RADIO FREQUENCY IDENTIFICATION TRACKING OF INTERNATIONAL SHIPMENTS OF HAZARDOUS AND RADIOACTIVE MATERIALS

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SUMMARY

The U.S. Environmental Protection Agency (EPA), working with other stakeholders, is exploring the feasibility of using radio frequency technology to track hazardous wastes entering the U.S. It is anticipated that this technology can provide near real-time, accurate data to enforcement and compliance officials on the status of international shipments of hazardous and radioactive materials. While the demonstration pilot is focused on the U.S./Mexican border, the results from this pilot may inform the application of this technology to a much broader range of international trade in environmentally dangerous goods and substances.
Currently, there is no accurate inventory or accounting of hazardous waste entering the United States from foreign-owned Mexican manufacturing plants known as maquiladoras. The current paper-based manifesting system does not allow for timely tracking of shipments that enter the U.S. but do not arrive at the designated receiving facility. Inspection evidence has indicated that some of this material is being abandoned in warehouses on both sides of the border. An enhanced tracking system that provides timely, accurate data to regulatory officials is needed to prevent illegal disposal. An integration of a tracking technology, such as radio frequency identification, with the current manifest system may allow near real-time tracking of international hazardous waste shipments from the generator to the receiving facility. This article provides information about a range of radio frequency identification technology applications the U.S. will test in a series of import/export hazardous waste shipping scenarios to determine if it is an appropriate technology for voluntary implementation by generators and shippers of trans-border waste. While this article focuses on hazardous and radioactive materials, it is feasible that this technology could be used to track other materials of interest. With "just-in-time" inventory systems being used globally, where supplies of raw materials are not maintained on-site, any tracking system that can reduce time spent crossing international borders will be advantageous to these facilities.

1 INTRODUCTION

There is a lack of accurate information concerning the hundreds of thousands of tons of hazardous waste that cross into the United States each year from Mexico[1]. Much of this waste is from the foreign-owned maquiladora (manufacturing and assembly) facilities in the Mexican border zone. The Resource Conservation and Recovery Act, part of the Solid Waste Disposal Act, requires that all hazardous waste be tracked from cradle–to–grave. Currently, due to the paper-based manifest system being used, the U.S. Environmental Protection Agency (EPA) is unable to fully determine when the maquiladora waste enters the U.S. and when, or if, the waste reaches the designated receiving facility. Mexico is not required to file a Notice of Intent to import these materials, as they classify them as returned product and not hazardous waste. The Department of Homeland Security has identified hazardous material shipments as being vulnerable to terrorist attack[2]; therefore greater accountability of these shipments while in transport is needed.

The need for tracking and monitoring international shipments of hazardous wastes is a global one. For example in Europe, the European Union Network for the Implementation and Enforcement of Environmental Law – TransFrontier Shipment Seaport Project, which inspected cross-border shipments of hazardous wastes from Europe to overseas countries, found that 20% of the inspected wastes shipments were illegal[3].

2 MEXICAN MAQUILADORA SYSTEM

In 1965, Mexico introduced their Border Industrialization Program or maquiladora program. This program encouraged foreign corporations to locate their manufacturing and assembly plants in Mexico by eliminating duties on raw materials imported into Mexico. Raw materials can be imported into Mexico without import duties, as long as the waste products from these materials are exported to the country of origin. Foreign-owned companies took advantage of the lower labor costs and reduced shipping distances for products, resulting in heavy industrialization in the Mexican border zone. As of October 2006, there are more than 2,294 maquiladora facilities in the six Mexican border states, employing close to 1 million people. These facilities produce a number of goods, including chemicals, electronic parts, textiles, automotive components and machinery, valued at more than $112 billion in 2005[4].

3 LEGAL REQUIREMENTS

3.1 U.S. Legal Requirements

Hazardous waste in the U.S. is regulated through Resource Conservation and Recovery Act which is administered by the EPA and the states[5]. Resource Conservation and Recovery Act's requirement for cradle-to-grave tracking of wastes is made more complex when the generator is in one country and

the receiving facility is in another. Each shipment of waste is required to be accompanied by a Uniform Hazardous Waste Manifest. EPA is considering implementation of an electronic manifesting system to allow automation of the process, improving the timeliness of the tracking of these shipments. There is no regulatory requirement for the physical tracking of maquiladora waste, and any adoption of radio frequency identification tracking of hazardous waste will be on a voluntary basis.

3.2 Mexican Legal Requirements

The foreign-owned maquiladoras operate solely under Mexican laws and regulations. The Secretariat of Environment and Natural Resources is responsible for setting standards and administrating the General Law of Ecological Balance and Environmental Protection. Article 153 of the Fourth Title, Chapter VI outlines the procedure for the export of hazardous waste to other countries. Formed in 1992, the Federal Attorney General for Environmental Protection enforces the environmental regulations and conducts inspections of maquiladora facilities.

Numerous countries, including the United States, Germany, Japan and Korea, participate in the maquiladora program. If the raw materials supplied to any of these facilities originate in the U.S., the wastes derived from these raw materials are returned to the U.S. Because Mexico does not consider these exported materials a hazardous waste, but instead a returned product, they do not submit a Notice of Intent to the U.S.

3.3 International Treaties Governing Mexican Hazardous Waste

Wastes from "temporarily imported" raw materials must be returned to the country of origin, as stated in Annex III of the Agreement between the United States of America and the United Mexican States on Cooperation for the Protection and Improvement of the Environment in the Border Area, known as the La Paz Agreement. The U.S. and Mexico signed the La Paz Agreement in 1983. The current Border 2012 program, which evolved from the La Paz Agreement, states under its Goal # 3 that it will "by 2004, evaluate the hazardous waste tracking systems in the United States and Mexico, and during the year 2006, develop and consolidate the link between both tracking systems"[6]. Due to operational deficiencies in both the Mexican and the U.S. waste tracking databases, both systems have been discontinued, and this Border 2012 goal has not been achieved as of this publication. Goal # 6 of the Border 2012 program is to "Improve environmental performance through compliance, enforcement, pollution prevention, and promotion of environmental stewardship," and this project will help ensure compliance with the Resource Conservation and Recovery Act waste tracking requirements.

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal went into force in 1992[7]. Mexico has ratified the

Convention but the United States has not. The Basel Convention can take precedence over the North American Free Trade Agreement (NAFTA), allowing countries to ban hazardous waste imports if they will not be managed in an environmentally sound manner.

Mexico, the U.S. and Canada are signatories to NAFTA, which went into effect in 1994. The Preamble to NAFTA states that its purpose is to reduce distortions to trade, increase competitiveness and create an expanded and secure market for goods, in a manner consistent with environmental protection and conservation. Signatories to the agreement also agree to strengthen the development and enforcement of environmental laws. Separate from NAFTA, but strongly aligned to it, is the Supplemental Agreement on the Environment, which promotes environmental enforcement.

4 RADIO FREQUENCY IDENTIFICATION TECHNOLOGY

4.1 Technology Description

A typical radio frequency identification system consists of four main components: tags, an encoder, readers and central processing unit. An radio frequency identification tag consists of a micro-transceiver and a flexible antenna sealed in a plastic-coated inlay, which can be applied to or incorporated into a product for the purpose of identification. The encoder writes information to the tag that is acquired by a reader. The radio frequency identification system operates by transmitting data using radio waves for communication between a tag and a reader, and ultimately to a database. Power is supplied either by a battery or by energy from the reader. The distance from the reader at which a tag can be read varies from a few feet to over 100 feet, depending on the type of tag used. Line of sight of the reader with the tag is not required, as is the case with barcodes.

4.2 Current Applications of Radio Frequency Identification to Track International Movements of Goods

Radio frequency identification technology is a proven, commercially ready tracking technology in the global supply chain, having been tested and implemented in a large number of applications worldwide. EPA and Oak Ridge National Laboratory have successfully demonstrated the use of radio frequency identification technology to track radioactive materials in commerce[8]. The U.S. government is currently pilot-testing radio frequency identification for a wide variety of applications[9, 10] as is the commercial sector. For cross-border applications, U.S. Customs and Border Protection (CBP), part of the U.S. Department of Homeland Security, is using radio frequency identification and other technologies to track both people and goods entering the U.S. "The development of wireless technology and radio frequency identification will guide the future of communications and tracking technology"[11]. Information on specific programs can be found at the CBP website[12,13].

5 TECHNOLOGY TESTING APPROACH

5.1 EPA's Technology Verification Program

EPA's radio frequency identification testing will be conducted under its Environmental Technology Verification Program, established in 1995 to develop testing protocols and verify the performance of innovative technologies that have the potential to improve the protection of human health and the environment. The goal of the Environmental Technology Verification Program is to provide credible performance data for commercially ready environmental technologies, collected through rigorous and verifiable testing, to speed implementation for the benefit of purchasers, vendors, stakeholders and the public.

In 2005, the Environmental Technology Verification Program began a new element to evaluate innovative and commercially ready technologies that have the potential to address high-risk environmental problems. This new program, Environmental and Sustainable Technology Evaluations continues to maintain the quality assurance, cost sharing, and stakeholder involvement that are fundamental operating principles of Environmental Technology Verification. The radio frequency identification project was competitively chosen as one of the initial technologies to be tested. The Environmental Technology Verification / Environmental and Sustainable Technology Evaluations Program is a partial cost-sharing program with stakeholders, where vendors supply their technology and participate during testing. The testing process is transparent, with all results being published on EPA's Environmental Technology Verification website, http://www.epa.gov/etv/. EPA anticipates conducting verifications of up to 10 potential vendors in the first round of testing.

5.2 Stakeholder Involvement

Officials from Mexico, the United States and Canada have agreed to participate in radio frequency identification technology verification. Mexican officials will include representatives from The Secretariat of Environment and Natural Resources (regulatory), Federal Attorney General for Environmental Protection (enforcement) and Aduana (Customs). Officials with the EPA Office of Enforcement Compliance and Assurance, Office of International Affairs, Office of Solid Waste and Region VI and XI will be active partners. Other federal agencies include the U.S. Department of Homeland Security, including CBP, and the U.S. Department of Transportation. The test information will be shared with the U.S. Intra-Gov Working Group for Radio Frequency Identification, where U.S. agencies using radio frequency identification technology transfer information on implementation and work toward standardization. Environment Canada will track progress on the testing, as the testing is designed to allow for the transfer of the radio frequency identification systems to the U.S./Canada border.

State agencies, including the Texas Commission on Environmental Quality and the New Mexico Border Authority, will participate in the data gathering effort. Three maquiladoras and two Mexican trucking firms will volunteer their time and equipment to support the testing. Up to 10 radio frequency identification vendors will be demonstrating their system's capabilities during separate testing events. Each vendor is responsible for providing their hardware and software, and setting up and maintaining their radio frequency identification equipment at the testing locations.

6 RADIO FREQUENCY IDENTIFICATION TESTING PROTOCOL

The site selected for this pilot is a U.S./Mexico border crossing away from a more heavily utilized crossing, in an attempt to avoid any slowing of trade as the tests are carried out. This pilot is also sensitive to and will assess the potential for multiple readers to conflict with other signals used in other tracking applications.

To accurately simulate hazardous waste and raw material shipments, three types of containers will be tracked, including: 55-gallon poly drums, 55-gallon metal drums and corrugated cardboard cubic yard boxes. It is anticipated the radio frequency identification signals will respond differently when attached to each of these material types. Packing configuration within the truck will also be varied to determine the effect on the radio frequency identification signal. The radio frequency identification tags will read at five checkpoints, including the generator facility, the Mexico border crossing, the New Mexico customs crossing, a warehouse facility and the simulated receiving facility.

For testing, each radio frequency identification tag will be programmed with a unique number that will link to information in a secure web-based database, containing data from EPA's Uniform Hazardous Waste Manifest. Hazardous waste is identified and shipped by separate waste streams, reflecting the specific composition of each waste. Therefore, each separate container of waste, rather than the full load on the vehicle, is the relevant tracking unit. It is the need for more focused tracking and data gathering, down to the container level and providing information that links to the specific waste stream that differentiates this application of radio frequency identification from other tracking applications currently in use.

During the testing, the measurement parameters will include radio frequency identification tag read accuracy, operational frequency, effective radiated power (power level), environmental conditions (temperature, humidity, wind speed, particulates), truck trailer conditions (shock, vibration, temperature, humidity) and truck velocity. Supplemental evaluations will be conducted on information technology systems compatibility, system security (ability to cause interference), cost and ease of operation.

While we know generally that active battery-powered tags are more expensive to acquire and operate than passive tags, this pilot will provide more specific cost data for implementing an radio frequency identification system on a container basis than is currently available. Due to the different approaches being proposed by the individual vendors, it is too early to predict actual operating costs. Based on costs determined during the 2005 EPA radio frequency identification tracking of radioactive materials in commerce study[14], unit costs for hardware included $3,400 per reader and $85 per active battery-powered tag. One time software and installation costs totaled $10,300. The radio frequency identification industry predicts that system costs will become more economical as standardized protocols are adopted and more applications are brought on-line. Field testing will begin when all funding sources for the pilot are in place.

7 CONCLUSION

In order to be able to verify cradle-to-grave tracking of hazardous waste from Mexican maquiladoras, as required by Resource Conservation and Recovery Act, EPA needs more near-real time accountability of this material. Tracking of hazardous materials with radio frequency identification could provide timely, verifiable information to U.S. enforcement officials regarding the quantity and composition of the material entering the country and confirm that the material has reached the designated receiving facility. Mexican enforcement and Customs officials will receive verification that the waste has returned to the country of origin, as required by Mexican environmental law. With a viable radio frequency identification system in place, regulators, generators, shippers and importers would all benefit from this additional layer of visibility, ensuring accurate and timely documentation that their waste shipments reach the correct facility and were not abandoned or inappropriately disposed of along the way.

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