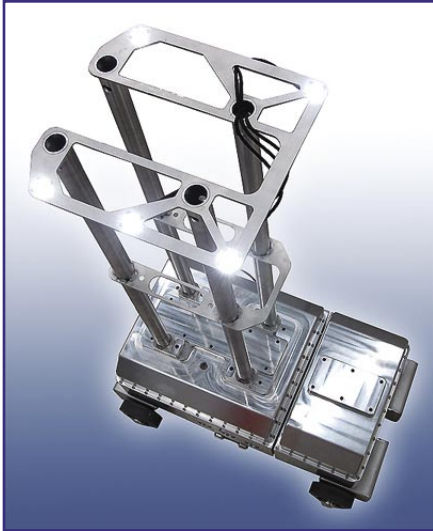


Inspector Underwater In-Tank Inspection Robot



Mast-top mounted LED lights enable the precision navigation global positioning camera, mounted on a boom inside the tank hatch, to track the robot. The mast height keeps the LEDs above any sediment and turbidity.



This view of the underside shows the enclosed port (center) for the downward-looking laser scanner and video camera, as well as the four independently powered and steerable drive wheel pods.

Equipment Mounting Options:

- Indexable, twin-arm sensor module
- Front end mounting bar with multi-functional holes extending port and starboard to allow for mounting of sensors, optional tank bottom cleaner or other devices.
- Low-slung, arm-mounted equipment plate on starboard side
- Top deck can accommodate additional sensor mounting.
- Additional options include tank bottom cleaner, specialized sensors, environmental mapping and robotic arms.



The Inspector is a semi-autonomous, underwater robotic delivery platform designed to survey and position a variety of sensors or repair tools within flat-bottom water storage tanks at nuclear power generation stations. All sensor-detected flaws are precisely mapped into memory, enabling a return to the location(s) with an accuracy of +/- 1/8 inch (3 mm), even if the robot is removed from the tank and redeployed back in at a later date. The Inspector system consists of: the robot, a global positioning camera assembly, navigation and operation software, and mounted sensors (by others).

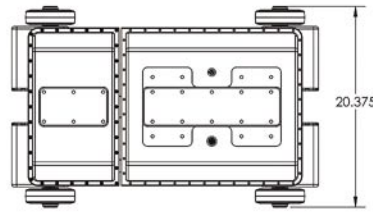
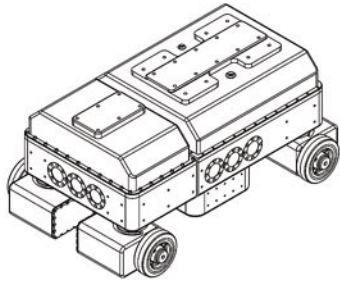
The features of the Inspector system include:

- Five on-board color video cameras
- Overhead precision navigation system
- On-board down-looking video capture
- Highly maneuverable four-wheel steering
- Four wheel independent drive motor system
- On-board downward-facing 3D laser scanner
- Split chassis design provides constant all-wheel contact
- Laser range finders on all four side for near-wall positioning
- Virtual view User Interface enabling precise manual control
- Sediment-clearing rotating brush assembly (several designs)
- Real-time video imaging forward / rearward / left side / right side

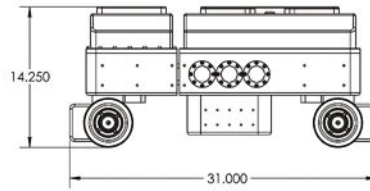
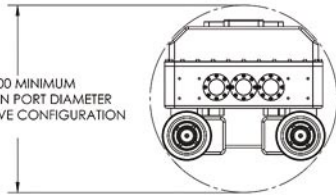
The Inspector robot is designed to fit through the most narrow tank top access hatch, a diameter of 19 in. (48 cm).

Maneuverability:

The Inspector is exceptionally maneuverable thanks to an independent, steerable drive wheel system. Each wheel pod can rotate 193° and each wheel motor is independently variable. Steering and drive motors are software coordinated, enabling a full range of motion: forward/backward, side-to-side, spin on central axis, diagonal or “crabbing” and radius turns. The robot’s top speed is in excess of 6 in. (15,2 cm) per second. The split chassis design allows the Inspector to maintain ground contact with all four wheels when moving across surfaces with different elevations. ●●●



Ø 19.000 MINIMUM
INSTALLATION PORT DIAMETER
SIDEWAYS DRIVE CONFIGURATION

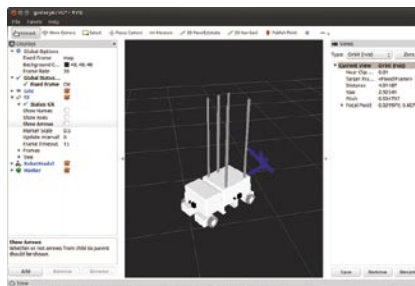


Inspector System Specifications

Elements	Details
Length:	31 in. (78,7 cm)
Width:	20.38 in. (15.75 in. for tank insertion) (52 cm & 40 cm)
Height (chassis):	14.25 in. (36 cm)
Weight (in air):	245 lbs. (111 kg)
Weight (in water):	100 lbs. (45 kg)
Construction (chassis):	Machined from solid billets of 6061-T6 aluminum stock
Video cameras:	5 ea. on-board high-resolution color 1 ea. high-resolution monochrome (for global positioning)
Scanning laser power:	35 MW
Scanning laser resolution:	0.01 in. (0,3 mm)
Range finder laser power:	7 MW ea.
LED arrays	4 ea. on chassis perimeter at 705 lumens ea. 4 ea. in bottom video port totaling 2,800 lumens 5 ea. on mast at 235 lumens ea.. (1,175 lumens total)
Power input voltage to control unit:	100 to 240 VAC 50 to 60 cycles
Underwater temperature range:	32° to 122° F (0° to 50° C)
Top speed (omni-directional):	In excess of 6 in. (15,2 cm) per second

Precise In-Tank Navigation and Positioning:

The Inspector is positioned using a combination of inputs: the vertical video view from the global positioning camera at the top of the tank, as well as the forward, rearward, lateral and down-looking views from five on-board cameras and four laser range finders. The information from these sources, in addition to direction, speed and position inputs from sensors in the drive motors and wheel pods, is processed by the software to create a virtual tank floor environment and robot avatar. The operator can visually track and, when necessary, control the robot with keyboard command in the virtual environment using the avatar. The user interface numerically displays the precise XY-axis location of the robot. ●●●



Inspector Deployment Example

- The robot is lowered into a tank and later recovered using steel cables.
- The robot receives power and communicates with its control console through a power/data umbilical cable.
- The lifting cable and umbilical are fitted with floats so as not to impede the robot on the bottom of the tank.
- Once the robot is on the bottom, the global positioning camera assembly is lowered through the manway and clamped to its rim.
- The assembly consists of a high-resolution monochrome camera mounted at the end of a long boom.
- The camera enables the navigation software to precisely track the position of the robot using the bright LED lights on the robot's mast-top.
- With the assembly clamped in place, the boom tip is raised so that the camera is just below the surface of the water at, or near, the center of the tank.
- Inspector robots are capable of operating semi-autonomously or under direct control.
- Search patterns are pre-programmed into the system, based upon tank sizes, footprints, and internal floor structures.
- The robot begins the inspection sequence by finding the tank wall and moving around the perimeter.
- During this phase, the robot detects and maps where the cross-tank floor plate welds meet the wall.
- Upon completing the perimeter sweep, the robot follows each long welded joint and detects the short, intersecting welds.
- This enables the system software to map the location of the individual floor plates as well as any obstructions, such as piping or structural supports.
- After identifying all floor plates, the robot is directed to scan the area of individual plates with the attached sensor package, using a "lawn-mowing" pattern to ensure complete coverage. ●●●

For more information, contact:
sales@newtonlabs.com



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