# ARIBO-Industrial Hygiene Inspection Program Proposal

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## 1. Introduction

Throughout the Army, Industrial Hygiene (IH) teams are responsible for inspection, environmental reconnaissance, and emergency response. Industrial hygiene is an integral part of installation force protection and is an important component of an installation’s toxic industrial chemical spill planned response. Current best practices for conducting the IH mission requires direct human exposure to these hazardous environments. Robotic systems offer the potential to remove humans from these dangerous situations while maintaining the reliability and accuracy of the response team. Applying robotic solutions to this domain also contributes to the DoD unmanned systems goals outlined in “The Unmanned Systems Integrated Roadmap FY2011-2036.”[[1]](#footnote-1) Furthermore, robotic IH solutions are a force multiplier because these systems can be sent into a hazardous environment, parked, and allowed to collect data autonomously. Additionally, using robotic platforms for the IH environment is faster and safer than equipping and decontaminating a human. Finally, if successful, this project has potential DOD-wide application.

## 2. Trends

Ageing stocks of munitions and newly developed systems are creating larger quantities of dangerous materials that require monitoring and potentially, emergency response. In the current austere fiscal environment, enlarging a trained, professional IH team is a significant challenge. It is desirable to reuse/re-purpose existing inventory and to improve efficiency where possible. One way to accomplish this goal is to automate tasks using technology such as robots and networked systems. This automation can allow a smaller team of trained personnel to effectively manage a large group of tasks.

## 3. Problem

An Industrial Hygiene mission is to reduce soldier and employee exposure to environmental factors and stresses including: chemical (e.g., liquid, particulate dust, fumes, mist, vapor and gas), physical (e.g., electromagnetic radiation, temperature, ambient pressure, noise, vibration and ionizing radiation), and biological (e.g., agents of infectious diseases, insects, mites, molds, yeasts, fungi, bacteria and viruses) elements. The majority of hazards come from industrial processes on Army installations. Army industrial hygiene personnel are at risk from exposure to these hazardous environments in the conduct of their duties. Additionally, rapidly equipping human teams for response to incidents and post-action decontamination pose difficult challenges.

## 4. Solution

We propose that United States Military Academy (USMA) cadets, through an engineering design project over the course of two years, design and modify ground mobile robots (e.g., Packbot 510) with industrial hygiene sensors and data acquisition equipment. This effort would be under the supervision of the TARDEC Ground Vehicle Robotics (GVR) branch and industrial hygiene inspectors from Fort Knox and West Point. The Electrical Engineering faculty at the United States Military Academy have experience with designing robotic solutions for military problems using the Packbot chassis. Additionally, access to experts in the radiological (through the Physics and Nuclear Engineering department) and chemical (through the Chemical and Life Sciences department) fields provides a wealth of expert knowledge and experience to ensure project success.

Packbots are a program of record in the Army inventory and are readily available for re-purposing to the IH mission. The Electrical Engineering and Computer Science department has numerous Packbots on hand to conduct its research. Over the past two years, the cadets and faculty have worked on creating autonomous reconnaissance robots using the Packbot chassis and laptops. This knowledge base allows the Academy to quickly begin new research for robotic applications in a new domain.

In the first year of the project (Academic Year 2013-2014) the USMA research team would characterize sensors, integrate the sensors with the Packbot chassis, and test an initial system that operates using wireless remote control. This initial concept vehicle would use existing communications systems on the robot and the associated computer hardware.

During the project’s second year, the robot’s systems would be improved based on lessons learned from year one and feedback from the stake holders. The system would also be automated to provide the system some autonomy. Creating autonomous functions allows the operator the freedom to focus on other tasks and also moves towards the DoD goal of one operator for many systems. This autonomy can take the form of features such as obstacle avoidance, simultaneous localization and mapping (SLAM), and navigation.

## 5. Benefits

Through the use of robotic-enabled ground vehicles in a structured, controlled environment, the ARIBO-IH pilot will increase researchers’, manufacturers’, and users’ understanding and familiarity of these systems in real-world operational scenarios. The ARIBO-IH pilot safely provides the service of IH inspections, removing the human IH professional from a potentially hazardous situation while reducing cost. Additionally, the project will facilitate the design, standardization, deployment, and supervision of the resulting ARIBO-IH inspection robots. Finally, by using the USMA cadets as researchers, they are exposed to Army technologies and systems at the beginning of their careers. The benefits of generating officers with technological backgrounds in robotics systems is paramount to achieving the DoD’s long term unmanned systems goals.

## 6. Examples

The robotic systems developed under this project could be employed in a number of situations to include:

* Environmental reconnaissance in routine industrial hygiene tasks and emergency response
* Weather station at the emission source
* Ventilation duct inspection
* Investigate suspected terrorist devices
* Site abatement or mitigation projects

## 7. Budget

Travel:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Trip Purpose** |  | **Team Cost** | **Frequency** | **Project Cost** |
| Coordination Meetings (Ft. Knox, KY) | $ | 3,500.00 | 1 | 3,500.00 |
| Cadet Client Meetings (TARDEC) | $ | 3500.00 | 2 | 7,000.00 |
| System Testing (Bluegrass Army Depot) | $ | 2500.00 | 2 | 5,000.00 |
| **Total Travel** | $ |  |  | 15,500.00 |

Equipment:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Equipment** |  | **Team Cost** | **Units** | **Project Cost** |
| System sensors (e.g., radiac, hazmat, IMU) | $ | 32,000.00 | 1 | 32,000.00 |
| Expendable Supplies | $ | 900.00 | 1 | 1500.00 |
| System Packing | $ | 4,000.00 | 1 | 4,000.00 |
| Computing Systems | $ | 5,000.00 | 1 | 6,000.00 |
| Robot Maintenance | $ | 5,000.00 | 1 | 3,000.00 |
| iRobot Developer Support Package | $ | 9,000.00 | 100% | 18,000.00 |
| System Technician | $ | 60,000.00 | 100% | 120,000.00 |
| **Total Equipment Cost** | $ |  |  | 184,500.00 |

Salary:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Technical/Admin Support** |  | **Annual EECS Cost** | **%Usage** | **Project Cost** |
| None | $ | 0.00 |  | 0.00 |
| **Total Labor Costs (x 2 years)** | $ |  |  | 0.00 |

**Total Estimated Project Cost**: $200,000.00

## 8. Conclusion

Industrial Hygiene monitoring and response functions possess the potential for improving efficiency and safety through the use of robots. Robotic systems such as the Packbot can remove humans from dangerous environments while accurately and reliably conducting tasks that are critical to operations on all Army installations. These improvements in efficiency and safety can be obtained in a fiscally responsible manner through the use of existing Army systems and the expertise resident at the Department of Electrical Engineering and Computer Science at the United States Military Academy. Additionally, research conducted at the Academy benefits the Army long-term by exposing future officers to Army programs and technology at the beginning of their career.

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1. DoD, "The Unmanned Systems Integrated Roadmap FY2011-2036," Department of Defense, Washington, D.C., 2011. [↑](#footnote-ref-1)