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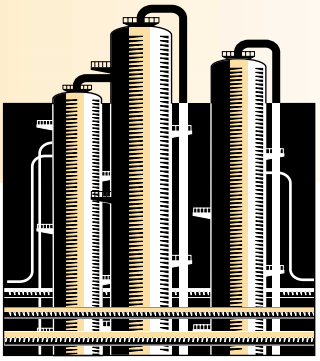
Success Story



Robotics Inspection System for Storage Tanks

New Robotic System Provides In-Service Interior Inspection of Liquid Storage Tanks

Benefits

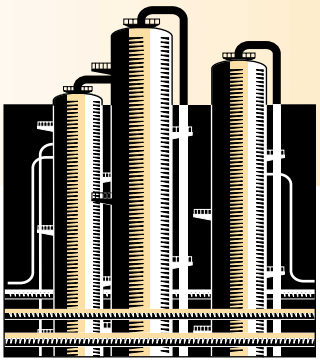
- Reduces inspection costs by $50,000 to $500,000 per tank by eliminating tank draining, cleaning, and downtime
- Eliminates need to vent CO_2 and VOCs from tanks during cleaning
- Limits personnel exposure to noxious fumes, hazardous chemicals, and confined spaces
- Reduces environmental hazards by eliminating need to dispose of cleaning agents from tank bottoms
- Demonstrated energy savings of more than 95% for cleaning tanks

Applications

The Maverick robot can be used to evaluate the integrity of all liquid storage tanks. Most notably, it is used in petroleum-based tanks where chemical leakage is most hazardous and the environment inside the tanks is volatile or flammable.

Around the world, billions of gallons of gasoline and jet fuel are stored in huge tanks. If these tanks leak, the poisonous chemicals they contain can seep into the groundwater. This potential hazard makes inspecting the tanks a high priority, which is a tedious and expensive task that temporarily puts the tanks out of commission. Bulk liquid storage tanks used in the petroleum, chemicals, and forest products industries are inspected periodically for structural integrity and corrosion damage. The American Petroleum Institute (API) has developed and adopted Standard 653 (API 653) that sets forth the criteria and timing for inspecting petroleum aboveground storage tanks (AST) worldwide. Increasingly, governments and regulatory bodies are using API 653 as a basis for mandating AST inspections.

In-Service Interior Bulk Liquid Storage Tank Inspection Using the Maverick Robot



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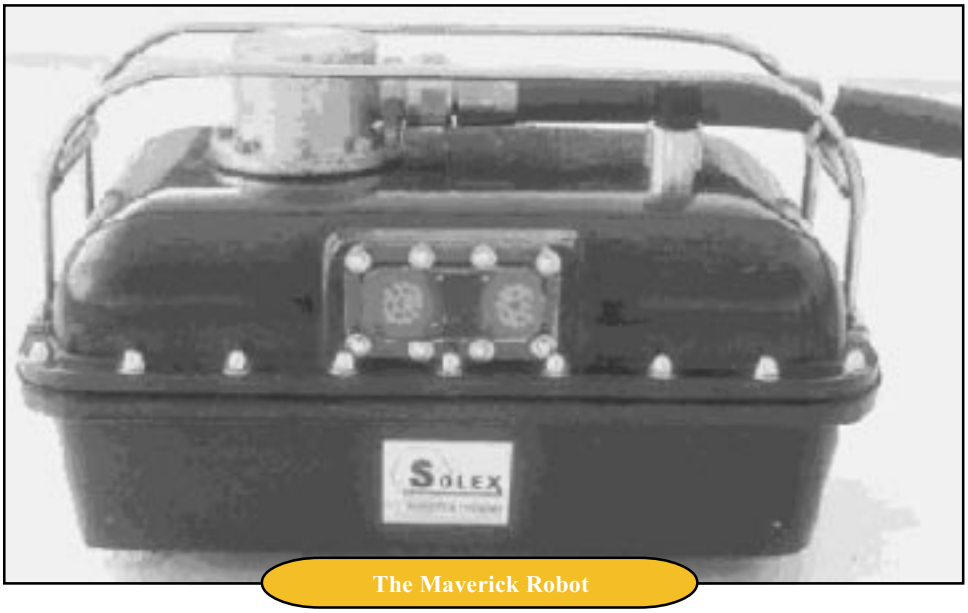
The typical procedure for this type of inspection requires personnel to drain the tank and clean it with water or solvents, empty sludge residue, and manually inspect the tank. Costs for draining and cleaning the tank, temporarily storing tank contents, waste disposal, and operational downtime make this procedure expensive. Personnel who clean and test the tank often find they must work under safety and health requirements associated with "confined space" work. Due to the types of products stored in tanks, cleaning and inspection personnel working inside a tank have significant risk of exposure to hazardous and toxic materials.

"Solex Robotics came out to Amoco's Baton Rouge terminal Port Hudson facility and made an in-service inspection of one of our storage tanks. The inspection was completed safely and in a cost-effective manner."

-Mark Sesselman
Amoco



The Maverick Robot

Solex Environmental Systems, Inc., has developed an alternative inspection system, the Maverick robot. This new system uses a remotely operated robotic inspection vehicle submerged in the tank liquid. The vehicle travels on the interior tank floor using traction wheels. At the job site, the equipment is deployed by raising the robot to the top of the tank with a crane and then lowering it through the open manway. An umbilical cable connects the robot to the computers in a nearby trailer, where all functions of the robot are controlled in comfort. The robot travels around the tank floor where it uses specialized sensors and imaging systems to inspect the welded steel bottoms for signs of thinning or leaking. The robot includes a multichannel ultrasonic sensor array to map and correlate metal thickness data, an onboard video system to record inspections, and a sonar positioning system to track movement within the tank.

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Project Partners

- Solex Environmental Systems, Inc.
  Houston, TX
- Texas Natural Resource
  Conservation Commission
  Austin, TX

The Maverick robot was designed with a safety-first policy. It is engineered for operations in tanks containing hazardous and nonhazardous materials. The Maverick robot has received multiagency safety certification for operating in Class I Division 1, Group D (hazardous and potentially explosive) environments. API has also endorsed robotics as way to complete a 653 tank floor inspection survey. The Maverick robot requires no waiver by health and safety departments to operate in diesel, gasoline, jet fuel, kerosene, fuel oil, and other middle distillates.

NICE^3 Helps Demonstration and Commercialization

As a participant in the U.S. Department of Energy's NICE^3 (National Industrial Competitiveness through Energy, Environment and Economics) Program, Solex received a $425,000 grant to help demonstrate and commercialize this new inspection system. Solex tested and refined the Maverick robot and obtained requisite safety certifications over more than a one-year period, which included six demonstrations at several sites and critiques by industry and government experts. One demonstration was conducted at the BP Amoco Texas City Refinery for representatives of the Texas Natural Resource Conservation Commission's Clean Industries 2000 Program with other refining and chemical industry personnel in attendance.

In one NICE^3 demonstration, the Maverick robot provided an API 653 inspection in a 174-ft diameter tank containing 206,000 barrels of light crude at BP Amoco's Port Hudson, Louisiana, facility. To complete a conventional inspection, the company would have to hire barges for 35 days to provide alternate storage capacity for the crude, and personnel would have to drain the tank, remove the sludge, clean the tank bottom, and degas the shell before the inspection. Using the Maverick robot, the tank stayed in-service during the entire inspection. Based on prior bids, the Maverick robot demonstrated cost savings of more than $185,000 in lieu of a conventional inspection method. In addition to reducing costs, the new inspection process generated less waste, eliminated the need to empty and clean the tank, and limits personnel exposure to petroleum-based gases in the confined space of the tank interior. Eliminating the need to empty the tank also reduced CO_2 emissions and saved energy.

Another demonstration project was conducted in a large fuel oil storage tank (120,000 bbls, 164 ft in diameter, 51 ft high, 21,000-sq ft bottom, dome with internal floating roof) at the Colonial Pipeline facility in Francisville, Louisiana. Specific testing goals targeted refinements to the sonar tracking system and deployment into a tank with an internal floating roof. Prior to the demonstration, an extensive safety review was conducted. Procedures to allow safe deployment of the equipment into confined spaces were jointly written along with all of the required permitting with Colonial personnel to control operations. The Maverick robot was able to measure and record 35,000 data points in less than three hours.

OIT

October 2000

Technology Capabilities

The Maverick robot is a rugged, explosion-proof inspection system for in-service aboveground fluid storage tanks. The Maverick robot is a remote-controlled, purged and pressurized, submersible inspection platform. The system performs floor inspections from inside the tank while submerged in refined petroleum and chemical products, including diesel, gasoline, jet fuel, kerosene, fuel oil, and other middle distillates. The instrumentation payload includes a multichannel ultrasonic sensor system to map and correlate metal thickness data, an onboard video system to record inspections, and position tracking sensors. The ultrasonic sensor system provides a detailed view of the tank bottom. The system can present metal thickness data in A, B, or C-Scan formats. Setup at the job site is quick.

Energy Savings and Pollution Prevention

The total U.S. cumulative energy savings from the Maverick robot through 1999 is estimated to be 276 billion Btu directly as a result of eliminating the need to drain and clean the tank. The associated cumulative reduction in CO_2 emissions is estimated to be 21,000 tons. The continued use of the Maverick robot is estimated to approach an energy savings of 116 trillion Btu in the year 2010. Similar reductions in CO_2 emissions from tank inspections is expected to exceed 8.7 million tons per year nationwide by 2010 due to reduced tank venting requirements and sludge disposal.

Estimated Emissions Reductions and Energy Savings Using the Maverick Robot at Port Hudson

	CO_2 and VOCs *(tons)*	Energy Use *(million Btu)*
Conventional Inspection Process	2,565	27,108
Maverick Robot	9	125
Reduced Emissions/Energy Savings	**2,556**	**26,983**

The Maverick robot was recently chosen by R&D magazine to receive one of its prestigious 1999 R&D 100 Awards. Since first established in 1963, the annual R&D 100 awards ("the Nobels of New Technology") have been presented to the top 100 most outstanding technology developments with commercial potential.

Industry of the Future — Petroleum

Petroleum is one of nine energy- and waste-intensive industries that is participating in the U.S. Department of Energy's (DOE) Office of Industrial Technologies' Industries of the Future initiative. Using an industry-defined vision of the petroleum industry in the year 2020, the industry and DOE are building collaborations to develop and deploy technologies crucial to the industry's future.

OIT Petroleum Team Leader: James Quinn (202) 586-5725.

NICE³ – National Industrial Competitiveness through Energy, Environment, and Economics: An innovative, cost-sharing program to promote energy efficiency, clean production, and economic competitiveness in industry. This grant program provides funding to state and industry partnerships for projects that demonstrate advances in energy efficiency and clean production technologies. Awardees receive a one-time grant of up to $525,000. Grants fund up to 50% of total project cost for up to 3 years.

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