Innovative Survey Techniques Using Position-Sensitive Gas Flow Proportional Counters and Real Time Location System (RTLS) Technology

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Frederick P. Straccia Robert E. Leddy



Advanced Survey Technology

Hardware: Surface Contamination Monitor (SCM) Software: Survey Information Management System (SIMS)







SCM / SIMS Overview

- Developed under NRC SBIR program & presented in NUREG/CR-6450
- Design Goals
 - Measure & Record 100% of area surveyed
 - Minimize Human Factors
 - Detect / Sort / Measure
- Named "Blue Chip Technology for Schedule & Performance" by the USDOE
- SCM uses Position Sensitive Proportional Counters
- Creates easy to understand digital images & graphical depictions of survey data (SIMS)
- Accepted by the USNRC, USDOE, USDOD, EPA, State Regulators, & ORISE (IVT)



SCM Detector

Position Sensitive Proportional Counter (PSPC)

- Functions like any proportional counter
- Uses P-10 gas
- Single anode wire
- Uses principal of charge division to determine where along the anode wire an event occurs
- Large detector behaves like a series of aligned 5 cm detectors
- Allows correlation of survey data with position / location
- Detectors can be fabricated to any size
 - Use 1 and 2 m lengths



SCM Platforms



Floor Monitor



Mobile Monitor



Wall & Ceiling Monitor





Conveyorized Monitor

SCM / SIMS Features & Advantages

- Designed to eliminate human factors that introduce errors
 - Constant survey speed maintained by drive motor
 - Data logged directly to computer
 - Detector mount maintains fixed source to detector distance
 - Not subject to grid registration errors
 - Critical for detection of low levels of activity (especially alpha)
- Bins survey information in 25 cm² pixels
 - 5 cm of forward travel by 5 cm along the anode wire
- Backgrounds associated with small area detectors
- 400 Measurements taken per square meter
- Two modes of operation Dynamic & Static



SIMS Features

WHEN DETERMINING MAXIMUM ACTIVITY - EACH 25 cm² PIXEL IS ACTUALLY 25% OF 4 OVERLAPPING 100 cm² AREAS.





SCM Modes of Operation



Dynamic / Rolling Mode





Static Mode





SCM OPERATIONS Dynamic Mode

Position Correlated

- Scan speed controlled by drive motor
- Encoder based data acquisition for position correlation
- "Strips" stitched together to produce one survey







SCM OPERATIONS Static (Corner) Mode

- Fixed measurement with timer based acquisition
- Used for areas inaccessible to the cart
- Survey data can be "stitched" to data obtained in the dynamic (position correlated) mode
- Typical applications
 - Floor / wall joints
 - Stairs
 - Overheads







SCM OPERATIONS Display



Operator Display Shows Location & Intensity of Activity



SIMS Features Survey Reports

- Summary of survey parameters
- Data summary mean, max, min, standard deviation
- 2-D color image of survey area results
- Exception report with 2-D display of areas over action levels (both 100 cm² and 1 m²)
- Cumulative frequency distribution (CFD) plot



Cumulative Frequency Distribution

- Includes large number of individual measurements
- X-axis presents cumulative number of times counts up to the value have been observed
- Y-axis is the percent of each value of the total number of observations
- Y-axis is a standard deviation scale
- Value at 50th percentile represents average value of the data
- Standard error of average value extremely small



SIMS Features Cumulative Frequency Distribution Plot



CFD Shows Normal Distribution Indicative of Background



CFD From Sample Report of Contaminated Area









2-D Display Allows Visualization of Patterns of Contamination



















Technology is extremely effective in the identification of discrete particles







100 CM² - Beta



100 CM² - Alpha





SCM/SIMS Sample Project

Rocky Flats Environmental Technology Site, Golden, CO Radionuclides of Concern: Pu-239, Sr-90, Cs-137

- Designed and performed final status surveys for Plutonium (low level alpha) using SCM / SIMS at Buildings 123 and 779
- SCM only technology to volunteer & pass blind test for detection of low level alpha activity
- Interfaced with IVT, regulators, and stakeholders
- Site Closure Achieved
- Also provided RP program assessment for Building 371 / 374





SCM/SIMS Sample Project

BNFL 3-Building Project (K-33, K-31, K-29) Radionuclides of Concern: Pu-239, Sr-90, Cs-137

- Development of dose based endpoint criteria
- Development of survey plans and procedures
- Development of Technical Basis Documents
- Served as key technical interface between BNFL and DOE
- Designed, managed, and conducted Characterization, Remedial Action Support and FSS surveys using SCM/SIMS
- Surveyed over <u>120 acres</u> of floor space and corresponding overheads
- Obtained over 200 million measurements
- Survey results collaborated by DOE's IVT



"The team consistently produced technically sound surveys at high production rates, while always working safely." BNG America



SCM/SIMS Sample Project

Former Naval Air Stations Alameda, Brunswick, & Willow Grove Radionuclides of Concern: Ra-226, Pu-239, U-238, Sr-90, Cs-137, H-3

- Review HSA, develop work & task specific plans
- Design and perform scoping, characterization & final status surveys
- Develop characterization & final status reports
- Assist with stakeholder relations
- Surveyed over 1.3M ft² and obtained over 49M measurements with SCM



Team received safety award from Navy





SCM/SIMS Sample Project

USDOE, Fernald Site Radionuclides of Concern: U, Th, Ra

- Developed survey plans
- Designed and performed scoping, characterization & final status surveys
- Developed characterization & final status reports
- Performed walkover gamma surveys
- Compressed project schedule





SCM/SIMS Sample Project

TVA Watts Bar Nuclear Plant

Radionuclides of Concern: Fission & Activation Products

- Developed Survey Plan for the Unconditional Release of the Unit 2 Containment & Annulus from Unit 1 RCA (Rezoning)
- Developed survey plans
- Designed, managed, and conducted free release surveys to "indistinguishable from background" endpoint criteria using SCM/SIMS & portable survey instruments
- Provide radiological engineering support
- Developed final report to support release of the areas, materials and equipment
- Provided technical supervision







SCM/SIMS Sample Project

South Texas Project Nuclear Plant

Radionuclides of Concern: Fission & Activation Products

- Designed comprehensive survey and sampling plan for free release of 1,900 ft of roadway
- Surveyed more than 48K ft² in 1 week (1.7M measurements)
- High / variable ambient background
- Generated final report supporting free release of road









STP Survey Information

- Release Criteria: IE 81-07
 - Indistinguishable from Background
- Isotope of Concern: Co-60
- Scan Rate: 2" per second
- Minimum Detectable Count Rate
 - <4,000 dpm/100 cm² (standard background)
 - ~7,500 dpm/100 cm2 (elevated background)
 - Additional asphalt samples analyzed in those areas



SCM/SIMS Sample Project

South Texas Project Nuclear Plant

Radionuclides of Concern: Fission & Activation Products





Real-Time Locating System (RTLS)

- Indoor GPS
- Provides 3-dimensional information within rooms or areas
- Hardware Used
 - Anchors fixed locations in a room or area
 - Tags attached to mobile people or things
- Provides real-time location information plus other information



RTLS Technologies

- Radiofrequency Identification (RFID)
- Optical Locating
- Ultrasound ID
- Bluetooth
- Near Field Electromagnetic Ranging
- Ultra Wideband (UWB)



UWB Technology

- Ultra-Wideband RF
 - decaWave DW1000 chip
 - CMOS IC based on 802.15.4-2011 standard
- Applications
 - Real-time location systems RTLS
 - Two-way ranging current SIM-Teq use
- Benefits of UWB
 - Position accuracy ~10 cm
 - SIM-Teq app ~15 cm
 - Range potential 290 m (LOS)
 - SIM-Teq app ~35 m
 - Transmits through non-metallic objects
 - Low power consumption







SIM-Teq Survey Meter Training Using TWR

• Two-Way-Ranging (TWR) Application

- Calculates distance between devices
- Source configurable (1 mR/hr 99,000 R/hr @ 1 ft)
- 1/r² meter response
- ~100' range
- Excellent positioning resolution in all axis (~6" resolution)
- Manual Control with SCC App
- Retain full functionality of instrument
 - OEM meter movement and selector switch
 - Functional window response
- Adjustable background
- Open Architecture



Source



Electronic Dosimetry Training Devices

OEM Components

- Case
- Speaker
- Display
- Push Button(s)
- ISO Connector (DMC2000)
- Fully Configurable (except histogram)
- Features and Functions:
 - Turn on/off (autonomous and 'fast-entry' mode)
 - All display functions
 - All alarm functions
 - All faults (plus blank screen)
- Supports Accessories
 - Telemetry (2000 and 3000)
 - PAM
 - iMUX
 - LED
 - Earphone













Basic UWB RTLS Network



Current RTLS System

- Wired Anchors LAN used for both communication and POE power
 - Standard POE (1 Anchor per line)
 - Custom POE (12-15 Anchors per line)
- Independent Tags
 - Tags are serialized but incapable of connecting to external equipment
 - Tags are rechargeable
- 3000-5000 Tags per Location Area
 - i.e. Floor, Building, etc.
- TCP/IP based communication
 - Internal to system
 - External output to End User Application
- Accuracy Depends on Anchor density
 - High density <10 cm
 - Low density ~30 cm





Future RTLS System Applications

- Embedded Modules in Electronic Dosimeters
 - Mirion-RSCS Collaboration for DMC 3000, WRM2, and RTLS
 - Demonstration at 2 Canadian sites in June/July
 - Potential for all Rad Workers wearing RTLS-equipped dosimeters providing real-time dose rate information (radiation 'heat mapping' display)
- Embedded Modules in Survey Meters
 - Automated survey documentation
 - Faster and more reliable information
- Embeddable Modules in SCM
 - Use of positioning system for automated documentation of detector location





Other RTLS Applications

- Personnel location and monitoring
- Inventory Control
- Equipment tracking
- FME
- Waste tracking
- Confined space environmental measurement
- Tools that identify specific requirements by location (i.e. torque wrench near specific bolts will know proper foot-pounds)



RTLS Challenges

- Infrastructure
 - Anchor installation
 - Network installation
 - Location Survey/Mapping
- Backend Customization
 - User interface
 - Existing system integration
- Location Resolution
 - Use case dependent e.g. Radiation survey data
- Instrument Integration
- Funding



Questions?

THANK YOU

