



# Houdini: Reconfigurable In-Tank Robot



**Developer:** RedZone Robotics, Inc.  
**Contract Number:** DE-AR21-95MC32092  
**Crosscutting Area:** Robotics

**Deactivation & Decommissioning**  
**FOCUS AREA**

**Problem:**

The retrieval of radioactive, chemical, and other wastes stored in the Department of Energy (DOE) surface and underground waste storage tanks is a hazardous and geometrically challenging task which defies strictly manual methods or existing remote technology. The use of remote equipment has been identified as the necessary mode of tank waste removal. A variety of remote systems and tools are needed to provide a range of capabilities for tank waste retrieval.

Mobile worksystems are attractive for in-tank operations because they provide flexible tool deployment platforms. However, existing mobile worksystems with sufficient work capability are too large to be deployed through existing tank openings.

**Solution:**

The developed system (named Houdini) will perform waste retrieval, waste mobilization, waste reduction, and other decommissioning tasks. Houdini is a tethered, hydraulically-powered, track-driven worksystem with an expandable frame chassis. When

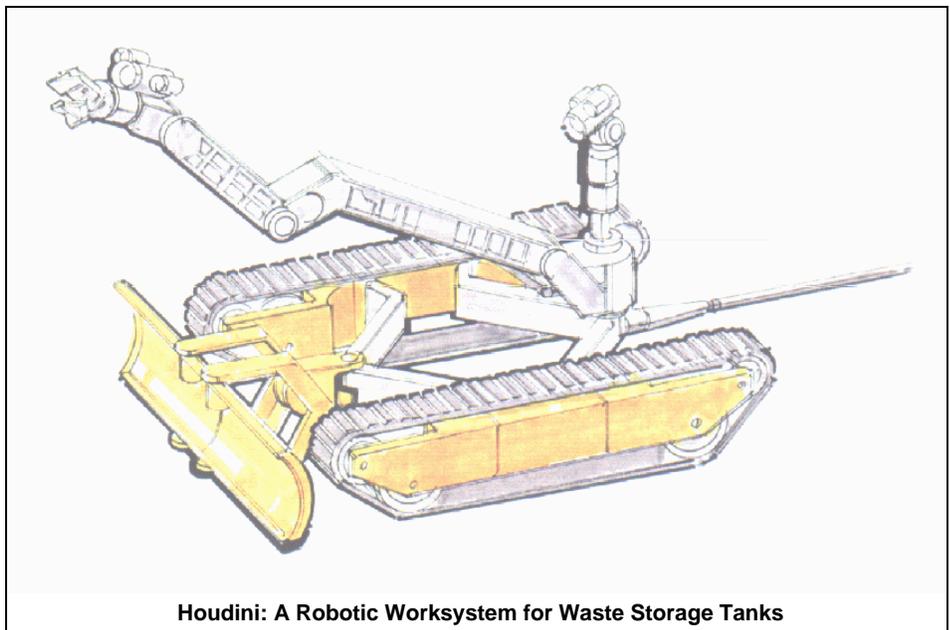
fully deployed, Houdini measures approximately 4 feet x 5 feet, but the system can be collapsed to fit through confined entries as small as 22.5 inches in diameter. Houdini also can be scaled to different sizes to be used for various applications within hazardous environments.

The Houdini concept was originally developed specifically to respond to the waste retrieval problem at the Fernald and Oak Ridge National Laboratory (ORNL) sites. Although the specification and design of Houdini was tailored to the Fernald K-65 silo application, Houdini will support the final remediation of Silos 1, 2, & 3 at the Fernald site and

Gunite tanks at ORNL. In fact, the initial application of Houdini is currently planned for the Gunite tanks at ORNL.

**Benefits:**

- ▶Houdini can be used to retrieve waste from tanks for treatment and long-term storage and can perform heel and debris removal from waste storage tanks during and after bulk materials removal by other means
- ▶Support waste retrieval in the Gunite and associated tanks treatability study at ORNL
- ▶Tracked locomotion enables travel



Houdini: A Robotic Worksystem for Waste Storage Tanks



on, over, and through various materials

►Smooth surfaces and no entrapment corners allow for easy system decontamination by spray washdown

►The system is sealed for spray washdown and for operating fully submerged

►A plow blade provides substantial material mobilization rates

►A dexterous manipulator deploys tooling for various tasks

### **Technology:**

In comparison to currently available mobile robot systems, Houdini's folding frame technology provides a substantially larger work platform which can fit through existing tank openings. As a larger platform, Houdini is more powerful, more efficient, and more capable than smaller mobile systems.

Houdini's reliable actuation systems, low-voltage servovalving, inherent spark-proof hydraulic operation, environmentally-safe hydraulic fluid, self-collapsing capability (under gravity) for removal, hand-operable winch, and hard-wired suitcase control console make for a system that's safe and efficient to operate. The use of the tether as an emergency retrieval device, the inherent low speeds (3 mph maximum), and low forces generated by the system reduce the likelihood of tank damage during system operation.

With few moving parts and employing cost effective off-the-shelf technologies, Houdini is a reliable worksystem that's designed for full immersion. Houdini's modular design enables efficient system maintenance. System modules can be replaced easily, which enables efficient maintenance. Houdini provides simple, familiar material handling capabilities similar to the bulldozers and backhoes of the construction industry. Additionally, Houdini is designed to operate in radioactive environments.

### **Project Conclusion:**

The project was completed in January 1997. A successful demonstration was performed from December 10-12, 1996, at the ORNL Tanks Technology Cold Test Facility to demonstrate the tank waste retrieval system. The Houdini, remotely operated robot was tested with the Modified Light Duty Utility Arm (MLDUA) and the Confined Sluicing Waste Dislodging and Conveyance System which will be utilized in remediating the Gunite Tanks at ORNL.

The cold tests are being performed for use as full-scale testing and to train site personnel for the sludge retrieval that will be conducted in the North Tank Farm at ORNL.

### **Contacts:**

This project is a collaboration of RedZone Robotics, Inc. and Carnegie Mellon University's Robotics Institute. Both organizations are distinguished for their abilities and demonstrated

experience of integrating complex robotic technologies into systems that prove themselves in both research and real world contexts. For more information on this project, the contractor contact is:

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