The Advanced Monitoring System Initiative: Optimizing Delivery and Application of New Sensor and Monitoring Solutions

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AMSI
Advanced Monitoring Systems Initiative (AMSI)

• Operated by:
  – Nevada Site Office of the U.S. DOE and
  – Bechtel Nevada

• Funds provided by:
  – DOE EM Office of Science and Technology

• Mission:
  – Accelerate the development and application of advanced monitoring systems
AMSI Operating Characteristics

- Focuses its resources on high-impact solutions to end-user needs and is driven by end-user application requirements.
- Looks for strong end-user support, including
  - co-funding of the proposed work and
  - commitment to include in end-user baseline.
- Emphasizes partnership to accomplish its work.
- Emphasizes late stage engineering, test and evaluation in end-user application conditions
- Does not fund research projects.
AMSI Emphases

• Emphasizes the importance of remote and automated, unattended operation

• Emphasizes internet communication in sensor and monitoring system operation, for
  – Data recording, display, and summarization
  – Information sharing
  – Instrument control

• Employs the spiral development model, i.e., build-a-little, test a little, repeat.
AMSI Resources

Nevada Test Site

HazMat Spill Center
AMSI Resources

• Nevada Test Site (NTS)
  – Hazardous Materials (HazMat) Spill Center
    • a one-of-a-kind facility permitted for releases of hazardous materials for training and testing under controlled conditions
  – National Center for Combating Terrorism (NCCT)
    • newly created center for training first responders to terrorist acts
    • no other place in the U.S. where all combating terrorism activities can be addressed in an integrated manner
Other AMSI Resources

- Industry
- Universities
- National Laboratories
- Bechtel Nevada
- Special Technologies Laboratory
- Remote Sensing Laboratory
- Desert Research Institute
- Nevada Universities
AMSI Monitors for Rads & Metals

- **Tritium**
  - in the vadose zone
  - in groundwater
- **Technetium-99 in groundwater**
- **Strontium-90 in groundwater**
- **Wireless sensor platform**
  - Landfill performance
- **Universal sensor platform**
  - Cr(VI) in groundwater
Monitoring Tritium in Vadose Zone

• **Purpose**
  – Monitor for escape/migration of tritium from nuclear waste containments

• **Benefit**
  – Early detection can stimulate early action to stop the escape/migration; avoid higher remediation and potential health costs

• **Customer**
  – NTS, SRS, Hanford, BNL are potential customers
Monitoring Tritium in Vadose Zone

• Developer
  – Science and Engineering Associates, Inc., Santa Fe, NM

• Technology Characteristics
  – Uses gas proportional counting
  – LOD < 100,000 pCi/liter water
  – Future: Condense water vapor & use Proton Exchange Membrane to separate H and T from Oxygen prior to counting
Monitoring Tritium in Vadose Zone

At NTS Greater Confinement Disposal site
AMSI
Monitoring Tritium in Groundwater

• **Purpose**
  – Monitor for migration of tritium and contamination of groundwater
  – #1 need identified in the metals & rads sessions of the Long-Term Monitoring Sensor and Analytical Methods Workshop, Orlando, FL, June 2001

• **Benefit**
  – Estimated savings of $65K/well/y in avoidance of mobilization of personnel and equipment for sampling and analysis to fulfill regulatory requirements (FFCAs & COs)
Monitoring Tritium in Groundwater

• Customer
  – NTS Groundwater Monitoring Program.
  – Other potential customers include LBNL and SRS.

• Developer
  – Science and Engineering Associates, Inc., Santa Fe, NM
  – Univ. of Nevada, Reno
Monitoring Tritium in Groundwater

• **Technology Characteristics**
  
  – Needs daily measurement at 800 to 5000 bgs and at tritium levels of 1000 (300) to 200,000 pCi/L
  
  – UNR reacts water with NaK to produce H & T gas; uses a proportional counter to measure beta decay of the tritium; finally captures H & T on getter. Requires replenishment every 50-100 days

  – SEA will condense water and HTO from the sparge sampling stream (P10) and use a Proton Exchange Membrane module to separate H and T from oxygen prior to counting. Target LOD < 20,000 pCi/l = DWS
Monitoring Tc-99 in Groundwater

- **Purpose**
  - in situ monitoring of Tc-99 to monitor plume migration and performance of remediation activities.

- **Benefit**
  - faster, cheaper method of monitoring plume migration and effectiveness of Tc-99 remediation processes at the Hanford site (approx. one day turnaround vs 30 to 45 day turnaround for baseline method; no mobilization for sampling).
Monitoring Tc-99 in Groundwater

• Customer
  – Hanford Ground Water Monitoring Program
  – Potential customers include Fernald, Paducah

• Developer
  – Pacific Northwest National Laboratory
    (Oleg Egorov, John Hartman, Jay Grate, et al)
Monitoring Tc-99 in Groundwater

• Technology Characteristics
  – Selectively and reversibly concentrates technetium (pertechnetate ion) on anion exchange absorption absorption beads; measures light from scintillator beads that emit light when struck by beta particles from the decay of Tc-99.
  – LOD for 10 minute counting period = 7 Bq/L
  – Regulatory limit = 33.3 Bq/L.
Monitoring Tc-99 in Groundwater

Tc-99 Sensing Approach

Sample Cell with Bead Pack

- Preconcentrating beads
- Scintillating beads

Sample Inlet
Sample Outlet
Monitoring Sr-90 in Groundwater

• **Purpose**
  – in situ monitoring of Sr-90 in groundwater

• **Benefit**
  – faster, better, cheaper method of monitoring the effectiveness of Sr-90 remediation (barrier plus pump-and-treat plus phytoremediation) at the Hanford N-Reactor site (approx. one day turnaround vs 30 to 45 days for baseline method; no mobilization for sampling)

• **Customer**
  – Hanford Groundwater Monitoring Program
Monitoring Sr-90 in Groundwater

• Developer
  – Pacific Northwest National Laboratory
    (Ron Brodzinski)

• Technology Characteristics
  – Measures Cherenkov light produced in water by high-energy beta particles from decay of Y-90 daughter of Sr-90
  – Drinking water standard is 8 pCi/l
  – Lab prototype sensitivity = 14 pCi/l
  – Target is 1.4 pCi/l (larger cell; longer times)
Wireless Sensor Platform  
(Monitoring moisture in landfill covers)

• Purpose
  – Wireless means of powering and “reading” sensors embedded in landfill covers (e. g., volumetric soil content and soil water potential)

• Benefit
  – Monitor barrier performance, provide early notice of degradation, need for maintenance
  – No wires need penetrate to the subsurface
Wireless Sensor Platform
(Monitoring moisture in landfill covers)

• **Customer**
  – Idaho National Engineering and Environmental Laboratory
  – Other western DOE sites are potential customers

• **Developer**
  – INEEL (Dennis Kunerth, John Svoboda)

• **Technology Characteristics**
  – An induction coil both powers the sensors and collects the sensor output via rf signal generated by embedded microprocessor
  – Prototype functional to 8 ft bgs in dry Idaho soil
Wireless Sensor Platform
(Monitoring moisture in landfill covers)

- Measurement concept, with multiple sensor packages.
- Each package contains multiple sensors and can be individually interrogated.
- The surface data logger is portable but it can be left in place.
Wireless Sensor Platform  
(Monitoring moisture in landfill covers)

- The red coil is the platform power receiver and data transmission antenna.
- The PC board attached to the antenna is the microprocessor and A to D converter.
- A partially assembled system shown at the left includes (at the bottom):
  - A heat dissipation sensor (beige) for measuring soil water potential
  - A TDR sensor (green) for measuring volumetric water content
- The sensors are commercially available.
Testing the INEEL Wireless Sensor Platform at the NTS

Note loop antenna and data logger box for charging / readout
Monitoring Cr(VI) Using Universal Sensor Platform

• Purpose
  – Provide in situ real-time monitoring of Cr(VI) in groundwater

• Benefit
  – Much better temporal monitoring coverage without much greater cost.
Monitoring Cr(VI) Using Universal Sensor Platform

• Customer
  – Hanford Groundwater Monitoring Project
    • Accurately monitor Cr(VI) in the pore water of Columbia River sediments and gravel beds (salmon spawning area), which are fed by contaminated groundwater from the DOE Hanford site
    • Ensure that groundwater remediation activities are producing desired consequences for protection of aquatic species (salmon)
Monitoring Cr(VI) Using Universal Sensor Platform

• Developer
  – Burge Environmental (Scott Burge)
    • Uses a colorimetric reaction with diphenylcarbazide and the Burge “universal” sampling, analysis, and calibration system
  – PNNL (John Hartman & Oleg Egorov
    • Cr(VI) determination without reagents, using liquid core optical waveguide and UV/Vis absorption spectrometry
Monitoring Cr(VI) Using Universal Sensor Platform

- **Technology Characteristics**
  - Regulatory standard is 11 ppb.
  - Automated hourly measurements.
  - Automated in-field calibration.
  - Duty cycle of at least several days (e.g., to replenish reagent in Burge case).
  - PNNL LOD ~ 1 ppb
  - Burge Environmental LOD ~ 1 ppb.
    Reagent reservoir ~ 100 analyses (100 hours).
Monitoring Cr(VI) Using Universal Sensor Platform
Burge Universal Sensor Platform

- Solar power & battery storage
- Sample pumps
- Stirring motor
- Air compressor
- Valves
- Green LED photoabsorption cell
- Field calibration capability
- Laptop computer
- RF modem for remote control & data communication

Models for monitoring chloroform, trichloroethylene are also available.

http://www.burgenv.com/index.html
Key AMSI Achievements

• Involving end-users

• Getting end-user commitment to include the product in their *application* baseline
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