Commercial Vehicle Radiological System Module of an Integrated Safety and Enforcement System for the 21st Century with Homeland Security Benefits

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Abstract

The Department of Energy (DOE) Oak Ridge National Laboratory (ORNL) is currently prototype testing state-of-the-art sensor technologies associated with detection of radiological materials in-commerce. These technologies are deployed at an Evaluation User Facility at the I-40/I-75 Weigh and Inspection Station in Knoxville, TN. This real-world testing addresses radiological and nuclear material detection in commerce and is part of a larger program entitled Performance-Based 21st Century Commercial Vehicle Inspection System, which is an Integrated Safety and Enforcement System for the 21st Century with Homeland Security Benefits.

The initial deployment of the Commercial Vehicle Radiological System Module in Tennessee is unique in that it is the first system, of its kind, to be installed at Weigh and Inspection Stations under the auspices of State safety and law enforcement entities. This safety and security initiative serves the security, safety and enforcement needs of local, state and federal government entities and utilizes the respective state's existing weigh and inspection infrastructure. The weigh and inspection infrastructure is a recognized and accepted infrastructure by the commercial carrier industry, and thus the deployment of the Commercial Vehicle Radiological System Module will have a negligible impact on interstate commerce. Safety Monitoring includes drivers, vehicles and cargo addressing safety of shipments in transport, identification of unsafe vehicles and carriers, and monitoring of domestic and foreign commercial vehicles (as it relates to North American Free Trade Agreement [NAFTA]). Enforcement opportunities address cargo safety, tracking, placarding, motor carrier safety regulations, hazardous materials regulations, and over dimension and over weight commercial vehicles. Homeland Security Applications address Radiological Dispersal Device (RDD - "Dirty Bomb") identification, identification of unsafe or illicit transport of hazardous materials including chemicals and radiological materials, food safety and screening for shipments of illicit drugs.

Continuous Improvement Goal

The overall goal of this project is to continuously improve commercial truck and bus, safety and security, through the application of state-of-the-art technologies to driver, vehicle, and cargo inspections. The prototype system is assisting enforcement officers to perform their job more effectively and efficiently, enhance homeland security monitoring of highway transport and thereby create a National Performance Based Infrastructure for Commercial Vehicle Inspection for the 21st century.

Program Approach

To accomplish the continuous improvement goal, a Performance Based Commercial Vehicle Inspection Program Roadmap has been created utilizing a phased systems integration approach and addressing the following primary components of commercial vehicle operations: the **Driver**, the

Vehicle, and the **Cargo**. The identity and the condition of each of these three components are currently being validated. Technology becomes the supporting tool to undertake the safety and security mission in an effective and efficient manner. To achieve the continuous improvement goal of a 21st Century Commercial Vehicle Inspection Process, a plan has been developed that can assure success. First, an environment was established in which the program could be successfully undertaken. Two critical needs for a successful program were:

- Performance Based Commercial Vehicle Inspection System Advisory Group
- Performance Based Commercial Vehicle Inspection Evaluation User Facility(s)

The advisory group assures the program meets the needs of the various stakeholder groups. The Evaluation User Facility(s) assures that the products selected can function within the demanding roadway environment that vehicle inspection takes place.

Candidate Technologies

A performance based commercial vehicle inspection process is envisioned that will be virtually transparent to the carrier and will more objectively select trucks and buses for additional detailed inspection procedures. This will increase the effectiveness of safety enforcement and increase the productivity of the motor carrier industry. Homeland security will be enhanced through this performance based automated inspection process. For example, the same technology used to automate mandated driver safety information could also contain security information about the driver. Biometric technology used to identify drivers could also be used to identify potential suspects of drug smuggling or terrorism. The following table identifies Program Area Candidates, associated technologies, applications, and their envisioned use.

Cross Walk of Envisioned Use of "Plug and Play" Program Area Candidates				
Program Areas	**Program Area Candidates**	**Technology**	**Applications**	**Envisioned Use**
VEHICLE				
	Brakes			
		Infrared	Heat Detection	Mobile Screening
		Strain Gauge	Brake(s) Integrity	Fixed Performance Based
	Tires			
		Infrared	Heat Detection	Mobile Screening
		Imaging	Pressure, Tread Depth, Sidewall Integrity	Fixed Performance Based
	Weigh-in-Motion	Strain Gauge	Fixed – High Speed	Fixed Screening and Validation
	Carrier/Equipment Identification	Satellite, Smart Card, Bar Code, RF tagging	Tracking, Insurance, Safety Rating, Registration, Hours_of_Service	High Risk/Visibility Carriers – Graded Approach
	Carrier/Equipment Maintenance	Sensor Based	Condition Based Maintenance	High Risk/Visibility Carriers – Graded Approach
DRIVER				
	Credentialing	Smart Card	HAZMAT/Tanker	Mobile Screening

Cross Walk of Envisioned Use of "Plug and Play" Program Area Candidates				
Program Areas	**Program Area Candidates**	**Technology**	**Applications**	**Envisioned Use**
			Driver Certification	
	Identification	Smart Card Biometrics	Identification and Tracking	Fixed Screening and Validation
	Human Factors	Sensors	Fatigue, Gaze Distraction, Cognitive Inattention, and Medical Impairment	Alerts
	Integrated Justice	Interactive Integrated Databases	Interactive Info Queries and Updates	Fixed and Mobile Access
CARGO				
	Shipping Papers (Manifests)	RF Tags and AIS	Identification and Validation of Cargo	High Risk/Visibility Cargo - Graded Approach
	HAZMAT (ID and Tracking)	RF Tags on HAZMAT Package	Identification and Validation of Cargo	High Risk/Visibility Cargo - Graded Approach
	CBRN Detection	Detection Sensors	Remote Identification of CBRN in transit	Supporting Homeland Security, Emergency Response, Customs Border Patrol and Non-compliance

Phased Systems Integration Approach

Under the guidance of a system advisory group, "plug and play" technologies are being identified where business processes can potentially be streamlined by automation. These technologies are being integrated into a working prototype that are being evaluated at the Evaluation User Facility and tested in a real-world setting at a state weigh and inspection station. Successful technologies will then be fielded as appropriate.

Program Elements

The following key program elements include:

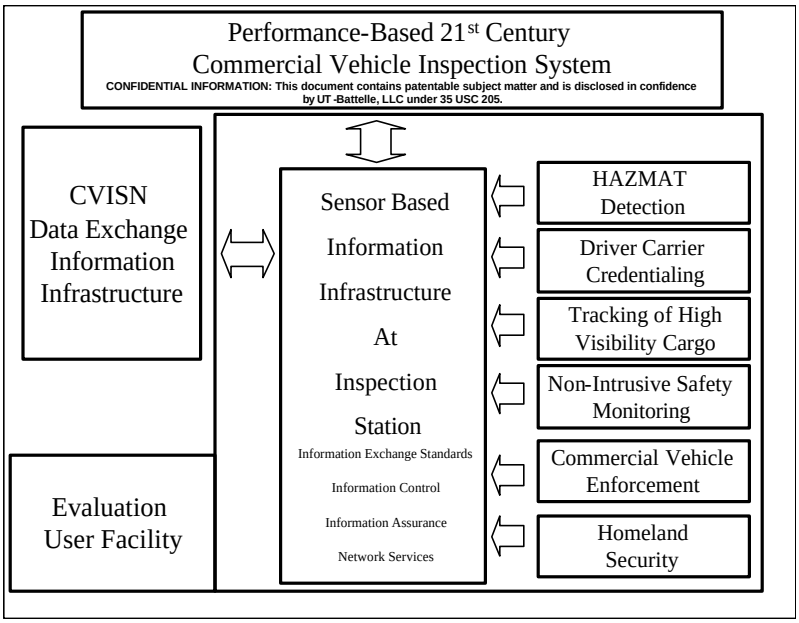
- Sensor-Based Information Infrastructure
- Specification-Based Migration to Performance-Based Inspection
- Commercial Vehicle Inspection System Advisory Group
- Performance Based Commercial Vehicle Inspection Evaluation User Facility
- Best-of-Breed Plug and Play Applications

The below figure illustrates how all the respective program elements will interact together to form the Performance Based Commercial Vehicle Inspection System.

Sensor-Based Information Infrastructure

Each of the program elements is dependent on a sensor-based information infrastructure. In moving from a rule based to a performance based methodology new functionalities are required in the information infrastructure that allow for real-time measurement, intelligent control and calibration of the sensors, scalability in both number and type of measurements, secure and authenticated transfer of information, and optimal human understanding of the information.

Key to any information system infrastructure is integrity. The information must be accurate, protected, accessible only by authorized persons and available when required. To guarantee trusted information, the infrastructure is being designed from an integrated end-to-end information assurance perspective. This requires that data has "value" and must be protected; that all associated persons involved are authenticated to ensure non-repudiation and have limited access based on assigned roles, that information security policy is strictly enforced; that all systems and sensors are performing correctly and data integrity has been maintained.



The sensor based information infrastructure will be compatible with the National Intelligent Transportation System architecture. Commercial Vehicle Information Systems and Networks (CVISN) is focused on safety information exchange, credentials administration and electronic screening particularly from databases not sensor based information systems. While the sensor based information infrastructure complements the current CVISN effort, it is independent of CVISN and can be executed in parallel.

Specification Based Migration to Performance Based Inspection

It is commonly recognized that changes in policy will occur as at the federal government evolves from specification-based regulations to performance-based regulations. This requires creating an integrated environment where near real-time sensor-based inspection systems and relevant records are made available via a high-speed network to the inspection personnel. These performance-based inspection processes will be fielded at state inspection weigh stations and allow commercial vehicle inspection personnel to perform their job more effectively and productively. Additionally, it will significantly increase the number of inspections on non-compliant carriers that take place and the objectivity of the inspection process, which will in-turn, create a safer and more efficient environment for all users of today's highways.

Commercial Vehicle Inspection System Advisory Group

A system advisory group that includes representatives from federal, state and private sector experts in enforcement, customs, motor carrier operations, insurance, emergency response, security, academia and the Department of Energy National Laboratories has been established and chartered by the lead government agency(s) to guide the transformation to the performance based inspection process. The system advisory group, with academia and Oak Ridge National Laboratory (ORNL) as the facilitator, is providing guidance and direction on all aspects of program parameters

identification, technology applications and prioritization to ensure success of the Performance Based Commercial Vehicle Inspection System.

Performance Based Commercial Vehicle Inspection Evaluation User Facility

The Commercial Vehicle Inspection Evaluation User Facility is a conduit for the technology transfer process. The facility is a partnership between a State Commercial Vehicle Enforcement Agency and the state's designated transportation research center. The Evaluation User Facility combines a state's safety and weigh inspection station with a transportation research center. "Best-of-breed" technologies and applications are being evaluated and will be implemented and instrumented at the state weigh inspection station. A high-speed network links the two facilities so that data can be evaluated and stored at the transportation center. The transportation center is linked to the Internet and enables authorized researchers to access the data and participate in the evaluation process. Via the Internet, connections between regional evaluation user facilities will be linked forming a virtual national user facility. This concept allows a close link between the state enforcement agencies, the transportation research centers and the lead federal agency(s) enhancing the research and development process and providing feedback from the states.

The first instance of an Evaluation User Facility is in the state of Tennessee, with the National Transportation Research Center (NTRC) and the Tennessee Department of Safety's Watt Road Weigh Inspection Station. These facilities are physically located less than 10 miles apart. NTRC, ORNL and the Watt Road Weigh and Inspection Station are currently connected via the Internet. The University of Tennessee is the designated state Transportation Research Center. ORNL/UT/NTRC is a national user facility site for the Department of Energy. Also, ORNL is the premier high performance computing and networking facility for the Department of Energy. ORNL, in cooperation with the Department of Energy, has been involved in the development of secure collaboration technology to provide both data access and instrumentation control over the network to research worldwide.

"Best-of-Breed" Applications integrated into Century Commercial Vehicle Inspection Station

Utilizing the above strategy, Commercial Vehicle Inspection Station is established and other Weigh and Inspection Stations are scheduled to be established based on performance based inspection criteria at the Evaluation User Facility. These state-of-the-art facilities are being designed, developed and fielded in such a manner as to accommodate current and future "best-of-breed" performance based inspection technologies. The system advisory group will guide the selection of the "best-of-breed" inspection technologies and applications.

Current Expansion of Prototype

Ongoing efforts of the Commercial Vehicle Radiological System Module of an Integrated Safety and Enforcement System for the 21st Century with Homeland Security Benefits are:

- To develop a deployable national commercial vehicle compliance monitoring system that will identify shipments not compliant with Federal and State regulations (e.g., transportation safety and security, agricultural, and environmental), and
- To increase the safety and security of the interstate highway transportation system.

Commercial Vehicle Radiological System Module Origination
The Commercial Vehicle Radiological System Module, presently employs an Exploranium AT-900 Radiation Detection system. This system maximizes the probability of detecting deeply embedded radiological contamination and/or sources. The system sensitivity may be as low as 1 nSv/h. The unit is ISO-9002 certified by the manufacturer. The unit consists of high-volume polyvinyl scintillators utilizing two large diameter (2") photomultiplier tubes per scintillator.

Interagency Teaming and Private Industry/Government Teaming Approach
Interagency Teaming (DOE, DHS, DOT, TSA, and EPA) leverages the current U.S. Government investment and results in operational test results and information sharing for multiple federal agencies. It further provides on-going operational equipment for States utilizing existing infrastructure (weigh stations) to minimize impact of increased security and monitoring on interstate commerce.

Private Industry and Government Teaming utilize commercial off-the-shelf technologies, thus ensuring the shortest time to implement safeguards and security strategies for homeland defense and highway safety. This approach facilitates the integration of transportation data with radioactive signatures.

Commercial Vehicle Radiological System Module Project Objectives
The Commercial Vehicle Radiological System Module Project's primary objective is to characterize radiological materials (man-made, naturally occurring radioactive material [NORM] and technically enhanced NORM [TENORM]) on US Highways. A second objective is to determine maximum throughput of traffic while maintaining sensor data quality (e.g. how fast, how many, etc.). A third objective is to enhance public safety via dynamic, real time evaluation of compliance with DOT regulation, tracking and ensuring integrity of RAM and HAZMAT shipments, and identifying non-compliances and violations, lastly to unite interagency objectives in compliance, law enforcement and security.

Commercial Vehicle Radiological System Module Project Benefits
The Commercial Vehicle Radiological System Module Project benefits include characterization of NORM and TENORM on US Highways and the sharing of this data. This is resulting in increasing throughput of traffic for valid NORM and TENORM. The sharing of this data is also enhancing emergency response and safety for EPA, FEMA and First Responders, ensuring adherence to DOT regulations, and enhancing ability to track (real-time) large RAM source shipments; and promoting interagency sharing of information for homeland defense.

There are multiple agencies responsible for Radioactive Materials (RAM) shipments. These agencies benefit from the in commerce screening of RAM shipments. The Commercial Vehicle Radiological System Module provides a training platform for RAM. It collects and catalogs data associated with the identification of RAM shippers, carriers, and frequency of RAM shipments in shipping lanes; and provides data points for regulatory improvements.

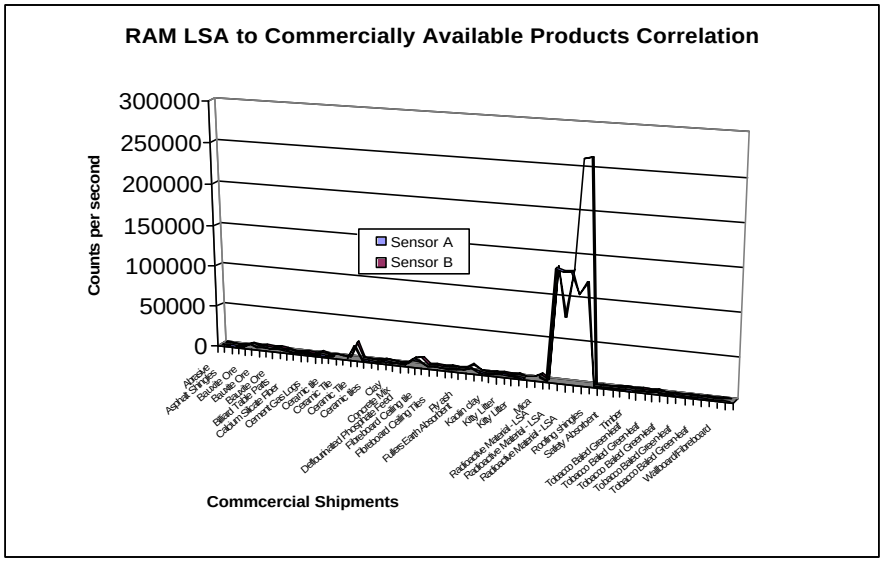
Additionally, potential benefits, as planned additional technologies are deployed in the Commercial Vehicle Radiological System Module will provide enhanced radiation data for identification and monitoring of RAM source shipments. These additional technologies deal with:

- Neutron detection capability for identification of Uranium and Plutonium,
- Gamma spectral information for qualitative and quantitative identification of radioactive material,
- Verifying cargo through use of spectral data, and
- Additional radiation data improves screening and reduces impacts to interstate commerce

Commercial Vehicle Radiological System Module - Current Concept of Operations and Sampling Criteria

Twelve million commercial vehicles pass the Tennessee I-40/I-75 Watt Road Weigh and Inspection Station of the Evaluation User Facility annually. All HAZMAT commercial vehicles are directed to Static Scales. All commercial vehicles are screened for overweight and over-dimension. Current Commercial Vehicle Screening Process Utilizes:

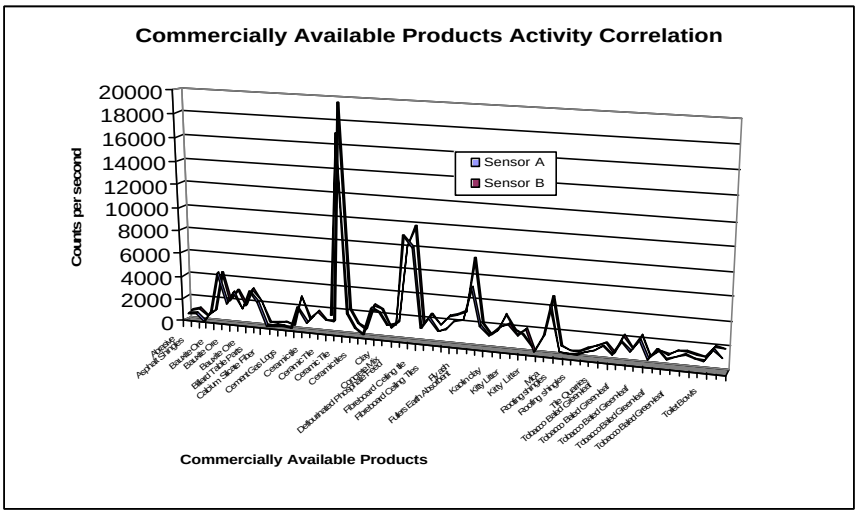
- PrePass, (a commercial pre-screening system utilized in Tennessee)
- Weigh-in-Motion, or
- Static Scale.



The following figures correlate commercial available products, containing NORM and TENORM with radiological activity. Commercial Vehicles pass through radiological sensors prior to stopping on Static Scale. Radiological Sensors are monitored as each commercial vehicle approaches Static Scale. If an alarm is detected, the commercial vehicle is subjected to further inspection. At a minimum, cargo type is identified, documented, and shipping papers are obtained and the driver is interviewed.

Current Commercial Vehicle Radiological System Module Study Data Analysis

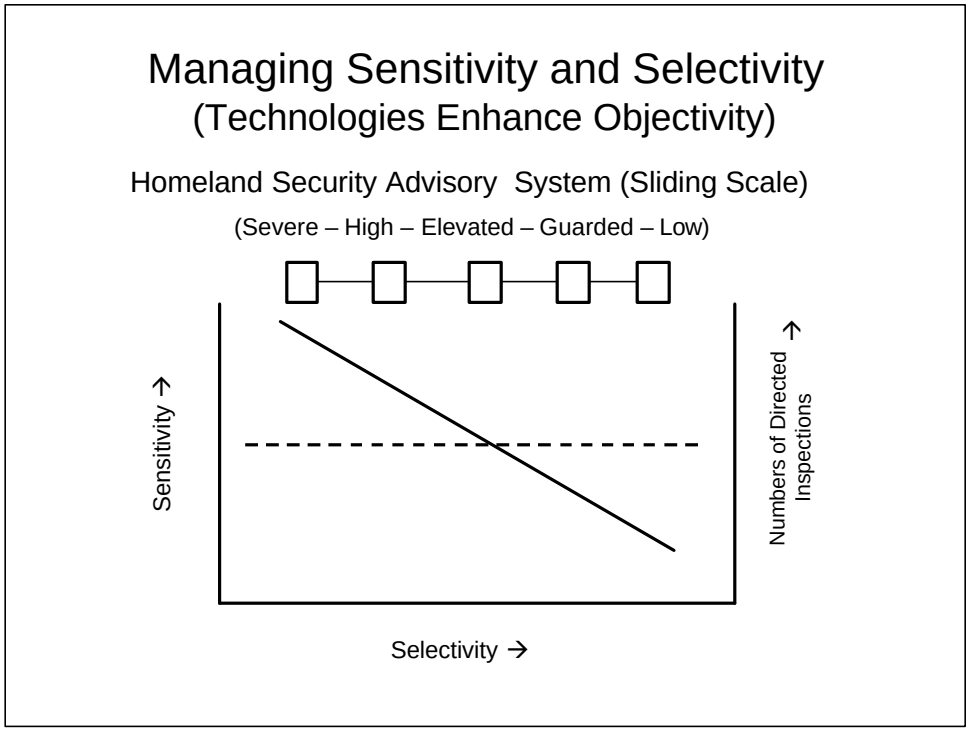
The current Commercial Vehicle Radiological System Module data analysis activities include evaluating the sensitivity and selectivity of bulk monitoring technology, including both fixed and mobile sensors. From these bulk monitoring technologies, correlation signatures are being



developed for commonly shipped isotopes and radiological materials by identifying naturally occurring radioactive materials, identifying technically enhanced radioactive materials, and defining confidence levels for instrument readings correlated with specific cargo types. The figures illustrate qualitative data that is representative of data that from November 2002 to the present.

Commercial Vehicle Radiological System Module of an Integrated Safety and Enforcement System for the 21st Century - Futures

From this analysis, and additional monitoring technologies, a compliance management strategy will be developed for commercial vehicle enforcement using radiation detection technology.

Implementing and expanding the Commercial Vehicle Radiological System Module as a module of an Integrated Safety and Enforcement System for the 21st century will result in the Identification and Monitoring of Radiological (in commerce) Shipments (IMR*ic*S) and will continue to benefit both state and federal authorities under the auspices of State safety and law enforcement entities.

This safety and security initiative serves the security, safety and enforcement needs of local, state and federal government entities and utilizes the respective state's existing weigh and inspection infrastructure. The weigh and inspection infrastructure is a recognized and accepted infrastructure by the commercial carrier industry, and thus will have a negligible impact on interstate commerce. Applying and enhancing technologies to this process will enhance objectivity by managing sensitivity and selectivity associated with the Homeland Defense Advisory System. In today's environment, as the Homeland Security Advisory System is elevated, sensitivity increases but selectivity remains low as depicted by the solid line in the following figure. When the Homeland Security Advisory System category is downgraded, sensitivity is reduced and selectivity is allowed to increase. The Commercial Vehicle Radiological System Module is assisting professionals in effectively managing this sensitivity and selectivity (the dashed line), as depicted in the following figure.