

# Rapiscan Eagle<sup>®</sup> C02 Occupied Vehicle Inspection System



[www.rapiscansystems.com](http://www.rapiscansystems.com) • [sales@rapiscansystems.com](mailto:sales@rapiscansystems.com)

**AMERICAS, CARIBBEAN**  
2805 Columbia Street  
Torrance, California 90503  
UNITED STATES of AMERICA  
Tel: +1 310-978-1457  
Fax: +1 310-349-2491

**EUROPE, AFRICA, MID EAST**  
X-Ray House  
Bonehurst Road  
Salfords  
Surrey RH1 5GG  
UNITED KINGDOM  
Tel: +44 (0) 870-7774301  
Fax: +44 (0) 870-7774302

**ASIA**  
240 Macpherson Road  
#06-04 Pines Industrial Building  
Singapore 348574  
SINGAPORE  
Tel: +65-6743-9913  
+65-6743-9892  
Fax: +65-6743-9915

**AUSTRALIA**  
Rapiscan House  
4 Ross Street  
South Melbourne Victoria  
Australia 3205  
AUSTRALIA  
Tel: +61 3 9929 4600  
Fax: +61 3 9929 4655

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## Revisions

With continual development of our products, Rapiscan Systems reserves the right to amend specifications without notice.

# 1 OVERVIEW

The New Rapiscan Eagle C02 (“Eagle C02”) is a member of Rapiscan’s C-Series of occupied vehicle inspection systems with the following unique features:

- **A 225 kVp X-ray imaging system.** The Eagle C02 provides the highest image quality X-ray inspection system available for occupied car and small vehicle screening. The Eagle C02’s transmission X-ray imaging system provides excellent coverage of all parts of a vehicle from axle upwards.
- **Rapiscan’s material separation technology.** The Eagle C02 is offered with material separation capability, which helps the inspector find low density contraband, such as explosives and narcotics. These low density materials appear differently in the X-ray image than high density materials, such as steel. The material separation capability requires the optional dual-energy X-ray detectors available with the Eagle C02.
- **Occupied Vehicle Scanning Capability.** The Eagle C02 is available with a 3m x 3.3m scanning tunnel which is provided with a several specialist sensors which work together to ensure that passenger dose is in line with typical international radiation safety regulations.
- **Side View OR Top View Imaging Configuration.** The Eagle C02 is available with either side view or top view source configurations. In the top view configuration, the maximum tunnel height is restricted to 2.9m with vehicle ramps leading into and away from the scanning zone.
- **Optional RefleXion Technology.** The Eagle C02 can be specified with optional Eagle X-Series – RefleXion Technology. (**Eagle C02 - 360 View**) a medium energy X-ray source designed to scan the underside of the vehicle including; the load area, the tires, around the engine and under the floor.

The Eagle C02 is designed to scan cars and small vehicles to verify the contents and to identify the presence of hidden contraband, such as weapons, explosives and narcotics. The unit is fully self-contained with all of the equipment and features required to perform inspections at locations, such as critical infrastructure, government facilities and sporting stadia.

The Eagle C02 has a 225 kVp X-ray imaging system with a high resolution detector array. Once installed the system may be relocated to a different site when required. The Eagle C02 takes X-ray images of cars and small vehicles as they drive through the stationary inspection tunnel in either direction. Scanning is automatic and does not require operator intervention except to inspect the series of X-ray images that are produced, one image per scanned vehicle.

The Eagle C02 produces a high-quality X-ray image of a vehicle, its occupants and its contents, which is immediately displayed on a monitor at the inspection workstation. The inspection workstation may be located anywhere within 80 m of the scanning location in a standard installation. Optionally, greater distances can be accommodated. The inspector then evaluates the image using the comprehensive features of the Rapiscan Cargo Viewer software.

The Eagle C02 offers best-in-class X-ray inspection capability. It is available with the following features.

- Drive-through scanning of occupied vehicles
- Radiation safe for vehicle occupants, bystanders and operators
- 3 m (W) x 3.3 m (H) inspection tunnel [side view configuration] or 3m (W) x 3.0m (H) inspection tunnel [top view configuration and/or RefleXion technology]
- Penetration up to 35 mm steel
- All needed inspection capabilities provided at the Inspection Workstation

- Industry leading X-ray imaging quality
- New safety control system to ensure constant driver dose independent of drive through speed
- New scan control system to ensure constant image quality independent of drive through speed
- Improved mechanical design with better weatherproofing
- Updated software interface using latest generation technology
- Easy-to-use Rapiscan Cargo Viewer software
- Operator Assist tools increase inspection efficiency
- Operating environment range supports worldwide deployment
- Easy to maintain

Options available with the Eagle C02 include

- Underside RefleXion Technology
- Dual energy material separation imaging
- Gamma and/or neutron radiation detection
- Automated capture of the license plate in most countries
- Cold and/or hot weather package for expanded operational environment
- Inspection office with amenities
- Additional inspection workstations for multiple inspectors

## 1.1 Rapiscan Eagle C-Series Products

Rapiscan Eagle C-Series occupied car and small vehicle inspection systems include

- Eagle C02 (Side View) – 225 kVp X-ray imaging system for scanning cars and small vehicles with a maximum height of 3.0 m and a maximum width of 2.8 m
- Eagle C02 (Top View) – 225 kV X-Ray imaging system for scanning cars and small vehicles with a maximum height of 2.8m and a maximum width of 2.8m
- Eagle C02 - 360 View, incorporating RefleXion Technology – Providing the perfect combination of inspection capability, with a 225 kVp X-ray imaging system used to scan through cargo and the vehicle itself and a RefleXion technology source being used to scan the underside of the vehicle. for scanning cars and small vehicles with a maximum height of 2.8 m and a maximum width of 2.8 m

Easily installed, but also re-locatable, Rapiscan Eagle C-Series occupied car and small vehicle scanners provide operational flexibility. The systems are typically installed at the entrance to critical facilities or buildings as a way of ensuring security of in-bound vehicles. They are also installed at the exit to facilities to detect theft. A maximum drive through speed of up to 30 km/h for the Eagle C02 and a maximum of 8 km/h (5 mph) for the Eagle 360 View with RefleXion Technology, provide vehicle throughput of hundreds of small vehicles per hour. Image inspection stations may be installed within existing facilities, such as within a security control office. Alternatively, optional inspection booths may be ordered with the C02.

An Eagle C-Series car and small vehicle scanner, is used in a drive-through mode where vehicles are driven through the stationary inspection tunnel. The X-ray exposure is started and stopped automatically to minimize radiation exposure to bystanders and crew members.

## 1.2 Application Scenarios for Rapiscan Eagle C-Series Products

**Inspection at Entrance to Facilities.** The Eagle C-Series scanner is deployed at the entrance to a facility and all vehicles that enter the facility are scanned. During the scan, the license plate detail is captured and a digital photograph is taken of the driver and front seat passenger. This allows inspectors to see the contents of the vehicle, to review the number of passengers in the vehicle and to compare the image to any previous images for that particular vehicle. This approach allows routine scanning of vehicles to be used to determine anomalous behavior.

**Inspection at Exit to Facilities.** Where a facility is producing or handling critical items, vehicles leaving the facility may be inspected using an Eagle C-Series scanner to search for items that should not be removed from the facility due to security or theft reasons. Exit images may be compared to entrance images for the same vehicle to check for differences.

**Variable Throughput.** Inspection throughput tends to vary throughout the day. For example, a facility with shift workers may experience multiple peaks of activity throughout the day. Eagle C-Series systems provide capability for scheduling images to multiple inspectors during peak periods, with only a single inspector being required at other periods of the day. This helps to maximize productivity and minimize operational costs.

**Finding Threat Items.** With the X-ray beam oriented perpendicular to the scanned object in a side-shooter configuration, excellent inspection capability is provided for the vehicle doors, trunk and roof as well as the wheel arches and engine compartment. Optional materials separation capability helps to determine the presence of low-Z materials (such as explosives and narcotics) at all locations within the vehicle. The optional RefleXion technology is designed to scan the underside of the vehicle including; the load area, the tires, around the engine and under the floor. For large vehicles, the system scans around the engine, in the tires and fuel tank and even between the chassis rails.

## 1.3 Rapiscan Approach to Cargo and Vehicle Inspection Products

All Rapiscan cargo and vehicle inspection products reflect our corporate commitment to excellence in imaging performance, design, ease-of-use and quality. This commitment results in products that have best-in-class imaging, low cost of ownership, high reliability and high operator satisfaction. Rapiscan offers its customers the largest selection of cargo and vehicle inspection products that share a common design philosophy.

- Modular design elements that are common across multiple products – Common design elements, such as the operating software, enable operating and maintenance staff trained on one product to quickly move to a different product. It also simplifies operation, training, service and spares.
- Multiple operation modes for one product – One product is able to inspect in different ways to respond to changing operational requirements. For example, an Eagle M-Series mobile scanner can also be used as a drive-thru portal scanner when high throughput is required. This capability provides operational flexibility and maximizes the effectiveness of each scanner.
- Products available to meet the full range of inspection requirements – Rapiscan's unmatched range of cargo and vehicle inspection products enables us to work with customers to define a solution that meets their inspection requirements. We can choose from products capable of scanning occupied vehicles to dense cargo in mobile, gantry, portal and fixed deployment configurations, which can be used alone or in optimal combinations.
- Minimize cost of ownership – Rapiscan recognizes that a customer's price for a scanner must include the cost of ownership over the unit's lifetime as well as the cost of acquisition.

Therefore, we are constantly working to reduce cost of ownership, such as by improving fuel efficiency and offering shore power operation for our Eagle M-Series mobile products.

## 2 FEATURES

The Eagle C02 is a re-locatable car and small vehicle cargo inspection system consisting of a 225 kVp X-ray generator and high resolution detector array. The system scans automatically when a car or small vehicle is driven through the inspection tunnel between the X-ray generator and the detector array. The resulting X-ray image is immediately displayed on a workstation in the nearby inspection office. The system is fully self-contained and requires no civil works, except for provision of a single phase mains supply and a flat space on which to install the equipment.

### 2.1 Imaging System

**X-ray Generator.** The Eagle C02 uses a small focus X-ray tube and stable high voltage generator to generate a 225 kVp X-ray beam. The X-ray generator is heavily shielded and the beam tightly collimated into a fan shape, which minimizes radiation dose while maximizing beam intensity at the center of the object being scanned. The fan beam, is oriented to inspect from the axle to the top of the vehicle without corner cutoff.

**Detector System.** The Eagle C02's detector system uses a scintillating cadmium tungstate crystal mounted to a silicon photodiode to detect transmitted X-rays. The detectors and their electronics are organized in modules within a hermetically sealed enclosure. This design minimizes the X-ray generator-to-detector distance while still enabling 100% inspection of the passing vehicle. The detector housing protects the detectors from environmental degradation. Doors provide easy access for servicing individual modules. The output from the detectors is sent to Rapiscan proprietary imaging electronics and then to the Image Analysis Workstation for display.

**Computer Hardware.** The Eagle C02's computer system is used to acquire the X-ray data, create the X-ray image, display and process the image and store and retrieve images from the database. It utilizes commercially available Windows PC workstations, which run the Rapiscan Cargo Viewer software. High-resolution, color flat-panel monitors display the X-ray image, the user interface controls and CCTV images from the scanner. There is a hard drive for data storage and a CD/DVD drive for data archiving. Images are displayed on the flat panel color monitor and printed on a color printer. The images can also be sent to nearby offices for review and evaluation.

**Computer Software.** Rapiscan's Cargo Viewer software used on the Eagle C02 supports the entire cargo inspection process, including check-in, scanning and image evaluation. The inspector uses Cargo Viewer to view, process, evaluate and store the X-ray images. Cargo Viewer includes a comprehensive suite of image processing tools, including contrast and brightness adjustment, magnify/demagnify, edge enhancement, filters, and histogram functions. Features of interest in the image can be highlighted and annotated for future reference. Each of Rapiscan's cargo and vehicle inspection products uses the same Cargo View software, so that trained inspectors can operate different Rapiscan scanners.

## 3 OPERATION

The Eagle C02 scans an object, such as a car or small vehicle, in a single pass from approximately the axle to the top of the object. The resulting transmission X-ray image shows the entire object and its contents. During a scan, CCTV cameras are used to monitor the inspection tunnel and the area around the unit. The optional Optical Character Recognition (OCR) capability captures a license plate in most countries around the world. The X-ray image is immediately available to the inspector(s) in the inspection office. Images can also be wirelessly transmitted to additional inspectors at another site.

### 3.1 Scan Modes

The Eagle C02 scans in drive-thru mode. Traffic control is afforded using a Red/Green traffic light to support a safe, continuous flow of vehicles through the system. The traffic control system typically has the following components:

- Traffic control light to signal when it is safe to enter the inspection region
- Vehicle speed measurement device. Measured speed through the gantry is used to adjust the X-ray image acquisition rate, if necessary.
- An “approach” sensor, which senses a vehicle approaching the inspection tunnel, controls the traffic light and prepares the X-ray source to turn on.
- A “beam on” sensor that detects the front of the vehicle to be inspected and turns the X-ray source on. This sensor is also used to turn the X-ray beam off once the vehicle has been scanned.
- CCTV cameras for monitoring the facility and its vicinity.

Inspection of a vehicle typically consists of the following sequence of events:

1. If there is no vehicle currently being scanned, the traffic control light is green signifying that it is safe for the next vehicle to proceed.
2. The vehicle proceeds towards the inspection tunnel at a target speed of up to 30 km/hr, although a good quality image will be obtained for drive through at lower speeds. When the vehicle enters the inspection tunnel, the traffic control light turns red to prevent another vehicle from entering.
3. The vehicle drives through the inspection tunnel.
4. The vehicle drives out of the inspection region to a parking area and waits for the inspection results.

### 3.2 Throughput

In drive-thru scan mode, typical scan throughput is several hundred vehicles per hour with a continuous supply of vehicles ready to be scanned.

### 3.3 Crew

The crew of the Eagle C02 consists of at least one inspector although more inspectors working simultaneously may be required in times of high throughput. A ground guide can help to direct vehicles to a check zone if the inspector identifies an image as suspicious.

### 3.4 Operating Environment

The Eagle C02 is designed to operate in a wide-range of weather conditions.

- Standard Operating Temperature range: -10°C to 40°C
- Optional Cold Weather Kit extends the low temperature range to -40°C when cold weather operating requirements are followed (see below)



- Optional Hot Weather Kit extends the high temperature range to 55°C.
- Humidity 5% to 95% non-condensing
- Wind gusts up to 20 m/s
- Altitude up to 2000 m.

The design draws on Rapiscan Systems' experience in deploying cargo and vehicle inspection systems at a wide variety of locations. The Eagle C02 units are designed to perform in all deployment environments, including seaside, dusty and sandy sites and tropical conditions and various weather conditions, including rain and snow. The unit must be operated in accordance with the Operator Manual and maintained in accordance with the Maintenance Manual. Design features, including paint and finishes, are intended to prevent corrosion in a marine environment. Floodlights are located on the unit to support scanning operations after dark or in poor visibility conditions.

**Cold Weather Operation.** The optional Cold Weather Kit is required for operation at sites where the minimum temperature is -20°C to -40°C. At these temperatures, the following Eagle C02 cold weather operating requirements must be followed:

- Use specified low temperature coolant fluids
- Allow for an extended equipment warm up time prior to operation
- Maintain mains electricity supply to warm key components during system off conditions.

## 4 SAFETY

The Eagle C02 is designed and manufactured to applicable international safety standards and regulations. The safety system includes X-ray warning lights, alarms and signs; emergency stops and safety interlocks and CCTV cameras. The emergency stops and interlocks immediately stop X-ray production and must be in the required configuration for the unit to operate. The status of the safety system is displayed on the onboard monitoring and control system.

**Radiation Safety.** The Eagle C02 is designed to be radiation safe for the operating crew, vehicle occupants and bystanders, in accordance with typical international and local radiation safety regulations. As with all Rapiscan products, the principle of ALARA (As Low As Reasonably Achievable) is fundamental to the design.

- Operating Crew – Image Inspectors and supporting ground crew are located outside the radiation exclusion zone for the equipment. The cumulative radiation dose rate in these areas does not exceed allowable levels during scanning
- Bystanders - To protect nearby personnel and prevent unauthorized access, the Eagle C02 includes warning lights and alarms and radiation exclusion zone warning signs. The cumulative dose rate at the radiation exclusion zone boundary does not exceed the maximum allowable.
- Vehicle Occupants - The Eagle C02 is designed to be radiation safe for occupants of the vehicle being scanned. The radiation dose from the low-energy X-ray beam does not exceed the maximum dose allowable.

**Radiation Exclusion Zone.** To protect bystanders during a scan, a radiation exclusion zone surrounds the Eagle C02 unit. The radiation dose at the exclusion zone boundary does not exceed the maximum allowable. The size of the Eagle C02 exclusion zone depends on factors, including the throughput. Assuming 100 cars of typical size (4 m length) are scanned per hour, the exclusion zone extends 2 m behind detector boom and 4 m in the scan direction.



## 5 IMAGES

Representative examples of Eagle C02 X-ray images are presented in Figures 4-5.

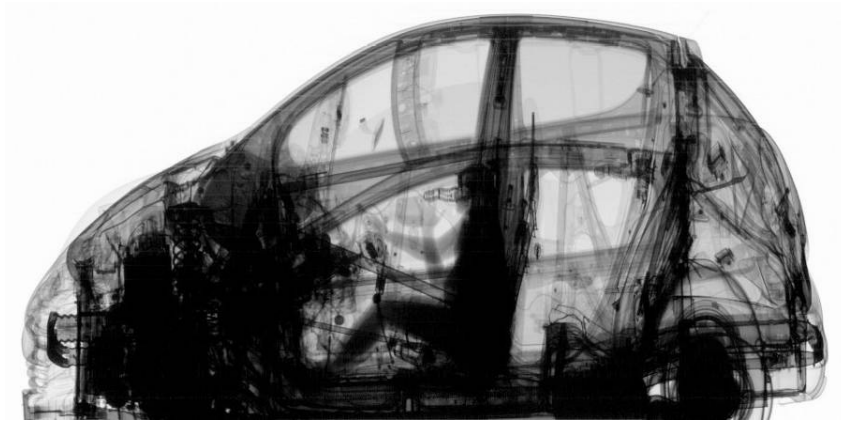


Figure 4. Representative Eagle C02 Grayscale Image

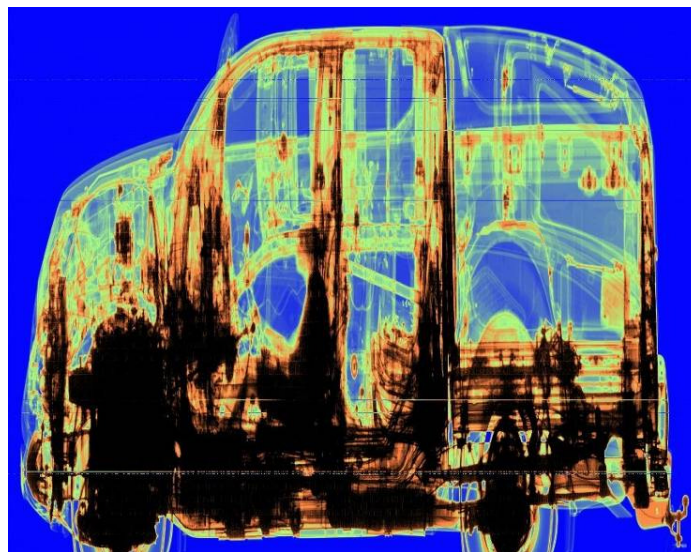


Figure 5. Representative Eagle C02 Pseudo-Colour Image

## 6 PERFORMANCE SPECIFICATIONS

Specific features of the Eagle C02 are listed in Table 1.

Table 1. Eagle C02 Features

<b>Main System</b>	
Platform	Re-locatable gantry
Utilities	Single phase shore power
<b>Deployment</b>	
Boom Orientation	90° to inspected object
Set-up	5 minutes in standard operating environment
<b>Inspection</b>	
X-ray Generator	225 kVp X-ray tube and generator
Inspection Field of View	0.2 m to 3.2 m tall x 3 m wide x any length [Side View] 0.0m to 2.8m tall x 3m wide x any length [Top View]
Scan Mode	Drive-through Scanning Mode
Drive-thru Scan Mode	<ul style="list-style-type: none"> <li>• Scan Coverage</li> <li>• Scan Direction</li> <li>• Scan Speed</li> <li>• X-ray Energy</li> <li>• Throughput</li> </ul>
Crew	Single image inspector Optional additional inspectors and/or ground guide
Inspector Workstation	Minimum of one image inspector Optional workstations for additional inspectors
Optical Character Recognition	Optional
Radiation Detection	
Gamma Radiation	Optional
Neutron Radiation	Optional
<b>Imaging Performance</b>	
Steel Penetration, mm	37 mm at 225 kVp
Wire Resolution in Air, mm	2 mm copper wire in air
Contrast Sensitivity, %	5% (0.5 mm steel behind 10 mm steel) at 180 kVp
Spatial Resolution in Air, mm	4 mm
Material Separation	Optional, requires dual-energy detector configuration.

Radiation Exclusion Zone	2m wide (beam direction) x 4m long (scan direction) for 100 vehicles/hr
<b>Environment</b>	
Temperature	-10°C to +40°C -40°C with optional cold weather package +55°C with optional hot weather package
Humidity	5% to 95% non-condensing

**Material Separation.** With the optional Rapiscan material separation technology, low atomic number and high atomic number materials appear differently in the X-ray image. This capability enables low density contraband, such as explosives and drugs, to be distinguished from high density materials, such as steel. The example material separation X-ray image presented in Figure 6 shows a typical van with fairly cluttered contents. The image is coloured such that high Z (steel) items appear blue, while Low Z items are coloured in green. The optional material separation capability also requires a dual-energy detector set to be fitted.

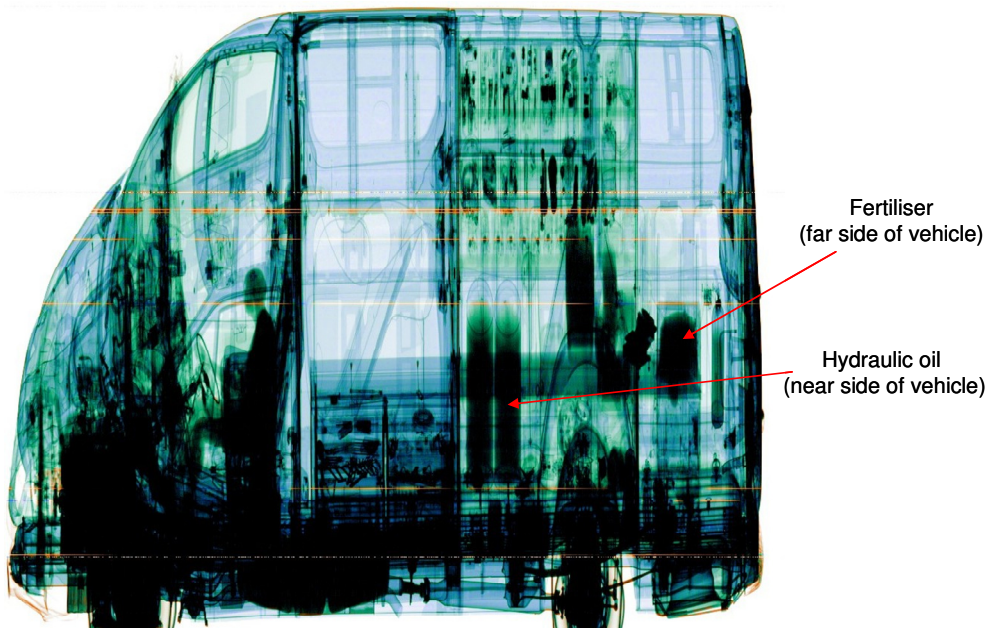


Figure 6. Material Separation Image

**Radiation Detection.** The Eagle C02 is available with an optional integrated radiation detection capability, so that radioactive materials in the cargo are detected during a scan. The system is available with gamma and/or neutron radiation detection. The longitudinal location of the alarm is shown on the X-ray image. The radiation detection system is integrated with the X-ray imaging system, so that they do not interfere with each other.

## 7 OPTIONS

Table 2 lists the options available with an Eagle C02 unit. Unless specifically noted in Table 2, each option can be ordered separately with any other option.

Table 2. Eagle C02 Options

Option	Standard
<b>Inspectors</b>	
Additional Inspection Workstations	One inspector workstation
Inspector Office	Not included in standard configuration
Inspector Office Amenities, such as <ul style="list-style-type: none"> <li>• Microwave Oven</li> <li>• Small Refrigerator</li> </ul>	Not included in standard configuration
VHF or UHF Radio Set	Not included in standard configuration
Automatic Number Plate Recognition	Not included in standard configuration
Wireless remote connection for operator workstation (20m)	Not included in standard configuration
Hardwired LAN (Local Area Network) connection 100m	Not included in standard configuration
<b>Inspection</b>	
RefleXion Imaging	Not included in standard configuration
License Plate Reader	Not included in standard configuration
Gamma Radiation Detection	Not included in standard configuration
Neutron Radiation Detection	Not included in standard configuration
Material Separation, including dual energy detector set	Not included in standard configuration
<b>Operating Environment</b>	
Cold Weather Package – extends operating temperature to -40°C	Operating Temperature Range: -10°C to 40°C

Hot Weather Package – extends operating temperature to 55°C	Operating Temperature Range: -10°C to 40°C
<b>Other Options</b>	
Fiber Optic Remote connection (300m)	Not included in standard configuration
Dual Direction Scanning	Not included in standard configuration
Custom Paint color	Not included in standard configuration
Traffic Barriers	Not included in standard configuration