



# Intelligent Mobile Sensor System (IMSS) for Autonomous Monitoring & Inspection (AMI)



**Developer:** Lockheed Martin  
**Contract Number:** DE-AC21-92MC29112  
**Crosscutting Area:** N/A

Mixed Waste  
**FOCUS AREA**

**Problem:**

Current methods for inspecting and monitoring stored waste requires personnel to walk through the storage area with various instruments or rely on passive monitoring. Public and occupational health risks are involved with these techniques, along with high costs and environmental risks. Passive detectors rely on fixed sensors dispersed within the containment building. If leaks occur operators must enter the area and locate the leaking container. Extended exposures during normal inspection can add up quickly causing concern for human health.

**Solution:**

A mobile robotics device with enhanced intelligence and dexterity has advantages in reducing risks and costs. The Intelligent Mobile Sensor System (IMSS) is capable of operating in narrow aisles and interpolating the free aisle space between rows of stacked drums. It uses an integrated sensor suite for leak detection, and interfaces with the site database for inspection planning, data correlation, updating, and report generation. The robot

would be capable of departing on an assigned mission, collecting required data, recording which portions of its mission had to be aborted or modified due to environmental constraints, and reporting back when the mission was completed.

**Benefits:**



- ▶ Detecting drum location, surface dents, and drum tilt
- ▶ Detecting rust, corrosion, fluid, or other defects
- ▶ Detecting, reading, and verifying labels
- ▶ Human and environmental risks lowered

**Technology:**

The key technologies in IMSS are the inspection sensors, the autonomous navigation system, and the integrated database system. The required inspection platform is similar to a science mission in that it must gather, store, and correlate data. The sensor systems to be used include commercial components as well as derivatives of those designed to survey the Martian surface from a rover (miniaturized to fit on a vehicle and with a computer interface).

The tasks of initially locating the drums, detecting surface dents, and measuring drum tilt are essentially three-dimensional tasks, requiring accurate measurement of three dimensional points on the surface of the drums. Active vision techniques using structured light or laser ranging are better for cost and performance. Two reasons for this are: 1) the majority of the drum surface is visually smooth and featureless and 2) stereo vision algorithms typically are much more computationally intensive and less reliable than direct range measurement using structured light or laser ranging. identification of



other defects and labels relies on a color vision system. All defects are processed onboard in real time.

Safety qualification of a vehicle operating in close proximity to hazardous and volatile wastes is an issue at Department of Energy (DOE) facilities. The vehicle must operate in a potentially explosive environment, there must be no collisions with containers that might release contaminants into the environment, and the vehicle must be fail-operational so that in case of equipment failure, the vehicle can still return to its base without human operators retrieving it. The IMSS is designed to meet all applicable requirements for safe operation in a wide range of environments.

The IMSS is one of three drum inspection technologies to participate in a "bake-off" among similar and competing technologies. The other two systems are the Automated Baseline Change Detection (ABCD) System (also developed by Lockheed Martin) and the Intelligent Inspection and Survey Robot (ARIES, developed by the South Carolina Universities Research and Education Foundation).

#### **Project Conclusion:**

The project was concluded in June 1997. The major goal of the project was the evaluation and validation of the vehicle system in operational environments. The three specific parts of this process were the field trial activities at the DOE site in Fernald, OH, the preparation and

system upgrade phase in Denver, and the installation and test at the DOE's Idaho National Engineering and Environmental Laboratory (INEEL) site. Each of these operations provided insights both into the operational characteristics of the system as well as the way in which the inspection process could be enhanced for the safety of inspectors and for the consistency of the inspection process. Currently, INEEL will deploy this system at their Waste Management Complex for drum inspection and to assess the long-term reliability and performance of the system.

#### **Contacts:**

Robotics and automation have been core technologies at Lockheed Martin for its aerospace and defense activities. Lockheed Martin is actively applying this technology base to DOE's needs. For information on this project, the contractor contact is:

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DOE's Federal Energy Technology Center supports the Environmental Management - Office of Science and Technology by contracting the research and development of new technologies for waste site characterization and cleanup. For information regarding this project,

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