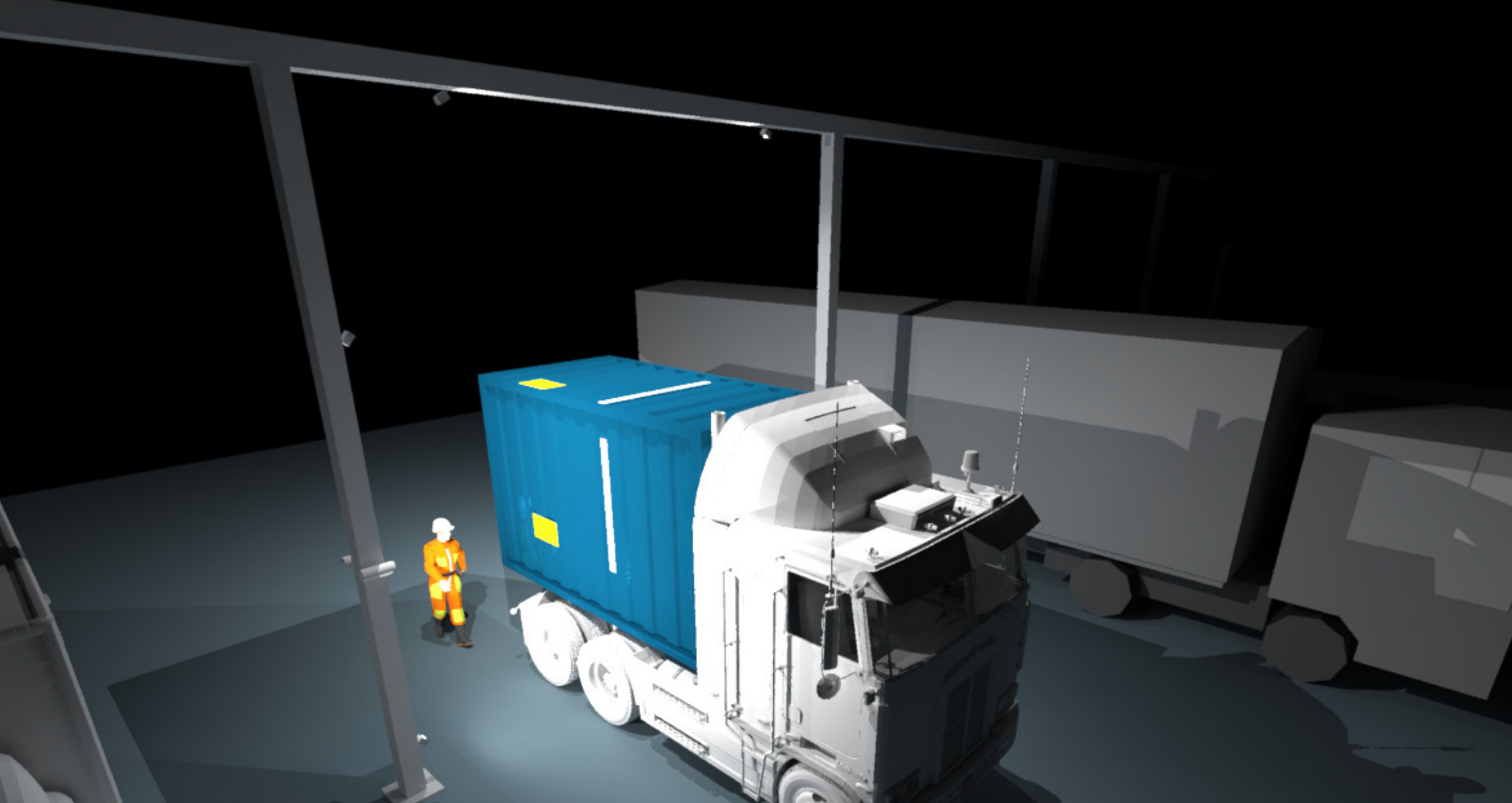




Application Focus: Lighting for Container Recognition Systems



Raytec is the world leader in LED lighting for safety and security. VARIO2 is our range of award-winning LED White-Light and Infra-Red illuminators designed to enhance the performance of any security system. PULSESTAR is our range of pulsed lighting solutions, designed specifically for transport systems or projects that involve fast-moving objects.

In this Application Focus, we explore the lighting requirements for a container recognition system (CRS), exploring some of the key elements to consider when specifying lighting for these applications.

What is a Container Recognition System?

Firstly, let's start by looking at what a container recognition system is and how they're used.

Container recognition uses an automated system that utilises intelligent image processing to identify, check, and store a series of numbers, letters or barcodes that normally appear on the top, or side, of a container. The system will then store the information and use it to direct operations on-site and control the movement of goods. Some systems also have additional uses, such as capturing the license plate of the vehicle carrying the container.

What Are the Systems Used For?

The end goal of the system is to be able to track and record the location of each and every container and avoid cargo becoming unaccounted for. There are two main uses for these systems:

Tracking the Movement of Goods

Similar to how you would track an online parcel, the journey of a container needs to be tracked, the convey vessel recorded, and the destination noted. This is where the container recognition system comes into play. To track the location of the container, it is important to know which convey vessel it is travelling on, and its destination. This mainly helps the storage logistics of the port.



Logistics and Storage Control

Sites such as freight centres and transshipment stations use container recognition systems to control when and where a container is stored. With sites often being extremely large, the system plays a critical role in ensuring the freight centre can operate efficiently.



While there are many elements to a successful CRS, dedicated high-quality illumination plays a vital role at the point where the container characters are captured for the system to process. It's this process of capturing the image which we will focus on for the remainder of this Application Focus

NOTE: The container number enables operators and shippers to identify and track equipment that is used in the movement of cargo.

Why is Lighting Needed for Container Recognition Systems?

We'll start by looking at why dedicated illumination is needed as part of a container recognition system.

24/7 Operation

Container recognition systems are often required to operate 24 hours a day, meaning ambient light alone is not sufficient to provide the camera with high-quality images day and night.

Weather Conditions

Poor, variable and changing weather conditions will significantly affect the quality of the image that a camera can obtain. With container recognition systems often deployed in coastal locations, this is a common challenge. To manage changes in light and weather, it may be necessary to set a higher f-stop on the camera (which reduces the amount of available light) to achieve the perfect set-up. Camera set-up is something we'll discuss in more detail later but ultimately is likely to mean more light is required to achieve high-quality images.

System Reliability

Lighting helps to ensure high-quality, consistent images of the information on the side or top of the container and is a vital cog in the reliability of the entire system.

OCR (optical character recognition) software is used to process the images and convert them into digitally encoded text which the system uses to coordinate operations. If the OCR software is unable to read the labels clearly, it may lead to;

- Incorrect data, producing errors within the system. This may result in containers becoming lost, or cause delays. This is likely to be detrimental to the operator both in terms of cost and reputation.
- Bottlenecks of vehicles passing through the system. This is likely to the flow of vehicles entering and exiting the entire site and could have a significant impact on the overall efficiency of the site.

Specifying Lighting for Container Recognition Systems

Wavelength

When specifying lighting for a CRS, one of the first considerations is the wavelength of light which will be most suitable for the system.

850nm Infra-Red

850nm Infra-Red (IR) is commonly used within container recognition applications. Cameras are most receptive to this wavelength of IR enabling them to support the best night-time images. IR is ideal for capturing the detail of a container number or barcode.

Being semi-covert, an 850nm illuminator gives off a slight red glow, but this is only visible up close, or when looking directly into the light, and generally is not a cause of concern when used for container recognition.

If the primary aim of the CRS is to capture the container number or barcode, we would always recommend the use of 850nm over other wavelengths. However, it's important to consider other lighting goals which the CRS may have.

NOTE: 940nm IR solutions also exist which are fully covert. However, unless this is a specific requirement we would always recommend 850nm to provide the best results. While 940nm delivers virtually invisible, covert lighting, it does result in reduced performance (typically up to 40% less) and requires a very sensitive camera.

White-Light

While 850nm IR may provide the best results for capturing the container number or barcode, many systems may have other lighting goals which require colour images to be captured which leads us to consider the use of White-Light.

Some container recognition systems are also used to identify damage to the container as they pass through. In these applications, the use of White-Light can provide a greater level of detail and increase the performance of the analytics software used to identify issues.

White-Light is highly visible to the human eye which may limit its suitability for certain applications (if it's felt that it could distract the driver). However, with container recognition systems usually deployed on private roads, away from the public highway, this is often less of a concern compared to traditional ANPR/LPR systems.

730nm

730nm, or Far Red, is less commonplace in container recognition but is an effective solution for an increasing number of systems which are also looking to illuminate inside the vehicle carrying the container.

730nm illumination provides the best results for seeing through a vehicle's windscreen and supports driver and passenger recognition which may be running in tandem with the container recognition system. This is a topic Raytec have covered extensively in the past; you can access our webinar below where we discuss some of the challenges and recommendations when trying to see through the windscreen.

[ACCESS THE WEBINAR](#)

With similar properties and performance to White-Light, 730nm illumination could also be used to illuminate the container. However, we'd only recommend the use of 730nm if there's a need for the illuminator to provide a dual use of container recognition and driver recognition.

Constant vs. Pulsed

In addition to different wavelengths, specifiers must also decide between using either constant or pulsed illumination when specifying lighting for a container recognition system.

Let's start by looking at the difference between the two.

Constant Illumination

This is when the light is switched on 100% of the time.

For transport applications, constant illumination is generally used when the vehicle is stationary or moving at lower speeds. While each application should be judged on an individual basis, it is less common for container recognition systems to encounter issues with motion blur, or other challenges associated with capturing images with higher-speed applications. The vehicle carrying the container is usually either stationary or travelling at low speeds. For this reason, constant light is often sufficient.

One of the benefits of using constant light is the easier set-up compared to pulsed. As the light is left on constantly, there will be no need to configure the illuminator to sync with the camera or other hardware.

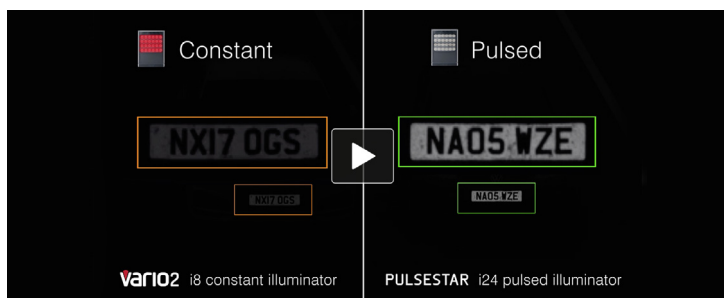
Pulsed Illumination

Pulsed (or strobe) illumination is used to provide on-demand lighting to accurately record images of fast-moving objects. A pulsed illuminator is designed to sync directly with the camera's shutter via a digital input.

Capturing high-quality images of fast-moving objects presents several challenges, particularly with motion blur. Increasing the shutter speed of the camera and reducing the aperture of the lens are examples of how users can overcome motion blur, however, this in turn will require significantly more light in order to achieve high-quality images.

Because the illuminator is synced with the camera's shutter, a pulsed illuminator will only be switched on for a fraction of the time compared to a constant light illuminator. This allows the power of the illuminator to be increased, without compromising reliability, and means that a higher quality image can be captured if the vehicle is moving at a faster speed.

While constant light is often adequate for the majority of container recognition applications, the increase in power that pulsed illumination provides can also help overcome issues such as challenging weather conditions and glare, and specifiers should consider the use of pulsed light if they are experiencing image quality issues with their existing set-up.



The image shows a side-by-side comparison of two video frames. The left frame, labeled 'Constant', shows a vehicle's numberplate 'NX17 OGS' with a white play button icon in the center. The right frame, labeled 'Pulsed', shows the same vehicle's numberplate 'NA05 WZE' with a green border around it. Below the left frame is the text 'VAR102 i8 constant illuminator' and below the right frame is 'PULSESTAR i24 pulsed illuminator'.

Watch our video where we compare Constant vs. Pulsed lighting on numberplate readability.

NOTE: The vehicles are moving at around 70mph

[CLICK TO WATCH >](#)

Other Considerations

Avoiding Overexposure

Many applications suffer from overexposure to the container number or barcode, and clients often come to Raytec looking for a solution.

Overexposure generally occurs when the camera and illuminator are too close to the object or area in question. This causes a white spot on the image which you can see in image 1.0; a large white spot is visible and the horizontal code is difficult to read.

This is a major issue for the OCR software used by container recognition systems. If the code is unclear, the system cannot work effectively and would likely lead to errors or inefficiencies which we discussed earlier.



Image 1.0

Where should you mount your illuminators and camera to avoid overexposure issues?

To correct this issue, a more even coverage of light is needed. We'd suggest exploring two options;

- Using two illuminators, but angling them away from each other, will allow you to target the whole coverage area.
- Using a more powerful illuminator with a wider beam angle to target the whole area and create picture uniformity.

Harsh Environments

Container storage sites are generally located in coastal areas that represent an unforgiving environment for electrical equipment, due to the saline atmosphere where corrosion can be a common occurrence.

High levels of wind and rain are commonplace, and while this poses a challenge to capturing high-quality images, specifiers should also check the environmental protection that the illuminator has to ensure it's suitable.

Raytec's VARIO2 Extreme illuminators are rated for use in the harshest environments and operating conditions. Environmentally rated to IP67, and IK09, with extreme salinity and humidity protection, VARIO2 Extreme is the perfect lighting solution for marine applications.

Control

Illuminators used as part of a container recognition system will often be integrated with other devices, such as cameras and sensors. It's important to consider how the illuminator can be controlled, and how it can communicate with the system's other devices.

In many container recognition systems, the lighting is only activated during vehicle passage, helping to create smart, situational dependant lighting, which is far more efficient. For this reason, specifying an illuminator that is IP enabled so it can be connected to other devices via an ethernet connection is always a good option. This will allow the illuminator to communicate with other devices on the network and means it can be controlled remotely in real time.

Testing

Characteristics of a good quality image for a container recognition system include sharpness, spatial resolution and high contrast of the characters, as well as good positioning and an optimal viewing angle. As well as specifying the best components, testing the final solution is extremely important.

While it may seem obvious, taking the time to test your setup is a critical part of achieving an effective system. With many variables, such as vehicles travelling at different speeds, and different types of containers, the more testing that can be done before full deployment the greater chance of achieving high-quality, reliable images.

Set-up

The set-up of a container recognition system is very much dependent on the application itself; no two applications are the same. However, the set-up of the lighting should be dictated by the principal areas;

- Gantry height
- Vehicle speed
- Direction of travel
- Camera positions

These factors determine where the lighting should be positioned.

Image 2.0 is a typical example of a container recognition lighting set-up, where both the side and the top of the container need to be read by the OCR software. In this scenario, the lighting has been mounted above the cameras to avoid direct reflection or glare of the container number. VARIO2 White-Light W2 units have been used with a 120°x50° angle to maximise the even spread of light across the container.

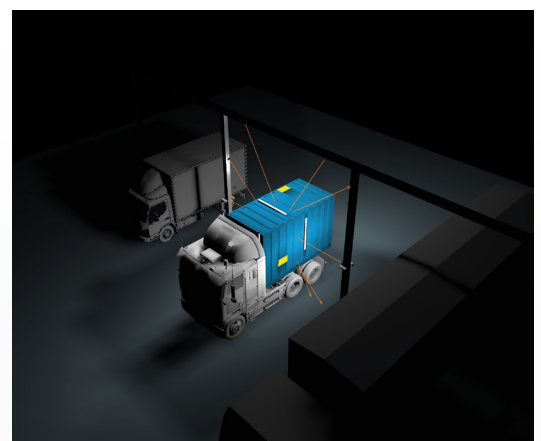
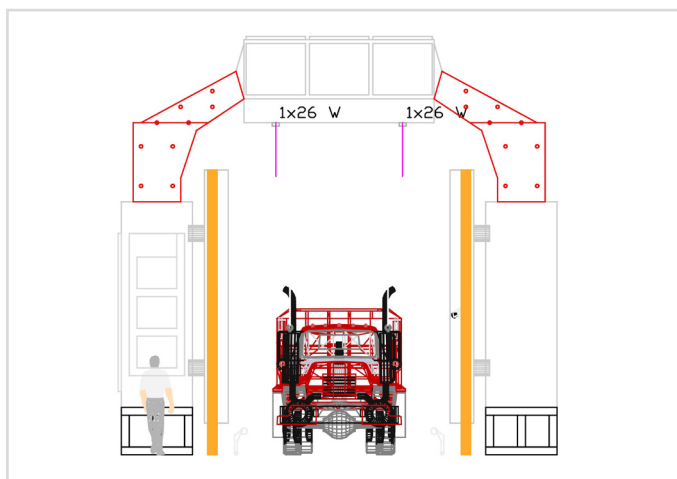


Image 2.0

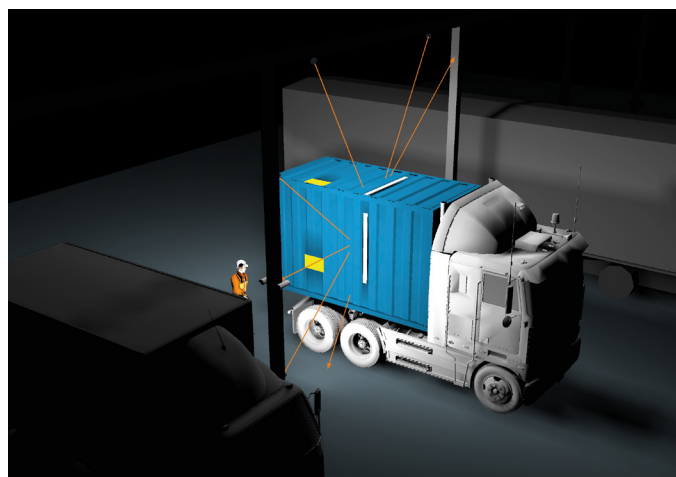
The Importance of Lighting Design

Lighting design should be considered an essential part of specifying lighting for a container recognition system. Undertaking a lighting design helps to ensure the correct light levels are achieved across the site and is essential for cameras to be able to capture high-quality images. It also provides specifiers with peace of mind and no surprises at the point of commissioning. As stated above, set-up is extremely project specific but, using lighting design will help make sure that all hardware is in the correct position and the correct results can be met.

For Infra-Red illumination, 2D design is used to plot the individual lamps onto the site plan and indicate the direction and spread of illumination. When White-Light is being deployed, a 3D design can also be used to provide the customer with a visual representation of the final appearance of the installed lighting solution.



2D



3D

Raytec offers a completely free lighting design service, providing you with a positional 2D or visual 3D representation of the final lighting solution, with detailed lux levels and a true indication of lighting performance. Our lighting design experts will guide you through the entire process, ensuring the optimum solution is achieved.

[CONTACT OUR LIGHTING DESIGN TEAM HERE](#)

How Raytec Can Help

Raytec has a full range of pulsed and constant light illuminators designed specifically for number and barcode recognition systems, as well as other ITS applications. PULSESTAR is our dedicated pulsed lighting range, available in White-Light and Infra-Red, as well as various power outputs to suit a wide range of projects. VARIO2 is our range of constant Infra-Red and White-Light lighting.

At Raytec, we love to talk lighting, and what's more, our people have many years of experience working with container recognition projects.

You can call us on **+44 (0) 1670 520 055**, or email Raytec Global at **sales@raytecltd.com** or Raytec Americas at **ussales@raytecltd.com**.