenance, or testing results in a change in system
1103 operation.
1104

1105 If a defect or malfunction is not corrected at the conclusion of system inspection, testing, or maintenance,
1106 provide written notice to the party responsible for the protected premises within 24 hours.
1107
1108

1109 **8.3 Making Repairs or Modifications to an Existing System**

1110
1111 Upon notification of a CCTV system malfunction, initiate repairs within 24 hours, unless the system user
1112 or party responsible for the protected premises agrees to a delay. If the system at the protected premises
1113 is impaired for more than 24 hours from the time of the defect or malfunction is identified, notify the
1114 owner or the designated responsible party in writing so other security measures can be implemented.
1115

When it is determined that there is no risk to the protected property or occupants, repair to the system is

1116 permitted to begin more than 24 hours after notification of a malfunction, provided that the owner or
1117 responsible party is notified in writing so other security measures can be implemented, if needed.
1118
1119 Consider temporary mitigating measures during CCTV system impairments. Base temporary mitigating
1120 measures on a risk assessment of the protected property or the occupants in consultation with the AHJ, if
1121 required. Implement instructions from the risk assessment for the period that the system is impaired.
1122
1123 Inspect and test all systems upon completion of installation, adding or deleting system components, any
1124 modification, repair, or adjustment to system hardware or wiring, any change in site-specific software, or
1125 any change in the structure being protected.
1126
1127 Fully test all components, circuits, system operations, and site-specific software functions known to be
1128 affected by changes.
1129
1130 Complete routine system maintenance in accordance with Section 8.2.
1131
1132 Where required by code or regulation, provide a revised Record of Completion form reflecting any
1133 system changes to the owner or responsible party.
1134
1135
1136

1137 **Annex A: Reference Standards**

1138

1139 *(This annex is not part of the standard)*

1140

1141 This publication, when used in conjunction with the National Electrical Code and manufacturers’
1142 literature, provides sufficient information to install and maintain CCTV systems. The following
1143 publications may also provide useful information:

1144

1145 National Fire Protection Association

1146

1 Battery March Park

1147

Quincy, MA 02169-7471

1148

(617) 770-3000 tel

1149

(617) 770-3500 fax

1150

www.nfpa.org

1151

1152 ANSI/NFPA 70-2017~~4~~, *National Electrical Code* (ANSI)

1153

NFPA 731: Standard for the Installation of Electronic Premises Security Systems

1154

1155

1156

1157

ANSI/UL 2044, Standard for Commercial Closed-Circuit Television Equipment, 2016~~08~~, revised 2010.

1158

1159

Current National Electrical Installation Standards™ published by NECA:

1160

(Insert Current List of NEIS Here)

1161

1162

1163

1164

1165