WG X-Ray Vehicle Scanning Gantry

The WG X-Ray Vehicle Scanning Gantry is a high-energy, rail mounted gantry inspection system designed for rapid, automated scanning of vehicles, sea freight containers and cargo.

The X-ray generator and X-ray detector array are mounted on an electric-powered gantry that runs on rails; the system automatically scans un-occupied vehicles and containers parked between the rails.

The system is designed for automated operation by a minimum number of personnel, the gantry is remotely controlled from a nearby office and the resulting X-ray images are sent to a nearby office for review and evaluation.

The system is ideal for inspection at critical facilities such as security check points, seaports and border crossings.

APPLICATIONS

- Airports
- Border crossings
- Commercial buildings
- Government buildings
- Military installations
- Prisons
- Seaports
- Security checkpoints

The WG X-Ray Vehicle Scanning Gantry is available in two models:-

- **WG G4500** 4.5 MeV X-ray generator with 300 mm X-ray penetration.
- **WG G6000** 6 MeV X-ray generator with 340 mm X-ray penetration; (dual energy) with Organic & Non Organic material separation technology - low atomic number and high atomic number materials appear differently in the X-ray image. This capability enables contraband such as explosives, to be distinguished from high atomic number materials, such as steel.

The Traffic Control and Monitoring System enables automated operation with scan throughput up to 38-40 vehicles per hour, when used with two (2) truck scanning positions. The scanning process is activated by the system operatives after the truck drivers have left the exclusion area.

The WG X-Ray Vehicle Scanning Portal inspects a 2.8 m wide object in a single pass from approximately 0.4 m to 4.6 m above the ground.

The linear accelerator pulse rate is adjusted according to the measured speed of the gantry, to eliminate image distortion and minimise radiation output. The resulting X-ray images are sent to a nearby office for review and evaluation.

The high-energy X-ray inspection system enables inspection of dense cargo, verification of manifests and identification of contraband, such as explosives, weapons and narcotics.

The non-intrusive inspection capability using high-quality X-ray images and Cargo Viewer software reduces the need for subsequent manual inspection.
The WG X-Ray Vehicle Scanning Gantry facility consists of the Gantry mounted on rails, which supports the X-ray generator and detector array, the Traffic Control and Monitoring System, the offices and the client supplied radiation shielding walls, (or client supplied containment building).

The WG X-Ray Vehicle Scanning Gantry product has a unique combination of features:-

- Automated scanning operation
- Can scan up to two (2) trucks in one scanning process, 38-40 trucks per hour
- Easy to maintain
- High energy X-ray imaging technology
- High penetration to inspect dense cargo
- High-quality X-ray images
- Radiation safe for drivers, operators and bystanders.

**FEATURES**

The WG X-Ray Vehicle Scanning Gantry is a high-energy X-ray imaging system configured as a rail mounted system with the following principal elements:-

- A transmission X-ray imaging system, including the Varian M3 Linatron linear accelerator X-ray generator, X-ray detector array and computer hardware and software
- The gantry structure that supports the X-ray generator and detector array
- Containerised offices that house the inspector(s), operator and check-in officer and associated computer systems and other equipment
- A Traffic Control and Monitoring System (TCMS) that ensures a safe continuous flow of vehicles through the portal
- Client supplied walls surrounding the portal, which provide radiation shielding if sufficient space is not available to accommodate the required radiation exclusion zone, or housed in the clients building facility.

The X-ray imaging system is designed to scan an object up to 2.8 m wide object from 0.4 m to 4.6 m above the ground.

The X-ray generator and X-ray detector array are mounted on an electric-powered gantry that runs on rails; the system automatically scans un-occupied vehicles and containers parked between the rails. The resulting X-ray image of the cargo is sent for evaluation to an inspector in a nearby office. The system throughput can be increased by when using two (2) truck scanning positions.

**IMAGING SYSTEM**

**X-Ray Generator**

The Gantry uses a Varian M3 Linatron linear accelerator operating to generate a high energy X-ray beam. The X-ray generator is heavily shielded and the beam tightly collimated into a fan shape, which minimises radiation dose while maximizing beam intensity at the centre of the object being scanned. The fan beam is oriented to cover an area from the axle to the top of a truck or container on a truck without corner cut off.
Detector System
The Gantry’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 organised in modules arranged in an L-shaped array. This design minimises the source-to-detector distance while still enabling 100% inspection of the truck and cargo container on the truck. 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 proprietary imaging electronics and then to a computer for display.

Computer Hardware
The Gantry’s computer system is used to operate the facility, acquire the X-ray image, display and process the image and store and retrieve images from the database.

It utilises commercially available Windows PC workstations, which run the Cargo Viewer software. High-resolution, colour flat-panel monitors display the X-ray image, the user interface controls and the cargo manifest. There is a high capacity server for data storage and a CD/DVD drive for data archiving. Images are displayed on the flat panel colour monitor and printed on a colour printer.

The images can also be sent from the inspection office to other locations within the Gantry facility or to remote locations.

Computer Software
The Cargo Viewer software used in the Gantry 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/de-magnify, edge enhancement, filters and histogram functions. The Viewer software can be provided in Arabic. Features of interest in the image can be highlighted and annotated for future reference.

Facility
A typical layout of a WG X-Ray Vehicle Scanning Gantry facility is shown in the schematic drawing below.

Note: The diagram above shows one (1) scanning position. The system throughput can be increased by lengthening the scanning area to accommodate (2) truck scanning positions; this will provide an approximate throughput of 38-40 trucks per hour. The Spares storage and the concrete radiation shielding walls would not be included within our pricing, the client would arrange the supply of these locally.

Gantry Facility with Radiation Shielding Walls
The facility layout is optimised for the specific site and inspection requirements. The required radiation exclusion zone, which surrounds the portal, can be reduced by using concrete shielding walls on either side of the rails, as shown in the figure. The walls are typically thicker behind the X-ray detector than behind the X-ray generator. The walls can be cast in place or constructed of concrete panels to enable them to be disassembled and moved to a different site. The unit can also be installed within a building, which is designed to provide protection from the environment and radiation shielding. We would suggest the client consider this.
Offices
The Gantry facility includes two offices, a check-in office and an inspection office, which house the cargo inspection facility crew and their equipment. At the check-in office, information about the truck and/or container, the cargo and the inspection is entered into the database.

Shipping documents are also scanned into the database, the X-ray images are sent to the inspection office for review by the inspector(s) using the Gantry’s Imaging Analysis Workstation and Cargo Viewer software.

The operator, who monitors the facility operation, is also located in the Inspection Office. A third optional office (not included) may be dedicated to supporting service activities, including preventive and corrective maintenance and spare parts storage.

The offices are prefabricated from a 20-foot cargo container, which makes them easy to ship, transport, install and relocate. They are designed to provide a comfortable and safe work environment for their occupants.

They are built in a factory and outfitted with all required utilities, including electrical wiring, lighting, HVAC (heating, ventilation and air conditioning), and work spaces prior to shipment. Therefore, installation is limited primarily to attaching the office to the local power source and installing furnishings and equipment.

The offices are rugged and designed to work in the wide variety of environments experienced at seaports and border crossings worldwide.

This picture presents an exemplar interior of an Inspection Office for one inspector. It shows the computer monitors for operation, including CCTV images, image evaluation and monitoring and control.

The E-stop and loudspeaker microphone are also seen in the photograph. The Image Analysis Workstation and monitors shown are replicated for each additional inspector.

Traffic Control and Monitoring System
The Gantry facility includes a fully automated Traffic Control and Monitoring System (TCMS), which controls and monitors the flow of vehicles through the Gantry to ensure safe operation. The TCMS, is illustrated below, and typically includes the following elements:

- Traffic light at the entrance to signal when it is safe to enter the facility
- Sensor that detect when a truck has entered the facility and parked
- Sensor that detect when a truck has left the facility
- CCTV cameras for capturing an image of the vehicle license plate and container identification number and for monitoring the facility and its vicinity.
Note: The diagram above shows one (1) scanning position. The system throughput can be increased by lengthening the scanning area to accommodate (2) truck scanning positions, this will provide an approximate throughput of 38-40 trucks per hour.

Relocation
If required the Gantry cargo inspection facility can be designed for relocation to a new inspection site. The gantry and offices are can be disassembled, transported to a different location and reassembled at the new site. The client supplied concrete walls could be constructed from panels that could be disassembled and moved. If necessary, power can be provided by a generator could be moved with the system. The relocated unit provides the flexibility required to respond to changing operational requirements.

Operation
The TCMS for the Gantry supports a safe scanning operation of the system; the Inspection of a truck typically consists of the following sequence of events:

- If there is no truck in the facility, the traffic light at the entrance is green signifying that it is safe for the truck to proceed
- The truck proceeds into the facility and parks, all occupants leave the truck and leave the exclusion zone. When the one (1) or two (2) trucks enters, the traffic light turns red to prevent another truck from entering until the current scanning process is completed
- An image of the truck’s license plate and/or the container’s identification number is captured by the CCTV camera
- The operator activates the system, the X-ray beam turns on and the gantry traverses along the rails and passes over the trucks. The resulting X-ray image is sent to the inspection office for review by the inspector;
- Once the process is completed, the operator instructs the driver(s) to return to their trucks and they drive their trucks out of the area, to a parking area and waits for the results of the X-ray image evaluation
- Crew -The Gantry is designed for highly automated operation, which reduces the size of the crew required to operate the system. The typical crew includes an operator and inspector with an optional check-in officer
- However, the size of the crew can be reduced by fewer personnel sharing these duties, particularly at locations where traffic is light.

Safety
The Gantry is designed and manufactured to applicable international safety standards and regulations, the TCMS incorporates safeguards. The stop light at the entrance controls access to the facility. The CCTV cameras enable the operator to monitor the area. Warning lights and alarms indicate when the X-ray generator is enabled and operating and emergency stops immediately disable the generator. The status of the safety system is displayed on the gantry monitoring and control system.

Radiation Safety
The Gantry is designed to be radiation safe for the driver, crew and bystanders, in accordance with international and local standards. The principle of ALARA (As Low As Reasonably Achievable) is fundamental to the design.

Driver – The driver and any other vehicle occupants leave the truck and the exclusion area prior to the X-ray process commencing.
Crew - During an inspection, the crew members are housed inside the offices that are located outside the exclusion zone. Therefore, the crew is not exposed to a radiation dose above the maximum allowable; 

Bystanders - To protect nearby personnel and prevent unauthorized access, the Gantry facility includes a radiation exclusion zone, warning signs, lights and alarms and barriers and fences, as appropriate. External concrete shielding walls may be used to reduce the size of the exclusion zone and the unit’s overall footprint. The controlled area boundary is designed so that the cumulative dose rate at the boundary does not exceed the maximum allowable.

Images

Representative images are presented below; A rifle, pistol and three high density targets, which were hidden in the cargo, are clearly visible in the image.

![Image of Cars in a Truck]
Images of Mixed Cargo

<table>
<thead>
<tr>
<th>Container</th>
<th>Inspection Field of View</th>
<th>Scan Mode</th>
<th>Scan Speed</th>
<th>Vehicle Thru put</th>
<th>X-ray Generator</th>
<th>X-ray Beam Orientation</th>
<th>Operation</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handguns and rifles visible in container</td>
<td>0.4-4.6 m high x 2.8 m wide</td>
<td>Scans parked vehicles</td>
<td>8 km/h (nominal)</td>
<td>With 2 Truck Scanning positions, up to 43 vehicles per hour</td>
<td>Linear accelerator</td>
<td>90° to inspected object</td>
<td>Crew: Inspector(s), operator, check-in officer,</td>
<td>Temperature -20°C to 50°C standard -40°C to 55°C with optional cold/hot weather packages Humidity 0% to 100%</td>
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<td>Pallet of canned vegetables with small missile inside</td>
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<tr>
<td>Stowaways in a container</td>
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<td>Automobile height position for scanning cars</td>
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**Performance Specifications**

**Note:** The G6000 6 MeV X-ray generator with 340 mm X-ray penetration; (dual energy) has Organic & Non Organic material separation technology - low atomic number and high atomic number materials appear differently in the X-ray image. This capability enables contraband such as explosives, to be distinguished from high atomic number materials, such as steel.