THE COMPLETE GUIDE TO CCTV LIGHTING

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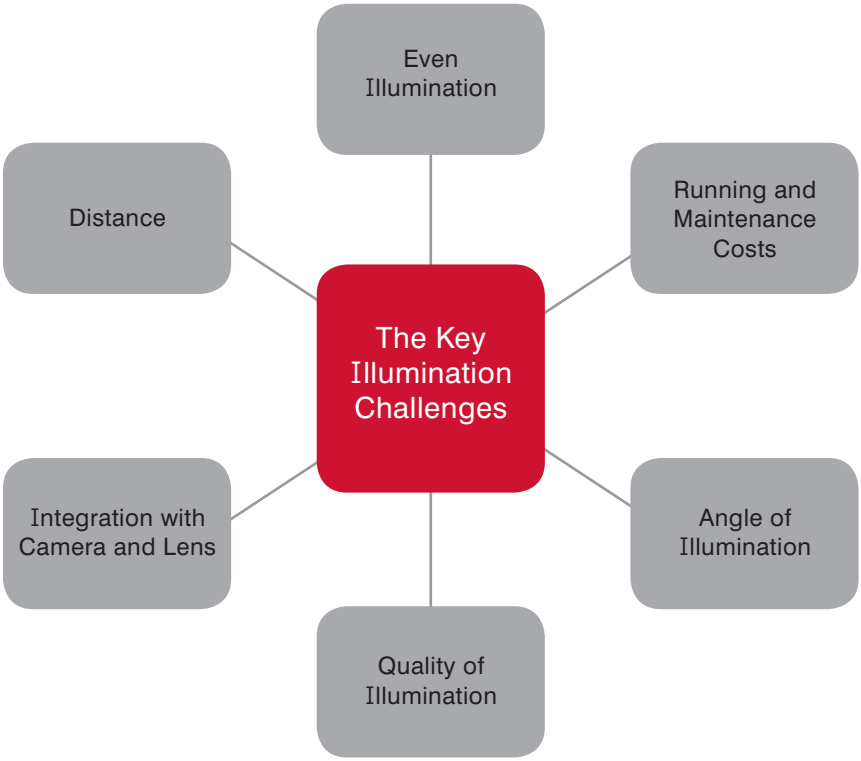
Most crime happens during the cover of darkness

The challenge to the CCTV professional is to ensure that video footage is effective on a 24/7 basis, 365 days a year. Lighting is fundamental to achieving this.

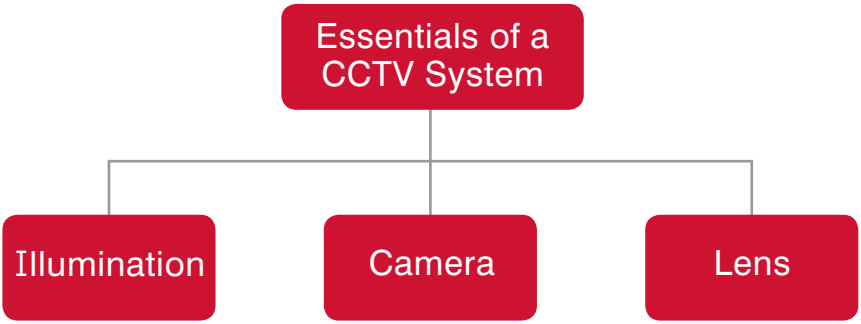
The key practical challenges of CCTV lighting are:



The Complete Guide to CCTV Lighting covers all of these challenges in detail to increase the understanding and appropriate use of lighting. Correctly designed lighting can make a significant impact on the performance and effectiveness of the CCTV system, ensuring the system works day and night.

CCTV Lighting - an Introduction

The Complete Guide to CCTV Lighting has been published to help installers, specifiers and end users better understand the challenges, opportunities and the role that CCTV lighting plays in video surveillance. Lighting, meaning Infra-Red and White-Light, is one of the 3 essential elements needed at the front end of every CCTV system:



LIGHTS - CAMERA - ACTION

As CCTV becomes more advanced the industry will move to view lighting with as much importance as the cinematic and photographic industries in capturing effective images.

To raise standards all CCTV should be designed for 24 hour surveillance, not just day-time operation. To be truly secure, a site must be protected day and night.

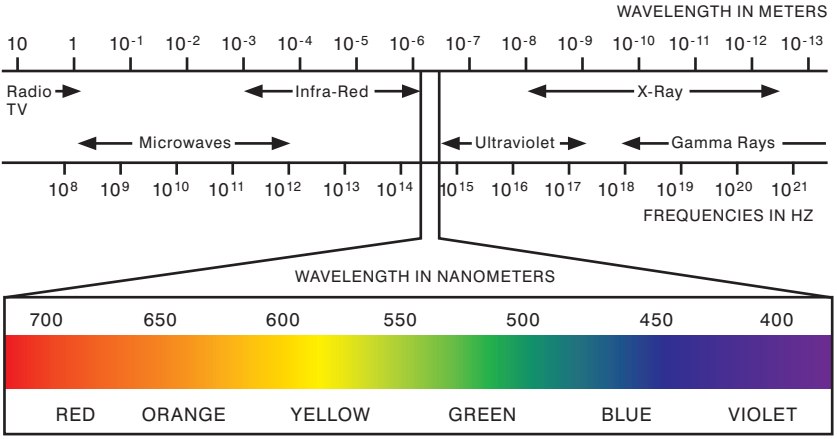
What is Light?

Light is fundamental to CCTV. Without light no images are possible as it is light reflected from the world around you that makes the world visible both to the human eye and to the CCTV camera.

The performance of any CCTV system depends not only on the essential components of camera and lens, but also relies totally on the quantity, quality, and distribution of available light. Light determines whether a subject can be viewed at all, at what distances, and the quality and direction of the light controls the appearance of the subject.

Light is energy in the form of electromagnetic radiation. The wavelength of light (also known as frequency) governs the colour and type of light. Only a very narrow range of wavelengths from approximately 400nm (violet) to 700nm (red) is visible to the human eye. However, CCTV cameras can detect light outside the range of the human eye allowing them to be used not only with

White-Light but also with Infra-Red (715-950nm) for night-time surveillance. Light travels at the colossal speed of 300,000,000m per second from a source such as the sun, an electric lamp or an Infra-Red lamp. Light travels in straight lines and causes shadowing where it is blocked.



The behaviour of light varies according to the material or surface its strikes. As it reaches a surface light is either reflected, diffused, absorbed, or more commonly, is subject to a mixture of these effects. Most surfaces reflect some element of light. Generally, the paler the surface, the more light it reflects. Black surfaces absorb visible light, while white surfaces reflect almost all visible light. Infra-Red is not always reflected in the same way as visible light. The way Infra-Red is reflected is dependant on the nature of the material - see the reflectance chart on page 12.

What is colour?

Wavelengths of light visible to the human eye are interpreted by the brain as colours from 400nm (violet) to 700nm (red). Between these polar wavelengths are the other colours - indigo, blue, cyan, green, yellow and orange. When visible White-Light is split into its component parts by a prism, or in a rainbow, these are the colours visible. When these wavelengths (from 400nm to 700nm) are seen together they appear as White-Light.

Before the 17th century it was believed that colour existed in objects, irrespective of the light by which they were seen. It was Isaac Newton who proved that light itself is the real source of all colours.

A green leaf looks green because it reflects green wavelengths present in White-Light. You can see this yourself by examining a green object under a red light: As the lighting contains no green, the object will appear black. To take a more familiar example, when you buy a coloured item of clothing you often take this to the door or window to check how it looks in daylight. This is because you know that incandescent interior lighting, although white, contains a slightly different mixture of wavelengths from the light outside, and consequently alters the apparent colour of the garment.

The exact same can be said in CCTV terms. The colour output of an illuminator effects the colour seen by the camera and on the CCTV monitor. For example, low pressure sodium street lighting produces a yellowish light, distorting colour images on CCTV systems. Achieving accurate colour CCTV images is a challenge and a skill. To provide true colour CCTV images, White-Light illuminators should provide colour corrected illumination matched to the visible spectrum.

TECHNICAL TIP

As light is the source of all colour, to get true colour CCTV images colour corrected White-Light, exactly matching the visible spectrum, is needed.

Coloured objects reflect light selectively. They reflect only the wavelengths (i.e. colours) that you see and absorb the rest. A red flower, for instance, contains pigment molecules that absorb all the wavelengths in white light other than red, so that red is the only colour it reflects.

At lower wavelengths than the visible spectrum the radiation becomes ultraviolet (UV). UV burns the skin, causing tanning, and is therefore unsafe for CCTV. At higher wavelengths than the visible spectrum the radiation becomes Infra-Red (IR).

What is Infra-Red light?

Infra-Red light is a light that the human eye can not see but the monochrome CCTV camera can. Near Infra-Red light is light of a longer wavelength than the visible spectrum, between 700 and 1,100nm, just beyond the visible spectrum. It is this near Infra-Red that is used for CCTV purposes.

As Infra-Red contains none of the colours visible to humans it cannot be used with colour cameras. To see Infra-Red, monochrome or day-night cameras, are needed. CCTV cameras using Infra-Red always provide monochrome images.

Applications that require covert surveillance, or applications where even low levels of overt lighting must be avoided for reasons of light pollution, are ideal for Infra-Red light.

Colour or Monochrome

The first decision facing CCTV professionals is choosing whether colour or monochrome images are preferred at night. In many instances the end user would prefer colour over monochrome but care must be given to provide true colour with a colour corrected illuminator. For example, many installers will be familiar with the yellow light provided by low pressure sodium street lighting. Using incorrect White-Light can actually damage the performance of a CCTV system leading to inaccurate colour rendition – a camera is only as good as the light available.

Where White-Light would be too intrusive (especially given recent legislation on light pollution), or where covert surveillance is required, Infra-Red should be the method of illumination. Infra-Red lighting can also illuminate longer distances than comparable power White-Light.

Brightness and Glare

Brightness is an observer's perception of illuminance from a given target. Its value is different in darkness to that in daylight. For example, the lights from car headlights appears to be brighter at night.

Glare is the result of excessive contrasts between bright and dark areas within the field of vision. It is a particular problem for road safety at night when contrasting bright and dark areas make it difficult for the human eye (and CCTV cameras) to adjust to changes in brightness. Such high contrasts cause problems for the human eye in three ways:

Discomfort Glare: The brightness brings a sensation of light pain and discomfort, such as looking at a light bulb.

Disability Glare: The eye becomes less able to discern detail in the vicinity of peak light. It includes drivers being blinded by oncoming traffic at night and causes a reduction in sight capabilities.

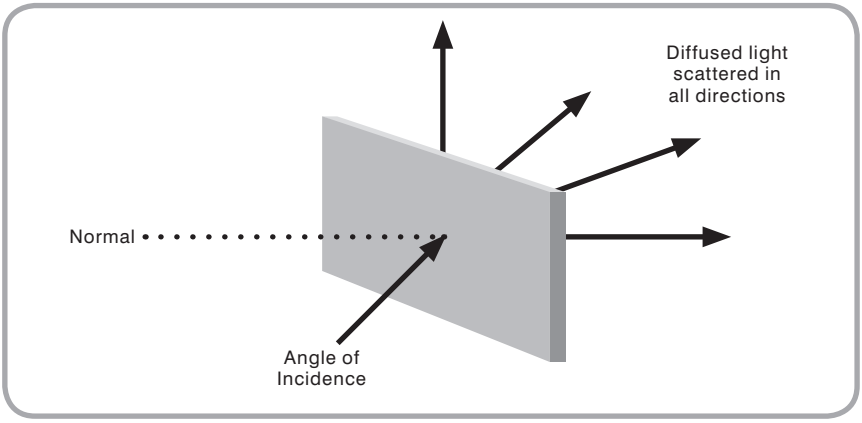
Blinding Glare: Strong light, such as that from the sun, is completely blinding and leaves temporary vision deficiencies.

SIMILAR EFFECTS OCCUR WHEN CCTV CAMERAS VIEW BRIGHT OBJECTS

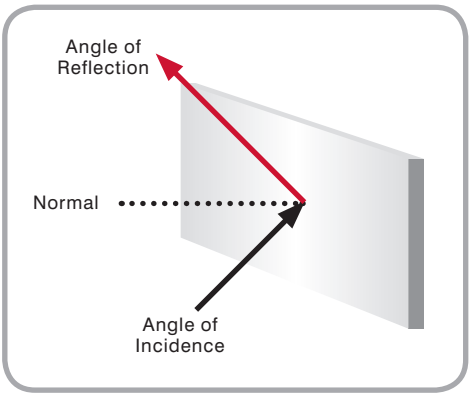
Light and Surface

To control lighting, you must understand how light changes in quality and direction when it meets a surface. The three main effects are diffusion, reflection or absorption. Often light is affected by a combination of these effects and all influence the quality of CCTV lighting.

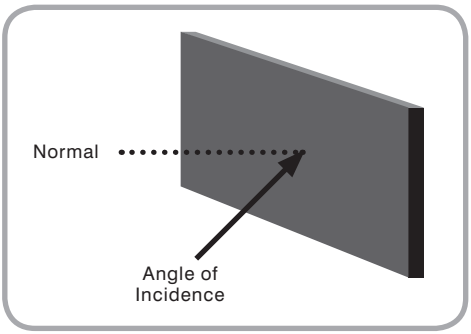
DIFFUSION - A diffusing material scatters light passing through it. The direction and type of the light is changed passing through the material.



REFLECTION - When light hits a surface it can bounced back as reflection. The quality of the surface impacts the type of reflection. Highly textured surfaces scatter light due to tiny irregularities in the surface material whilst flat surfaces, such as a mirror provide a more focused reflection.



ABSORPTION - Some surfaces actually absorb light. Coloured surfaces absorb some light and reflect the remainder – which is why they appear a particular colour. A black surface absorbs most of the light falling on it. The light energy is usually turned into heat, so dark materials heat up easily. For example, wearing a black t-shirt on a bright sunny day will generate extra warmth for the wearer.



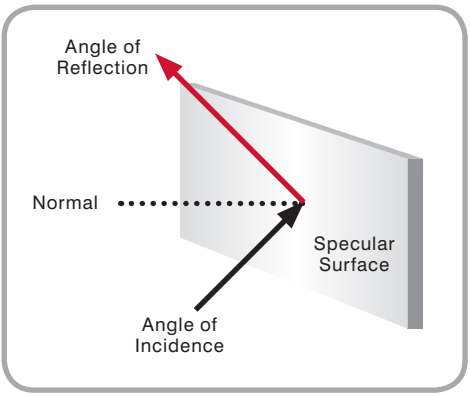
TECHNICAL TIP

When light hits most objects it is affected by a combination of diffusion, reflection and absorption.

Reflection

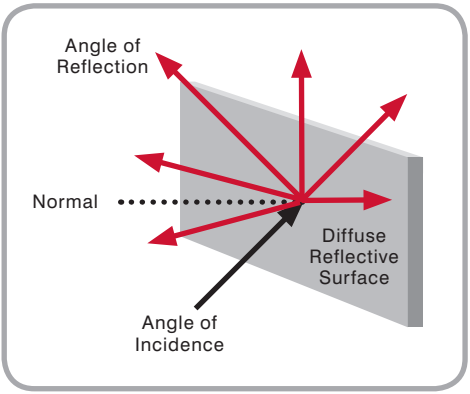
TYPES OF REFLECTION

SPECULAR - If a surface reflects light as a mirror it is said to be of specular reflectance. With specular surfaces the angle of incidence is equal to the angle of reflectance

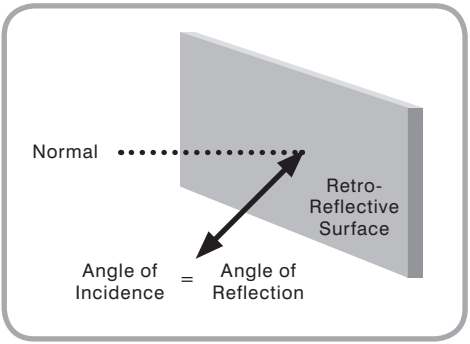


DIFFUSE - Diffuse reflection surfaces bounce light in all directions due to tiny irregularities in the reflective surface. For example a grained surface will bounce light in different directions.

A diffuse reflective surface can scatter light in all directions in equal proportions. This particular form of diffuse reflection is known as Lambertian reflectance.



RETRO-REFLECTION - Retro-reflective surfaces bounce light back in the direction it came from. Traffic Signs and Vehicle number plates have retro-reflective surfaces.



TYPICAL REFLECTANCE LEVELS - Reflectivity is a measure of the reflected power compared to incident power and objects reflect light to different intensities. Energy not reflected is absorbed and converted to heat. Low reflectivity objects absorb a lot of energy – hence why bricks feel warm. The photographic industry has calculated that the average object reflects approximately 20% of light. The table opposite shows some everyday objects and their level of reflectivity.

Material	Typical Reflectance (%) White-Light
Standard white paper	75
Aluminium	75
Glass windows	70
White cloth / fabric	65
Concrete (new)	40-50
Light oak wood (varnished)	40-50
Plasterboard	30-60
Bright steel	25
Cast iron	25
Open country (trees / grass)	20
Wood (mahogany / walnut)	15-40
Brickwork (new)	10-30
Brickwork (old)	5-15
Concrete (old)	5-15
Matt black paper	5

It is important to remember that the camera does not use the ambient light on a scene as detected by a light metre. The camera actually views the amount of reflected light from objects within a given scene subject to the levels of reflectivity.

TECHNICAL TIP

Materials have different reflective levels with white-light and Infra-Red light. For example, trees and grass have a very high level of reflectance to Infra-Red light.

Sources of Light

INCANDESCENT LAMPS (Including Halogen) - For CCTV purposes, bulb life is limited and they are very inefficient. They are generally expensive to run (typically 500 watts) and expensive to maintain (up to 3 bulb changes per year). End users are increasingly moving away from using halogen based lighting products in favour of longer life LEDs.

Incandescent bulbs were the first bulbs developed and are highly inefficient, wasting 90% of input energy as heat. Their heat output is such that they are extremely hot to touch and can heat surrounding objects in close proximity.

Halogen bulbs provide a minimal increase in efficiency and still waste as much as 85% of input energy as heat. Halogen bulbs are smaller and higher pressure than incandescent bulbs causing halogen bulbs to have an extremely hot surface hazardous to the touch. Bringing the bulb into contact with cold surfaces such as residue from fingerprints, particularly sodium, may cause bulb failure.

FLUORESCENT LAMPS - Their use for CCTV purposes is limited due to the perceived “beating” effect when used with a CCTV camera. They are generally low power and designed mainly for internal fitting. As they have a large diffused source the light output is difficult to focus and control.

Fluorescent bulbs are much more efficient than incandescent bulbs, operating at approximately 40% efficiency. Only 60% of the input energy is wasted as heat so fluorescent lamps run much cooler than incandescent lamps and can provide equivalent power from much lower electrical input. For this reason, and the fact that fluorescent lamps tend to last 10 – 20 times as long as an incandescent bulb, they are commonly used in domestic homes as long life bulbs.

However, fluorescent lamps produce a flicker imperceptible to the human eye but visible to cameras as a “beat” effect making fluorescent illumination unsuitable for video surveillance. Fluorescent lamps also contain the hazardous material mercury.

HID LAMPS - HID lamps could be used in CCTV. They are efficient, provide good colour rendition and are long life – up to 12,000 hours. However, they suffer from a slow start (2-3mins) and cannot be turned on immediately after being turned off.

High intensity discharge lamps are 60-80% efficient and compared to incandescent and fluorescent lamps provide much more light from a smaller package. HID forms include low pressure sodium (unsuitable for CCTV due to its yellow tinge), high pressure sodium (which is more acceptable but produces worse colour rendition than Metal Halide) and Metal Halide. Metal Halide HID bulbs provide a very natural, cool clear White-Light with excellent colour discrimination. HID lamps are commonly used for street lighting and in car headlights.

LED'S - LEDs are the fastest growing lighting solution for CCTV applications. They are extremely efficient and offer unbeatable reliability. LEDs offer the lowest possible running costs (less than 100 watts for highest power units) with the longest operating life (up to 10 years).

Light Emitting Diodes (LED's) are semiconductors that naturally emit a narrow band of light. They are a relatively new development in lighting but their usage is expanding rapidly on the back of clear technical advantages. LED's are comparatively expensive to purchase but provide extremely long life up to 100,000 hours. In comparison fluorescent bulbs typically last 10,000 hours and incandescent bulbs 1,000. LED efficiency is typically 80-90% with the greatest efficiency coming from LED's producing red light. Advantages of LED's include extremely low electrical consumption, low operating temperatures and continuity of colour through the operating life of the LED. Unlike traditional bulbs LED's are also highly durable, insensitive to vibration and their hard casing makes them difficult to break. They are also capable of emitting light at a given wavelength without the need for a filter and are quick start devices.

Power management and thermal management are important to ensure LED's deliver expected performance.

LATEST DEVELOPMENTS - Through hole LEDs are expensive to mount to PCBs and generally are not as robust as Surface Mount Technology. Surface Mount Technology (SMT) LED's offer better thermal management and allow the LED's to be "driven" harder without compromising performance.

CCTV Lighting – Which Wavelength?

WHITE LIGHT: A mixture of light from 400-700nm provides true White-Light

Practical Uses:
Illuminate an area for the CCTV system
Improve the overall level of illumination for key personnel
Provide a welcoming environment for authorised personnel
Deter crime by illuminating a secure area on intrusion
Can be used with monochrome, colour and day/night cameras

INFRA-RED:
715-730nm Overt IR, produces a red glow like a red traffic light.
815-850nm Semi-covert IR with a faintly red glow only just visible.
940-950nm Covert IR invisible to the human eye

Practical Uses:
Provide discrete or covert illumination for CCTV
Minimise light pollution
Provide very long distance illumination
Can be used with monochrome and day/night cameras

TECHNICAL TIP

As IR becomes more covert it becomes more difficult for the camera to see and consequently distances are reduced. 940-950nm IR should only be used with highly sensitive cameras fitted with high performance lenses. Focussing is also more difficult at those wavelengths as lenses start to operate more inefficiently with 940-950nm.

Light and Safety

As White-Light is visible to the human eye we have a natural protection against an overexposure to White-Light. The iris and the eyelids close to reduce the input of visible light. If this does not suffice we simply turn away from the light.

As we cannot see the Infra-Red our eyes cannot automatically adjust to overexposure. However, Infra-Red does produce heat – it is typically the Infra-Red we can feel on a hot sunny day as warmth. It is this heat from Infra-Red that we can use as a barometer of safety. The general rule of thumb is that if you can feel the heat of the IR unit do not look at the source.

Even the most powerful IR units, at angles of 10 degrees, are fully eye safe beyond distances of 2m.

TECHNICAL TIP

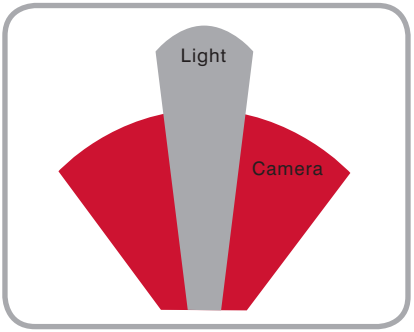
If you can feel the heat of the light source, do not look directly at the light

Beam Patterns

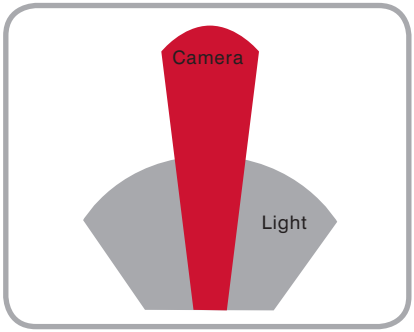
When providing CCTV illumination the beam angle should always cover the full field of view. The correct angle of illumination must be used to light the full scene. Modern Adaptive Illumination™ units allow the angle of illumination to be adjusted on site to suit the specific scene requirements.

TECHNICAL TIP

Match the angle of illumination to the cameras field of view. The only consistent practical way to achieve this is through Adaptive Illumination.



Lighting which is too narrow will produce "white out" or glare in the middle of the picture and means areas of the picture are not correctly illuminated.



Lighting which is too wide means wasted light and reduced viewing distance.

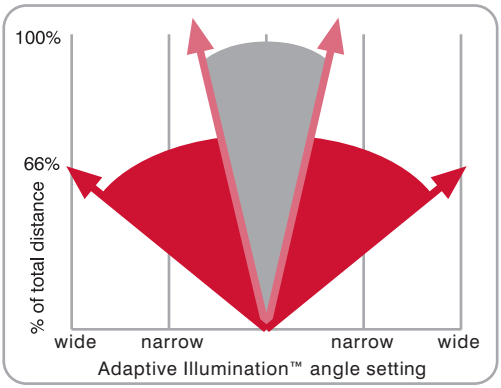
Traditional Beam Patterns

As standard, beam patterns from an illuminator are provided at a fixed angle, either narrow or wide. Historically spot and flood lenses have dominated but more recently these have been rejected in favour of more precise angles such as 10, 30 or 60 degrees. However, these are still fixed angle output, meaning they are inflexible on site. If the lighting requirements change or if the cameras field of view is changed the lighting may be unacceptable. Also, it means that all lighting decisions must be made prior to installation which is often difficult. Often final lens decisions and viewing areas are made during the installation process.

Typical Beam Patterns:
Spot
10°
20°
30°
60°
Flood

Adaptive Illumination™ Beam Patterns

Many installations use vari-focal lenses and ideally the installer requires the same level of flexibility with lighting to maximise system performance. Adaptive Illumination™ (AI) products do not provide light at a fixed output angle, rather they provide a range of output angles allowing the installer to select the angle that covers the exact field of view and provides the highest quality images. Adjustment is quick and convenient and any angle is easily selectable.



AI Beam Patterns
10 - 20°
30 - 60°
50 - 100°
120 - 180°

AI Narrow Angle Beam

AI Wide Angle Beam

Ultimate AI Beam Patterns
10 - 30°
30 - 90°
50 - 180°

Ultimate AI Narrow Angle Beam

Ultimate AI Wide Angle Beam

TECHNICAL TIP

The wide angle 120-180 degree Adaptive Illumination™ or 50-180 degree Ultimate Adaptive Illumination products provide a perfect solution to providing lighting for fully functional domes. Setting the angle to 180 degrees, a domes full range of view can be covered with only 2 illuminators.

The Inverse Square Law

THE INVERSE SQUARE LAW - The intensity of a light is inversely proportional to the square of the distance from the light source (the illuminator).

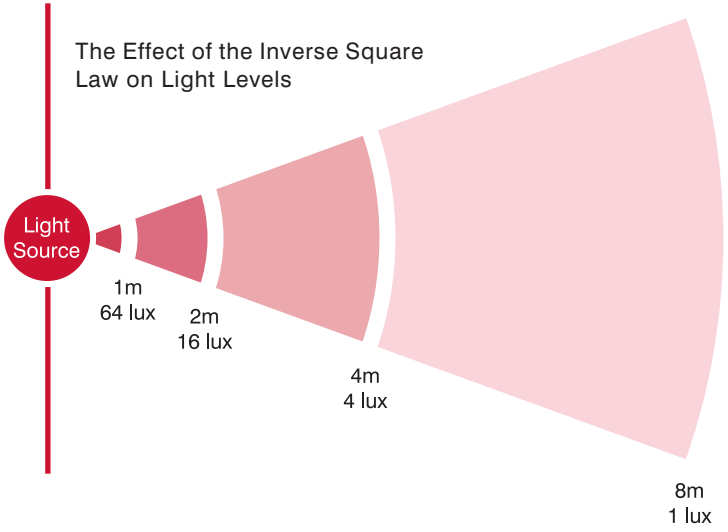
Light obeys the inverse square law so to fully understand the way that light travels, and the resultant impact on CCTV systems, some understanding of the inverse square law is required.

As light travels away from the point source it spreads both horizontally and vertically and therefore intensity decreases. In practise this means that if an object is moved from a given point, to a point double the distance from the light source it will receive only a ¼ of the light (2 times the distance squared = 4). Taking this theory further, if an object at 10m from a light source receives 100 LUX, moving the object to 40m, it will receive only 1/16th of the light (4 times the distance, squared = 16) resulting in the object receiving only 6.25 LUX.

The inverse-square law applies to both White-Light and Infra-Red light in the same way.

TECHNICAL TIP

The effects of the inverse-square law shows how a CCTV camera has to handle a wide range of light levels within a given field of view and shows the importance of even illumination.



Using Multiple Illuminators

The inverse-square law explains how light intensity reduces over distance but can also be used to calculate how many additional illuminators are needed to achieve specific increases in distance.

CALCULATING HOW MANY ILLUMINATORS ARE NEEDED TO COVER A GIVEN DISTANCE - If the distance from a single illuminator is doubled then the intensity of the light is quartered. Therefore to achieve double the distance of one illuminator, achieving the same power on scene, 4 illuminators are required (2 squared = 4). Similarly to achieve 3 times the distance of one illuminator, 9 illuminators are required (3 squared =9).

CALCULATING THE IMPACT OF MULTIPLE ILLUMINATORS ON DISTANCE - The inverse square law can also be used to calculate the effect of using multiple illuminators by taking the square root of the change in illumination intensity at source. For example, using 4 illuminators will produce a 2 fold increase in distance (the square root of 4 is 2), and using 25 illuminators will result in a 5 fold increase in distance (the square root of 25 is 5).

TECHNICAL TIP

There is no need to use multiple illuminators to achieve increases in distance. Tighter angle devices, or more powerful illuminators can provide the required additional power output.

1 UNIT = 1 x DISTANCE

4 UNITS = 2 x DISTANCE

No. of Illuminators	Distance Multiplier
1	1
2	1.4
3	1.7
4	2
5	2.2
6	2.4
7	2.6
8	2.8
9	3

9 UNITS = 3 x DISTANCE

TECHNICAL TIP

To double the illumination distance requires 4 times the power.
Double the number of illuminators provides a 1.4 times increase in distance.

Measuring Light

WHITE-LIGHT - White-Light is measured in LUX, the European standard. It is the level of illumination produced by one lumen over one square meter. In North America the foot candle is still widely used as a unit of measurement.

Power output of White-Light illuminators is measured in LUX
Ten LUX is approximately one foot candle.

Measurement of White-Light on scene can be simply recorded by use of a light meter. Typical LUX light levels are:

Bright Sunny Day = 10,000 – 100,000 LUX

Overcast Day = 1,000 – 10,000 LUX

Twilight = 1 – 100 LUX

Street Lighting = 5 LUX

Full Moon = 0.1 LUX

Bright, Clear, Starlight = 0.01 – 0.0001 LUX

INFRA-RED - As LUX is a measurement of visible light, and by definition Infra-Red produces invisible light, LUX cannot be used to measure IR power.

The most common form of measurement is mW per square metre, a simple statement of energy output from a light source over a given area.

COMPARING THE RELATIVE POWER OF ILLUMINATION DEVICES

The best solution for comparing the relative power and efficiency of different light solutions can be summarised as power output divided by electrical consumption

Efficiency = Power / Watts

White-Light efficiency: lumens / watts

Infra-Red efficiency: mW per square meter / watts

TECHNICAL TIP
LED's provide higher relative power compared to bulb based illuminators.

Evaluating Running and Maintenance Costs

Environmental and energy consumption issues are high on the global agenda. Given that £1 from every £5 spent globally is used on lighting, and much of this spend is on inefficient or unnecessary lighting particular attention should be given to this area. The pressure to save energy by looking at running costs will continually increase. Local Authorities and private industry are all looking at methods to save energy costs and lighting is one area due careful attention.

Traditionally lighting (including CCTV lighting) has been provided by mains driven bulbs. Although some bulbs are more efficient than others the future of lighting lies with Light Emitting Diodes (LEDs). Compared to any bulb, LED's provide significant savings on electrical consumption. LED's also provide truly long life performance with little ongoing maintenance cost. The table below shows the ongoing costs of RAYMAX and RAYLUX LED illumination compared to standard CCTV illuminators.

COMPARING THE OPERATIONAL COSTS OF CCTV LIGHTING

	Mains Driven Bulb	Low Voltage Halogen Bulb	LED RAYMAX and RAYLUX
Electrical Consumption	500W	200W	80W
Cost of Consumption*	£110 ($200)	£44 ($80)	£18 ($33)
Average Bulb Life	5 months	8 months	10 years expected life
Bulb Changes per year	2.4	1.5	N/A
Approx Bulb List Price	£75 ($135)	£60 ($120)	N/A
Cost of Bulbs per Year	£180 ($324)	£90 ($180)	N/A
Yearly Labour Cost**	£96 ($168)	£60 ($105)	N/A
Total Yearly Operational Cost	£386 ($692)	£194 ($365)	£18 ($33)

* Based upon 4,400 hours use per year at 5p kw/hr
** Labour costs calculated at £40 per bulb

NOTE:

All LED products provide cost saving advantages compared to bulb based illumination systems. However, the electrical consumption and operational life of LED's vary in relation to their efficiency. The above table uses RAYMAX and RAYLUX LED illuminators as a comparison to bulb based illuminators as these are the most efficient and cost effective LED units available. Using a Cool Running Thermal Management system the RAYMAX and RAYLUX achieve 10 years operational life and, in their largest variations, consume only 80W.

The previous table shows the operational costs of using one LED illuminator. Consider the cost savings on larger systems:

		OPERATIONAL COST PER YEAR			
		Mains Driven Bulb	Low Voltage Halogen Bulb	LED RAYMAX & RAYLUX	RAYLED Saving
10 units	GBP	£3,860	£1,940	£180	£3,680
	USD	($6,920)	($3,650)	($330)	($6,590)
50 units	GBP	£19,300	£9,700	£900	£18,400
	USD	($34,600)	($18,250)	($1,650)	($32,950)
100 units	GBP	£38,600	£19,400	£1,800	£36,800
	USD	($69,200)	($36,500)	($3,300)	($65,900)

IMPORTANT: On a 100 unit system using the most efficient LED's will provide a yearly saving of up to £36,800. Over the 10 year operational life of a CCTV system this is a total saving of up to £368,000! Also consider the labour intensity. A mains driven bulb system would require 2,400 replacement bulbs over a 10 year period.

COST SAVINGS POSSIBLE BY SWITCHING TO RAYLED ILLUMINATORS

- Potential saving on 1 illuminator of £368 ($659) per year
- Over ten years this is a potential saving of £3,680 ($6,590) for 1 illuminator
- Potential saving on 100 illuminators of £36,800 ($65,900) per year
- Over ten years this is a potential saving of £368,000 ($659,000) for 100 illuminators

Remember: LED's also provide increased site security!

TECHNICAL TIP

The larger a CCTV system becomes, the more important it is to use LED illuminators as the costs savings are multiplied. The zero maintenance of LED's is another major benefit on large systems.

EVENT DRIVEN LIGHTING

To further reduce electrical consumption of CCTV lighting installers can consider operating the illumination via either telemetry or PIR event driven alarms. Using event triggered illumination reduces consumption and extends product life. With visible White-Light systems it also helps reduce light pollution.

Whilst Event Driven activation is suitable for LED illumination, it is not always suitable for bulb based CCTV lighting. Turning bulbs on/off regularly puts great pressure on the bulb and will further reduce operational life. In addition, event driven illumination is particularly unsuitable for Metal Halide due to the warm up (or strike rate) of the bulb. Providing the lighting is visible, event triggered illumination can pro-actively deter the intruder and prevent a crime from taking place. This is particularly useful with White-Light illumination.

TECHNICAL TIP

LEDs are quick start and don't require a warm up period making them perfect for event driven lighting.

The Need for Even Illumination

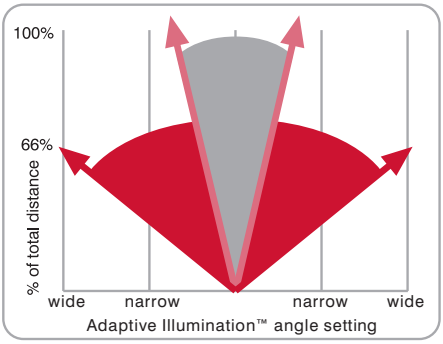
The most important aspect in designing any lighting system is achieving even illumination. All image capture devices, from the human eye, to the CCTV camera and lens, struggle to handle dramatic differences in light intensity within the field of view. Consider driving a car at night: You can see clearly when you are travelling on an empty road using only the headlights from your car. However, when a car approaches from the opposing direction your vision suffers. Why? Although the light on scene has actually increased, there is now a very strong peak light (from the oncoming car) and so the iris in your eye closes affecting your night vision. The same thing happens with CCTV cameras – bright spots within the image cause the lens to close and damage the night-time performance of the system.

To achieve the best CCTV images at night, even illumination is needed. This is achieved by using even illumination CCTV lighting products provided by some manufacturers. Rayled provide even illumination as standard.

Adaptive Illumination

Designed for RAYMAX Infra-Red and RAYLUX White-Light illuminators, Adaptive Illumination™ allows the installer to adjust the light projection from a single unit to fit the specific demands of any installation. Adjustment is quick and convenient and any light angle is easily selectable. Adaptive Illumination™ is patent pending technology available exclusively from Rayled.

Adaptive Illumination helps to provide evenly distributed light. Standard fixed illuminators provide a peak light source at the centre of the image and the light intensity tails off to the left and the right of the centre as the light has to travel further to the target and back. Adaptive Illumination minimises lighting variances in the scene by removing the central peak of light and moving the peak light points towards the outside of the image (areas where the light needs to be more intense as the light travels further to the target and back to the camera).



A Diagram showing the range of an Adaptive Illumination product

Light Pollution and CCTV

Light pollution is a global problem caused by inefficient, intrusive and unnecessary use of artificial light. Symptoms include glare, clutter, overillumination and sky glow. Light pollution is an increasingly hot political topic given recent government legislation to control and punish light pollution. It is the responsibility of CCTV professionals to provide lighting systems that provide high quality images and minimise light pollution.

TECHNICAL TIP

As it is invisible to the human eye, Infra-Red does not create any light pollution

The Categories of Light Pollution:

LIGHT TRESPASS - When light enters a zone or area where it is unwanted it is known as light trespass. This includes light leaking through a window, or into a neighbouring area. CCTV lighting must be designed to respect privacy zones.

GLARE - The result of a great contrast between the light and dark areas within an image. In CCTV glare can be a problem when a camera is looking directly into a light source such as a street light.

CLUTTER - Dense groups of lights cause an intense clutter of illumination that can actively grab attention and distract from the true target of a human eye either directly, or through a camera system.

OVERILLUMINATION - If light is used in excess quantities it causes illumination beyond what is necessary. It is normally caused by poor specification and contributes to energy wastage and overexposure in areas of the image.

SKY GLOW - The general glow over populated areas is known as sky glow. It is caused by a combination of badly directed light and light reflected from target subjects. Sky glow reduces contrast in the sky enough to obscure the stars at night.

TECHNICAL TIP

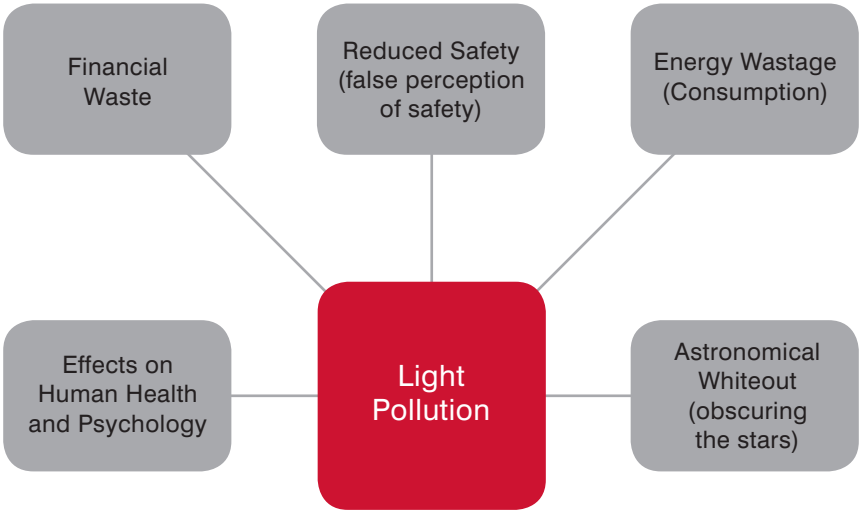
Adaptive Illumination means that the installer can exactly match lighting to the required field of view eliminating light trespass.

Consequences of Light Pollution

There are a number of problems associated with light pollution. In particular, the excessive use of light in CCTV systems may actually reduce safety and security rather than increase it. Badly or inappropriately installed lighting can lead to larger contrasts within the scene thus creating lower quality images, or create deeper shadows where undesirables can hide undetected. In addition, whilst excess lighting may actually be detracting from the CCTV image, it often provides pedestrians with a false impression of safety.

Given recent legislation covering light pollution, creating unnecessary light pollution now carries the threat of legal action.

Installers should be aware that professional CCTV lighting should be well specified, well designed and well directed. The beam should be pointed down to minimise light spill. Extra care should be taken with White-Light to ensure that only the target area is illuminated.



TECHNICAL TIP

Infra-Red causes zero light pollution. With white-light use event activated lighting and highly directional lighting tailored to the target area to minimize light pollution.

Regulations Concerning Light Pollution

The Clean Neighbourhoods and Environment Act is designed to improve the quality of the local environment. It gives Local Authorities additional powers to deal with statutory nuisances including light pollution. The Act does not preclude the use of white light illumination for CCTV, but it does state that the lighting should not cause a nuisance: The key term is “prejudicial to health or a nuisance”. As a result installers need to install lighting that has greater consideration to the surrounding environment. Correctly specifying the angle of illumination (or using Adaptive Illumination), to match the lighting to the target area or operating the light only upon an event trigger are all good practice.

All Rayled Illuminators provide highly directional lighting to minimise light pollution. In addition, Rayled’s Infra-Red lighting units cause NO light pollution.

BS8418 - The British Standard, BS8418 states there should be sufficient lights on site to illuminate the camera’s field of view making lighting an integral part of any CCTV system. However, it also states that cameras should not look directly into the sun or other light sources highlighting the need for dedicated CCTV lighting rather than relying upon existing lighting for CCTV.

DATA PROTECTION ACT - There are requirements that all CCTV systems should have appropriate, sufficient lighting to ensure 24/7 operation. The Data Protection Act promotes the use of professional CCTV lighting.

Specifying the Correct Camera

SENSITIVITY - This describes a CCTV camera's sensitivity to light and essentially measures the minimum light level needed to produce acceptable CCTV images. The danger here is specmanship from manufacturers. One image may be acceptable to one person and totally unacceptable to another.

Sensitivity is typically measured in LUX, with camera manufacturers stating the minimum LUX level needed to provide acceptable pictures. However, the camera manufacturers rarely state if the minimum LUX figure represents the minimum light on scene, at the lens, or at the camera chip.

Although LUX claims tend to be overstated, and although minimum LUX only describes a cameras performance with visible light, minimum LUX is still the only easily available measure of a camera's sensitivity.

TECHNICAL TIP 1

There is no such thing as a zero LUX camera – every camera needs light to produce a high quality images. Even the best, most sensitive cameras, produce higher signal, lower noise pictures with higher light levels.

TECHNICAL TIP 2

Monochrome cameras are generally more sensitive than colour cameras. With colour cameras 1/3 of the chip collects red light, 1/3 of the chip collects green light and 1/3 of the chip collects blue light and these images are overlapped. The result is that only 1/3 of the available chip size is capturing each type of light. With a monochrome camera the full sensor captures the light.

SPECTRAL RESPONSE - Whilst sensitivity relates to a cameras ability to see a given wavelength, spectral response describes how a camera performs over a range of different wavelengths of light. Of particular interest to CCTV lighting is a camera's performance in Infra-Red. By nature CCD cameras are more sensitive to Infra-Red light than the human eye but some are more sensitive than others. Consider the following example:

Camera 1: Provides 100% of its peak performance at 500-600nm, whilst at 700nm reducing to 70% and at 850nm 20%.

Camera 2: Provides 100% of its peak performance at 500-600nm whilst at 700nm this reduces to 90% and at 850nm 60%

Camera 2 has three times the relative sensitivity to 850nm IR light.

Camera 1 would need three times the amount of Infra-Red light on scene.

Specifying the Correct Lens

F-STOP / APERTURE - The aperture or f-stop of a lens determines how much light passes through it to the camera chip. In simple terms, the lower the f-stop, the more light the lens passes (although the quality and manufacture of the lens also effect the light through-put). The table below shows the impact of using different aperture lenses in a CCTV system:

f/Number	Light passed in %	Amount of light needed to achieve 1 lux at sensor
f/1 •	20%	5 lux
f/1.2	15%	7.5 lux
f/1.4 •	10%	10 lux
f/1.6	7.5%	13.3 lux
f/1.8	6.25%	16 lux
f/2 •	5%	20 lux
f/2.4	3.75%	30 lux
f/2.8 •	2.5%	40 lux
f/4 •	1.25%	80 lux

• = a full f-stop

TECHNICAL TIP 1

The lower the F-Stop of a lens, the more light it will pass to the camera sensor.

TECHNICAL TIP 1

With a zoom lens the best f-number is only achievable at the wide setting. As the lens is zoomed the aperture closes and this effects how much light is needed on scene to produce good images at low light levels.

TRANSMISSION - The efficiency of a lens is measured by its transmission. As light passes through the lens some level of light is lost as a result of its material, thickness and coating characteristics. Lenses with higher efficiency pass a higher percentage of the light. Whilst the f-stop of a lens describes how much light the lens will pass it is not a measure of its overall efficiency.

TECHNICAL TIP

The transmission of a lens changes with wavelength. For example, one lens may pass 95% of visible light and 80% at 850nm Infra-Red whilst another lens may pass 95% of visible light and 50% at 850nm Infra-Red. In specifying the lens, consider the wavelength of light it will be used with. Also be aware that glass lenses tend to be more efficient than plastic lenses.

Specialist Lenses

ASPHERICAL LENSES - Aspherical lenses provide superior low light performance as they use more of the available light. Whilst standard lenses can lose some light at the edges of the lens, aspherical lenses have a specialist front profile to catch all the light available. Low light applications can benefit from the use of an aspherical lens.

TECHNICAL TIP

Aspherical lenses provide improved low light performance.

IR CORRECTED LENSES - IR corrected lenses are designed to remove the issue of focus shift between day and night using specialist glass and coating technology to minimise light dispersion. Focus shift is caused by the different wavelengths of light. Each individual wavelength focuses at different points after passing through the CCTV lens.

COLOUR CORRECTED LENSES - Light sources, including the sun, produce a broad spectrum of lighting. White-Light as we know it, is simply the range of the lighting spectrum visible to humans. As a result, lenses have to control what lighting is passed through to the camera to create an image accurate to the images perceived by humans. Many low cost lenses do not efficiently match their colour pass with the visible spectrum so they provide inaccurate colour images. Colour Corrected lenses pass only visible light and focus each individual colour of the visible spectrum at the same point providing true colour, sharp images.

TECHNICAL TIP

Colour corrected lenses are not suitable for use with Infra-Red.

Filters

In CCTV a number of different filters are used to control and alter lighting. Typical filers include:

NEUTRAL DENSITY (ND) FILTER - ND filters are used to reduce light intensity by reflecting or absorbing a percentage of the light. They are rated by their optical density which refers to how much light they absorb. In CCTV ND filters are used to reduce the intensity of daylight, allowing the CCTV camera to be set-up for darker conditions: It is good practise to calibrate cameras during the darkest possible conditions so that when the aperture closes during peak light conditions the scene remains in focus due to an extended depth of field.

LONGPASS FILTER - Longpass filters block shorter wavelengths and transmit longer wavelengths. They are described by the wavelength at which they pass 50% of the light and are frequently used for bulb based Infra-Red systems. For example, a 715nm bulb based Infra-Red product will use a 715nm longpass filter to cut off light below 715nm and pass light above 715nm. At 715nm it will pass 50% of the light.

Longpass filers are inefficient in that they 'cut' much of the available power from a source. A typical Halogen bulb emits light from the visible spectrum through to Infra-Red. However, when it is used with a 715nm filter to convert it to an Infra-Red projector it simply cuts its power in the visible light range. These filters are easily broken and are expensive to replace.

SHORTPASS FILTER - A shortpass filter is the opposite of a longpass filter in that it passes light in the shorter wavelengths and rejects longer wavelengths. It is not widely used in CCTV.

IR CUT FILTER - These filters are designed to block Infra-Red wavelengths but pass visible light. They are commonly used by CCTV cameras to provide a colour image that more accurately reflects what the human eye sees by blocking Infra-Red light that the camera can see but the human eye cannot. For night time operation with Infra-Red the IR Cut filter must be removed.

TECHNICAL TIP

Use day/night cameras which mechanically remove IR cut filters for night-time operation.

POLARISED FILTER - Polarised filters are used in CCTV to reduce light from reflections. In particular they are useful to reduce reflected light from standing water or windows. Their overall effect is to darken the scene.

TECHNICAL TIP

LED's do not require filters to produce the correct wavelength of light and are therefore more efficient and cost effective

How to Specify Lighting:

1) INFRA-RED OR WHITE-LIGHT?

Identifying the purpose of the system identifies the type of light to use.

Infra-Red light provides greater distance, a varying degree of invisibility (depending on the exact wavelength) and no light pollution. Infra-Red is light designed only to be used by CCTV cameras.

White-Light provides the opportunity to illuminate an area for pedestrians, staff or vehicles in addition to the CCTV system. It can also be used as a visual deterrent when turned on if an intruder is detected by a PIR.

	Advantages	Disadvantages	Camera Type Suitable
White-Light	Visible deterrent	Light pollution	Colour
	Quick Start (LED only)	Reduced distances	B/W
	Full colour rendition		
	Easy set up		
Infra-Red	Covert	Limited deterrent	Day/Night
	Longer distances	More difficult to set up	Monochrome
	No light pollution		

2) ANGLE?

The illumination should ideally match the angle the camera / lens is set-to in order to provide best performance. If not, and too narrow an illumination angle is chosen, the camera will simply see a bright spot in the middle of the scene and the contrast between light and dark areas on scene will be too great to provide high quality images. Illumination which is too wide wastes energy and reduces achievable distance.

The table below shows the FOV angle for different fixed lenses as a reference.

FIXED LENSES

Lens (mm)	Horizontal FOV - 1/3" CCD	Horizontal FOV - 1/2" CCD	RAYMAX Infra-Red	RAYLUX White-Light
Dome Lens	-	-	RMxxx-AI-120	RLxxx-AI-120
2.8	92°	97°	RMxxx-AI-50	RLxxx-AI-50
4	64°	78°	RMxxx-AI-50	RLxxx-AI-50
6	44°	56°	RMxxx-AI-30	RLxxx-AI-30
8	38°	44°	RMxxx-AI-30	RLxxx-AI-30
12.5	22°	29°	RMxxx-AI-30	RLxxx-AI-30
16	17°	23°	RMxxx-AI-30	RLxxx-AI-30
25	11°	15°	RMxxx-AI-30	RLxxx-AI-30
50	6°	7°	RMxxx-AI-10	RLxxx-AI-10
50+	-	-	RMxxx-AI-10	RLxxx-AI-10

NB: AI-10=10-20°, AI-30=30-60°, AI-50=50-100°, AI-120=120-180°

TECHNICAL ISSUE

The adoption of vari-focal lenses has caused difficulty in specifying lighting. With vari-focal lenses the exact FOV is often only established on site through trial and error making exact matching to fixed angle lighting impossible in advance. Rayled provide a range of Adaptive Illumination™ vari-focal lighting allowing the output angle of an illuminator to be adjusted on site to match the set-up of a vari-focal lens.

VARI-FOCAL LENSES

Lens (mm)	Horizontal FOV - 1/3" CCD	Horizontal FOV - 1/2" CCD
Dome Lens	-	-
2.8 – 6	92° - 44°	-
3.5 – 8	78° - 38°	-
3.5 - 10.5	78° - 27°	-
4.5 – 12.5	60° - 23°	82° - 30°
7.5 - 120	-	35° - 2°
8.5 - 40	34° - 6°	-
10 - 30	20° - 7°	27° - 9°
Long Range Zoom	-	-

RAYMAX Infra-Red	RAYLUX White-Light
RMxxx-AI-120	RLxxx-AI-120
RMxxx-AI-50	RLxxx-AI-50
RMxxx-AI-50	RLxxx-AI-50
RMxxx-AI-50	RLxxx-AI-50
RMxxx-AI-50	RLxxx-AI-50
RMxxx-AI-30	RLxxx-AI-30
RMxxx-AI-30	RLxxx-AI-30
RMxxx-AI-30	RLxxx-AI-30
RMxxx-AI-10	RLxxx-AI-10

NB: AI-10=10-20°, AI-30=30-60°, AI-50=50-100°, AI-120=120-180°

3) DISTANCE?

After selecting the angle, the next consideration is distance. How far should the lighting illuminate? Installers and specifiers should be aware that as angle increases, distance decreases. As a guide, Rayled products can achieve the following distances:

Ultimate Adaptive Illumination	Wavelength	Illumination Angle 5-15°	10-30°	30-90°	50-180°
RM300	IR	***	370m (1,214ft)	200m (656ft)	140m (459ft)
RM150	IR	n/a	183m (600ft)	100m (328ft)	70m (230ft)
RL300	WHITE-LIGHT	n/a	240m (787ft)	130m (427ft)	90m (295ft)
RL150	WHITE-LIGHT	n/a	150m (492ft)	80m (262ft)	55m (180ft)

Adaptive Illumination	Wavelength	Illumination Angle 10-20°	30-60°	50-100°	120-180°
RM200	IR	300m (985ft)	160m (525ft)	112m (367ft)	64m (210ft)
RM100	IR	150m (492ft)	80m (262ft)	56m (184ft)	32m (105ft)
RM50	IR	75m (246ft)	40m (131ft)	28m (92ft)	16m (52ft)
RM25*	IR	n/a	20m (66ft)	14m (46ft)	8m (26ft)
RL200	WHITE-LIGHT	200m (656ft)	105m (344ft)	80m (262ft)	30m (98ft)
RL100	WHITE-LIGHT	120m (394ft)	65m (213ft)	45m (148ft)	18m (59ft)
RL50	WHITE-LIGHT	60m (197ft)	40m (131ft)	28m (92ft)	12m (39ft)
RL25*	WHITE-LIGHT	n/a	20m (66ft)	14m (46ft)	8m (26ft)

*Fixed angles of 30°, 50° and 120° only *** Consult with Rayled
RAYMAX Platinum versions are also available which achieve distances of up to 701m.

Note: These are maximum achievable distances and are subject to camera & lens performance. For medium performance cameras reduce distance by at least 30%. For low performance cameras distances can be reduced by at least 50%

4) CAMERA AND LENS CONSIDERATIONS

Exact performance of any illuminator in a CCTV system is dependant upon the camera and lens combination used. For best results a high sensitivity camera (for IR projects an IR sensitive camera) should be used with a high transmission lens. Generally a CCTV imaging system (camera, lens, illumination) is only as good as its weakest link.

Practical Installation Considerations

LIGHTING AND DOMES - Providing lighting for domes has long been a challenge for CCTV professionals as the lighting cannot be fitted to move with the camera as would be the case with a traditional PTZ system. However, there are three lighting solutions available for fully functional domes:

1. *Wide angle illumination:* New wide angle illuminators covering 120-180° allow the full 360° angle of a dome to be covered with only 2 illuminators.

2. *Target Area Illumination:* Illuminators can be used to target specific points of interest including gates and entry points on pre-set positions.

3. *Local Area Illumination:* Illumination can be fitted away from the camera to flood the scene. When the camera zooms in the whole area will be lit.

(See full article on Lighting for domes on page 40.)

LIGHTING AND PTZ SYSTEMS - Typically PTZ systems are used in applications where a single camera is designated to secure a large area. At long distances the camera lens is often zoomed in giving a narrow field of view and at short distances the camera lens pans to a wide angle. The flexibility of such a system requires the lighting to cover long distances and narrow and wide angles.

The solution is to use a twin lighting system. The old fashioned method was to use 1 narrow and 1 wide angle illuminator. The better solution is to provide even illumination. Both illuminators should be attached to the PT motor by a bracket.

A second solution for shorter range PTZ units is to use a single wider angle illuminator such as a 30° - 60° model. If the required distance is not too great a wide angle illuminator may be able to cover the maximum distance as well as the wide angle.

INFRA-RED AND FOCUS SHIFT - Focus shift is a potential issue encountered when setting up camera systems for 24-hour performance using Infra-Red. The different wavelengths of visible light (400-700nm) and Infra-Red (700-1,000nm) create different focus points through the lens onto the camera chip. This can lead to a loss of image focus at night, particularly if the camera is set up during daytime operation. The degree of focus shift depends on a variety of factors:

- Lens quality
- Wavelength of the IR. Longer wavelengths such as 950nm will provide a more exaggerated focus shift.
- IR response of the camera

Focusing the camera correctly for low light performance means the camera will be focussed for IR with the aperture fully open. During daytime operation the increased depth of field created by a closing aperture will counter the effects of focus shift. The best solution is to focus the camera using only Infra-Red. This can be achieved by:

- Setting up the camera at night using Infra-Red lighting
- Using an IR pass filter over the camera lens to simulate

TECHNICAL TIP

Some lens manufacturers now provide lenses which overcome all issues of focus shift.

BACK FOCUSING - Back Focus describes the relationship between the distance of the lens to the camera chip. This distance is critical to maintaining the proper depth of field through changing focal lengths and varying light conditions and setting it correctly can ensure the image stays in focus 24 hours a day. Correct back focus of the camera can be used to overcome the typical issue of a sharp daytime image followed by a blurred image at night. This situation is caused when, during bright sunlight, the lens is closed and the depth of field is very wide, whereas when the light level drops the iris opens and the depth of field decreases causing a lack of focus. For correct 24-hour focusing a camera should be back focused with the lens iris fully opened to simulate the worst possible depth of field.

Neutral Density filters can be used to cover the lens during back focusing to simulate lower light intensity on scene. This is an effective solution for colour cameras or cameras using White-Light CCTV illumination. However, for mono cameras, or day-night cameras using Infra-Red lighting, the best solution is to place an Infra-Red Pass filter over the lens.

HIGH SENSITIVITY CAMERAS AND LIGHTING - All cameras require light, sensitivity is simply a measure of how much light they need. High sensitivity cameras require less lighting to produce high quality CCTV images. However, even high sensitivity cameras should be fitted with professional CCTV lighting to provide even illumination. This allows the camera to provide sharp, clear images. Don't compromise the performance of a CCTV system

by removing lighting when high sensitivity cameras are used: Why pay for premium performance cameras if they are not set-up with lighting to provide premium images?

TECHNICAL TIP

High sensitivity cameras can achieve longer distances with CCTV lighting than standard cameras. They achieve lower noise, higher definition images.

MEGAPIXEL CAMERAS AND LIGHTING - Digital cameras record brightness on a per-pixel basis so the greater the amount of pixels the smaller surface area each pixel has available to capture light. The end result is that the greater the resolution the less sensitive the camera.

A megapixel constitutes 1,000,000 individual pixels and Megapixel cameras offer a number of advantages to installers including higher resolution, wider angle images, and the ability to digitally zoom images. However, they are by nature less sensitive than standard CCD cameras meaning they require additional lighting to achieve high quality images at night.

With Megapixel cameras ALWAYS use additional CCTV lighting to achieve high quality night-time images. Megapixel cameras only deliver their advantages when viewing a correctly illuminated scene.

TECHNICAL TIP

High Definition lighting is available for magapixel cameras.

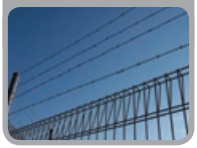
CAMERA INTEGRATION VS CCTV LIGHTING - A common tactic used to achieve visible images during low light conditions is to use frame integration on the camera. Frame integration overlaps fields of image to “multiply up” the available lighting. For example, x2 integration overlaps 2 frames of video while x10 integration overlaps 10 frames of video. This allows the camera to collect light over a much longer time period giving brighter images. However, as frame integration overlaps images to multiply lighting, movement in the scene causes blurred images. Frame integration also multiplies noise in the same way as it multiplies light.

TECHNICAL TIP

Integration can provide acceptable images in static scenes but provides blurred images when movement occurs. During “events” this leaves the camera unable to capture high definition images of the target. The best solution is to provide the camera with dedicated CCTV lighting to provide the best quality images.

INFRA-RED REFLECTIVITY - Crucially, different materials reflect IR to different levels. Infra-Red light inverts the colour of man made fibres. Foliage and man made fibres emit high levels of Infra-Red properties providing very clear, bright images when used with IR.

Typical Installations + Practical Guidelines

Application	White-Light	Infra-Red	Practical Installation Tips
PRISONS 	☀	☾	Long range IR looking along the perimeter for covert security or WL positioned at the perimeter looking inwards to both secure the perimeter and monitor the in-mate area.
MILITARY BASE 		☾	Perimeter positioned long range IR overlapping each camera position for maximum security. Use LED's to ensure there is never a failure with the lighting and the site is always secure.
RAILWAY LINES 		☾	Railway authorities require totally covert 950nm IR so the security lighting is not mistaken for signal lights. Use LED's as camera positions can be remote making maintenance of bulbs difficult.
PORTS 	☀	☾	IR lighting for longer distances looking out to sea or WL to monitor the coast line. Looking over water the image will be dark until something appears in scene providing a reflection point.
ANPR 		☾	Discreet IR must be used so the lighting does not distract the driver, either 850 or 950nm. Pulsed IR can provide higher power outputs – suitable when faster shutter speeds are used on the camera.
METRO SYSTEM 		☾	950nm IR can be used to cover the train tracks as with railway applications. Additionally IR can be used to ensure escape hatches are clear and secure.

DOME SYSTEM

WL or IR can be used with dome systems. The key is to use very wide angle illumination such as a 120-180 degree illuminator to cover the domes full field of view using the fewest possible lights.

INDUSTRIAL PARK

The perimeter of buildings can be secured 24 hours a day, without causing light pollution by using IR. Additionally, number plate capture cameras can be used to secure in / out roads.

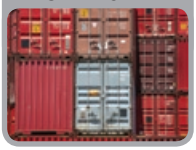
GRAFFITI

Use WL triggered by a PIR to visibly deter and disperse intruders when they enter a secure area by raising the light level as a visible warning they are being monitored. Alternatively intruders can be monitored covertly with IR.

DUMPING

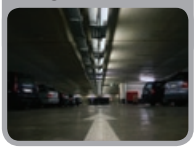
Dumping and fly-tipping generally occur under the cover of darkness. Using WL to illuminate poorly lit areas or PIR triggered WL will disperse intruders who know they are being watched. Alternatively intruders can be monitored covertly with IR.

HOLDING BAY



Use WL for multi-purpose applications such as holding bays. WL provides lighting to secure the goods in the holding area and provide ambient lighting for staff and vehicles.

CAR PARK



Either WL or IR can be used depending upon the desired purpose. WL can illuminate a car park for staff and secure vehicles. IR can monitor the car park and perimeter of a building at night.

HIGH END RESIDENTIAL

White-Light can provide illumination for residents as well as the CCTV system. Alternatively Infra-Red can be used to maintain the ambience at night-time and avoid any light pollution

Case Study: Lighting for Domes

Most crimes happen at night, yet this is when CCTV systems are most vulnerable. Research indicates that fully functional Domes are most at risk because of a lack of 'fit for purpose, dedicated lighting'. Providing Illumination for domes is a challenge because the light does not follow the movement of the camera.

WHY IS LIGHTING A PROBLEM FOR FULLY FUNCTIONAL DOMES? - There are two main issues to consider when providing lighting for Domes.

Firstly, fitting illumination to a Dome camera is more difficult than fitting illumination to a pan and tilt system. Dome lighting cannot be fitted to follow the movement of the camera. Consequently, many installations simply omit the use of dedicated lighting, or pass the responsibility (and of course the revenue) to the electrician to fit general wide area illumination which is not fit for purpose.

TECHNICAL TIP

Rayled provide bracketry solutions to allow CCTV lighting to be fitted to dome cameras.

The net result is that the night-time performance of dome cameras is compromised by a lack of dedicated CCTV lighting. Often the end user is simply asked to accept the quality of night-time pictures provided by ambient light sources such as street lighting. The need for dedicated CCTV lighting is clear. Ambient lighting can actually reduce the picture quality of many systems by producing uneven illumination, bad colour rendition and "hot spots" within the image. Of course, this is hardly surprising given that street lighting and other on scene sources are not designed for the CCTV camera. The extra investment in CCTV lighting can double the effectiveness of a Dome system, providing high quality images 24/7, not just during daylight conditions.

The second problem with Dome cameras is their sensitivity. Dome cameras tend to use smaller CCD's, and are often fitted with smoked domes, leading to lower performance in low light conditions. Fully functional Domes are also frequently supplied with integral zoom lenses that have a higher F-stop and further reduce light transmission. They are not as efficient as full format lenses. This makes it even more important for dome cameras to be accompanied with high performance, dedicated CCTV lighting.

GENERAL CONSIDERATIONS

COLOUR OR MONOCHROME? Are colour or monochrome images preferred at night? In many instances the end user would prefer colour images but care must be given to provide true colour with a colour corrected illuminator. For example, many installers will be familiar with the yellow light provided by low pressure sodium street lighting. Using incorrect White-Light can actually damage the performance of a CCTV system leading to inaccurate colour rendition – a camera is only as good the available illumination.

Infra-Red should be used where White-Light would be too intrusive, where covert lighting is needed, or where longer illumination distances are required. Of course, many cameras now switch between colour during the day and mono for night time operation to give the best of both worlds.

TECHNICAL TIP

White-Light is actually a combination of lights in the visible spectrum between 400-700nm. When these colours are found together they are perceived as White-Light. Infra-Red is a light just beyond the visible spectrum that the monochrome camera can see but the human eye cannot. It is typically 700-1,000nm.

Raylux - White-Light

Rayled provide a full range of Infra-Red and White-Light illuminators for use with any CCTV camera.

Raymax - Infra-Red

MAINTENANCE AND RUNNING COSTS - CCTV Lighting should always be energy efficient and provide low maintenance. With traditional bulb based lighting, operational costs significantly overshadow the cost of purchase and installation. Consider a 500W flood light that achieves an average bulb life of 3 months. The electrical costs are astronomical and every three months there are additional costs for labour and replacement bulbs, plus system performance is compromised during maintenance.

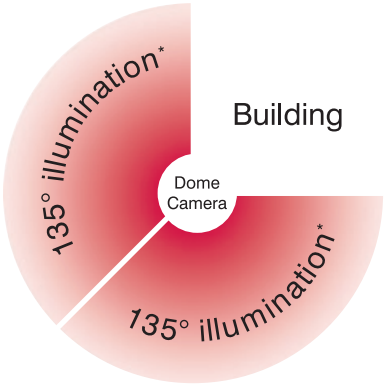
New solid state LED technology available offers significant savings on running and maintenance costs. LED illuminators have a life expectancy beyond 10 years and require no ongoing maintenance. However, not all LED illuminators are created equal. New surface mount technology (SMT) LED's deliver greater product life and greater efficiency levels.

THE SOLUTIONS

1: WIDE ANGLE LIGHTING - Achieving 360° degree lighting for Domes has traditionally been very expensive, requiring multiple illuminators. However, Rayled have recently launched a series of wide angle illuminators purpose designed for fully functional Domes. The new wide angle illuminators are available in RAYMAX (Infra-Red) and RAYLUX (White-Light) variations and are fitted with Adaptive Illumination™ providing vari-focal lighting. Adaptive Illumination™ is a new concept introduced and patented by Rayled allowing the installer to adjust the horizontal beam angle on site to match the specific needs of the installation.

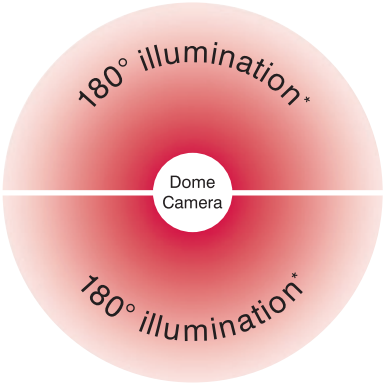
The specialist wide angle illuminators provide 120 to 180° degree illumination meaning it is now possible to illuminate up to 360 degrees at significantly less cost and with less installation effort than ever before using only 2 illuminators. Wide angle illumination is technically the best solution to Dome illumination providing purpose designed, even illumination fitted at the camera.

270° Illumination



*provided by 2 x 120-180° Adaptive Illumination™

360° Illumination



*provided by 2 x 120-180° Adaptive Illumination™

2: TARGET AREA ILLUMINATION - When a Dome is only concerned with specific security “hot-spots”, to limit light pollution, or to meet budgetary restraints, illumination can be targeted at specific vulnerable areas. Typically the Dome will track these areas on a pre-set tour and lighting can be used to illuminate each pre-set position such as an entrance point, or a very low lit area.

This method allows for greater distances to be covered with narrower angle illuminators. Using Adaptive Illumination™ the exact beam angle from the illuminator can be adjusted on site to suit each pre-set position.

3: LOCAL AREA ILLUMINATION - If lighting cannot be fitted at the dome then it can be positioned at sensitive areas to flood the area of concern. This is local area illumination and the critical factor is to ensure that, when the dome is zoomed into the scene, the full screen is well illuminated.

SUMMARY

Lighting is critical to the performance of every CCTV system, especially those using fully functional Domes. Recent developments in wide angle illuminators make 360° degree illumination a real possibility for the first time and installers also have the option of providing Target Area Illumination or Local Area Illumination where needed. Every dome camera now has the opportunity to be fitted with dedicated CCTV lighting to maximise performance.

Illumination Quality (IQ) Test:

Run through this quick 10 point check every time you specify or install a CCTV system:

1) Is Infra-Red or White-Light illumination required?

	Advantages	Disadvantages	Camera Type Suitable
White-Light	Visible deterrent	Light pollution	Colour
	Quick Start (LED only)	Reduced distances	B/W
	Full colour rendition		
	Easy set up		
Infra-Red	Covert	Limited deterrent	Day/Night
	Longer distances	More difficult to set up	Monochrome
	No light pollution		

2) Ensure the horizontal angle of illumination covers the full field of view? To provide high quality images it is essential. Simply match the illumination to the field of view of the camera/lens using a lens calculator (or see chart on pages 33-34.

TECHNICAL TIP

If the exact field of view is unknown Adaptive Illumination products can be used to provide vari-focal lighting.

3) What is the maximum distance to illuminate? Specify the illuminator model based on the illumination angle and distance required (see page 34).

4) If White-Light is needed, ensure that colour corrected White-Light is used. Check that red, green and blue colours can all be seen accurately during night-time operation.

5) If Infra-Red is needed specify the wavelength carefully. Lower wavelengths such as 850nm provide greater distances. Longer wavelengths such as 950nm provide covert illumination but achievable distances are reduced and there is an increased risk of focus shift between day and night.

6) Consider the maintenance and running costs of the illumination system. Ensure that long life, low consumption lighting is used.

7) Consider the positioning of the lighting. It should be fitted so that no camera is looking directly at a light source. The best solution is mounting the illumination at the camera position. Also consider any line of sight obstacles. As light travels in straight lines any obstacles such as overgrown foliage will create shadows.

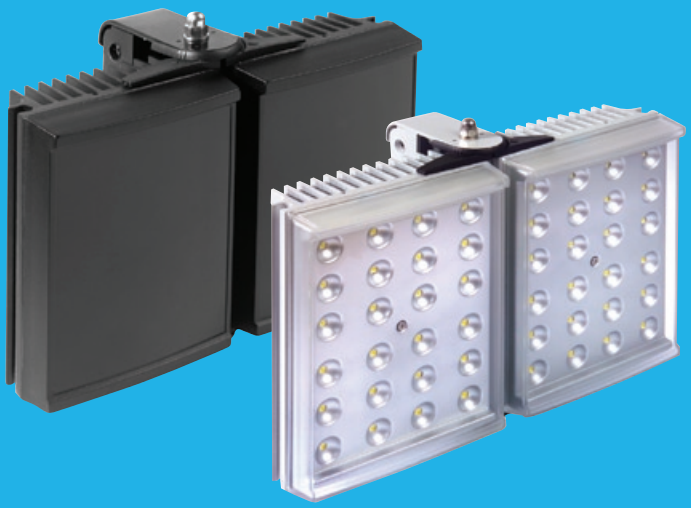
8) Consider the camera and lens. A high performance camera and lens will provide higher quality images with CCTV lighting. Lower performance camera and lens combinations will require additional lighting to provide similar results.

9) If the illumination is being used with a fully functional dome camera then a choice must be made between wide angle illumination, local area illumination or target area illumination. Wide angle illumination is preferential as it can provide 360° lighting for the dome.

10) Is light pollution a critical factor? Using White-Light ensure that the illuminators are pointing down to minimise light pollution. If no light pollution is permissible then Infra-Red lighting must be used.

TECHNICAL TIP

Even illumination – every CCTV lighting system should provide even illumination. This is the responsibility of the manufacturer and Rayled design every illuminator to have a highly even beam distribution. This aids the camera system in achieving higher quality images throughout the scene.



LOW ENERGY CCTV LIGHTING

Infra-Red • White-Light • Hybrid
10m–400m • 10°–180° • CCTV Lighting

ADAPTIVE ILLUMINATION™

COOL RUNNING™

SMT (SURFACE MOUNT TECHNOLOGY)

ENERGY SAVING

VANDAL RESISTANT