

Australian Standard[®]

Closed circuit television (CCTV)

Part 2: Application guidelines



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- Australasian Railway Association
 - Australian Communications and Media Authority
 - Australian Federal Police
 - Australian Security Industry Association Limited
 - Engineers Australia
 - National Security Association of Australia
 - Society of Motion Picture and Television Engineers
-

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STANDARDS AUSTRALIA

RECONFIRMATION

OF

AS 4806.2—2006

Closed circuit television (CCTV)

Part 2: Application guidelines

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NOTES

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Part 2: Application guidelines

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PREFACE

This Standard was prepared by the Standards Australia Committee EL-031, Intruder Alarm Equipment and Installations.

The objectives of this Standard are—

- (a) to provide a framework to assist customers, installers and users in establishing their requirements;
- (b) to assist consultants and users in determining the appropriate equipment required for a given application; and
- (c) to provide means of objectively evaluating the performance of an installed system.

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FOREWORD

This Standard will prove useful to those responsible for establishing operational requirements, writing specifications, selecting equipment, installing, commissioning, using and maintaining a CCTV system.

Closed circuit television, in its simplest form, is a means of providing images from a television camera for viewing on a monitor via a transmission system.

There is no theoretical limit to the number of cameras and monitors that may be used in a CCTV surveillance installation but, in practice, this will be limited by the efficient combination of control and display equipment and the operator's ability to manage the system.

The successful operation of a CCTV system requires the active cooperation of the user in carrying out the recommended procedures.

STANDARDS AUSTRALIA

Australian Standard

Closed circuit television (CCTV)

Part 2: Application guidelines

1 SCOPE AND GENERAL

1.1 Scope

This Standard provides recommendations for the selection, planning and installation of closed circuit television systems comprising camera(s), monitor(s), video recorder(s), switching, control and ancillary equipment for use in security and surveillance applications.

NOTE: This Standard does not cover audio.

1.2 Referenced documents

The following documents are referred to in this Standard:

AS

2342 Development, testing and implementation of information and safety symbols and symbolic signs

60529 Degrees of protection provided by enclosures (IP Code)

AS/NZS

1768 Lightning protection

2053 Conduits and fittings for electrical installations (all parts and amendments)

3000 Electrical installations (known as the Australian/New Zealand Wiring Rules)

4360 Risk management

4806 Closed Circuit Television (CCTV)

4806.1 Part 1: Management and Operation

4806.3 Part 3: PAL signal timings and levels

ISO

11064 Ergonomic design of control centres

11064-1 Part 1: Principles for the design of control centres

11064-2 Part 2: Principles for the arrangement of control suites

11064-3 Part 3: Control room layout

AS/ACIF

S009 Installation requirements for customer cabling

IEEE

802 Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements

802.11 Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications

ITU

BT.601 Studio encoding parameters of digital television for standard 4:3 and wide-screen 16:9 aspect ratios

OH&S Acts and Regulations (States and Territories and Commonwealth for its own employees)

1.3 Definitions and abbreviations

NOTES:

- 1 These definitions and abbreviations are intended to clarify the meaning and intent of the terms used normally by the CCTV industry. The list is not exhaustive and is subject to change as this Standard is reviewed.
- 2 For other abbreviations and common terms used in CCTV please refer to Appendix A.

1.3.1 *Alternating current (a.c.)*

Associated with a source of electric power supply where the polarity cycles periodically.

1.3.2 *Direct current (d.c.)*

Associated with a source of electric energy where the current flows continuously in one direction.

1.3.3 *Camera housing*

An enclosure to provide physical and/or environmental protection for the camera, lens and ancillary equipment.

1.3.4 *Camera minimum illumination performance*

The lowest possible light illumination reflected from the object (in lux) at which a camera gives certain video signal amplitude (analogue output types) or a useable image quality (streaming digital output types).

1.3.5 *Camera sensitivity*

Represented by the minimum iris opening (maximum F-stop) required to produce a full video signal when viewing a grey scale test chart (as specified in EN 61146.1), which is lit by 2000 lx at 3100 K $\pm$ 100 K colour temperature of the light source. The test chart has a grey scale with tones from black to white and a reflection coefficient of 89% for the white portion.

1.3.6 *Character generator*

A device for generating alpha-numeric characters and/or symbols and adding them into the image video signal, either as overlay or invisible text (embedded in the television signal hidden lines).

1.3.7 *CCTV camera*

A unit containing an imaging device producing a video signal from an optical image.

1.3.8 *CCTV camera equipment*

A unit containing a CCTV camera plus an appropriate lens and necessary ancillary equipment.

1.3.9 *CCTV control unit*

Equipment for controlling and monitoring the required operational functions of the CCTV system.

1.3.10 *CCTV surveillance installation*

An installation consisting of the hardware and software components of a CCTV system, fully installed and operational for monitoring a defined security zone.

1.3.11 CCTV system; CCTV surveillance system

A system consisting of camera equipment, monitoring and associated equipment for recording, transmission and controlling purposes, which may be necessary for the surveillance of a defined security zone.

1.3.12 Composite video burst signal (CVBS)

The video output signal of an analogue colour camera comprising the burst and colour information (colour), the picture luminance component (video), black reference (blanking) and the synchronization components (synchronization pulses) (see Figure 1).

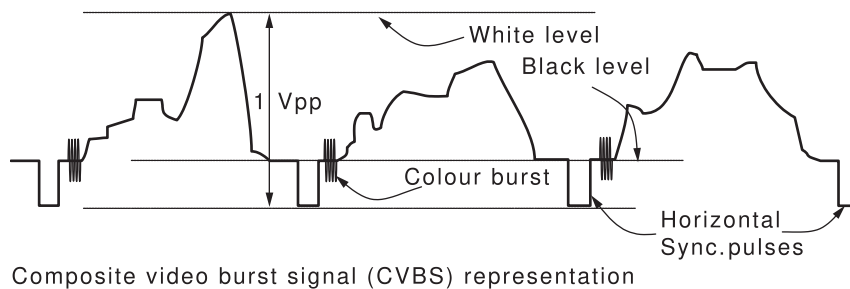


FIGURE 1 COMPOSITE VIDEO BURST SIGNAL (CVBS) REPRESENTATION

1.3.13 Composite video signal (CVS)

The video output signal of an analogue black and white (b/w) camera comprising the picture component (video), black reference (blanking) and synchronization components (synchronization pulses). It is defined as 1 Vp-p when measured from the lowest part of the synchronization pulses to the whitest level and when terminated with 75 Ω impedance (see Figure 2).

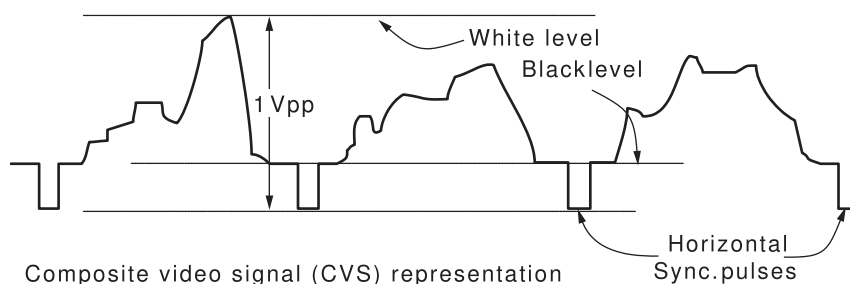


FIGURE 2 COMPOSITE VIDEO SIGNAL (CVS) REPRESENTATION

1.3.14 Computer monitor resolutions

The following computer display graphics resolutions are standardized:

- (a) VGA (video graphics array) = 640 × 480 pixels.
- (b) SVGA (super VGA) = 800 × 600 pixels.
- (c) XGA (extended GA) = 1024 × 768 pixels.
- (d) SXGA (super XGA) = 1280 × 1024 pixels.
- (e) UXGA (ultra XGA) = 1600 × 1200 pixels.

1.3.15 *Digital video recorder (DVR)*

A unit for capturing and storing digitized video images on hard disk or other permanent storage medium.

1.3.16 *Electronic iris*

An automatic electronic shutter that varies the camera sensitivity in relation to the varying light conditions in order to maintain the video output signal within defined limits.

1.3.17 *Electronic shutter*

An arrangement in the camera, which changes its sensitivity by electronically controlling its exposure time. Typically, the electronic shutter's longest exposure time, for PAL signals, can be 1/50 s and the shortest can go as high as 1/100 000 s. When the exposure becomes longer than 1/50 s the motion continuity is reduced. This is referred to as integration exposure.

1.3.18 *Event recording*

The event-controlled recording, which is typically alarm activated, for storing video images for a predetermined time.

1.3.19 *External synchronization*

A method of feeding reference timing signals to all analogue-connected devices (usually cameras) to ensure that their video output signals are synchronous. This is only possible if the cameras are designed to accept external synchronization signals.

1.3.20 *Fast-scan transmission*

Faster than the slow scan, but slower than a live-rate transmission (25 pictures per s), by means of analogue or digital signals over limited bandwidth transmission media. Typically 1 to 10 images per second.

1.3.21 *Focal length (f)*

A property of a lens, expressed in millimetres, which is defined by the distance between the optical plane of a lens and the convergent focus point. For a lens composed of multiple optical elements the focal length is measured from the secondary principal plane to the focus. Various focal length lenses give various angles of view for a given sensor size.

1.3.22 *Focus*

An important optical point of a lens which lies on the optical axis and has a property of having all the rays coming onto the lens in parallel to the optical axis converging through it.

1.3.23 *Illumination*

The amount of luminous flux on a unit area. When luminous flux of 1 lumen falls on an area of 1 m² (square metre) it is measured in lumens per square metre or metre-candelas, but it is better known as lux [lx].

NOTE: Most commonly used term in CCTV; very similar to the luminance except that it refers to objects that are secondary sources of light.

1.3.24 *Imaging device*

A device that converts an optical image into an electrical signal. Typically, this would be a CCD (charge coupled device) or CMOS (complimentary metal oxide semiconductor) chip.

1.3.25 *Imaging device illumination*

The level of illumination (in lux) at the photosensitive surface of the imaging device.

1.3.26 Image limiting resolution

A measure of the ability of a camera/lens combination, or television system, to reproduce details. The number of picture elements that can be reproduced with good definition. Resolution is expressed in television lines (TVL), where a horizontal resolution of 460 TVL is accepted as a high-resolution image for the current analogue PAL cameras. Vertical resolution is often not stated as it is accepted to be approximately equal to the PAL limiting vertical resolution of 400 TVL. This is calculated as a product between the maximum number of active lines (in PAL 576) and the Kell factor of 0.7.

1.3.27 Image sensor size

The size of the light-sensitive surface of the imaging device. The value is usually expressed in inches and it is used to refer to the diameter of the glass tube from which the camera tubes are constructed. This diameter is the same as the diameter of the image projection by a lens designed for such a tube.

NOTE: At the time of publishing, most cameras use CCD or CMOS chips and the nominal size of the chip represents the diameter of the image projected by a lens specifically designed for such a chip.

Some examples of sizes are as follows (see Figure 3):

- (a) 1" for 12.8×9.5 mm (16 mm diagonal).
- (b) $2/3$ " for 8.8×6.6 mm (11 mm diagonal).
- (c) $1/2$ " for 6.4×4.8 mm (8 mm diagonal).
- (d) $1/3$ " for 4.8×3.6 mm (6 mm diagonal).
- (e) $1/4$ " for 3.4×2.4 mm (4 mm diagonal).

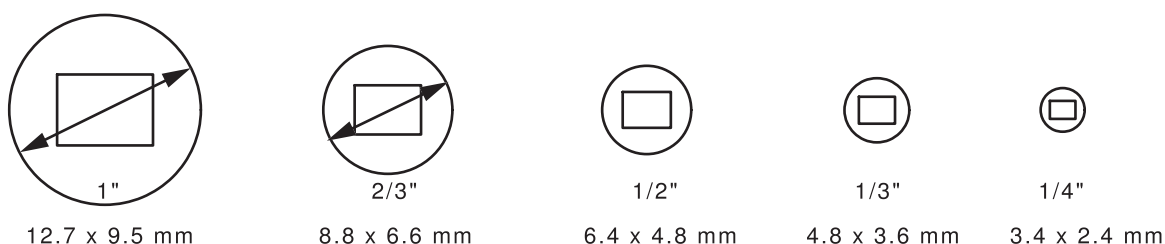


FIGURE 3 LENS IMAGE AND CHIP SIZE

1.3.28 Integration exposure

The reduction in motion continuity when the exposure becomes longer than $1/50$ s.

1.3.29 Iris (optical)

An optical-mechanical aperture mechanism inside a lens, which regulates the amount of light passing through the lens onto the imaging device of the CCTV camera. The adjusting can be manual or automatic (by means of electronic-optical feedback control).

1.3.30 Lens

An optical device for projecting an image of a desired scene onto the photosensitive surface of the imaging device. It is defined with a focal length (in millimetres), F-stop and the diameter of the projected image, expressed in inches ($1/2$ ", $1/3$ ", etc.).

1.3.31 Lens resolution

Expressed in lines per millimetre (l/mm), where line pairs are counted (i.e., only black lines as opposed to both black and white lines when expressing CCD chip resolution).

1.3.32 *Luminance*

The brightness of the surface of either a primary or a secondary source of light. Since brightness embeds subjective connotation, luminance is used as an objective, scientific term. Luminance depends on the luminous intensity of the surface itself, and depends on the angle at which it is being observed (measured per unit of projected surface area perpendicular to that direction).

NOTE: There are quite a few units for luminance. The internationally preferred metric unit is nit. One nit is equal to one candela per square metre of projected surface area.

1.3.33 *Luminous intensity*

The illuminating power of a primary light source, radiated in all directions. It is measured in candelas [cd].

NOTE: One candela is approximately the amount of light energy generated by an ordinary candle. Since 1948 there has been a more precise definition of a candela as the luminous intensity of a black body heated up to a temperature at which platinum changes from a liquid to a solid state.

1.3.34 *Luminous flux*

Similar to luminous intensity but defined in a certain solid angle. It is measured in lumens [lm]. One lumen is produced by a luminous intensity of 1 cd in one radian of a solid angle.

1.3.35 *Maximum F-stop—Aperture number of the lens (F)*

The index of the theoretical light-gathering power of the lens, expressed as the ratio of the focal length (mm) and the effective iris diameter of the lens (mm). The maximum F-stop is usually larger than 1 (1.4; 1.8, 2; 2.8; etc.).

1.3.36 *Minimum F-stop—Iris range*

The index of the lowest light transmission power of the lens.

NOTE: This is an especially relevant factor in CCTV when using auto iris lenses and very sensitive cameras for outdoor surveillance in very high reflectance areas, such as near snow, at high altitudes, or areas with bright white walls. Minimum F-stop should be in the order of F/90 or higher. The F-stop range, from the maximum to the minimum, is called iris range. For example, a lens can have a range of F/1.4–360.

1.3.37 *Neutral density filter (ND)*

An optical element that reduces the light by a certain factor. It is called neutral because it is supposed to reduce all the wavelengths (colours) by an equal amount, thus not changing the colour composition of the light.

ND-filters can be—

- (a) internal, in a lens, where they are used to increase the F-stop, which cannot be achieved by mechanical means (leaf-mechanism); and
- (b) external, where they can be used to test a camera's low-light performance or to adjust back-focus.

1.3.38 *Over-scanning*

Appearance of a camera video signal on a video monitor where a small percentage of the periphery of the image is not visible. This can be as high as 10% for both horizontal and vertical.

1.3.39 *Pan and tilt unit*

A motorized unit permitting the vertical and horizontal positioning of the camera and lens equipment.

1.3.40 *Picture storage/recording*

The storing/recording of video images.

1.3.41 *Preset position (shot)*

A function in pan and tilt units and/or zoom lenses, which allows automatic return to one or more predetermined positions.

1.3.42 *Ramping*

A characteristic of some zoom lenses whereby the effective aperture of the lens decreases as the focal length is increased.

1.3.43 *Scene illumination*

The level of illumination of the area under surveillance, in lux, which depends on the source light intensity and reflectivity of the objects the camera is looking at. A typical scale of various illumination levels is shown in Figure 4.

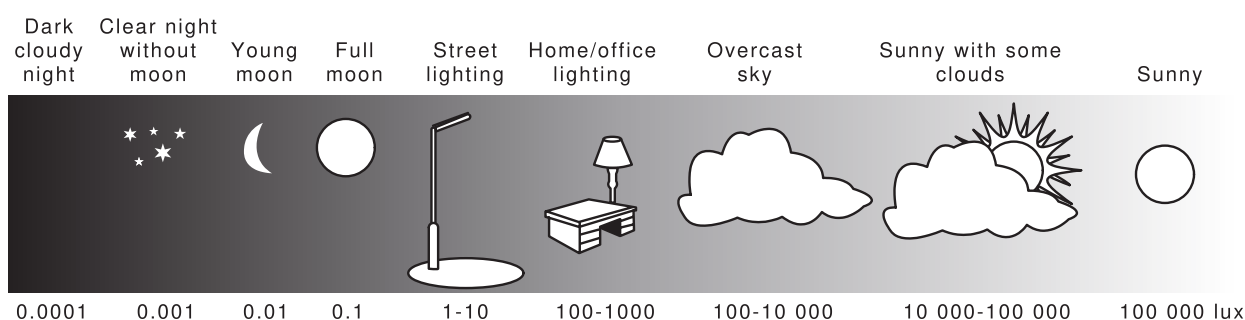


FIGURE 4 SCENE ILLUMINATION

1.3.44 *Scene reflectance*

The proportion of the scene illumination reflected by that scene, as a percentage, which ranges from a very low 1% for black velvet, 18% for mid-grey (approximately grass), 32% for a typical soil surface and up to 95% for bright snow.

1.3.45 *Slow-scan transmission*

The transmission of a series of non-real time images or parts of images, by means of analogue or digital signals over limited bandwidth transmission media. Typically, an image is transmitted in the range 1 to 32 s.

1.3.46 *Still image video compression*

Video compression where every PAL field or frame is compressed independently. Typical representatives are the JPEG and Wavelet (JPEG-2000) compressions.

1.3.47 *Temporal video compression*

Video compression where time is used in the process of reducing the redundancy (compression). Typical representatives are the MPEG and H26x series standards.

1.3.48 *Time/date generator*

A device for generating time and date and adding them to the image, either as overlay or invisible time/date (embedded in the television signal hidden lines).

1.3.49 *Time/date synchronization*

A procedure for keeping uniform time and date across a larger system. Usually one internal or external unit is used as a reference time server.

1.3.50 *Time-lapse recording*

The periodical recording of video signals at a rate lower than the source image rate.

1.3.51 *Time multiplexed recording*

A method of recording several video signals on one video channel by time multiplexing the frames or fields of these video signals.

1.3.52 *Transmission number of lens (T)*

The index of the actual light-gathering capability of the lens, which takes into account the transmittance quality of the optics (t), which is usually between 0.95 and 0.99. T-number is always bigger than the F-stop by a small fraction.

1.3.53 *Under-scanning*

An optional video monitor display mode where 100% of the image is visible.

1.3.54 *Vari-focal lens*

A lens with manually adjustable focal length, in which the image of the scene does not remain in focus because the focal length is manually changed. This adjustment is usually done once, during the installation.

1.3.55 *Video- and d.c.-driven auto iris*

Two types of auto iris control mechanisms. Video-driven lenses have an electronic assembly inside, which uses the video signal from the camera to determine the amount of iris opening required; d.c.-driven lenses do not process the video signal but, rather, receive a control current from the camera itself and open or close the iris based on such signal. Video-driven lenses will not work on d.c.-driven cameras, and the opposite is also true. Most of today's cameras, however, can use either of the two by selecting an appropriate switch.

1.3.56 *Video compression*

A procedure for reducing the amount of data required to represent video images.

1.3.57 *Video cross-point matrix switcher (short: matrix switcher)*

A unit for connecting a number of video input signals to several video outputs. It also allows any combination of input to output connection as a result of input activities, preprogrammed entries and/or operator selection. It may also accept alarm inputs and more than one control keyboard.

1.3.58 *Video distribution amplifier*

Equipment for distributing (multiplying) one video signal to multiple video outputs by active electronics means.

1.3.59 *Video equalizing amplifier*

Equipment for correcting gain- and frequency-related distortions (usually losses) in the video signal.

1.3.60 *Video monitor*

A device for converting PAL standard video signals into pictures on a display screen.

1.3.61 *Video printer*

Equipment for converting a video signal into a hard copy image on paper.

1.3.62 *Video recording media*

Media where electro-magnetic representation of video signals, audio, data and alarms are recorded. This could be in the form of analogue video tapes, digital data storage tapes, hard disks, CD-ROMs, DVD-ROMs, flash non-volatile memory and any other media that could store such information on a permanent basis.

1.3.63 *Video sequential switcher*

A unit for switching a number of video input signals to one output, manually or automatically or upon receipt of an external signal.

1.3.64 *Zoom lens*

A lens with adjustable focal length, in which the image of the scene remains in focus as the focal length is changed. It is usually expressed with the zoom ratio and the starting and ending focal length; for example, 10 × zoom, 6 mm–60 mm/F-1.4. The F-stop stated usually refers to the shortest focal length position.

1.3.65 *Zoom ratio*

A mathematical expression of the two extremes of focal length available on a particular zoom lens.

2 GENERAL CONSIDERATIONS

2.1 General

A CCTV system is the combination of camera equipment, lighting, signal transmission, monitors, recorders, etc., selected and installed to meet the customer's security surveillance requirements.

The recommended procedure for designing a CCTV system is as follows:

- (a) Carry out a security risk assessment and identify the client's vulnerabilities.
- (b) Determine which sensitivities may be successfully mitigated by video surveillance and or recording.
- (c) Develop surveillance and operational requirements.
- (d) Determine the functionality required to meet the operational requirements and develop the system concept.
- (e) Develop a technical specification.
- (f) Develop suitable work-method statements.
- (g) Develop a suitable inspection and test plan (ITP) using objective testing techniques.
- (h) Install and commission the system.
- (i) Complete as-built-drawings for the whole system.
- (j) Develop a training manual and train the client's staff.
- (k) Hand the system over to the client.
- (l) Recommend a suitable preventative maintenance plan.

2.2 Threat and risk assessment

Prior to CCTV system design, and to understand the purpose of it, the threat to the premises needs to be understood to allow the determination of the risks. The CCTV system then should be designed to mitigate the risks identified.

Risk assessment should be based on the principles set out in AS/NZS 4360 with CCTV treatment plans in accordance with AS/NZS 4806.1.

2.3 Operational requirement

2.3.1 General

All CCTV installations should have an operational requirement. Since persons without appropriate technical knowledge and expertise may have to become involved in the interpretation of the specifications for CCTV surveillance systems.

NOTE: One approach would be to write an operational requirement for subsequent development into a full technical specification prepared by a suitable technically qualified and accredited person.

2.3.2 Purpose and context of the operational requirement

The operational requirement is a key document for system designers. It is a statement of the purpose of the system and the intended outcomes of its development, from which functional concepts can be developed. The operational requirements definition process encourages clear thinking about what, where, when and by whom and, in particular, the purpose of the system. The process should involve all stakeholders such as managers, potential operators and, in particular, investigators, the legal bodies and law enforcement, who may be required to use information and pictures stored by the system.

The functional concept development process should involve people with the necessary skills to convert operational requirements statements into a functional concept from which technical specification and test procedures can be developed. At appropriate stages in the development of the technical specification, appropriate test procedures should be developed to ensure that the proposed implementation will meet the functional requirements. Without a detailed functional requirement and a qualifying objective acceptance test procedure there is little likelihood and guarantee that the system will meet its intended, specified and required purpose.

NOTE: Objective tests and measurements are outlined in Appendix C.

2.3.3 Guidelines for developing the operational requirement

The operational requirement should—

- (a) define the level of security required through threat and risk assessment;
- (b) determine and prioritize the key problems or issues that need to be addressed at the site;
- (c) identify where within the site these problems occur;
- (d) describe how each problem issue should be addressed;
- (e) define the area/volume to be covered by the system (coverage);
- (f) explain the purpose of covering each area/volume (function);
- (g) determine the need for live viewing (who will be viewing cameras, why, and what actions they may take);
- (h) decide the retention period required for stored images, the image quality required for evidentiary purposes, and the method to extract evidentiary information and pictures from the system (manual or automatic);
- (i) define the procedures to be followed when extracting, storing and handling images and data from the system;
- (j) establish the actions to be taken as a result of observations made in the retrieved information (images and other data, outputs);
- (k) define the response time expected from each part of the system;

- (l) decide the range of conditions under which the system and its components are expected to function (environment);
- (m) decide where and when the tasks will be performed and by whom (control);
- (n) decide on the worst case number of simultaneous events to which the system needs to respond (workload);
- (o) decide on the training requirements (training); and
- (p) list any other special factors not covered by the above.

NOTE: It may be that the operational requirement cannot be met with current technology or with the available budget. In this case the operational requirement should be amended to allow for this and the customer should be made aware that coverage/facilities might be restricted in areas of contention.

2.4 System operational criteria

2.4.1 General

The system operational criteria involve determination of—

- (a) the operational procedures at site, or at secondary operational point(s);
- (b) the system response times; and
- (c) the alarm response required for the level of threat assumed.

2.4.2 Determining operational procedures

2.4.2.1 General

The principal task of the fully trained operator is the effective use of the system to manage incidents and anticipate threats based on live camera views and reviews of recordings made. It may be necessary for the operator to be trained to analyse the content of the displayed pictures and associated alarms and take any necessary actions required to counteract the threat, manage the incident and reduce the after effects of the incident. Where appropriate, the use of automated systems for non-critical functions in order to free the operator for essential tasks should be considered.

2.4.2.2 Automation of equipment

Automation of the following functions should be considered:

- (a) Video switching to appropriate monitor.
- (b) Selection of PTZ camera preposition(s).
- (c) Control equipment/task assignment.
- (d) Lighting control.
- (e) Picture storage, recording and playback.

Some or all of the above functions may be controlled by—

- (i) alarm activation;
- (ii) external trigger;
- (iii) timed events; and
- (iv) manual intervention.

2.4.3 Alarm response

The triggering of an alarm condition to the CCTV system normally has priority over other inputs. However, irrespective of the degree of automation, the operator should be able to take manual control of the system after alarm.

Automation of picture selection after an alarm has been received should take the following into consideration:

- (a) Specification of the view(s) to be selected in each area where an alarm condition occurs.
- (b) Allocation of the monitors that display the pictures from those cameras. On-screen display of the camera identification or a mimic diagram of the installation can be useful.
- (c) Presentation of alarm pictures on designated monitors.
- (d) Handling of simultaneous alarm conditions.
- (e) Which pictures are to be stored or recorded and the image quality at which they are stored or recorded.
- (f) Flagging of the alarm point in time for quick and easy location during playback.

2.4.4 *System response times*

The following response times should be kept to a minimum:

- (a) Time elapsing from the generation of an alarm signal and its signalling to the CCTV system.
- (b) Control centre switching on receipt of alarm.
- (c) Camera positioning if preset functions on the zoom lens and pan and tilt unit are used.
- (d) Recording equipment start-up time or change from time-lapse mode to normal mode, if a time-lapse recorder is used, or frame rate change if a digital or network recorder is used.
- (e) DVR time-lapse mode (the time between subsequent images).
- (f) PTZ control latency when such control is done via network and/or via DVR which uses temporal video compression.
- (g) Operator's response time if intervention is required.

To minimize response times, cameras, monitors, video recorders, etc., should be continuously powered and the system should not generate more information than the operators can effectively manage.

Blanked monitors that display an image on an event trigger may be used to highlight a situation of potential interest and attract the operator's attention.

3 SYSTEM DESIGN CRITERIA

3.1 General

When designing CCTV surveillance installation the following criteria should be taken into account, bearing in mind the need to meet the operational requirement:

- (a) Determination of the zones or objects requiring surveillance.
- (b) Determination of the number of cameras, including their locations, required to monitor the agreed zones or objects.
- (c) Evaluation of existing lighting and consideration of new or additional illumination.
- (d) Evaluation of camera to monitor distances and consideration of best transmission media.

- (e) Evaluation of the need for cameras to be remotely powered from a backed-up source (possibly in the control or recording centre) and consideration of the best power distribution strategy.

3.2 Surveillance zone determination criteria

A CCTV surveillance installation is designed to monitor events of fundamental importance.

These events might be hold-up/theft, sabotage/vandalism, hazard, evacuation, etc.

Typical examples of monitoring applications are—

- (a) perimeter surveillance;
- (b) denial of access (access control system output);
- (c) safety breaches (dangerous zones, fire and robbery); and
- (d) property protection (vandalism, theft, accidents, etc.).

3.3 Criteria for determining the number of cameras and their location

In order to determine the number of cameras required in a system, the problems need to be identified, the location of occurrences need to be established and the action required (observation, recognition and/or identification) must be decided on. Once the zones, the objects requiring surveillance and the reasons have been established the number of cameras required in a CCTV system can be determined based on the fields of view and the resolution of the cameras.

Picture detail should be consistent and adequate for observation, recognition or identification as established in the review.

The operational requirement of the system and its use, as well as site constraints and service access, may restrict the camera location and increase the possibility of further cameras being required.

3.4 Camera and lens selection criteria

The camera and lens subsystems are required to manage the fields of view, clarity and light changes so that the images created can be objectively measured to confirm that they meet the requirement of the specification.

The selection criteria should take into account the following:

- (a) The camera sensitivity and aperture number of the lens for the prevailing and intended worst case light levels and types of light, including IR.
- (b) The focal length of the lens in relation to the size of the image sensor in the camera to give the required field of view.
- (c) The resolution of the camera and lens to reproduce the detail to give the necessary information in the field of view.
- (d) The camera/lens combination should be capable of operating in the expected maximum and minimum light levels (i.e., the lowest and the highest lens F-stop should be taken into account).
- (e) The camera/lens combination should produce images with minimum smear (e.g., where possible an auto iris lens should be used for outdoor surveillance).
- (f) The lens camera combination should be able to produce an acceptable image in the light range that is specified for the site.
- (g) The lens image area should be equal to, or greater than, the effective diagonal of the imaging device in the camera.

3.5 Camera selection

3.5.1 General

The selection criteria should take into account the following:

- (a) The ability of the camera equipment to satisfy the operational requirement under all specified environmental conditions.
- (b) Safety regulations relating to the site.

3.5.2 Selecting considerations

The following should be considered when selecting camera equipment:

- (a) White balance of colour cameras.
- (b) Electronic iris in relation to picture degrading for highlights.
- (c) Long exposure times in relation to movement blur.
- (d) S/N performance (i.e., noise at low-light levels, especially when using digital video recording equipment, the compression of which can accentuate the noise).
- (e) Spectral sensitivity in relation to the type of illumination.
- (f) Digital processing (e.g., backlight compensation, required for the site).
- (g) External synchronization, line-lock, internal synchronization.
- (h) The operating voltage (a.c. or d.c.) should preferably be low (12–24).
- (i) Backup power supply.
- (j) Temperature range to be experienced.

3.6 Lens selection

Selection of the correct lens type is as important as the camera selection.

A poor lens performance can significantly reduce the overall performance of the system. When selecting the lens the following should be taken into account:

- (a) The lens field of view (indicated in the manufacturer's nominal figure tables) may be reduced by any over-scan in the display device (when analogue monitor display is used) or it may be reduced by cropping of the DVR frame grabber onto which such camera is recorded.
- (b) The illumination of the sensor in the camera is defined by the aperture number of the lens and its transmission number, which is dependent on the design of the lens.
- (c) Internal lens reflections and ghosting can significantly impair the image.
- (d) CCTV zoom lenses are subject to ramping whereby the effective aperture number of the lens increases as the focal length is increased.
- (e) The quality of the image when using high F-stop numbers (most notably sharpness and contrast) should be maintained. This is typically done with neutral density spot filters whose optical performance can significantly influence the overall picture quality in very bright scenes.
- (f) Ensuring sufficient accuracy of the preset positions to repeated call-up of the same preset, if fitted.
- (g) The type of iris functionality (i.e., video-controlled, d.c.-controlled or manual).

Having selected the camera lens combination for difficult scenes, a camera of the type selected should be evaluated in conditions similar to those to be encountered at the installation.

3.7 Recommended object sizes

The size of an object (target) on the monitor screen should have a relation to the operator task, e.g., identification, recognition, detection or monitoring.

If digital recording is used, a full PAL frame resolution and highest picture quality should be used, i.e., 704×576 active pixels (this is equivalent to 720×576 ITU frame grabbing recommendations). Where possible, for better vertical resolution, TV frames are recommended instead of TV fields recording.

If the target is a person and the CCTV system has an installed limiting resolution of 400 TV lines or more, for the whole system end-to-end including record and playback, the minimum sizes of this target should be (refer to Figure 5) as follows:

- (a) For face identification, the entire target person should represent not less than 100% of screen height. It is assumed that a person's face (head) occupies around 15% of a person's height.
- (b) For face recognition, the entire target person should represent not less than 50% of picture height.
- (c) For detection of an intruder, the entire target person should represent not less than 10% of picture height.
- (d) For crowd control (monitoring), the entire target person should represent not less than 5% of picture height.
- (e) For vehicle number plate visual recognition, the licence plate characters should be not less than 5% of the monitor height.

All object sizes and images in the above measurements are assumed to be at optimum optical resolution, have good lighting conditions, be using the lowest compression setting for the system and be measured on a display device that shows 100% of the camera image view.

For systems based on VHS recording, or utilizing CIF size images, all above image sizes should be increased by approximately 50%.

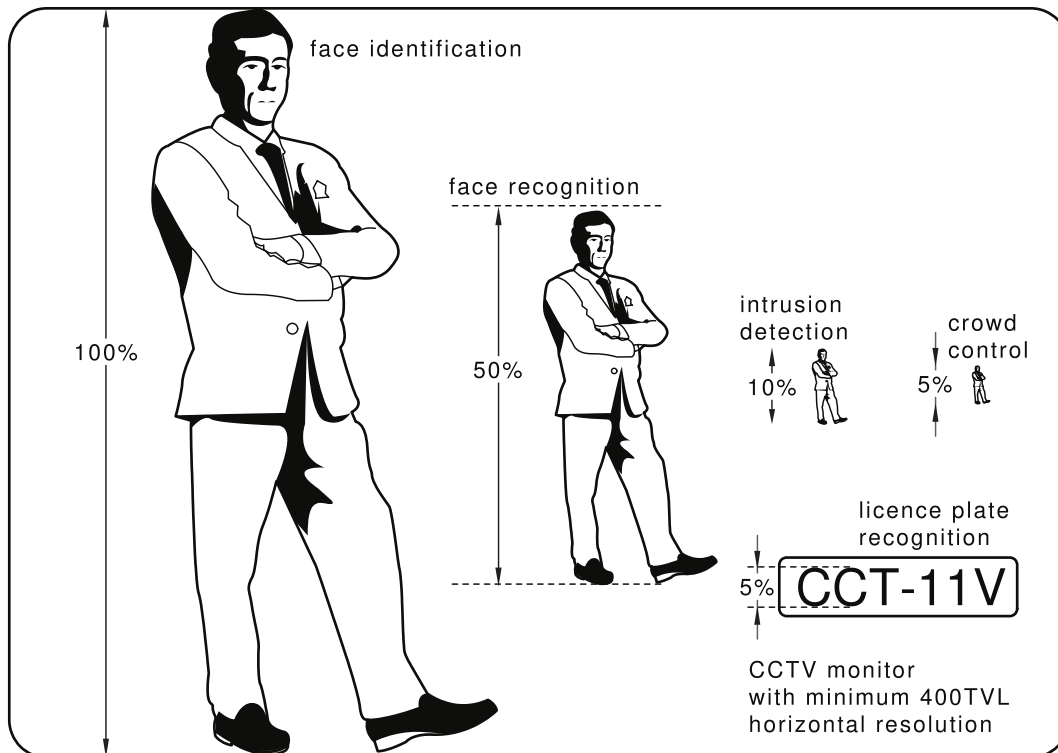


FIGURE 5 APPROPRIATE OBJECT SIZES FOR VARIOUS USES

3.8 Ancillary equipment

3.8.1 General

It is important to select and install the correct ancillary equipment for mounting the cameras. In addition to the environmental conditions listed in the operational requirements, the consideration given in Clauses 3.8.2 to 3.8.4 should be taken into account.

3.8.2 Camera housings

The following considerations apply to the selection of camera housings:

- Vandal resistance.
- Internal temperature change as a function of equipment heat dissipation and external ambient temperature.
- A camera and lens mounting arrangement that allows for the separation of video signal earth and housing and local safety earth.
- The size of the camera/lens combination with the allowance for video cabling to be smaller than the camera internal dimensions.
- Camera and lens cabling to be well protected from mechanical and weather wear.
- Access to the camera and lens, etc., for maintenance.
- Tamper devices/alarm contacts.
- An appropriate level of environmental protection (IP rating) as defined in AS 60529.

3.8.3 Pan and tilt units

The following considerations apply to the selection of pan and tilt units:

- Platform loading.
- Torque figures in relation to unbalanced platform loading and wind load.

- (c) Pan and tilt unit backlash on both axes.
- (d) Speed and range of movement of pan and tilt.
- (e) Accuracy of the preset shots, if fitted.
- (f) Privacy masking zones if used near private property, in high-security or on sensitive applications.
- (g) Optical distortion of the housing or dome glass.
- (h) Maximum tilt-up angle should allow for viewing of monitored objects above the horizon.
- (i) Additional features as required.

3.8.4 Towers and brackets

The following considerations apply to the selection of towers and brackets:

- (a) Fixing positions should allow for mechanical stability, future access and safe working. Planning considerations and architectural requirements should be taken into account.
- (b) Brackets and towers should be selected to support the maximum weight of the equipment and to provide sufficient rigidity for the camera equipment and other devices. As a general rule, the narrower the angle of view, the more rigid the mounting requirement will be. The rigidity of camera equipment fixings and the possibility of shock and vibration should also be taken into account.
- (c) Camera towers should preferably be of the winch-down or pivot type and be positioned to provide safe access for service.
- (d) No equipment should be mounted near overhead high-voltage cables.
- (e) Anti-tamper devices should be employed where required.
- (f) Mounting equipment siting should not compromise the overall security of the site.
- (g) Moving cameras should have sufficient clearance from adjacent objects.
- (h) Cabling to and from brackets and poles should be well protected from exposure to environmental hazards.

3.9 Evaluation of scene and illumination

The existing lighting should be evaluated for the level, direction and spectral content. Optimal light sources are those with a spectrum that best matches the camera imaging device response. Typically, where possible, cameras produce best details when they are positioned with the source of illumination on their side (i.e., not having intense sources of light in their field of view).

If additional lighting is required, the number, type, siting and power of the light sources should be determined, taking the following parameters into consideration:

- (a) Light efficiency and photometric performance of the light source.
- (b) Area to be surveyed by cameras.
- (c) Sensitivity and spectral response of the cameras, particularly colour cameras.
- (d) Reflectance of the materials making up the majority of the surveyed area.
- (e) Time delay to reach the specified light output of the lamp after application of power.
- (f) The loss of light output of the lamp due to ageing and lamp failure.
- (g) The new or additional light source selected should give acceptable pictures under all likely working conditions.

- (h) Illumination over the scene being surveyed should be as even as possible avoiding any area of very low light illumination. The ratio of maximum to minimum illumination within the covered area of any scene should ideally be 4:1 or better.
- (i) Where possible, lights should be mounted so that they do not impair the camera picture quality. The preferred position for the light is above the camera. The camera should not view the scene through intense beams of light.
- (j) There should be safe access to the lamps for bulb changing.
- (k) Particular attention should be paid to the direction of illumination. The aim is to produce a maximum of contrast for intruder detection. An object can only be detected if its brightness is different to that of its background.
- (l) For identification and recognition purposes, illumination should enable detailed features of the object as stated in the operational requirement to be observed.
- (m) Constant illumination or quickly changing lighting conditions.
- (n) Static or transient highlights in a uniform picture.
- (o) Environmental influences on visibility like rain, fog, etc.
- (p) Infra-red illuminators should preserve the minimum safety distance to prevent eye damage.

3.10 Selection of the video transmission system

3.10.1 General

There are many methods of video transmission and the suitability of a particular method for a given application should be carefully evaluated. Video transmission may be as simple as a single coaxial cable or as complex as a microwave link, digital networks or a mix of different transmission means.

Consideration should be given to prevailing and potential environmental conditions in those areas where the equipment and/or cables are to be installed. Special care should be taken when using coaxial cables in large sites, shopping centres and the like, where ground loop problems are most likely to occur. There should be no joins between camera and control equipment.

3.10.2 Transmission systems

The following are the main video transmission systems:

- (a) *Coaxial cable* Coaxial cable is used for the unbalanced method of analogue video transmission. The active signal travels through the centre wire while grounding is achieved via the copper shielding. The type of cable chosen should have a characteristic impedance of 75 Ω (Ohms). For long cable runs, amplifying or amplifying plus video equalizing equipment may be required to perform in accordance with AS/NZS 4806.3.
- (b) *Twisted pair transmission* The system uses standard telephone or data grade twisted pair cable (typically 100–150 Ω balanced pairs), which requires specialized transmission and receiving equipment. Twisted pair is also known as balanced transmission and is usually an analogue video transmission system.
- (c) *Microwave and radio frequency transmission* Microwave and radio wireless video transmission uses AM or FM analogue modulation for analogue transmission or a digital modulation method such as QPSK, QAM or OFDM. Correct alignment of transmitting and receiving equipment is essential. Various power outputs and antenna gains are used for achieving various distances. Systems normally need regulatory authority approval, although there are some frequencies allocated for free usage (such as in the 2.4 GHz band).

Microwave and radio wireless transmission can also be in digital form, the most popular of which would be in the form of one of the new IEEE 802.11 wireless digital Standards.

- (d) *Infra-red and laser transmission* This is a line-of-sight optical transmission system, applicable only to unobstructed signal paths. The signal used for transmitting can be either analogue or digital. The output of some transmitting devices can cause eye damage; therefore, warning labels must be fitted according to the appropriate safety standards. Alignment and rigidity of transmitting and receiving equipment is important. The transmission may be affected by fog, rain, snow, etc. The range can also be reduced by such phenomena and this should be taken into account.
- (e) *Fibre optic transmission* This is optical transmission and it may be either analogue or digital. Commonly available types (multimode fibre 62.5/125 μm or single mode 9/125 μm), together with the appropriate fibre optic connectors, should be used. An analogue transmission system should have sufficient dynamic range (optical budget) to overcome all likely system losses.
- (f) *Slow-scan and fast-scan transmission* This is a system suitable for both public and private telephone (PSTN) and data networks (ISDN). Many systems are available and they have widely varying connection and transmission speeds and resolution. System selection should be carefully evaluated against the operational requirement.
- (g) *Digital network transmission* This is a system where all video signals are digitized (at the camera, via an encoder/streamer or after going through a digital video recording system or video streamer) and available on any local area network (LAN), wide area network (WAN) or via the Internet.

3.10.3 Selection criteria for video transmission

Considerations for the selection of a transmission means, or a combination of different means, include the following:

- (a) Bandwidth of the transmission path.
- (b) Signal-to-noise ratio and signal distortion.
- (c) Latency, jitter, quality of service and multicasting support (IGMP) on digital systems.
- (d) Distance to be covered.
- (e) Interference or crosstalk immunity.
- (f) Security of communication.
- (g) Where the risk of transmission interception may exist, appropriate measures of protection such as signal encryption and/or physical treatment are recommended.
- (h) Constraints in physical installation.
- (i) Update rate, resolution and whether it is TV frame or TV field.
- (j) Other factors such as return path PTZ data functionality.

NOTE: Signal-to-noise ratio and signal distortions are cumulative and can cause picture degradation.

3.11 System diagnostics

In high-security or sensitive applications, consideration should be given to the detection of loss of signal and camera masking on any connected camera. An audible/visual system alarm should be generated for acknowledgment by system operators and a facility should exist where this alarm can be mapped to an alarm output for connection to an alarm system.