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**Possible Stakeholder Concerns Regarding
VOC-Arid ID Technologies Not Evaluated
in the Stakeholder Involvement Process**

T.S. Peterson

December 1995

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POSSIBLE STAKEHOLDER CONCERNS
REGARDING
VOLATILE ORGANIC COMPOUND IN ARID SOILS
INTEGRATED DEMONSTRATION TECHNOLOGIES
NOT EVALUATED IN THE STAKEHOLDER INVOLVEMENT PROGRAM

Prepared by

Todd Peterson
Battelle Seattle Research Center

for
U.S. Department of Energy
Office of Technology Development

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INTRODUCTION

The Volatile Organic Compounds in Arid Soils Integrated Demonstration (VOC-Arid ID) supported the demonstration of a number of innovative technologies, not all of which were evaluated in the integrated demonstration's stakeholder involvement program. These technologies have been organized into two categories and the first category ranked in order of priority according to interest in the evaluation of the technology. The two groups are:

1. ResonantSonic Drilling
2. SEAMIST
3. Cone Penetrometer
4. Passive Soil Vapor Extraction Using Borehole Flux
5. Tunable Hybrid Plasma
6. Arrayed Sampler
7. Colloidal Borescope
8. Bore Sampler
9. Unsaturated Flow Apparatus
10. Seismic Tomography
11. Portable Acoustic Wave Sensor
12. Gas Membrane Separation System.

ResonantSonic Drilling, Passive Soil Vapor Extraction Using Borehole Flux, Tunable Hybrid Plasma, and Gas Membrane Separation System were evaluated in detail in the VOC-Arid ID stakeholder involvement program. Separate stakeholder acceptance analyses present the results.

The second group, in no particular order, is a listing of all other technologies supported by the VOC-Arid ID. This group includes:

- Data Fusion
- Halosnif
- Directional Drilling
- Steam Reforming
- Fiber Optic Sensor
- Odyssey Sensor
- EMFLUX
- PETREX
- FTIR Instrument
- Prompt Fission Neutron Logging Tool
- Supported Liquid Membrane
- Engineering Simulator
- Supercritical Fluid Extraction
- PurgeMin
- Ion Selective Electrode
- Ion Trap Mass Spectrometer

The purpose of this report is to present issues stakeholders would likely raise concerning each of the technologies in light of commentary, insights, data requirements, concerns, and recommendations offered during the VOC-Arid ID's three-year stakeholder involvement, technology evaluation program. A secondary purpose is to provide a closeout status for each of the technologies associated with the VOC-Arid ID. This report concludes with a summary of concerns and requirements that stakeholders have for all innovative technologies.

POSSIBLE STAKEHOLDER CONCERNS

The following summarizes the issues stakeholders are likely to have with particular technologies supported by the VOC-Arid ID.

SEAMIST is a continuous membrane everted down a borehole to isolate a particular soil layer or area for characterization. The SEAMIST membrane lines the sides of the borehole to ensure obtaining a sample from just one area. The membrane - urethane coated polyester - is inflated and the pressure of the inflation pushes the lining down the well. To withdraw, the membrane is deflated and rolled back up.

Stakeholders may be concerned about the possibility of the membrane tearing and remaining in the subsurface to block the movement of soil gas, percolating moisture, or groundwater if used below the water table. They may ask about how the membrane will be dealt with if it becomes contaminated, and about the nature and effect of the gas used to inflate the SEAMIST membrane. They will find as an advantage the fact that the membrane is reusable, and that a variety of membrane materials are available for use with a range of soil types and contaminants.

Cone Penetrometer is an access technology that uses a truck with ballast and hydraulic rams to push a rod into the subsurface. Cone penetrometer pushes a 1 3/4" rod routinely to 80 feet and up to 200 feet. The technology is used primarily for exploratory characterization, but may be used for remediation including vapor extraction.

Stakeholders will evaluate favorably cone penetrometer's speed and economy. It can do in a day what it would take cable tool weeks to accomplish. Stakeholders may find as a disadvantage the small diameter of the holes the technology is able to open - a diameter too small for some down-hole characterization and extraction equipment. Stakeholders will be concerned about opening new wells, possibly providing pathways for contaminant migration, and about leaving a permanent legacy by grouting wells. Stakeholders may also raise questions about worker safety in relation to rods breaking under the weight and stress of the ballasted truck and hydraulic rams.

Arrayed Sampler is a characterization and monitoring tool comprised of a series of multi-sorbent cartridges with a range of sorbents controlled by solenoid from the surface, and packers to isolate particular subsurface zones for characterization.

Stakeholders may see as an advantage the technology's ability to obtain samples directly, circumventing the need to draw samples through tubes that may change sample quality. They may regard favorably the technology's ability both to obtain samples quickly and over a long period, given the technology's ability to remain in place. Stakeholders will favorably evaluate the technology's reusability and versatility in terms of being able to deal with a range of contaminants. They may raise the issue of how contaminated sorbents will be handled when they have reached the end of their useful life. Although the Arrayed Sampler demonstrated at Hanford was the first one ever built, concerns about its lack of regulatory track record were not raised at the time of its implementation in the field.

Colloidal Borescope is a characterization tool for measuring groundwater velocity and direction by tracking the movement of microscopic particles (colloids) in the groundwater. The technology's principal components are a computer capable of identifying colloids, a video cassette recorder, a lamp, a camera with a magnifying lens and a down-well compass to track the colloid's movement across the technology's field of vision. The technology requires at least a four inch well.

Stakeholders may have questions about whether the technology will impede groundwater flow or cause any mounding effects. They may point out as a disadvantage the technology's requirement of a steady groundwater cross-flow, as vertical upsurges move colloids out of focus. They will find an advantage the technology's ability to use existing wells.

BoreSampler is a characterization tool to take samples beyond where well casing has advanced. It is a point source sampler technology for obtaining soil gas and groundwater samples in undisturbed formations.

Stakeholders may rate as a disadvantage the technology's tie to cable tool drilling, which is expensive and slow and as one Hanford stakeholder said, "a painful way to drill." Stakeholders will be concerned about the complete capturing of soil gas samples drawn to the surface by vacuum.

Unsaturated Flow Apparatus (UFA) is a characterization technology that determines the transport characteristics of soils and sediments. UFA is a laboratory technology that, through the use of a centrifuge, speeds up the movement of contaminants through soils thus giving, in an accelerated time, a picture of how contamination will move through a particular sample of soil.

Because UFA is a laboratory technology, stakeholders may have fewer concerns than if it were a field technology. They may, however, ask about how contaminants introduced into soil samples are dealt with after laboratory tests are complete.

Cross-Hole Seismic Tomography is a characterization technology that uses compressional and shear waves to provide a picture of geologic structure and fluid saturation between two boreholes. A specific use would be to determine the configuration of the groundwater mound created by In-well Vapor Stripping. The technology lost its funding part way through its demonstration at Hanford.

As they did with ResonantSonic Drilling, stakeholders may raise the issue of the seismic effects the compressional and shear waves create on subsurface geology and nearby structures. The introduction of air into the subsurface by a pneumatic repeater (air gun) may also raise concerns. Stakeholders will ask if new wells will be needed to implement the technology, and for reasons of expense and environmental impact may oppose the installation of new wells.

Portable Acoustic Wave Sensor (PAWS) is a monitoring technology that uses acoustic wave propagation which is extremely sensitive to the properties of a thin film formed on the surface of the substrate through which the wave is propagating. The two independent responses of wave velocity and wave attenuation can be simultaneously monitored to

determine the identity and concentration of a contaminant. Contaminants are introduced in vapor phase.

Stakeholders may ask for comparisons in terms of performance and cost of **PAWS** with **Arrayed Sampler** and Gas Chromatography. They may find as advantages PAWS' ability to provide direct readings without the requirement of a separate analysis, and the fact that in its down-hole configuration, the technology does not bring contaminants to the surface. Stakeholders may evaluate PAWS as cheaper than baseline.

The following descriptions are of lower priority technologies associated with the VOC-Arid ID. One purpose of this report is to provide a close-out status for these technologies.

Data Fusion was an information management tool for integrating sets of data concerning technologies in the VOC-Arid ID. It was not fully implemented at Hanford.

Halosnif monitors chlorinated compounds. A principal component of the technology is a plasma excitation chamber. For this reason, stakeholders may ask for information about energy demand, elevated temperatures, thermal reactions and the possible creation of by-products.

Directional Drilling is method for horizontal drilling. Cobbles in the subsurface at the Hanford site caused the drilling apparatus to veer off-center and the demonstrated technology was not successful.

Steam Reforming is a treatment technology intended to strip off carbon tetrachloride from GAC canisters and destroy the contaminant. The technology was never able to deal with dehalogenization issues and so was unsuccessful.

Fiber Optic Sensor is a downhole monitoring technology that was never demonstrated at Hanford.

Odyssey Sensor characterizes the concentration of carbon tetrachloride in an extracted air stream by monitoring for chlorine. The technology operates at the surface with an air stream provided by an active vapor extraction system. The technology dissociates carbon tetrachloride molecules, but on a microscale in comparison to remediation technologies such as Tunable Hybrid Plasma. The technology is commercially available and was purchased for use in the expedited response action at Hanford.

Stakeholders may raise the issue of the generation of hydrochloric acid. They may request analysis of other by-products of the dissociation of carbon tetrachloride.

EMFLUX and **PETREX** are characterization and monitoring tools that passively collect VOC soil gas at the surface. These two commercially available technologies are gas detection systems that use a variety of sorbent materials. Support by the VOC-Arid ID

was less for development and demonstration than for the application of an existing technology.

Stakeholders are likely to be concerned about the complete capturing of soil off gas and the safe handling, treatment, storage, and disposal of saturated membranes.

FTIR (Fourier Transform Infrared) Monitor is a monitoring and characterization technology for the detection of off gassing to the atmosphere across a distance. Its components include an infrared source and a reflector. It operates on the same principle as the “electric eye” in an elevator that keeps the door open when passengers are entering. FTIR evaluates changes in the wave length of gases that the infrared beam passes through. As with **EMFLUX** and **PETREX** as well as **Prompt Fission Neutron Logging Tool** and **Odyssey Sensor**, VOC-Arid ID support was limited to applying an existing technology rather than developing and demonstrating a new one.

Stakeholders will ask questions about possible health effects of exposure to the infrared beam. They may point out the technology’s drawback of not being able to distinguish if contaminant release is from a single localized source or uniformly released between the infrared source and the reflector. They will see as advantages the non-harmful nature of the beam, the technology’s minimal energy demand, its ability to record the presence of a number of contaminants at once, the wide application of a similar, established technology and the technology’s mobility and relatively low cost.

Prompt Fission Neutron Logging Tool is a characterization device capable of logging outside of cased boreholes for the presence in the soil of isotopes such as plutonium and uranium that are fissionable with thermal neutrons. The technology generates a pulse of approximately two million neutrons. The neutron pulse excites any fissile material in the soil near the cased borehole. The excited fissile material emits gamma rays that the tool detects.

Stakeholders will be concerned about the effect of the neutron pulse on biota in the soil. They will be concerned about possible health effects on workers should the tool be accidentally activated above ground near workers. They will raise the issue of the tool’s radius of influence - how far the neutron pulse will be able to move through soil before dissipating. They will be concerned about the possible contamination of the equipment itself by radioactive elements. They will ask about the possibility and the results of a neutron pulse encountering a highly concentrated source of radioactivity.

Supported Liquid Membrane removes metal ions from groundwater. It is not, strictly speaking, a VOC technology, but has as its target co-contaminants such as uranium and technetium. It is designed to operate at the surface in a manner similar to pump and treat. The technology never made it to the field for demonstration.

Stakeholders will have concern about transferring radioactive contaminants from one environmental medium to another, and specifically about the possibility of bringing radioactive elements into closer proximity to humans and the surface environment.

Engineering Simulator is a computer modeling tool. Unless the technology was costly, time-consuming, or slowed the performance of field technologies it would not be likely to raise significant stakeholder concern.

Supercritical Fluid Extraction is a laboratory tool for extracting contaminants from a soil matrix for laboratory analysis. It uses supercritical fluids to displace contaminants in soil samples. It was not demonstrated in the field at Hanford.

PurgeMin and **Ion Selective Electrode** were not demonstrated as part of the VOC-Arid ID. For this reason they generated no data, and no evaluation of them was done.

Ion Trap Mass Spectrometer uses a commercially available ion trap applied as a laboratory tool or in a field trailer. It offers the advantage of being able to take samples directly without the necessity of sample preparation.

Stakeholders may evaluate favorably that the technology generates no energy, heat, or by-products.

STAKEHOLDER REQUIREMENTS FOR ALL TECHNOLOGIES

An analysis of stakeholders comments collected during focus group meetings and individual interviews revealed concerns and data requirements that apply to all of the technologies that were evaluated. Those making decisions about the use of any environmental technology should take these perspectives into account. Comments are sorted into the following categories: performance, cost, environmental health and safety, regulatory issues, and socio-political issues.

PERFORMANCE

Potential to increase contaminant mobility. Stakeholders require that a technology not increase the mobility of contaminants it is designed to remediate.

Subsurface injection. Some technologies inject substances ranging from water to microorganisms into the subsurface. This injection raises stakeholders' concerns related to regulation (e.g. Washington State's non-degradation standard for groundwater), effects on groundwater levels, effects on indigenous microorganisms, or the ability to monitor and control the consequences of subsurface injection.

Transfer of contaminants from one environmental medium to another. Stakeholders oppose removing contamination from one area or environmental medium only to transfer it to another, for example from the subsurface to the atmosphere. Technologies that do not immobilize or destroy contaminants on site will raise these concerns.

Ability to deal with co-contaminants. Stakeholders clearly express concern about a technology's ability to remediate all the contaminants it is likely to encounter. They are concerned about technologies that do not take care of the entire problem, leaving or mobilizing other contaminants. This is a particular concern with mixed radioactive and hazardous contaminants and important for in-situ technologies facing the challenge of residual co-contaminants.

Versatility. In a related issue, stakeholders prefer technologies that deal with a range of contaminants and that are effective in varying conditions of soil, temperature, climate,

and other site conditions. Stakeholders will challenge the wisdom of investing in a technology with narrow application.

Process/Secondary waste. Almost all remediation methods produce some type and quantity of process waste. There is significant stakeholder concern about how that waste will be treated, stored, transported, disposed of, or otherwise managed. Therefore, stakeholders will likely be critical of any innovative technology that generates secondary waste that concentrates toxicity or is more difficult to dispose of or recycle than secondary waste generated by a baseline technology.

Complexity. A technology's complexity of design and operation raises questions for stakeholders. There is a common belief that the more complex a technology, the more expensive it is, the more likely it is to fail, and the more costly and difficult it is to repair.

Maintenance and operation. Technologies that local labor can operate and maintain are preferable to those that require complicated, expensive, off-site maintenance.

Auxiliary technologies. Stakeholders evaluate a technology within the context of the entire system within which it operates. In order to assess one component of the system, stakeholders point out that it is necessary to evaluate the benefits and drawbacks of the entire system. Technologies that require auxiliary components raise issues if the supporting technologies are not completely described, understood, or reliable.

Off-site treatment/transport. Off-site transport, treatment, or disposal of contaminants concern stakeholders. These considerations include the complexities of dealing with varying jurisdictional authorities, possible environmental and health exposure, and accidents, as well as the impact of treatment and disposal facilities.

Timeliness. A technology may have significant benefits in terms of effectiveness, cost or other attributes, but may operate more slowly than a baseline technology. In evaluating technologies, stakeholders take into account rate of performance and time required to complete the job. Many believe that time is of the essence in remediation, particularly in relation to blocking the migration of contaminated plumes.

COST

In evaluating technology, cost is important to stakeholders without taking precedence over certain other considerations, especially health and safety. Stakeholders are concerned about the following aspects of cost:

Cost greater than baseline. Stakeholders will be interested to know if the cost to develop, operate, or decommission a new technology is greater than that for the baseline technology. A particular point of concern to stakeholders is life-cycle cost, including startup, operations, maintenance, and decommissioning. Stakeholders will ask to see an estimate of complete life-cycle costs.

Reduced budgets. Stakeholders point out that many decisions about technology development and deployment now have to be made in light of reduced budgets.

ENVIRONMENTAL HEALTH AND SAFETY

Stakeholders are interested in the effect any new technology may have on the health and safety of workers and the public. Specifically they will be concerned about the following:

Failure, and emissions or releases. This is a critical issue with stakeholders. Effects on the environment, the public, or on workers from the failure of a technology - which may range from release of contaminants to mechanical failure and injury - must be carefully considered. Stakeholders require that the ability to control and mitigate failure be built into any technology.

They are very concerned about any uncontrolled emissions or releases of contaminants or other hazardous materials resulting from installation, operation, or removal of a technology. Stakeholders require detailed information about the possible impact of releases on people, wildlife, vegetation, air, water, and soil.

Energy demand. The use of large amounts of energy, for example electric power, to construct, operate, remove, and decommission a technology will matter to stakeholders. A projected energy demand greater than the baseline technology's energy requirements will raise concern as will the possibility that using the technology and supplying it with energy will place an inordinate demand on or damage natural resources.

REGULATORY ISSUES

Track record. A technology with no history of approval within the federal, state, or local regulatory system will raise stakeholders' concerns. Regulatory track record refers to the regulations and regulatory guidance needed to evaluate a technology's compliance. Regulators' familiarity with a technology reduces regulatory uncertainty. Stakeholders will also have concerns about a technology that requires many complex regulatory approvals.

SOCIO-POLITICAL ISSUES

Future options. Stakeholders evaluate unfavorably technologies they see as foreclosing future options for remediation or land use. They will likely prefer methods that promote unrestricted future use of currently contaminated sites, including spiritual, traditional, and practical uses. Stakeholders are critical of technologies that change the physical nature of the land itself, or that preclude future waste processing or other remediation.

Potential to impact natural or cultural resources. Any potential impact from a technology on resources valued by a particular community or region will raise significant concern among stakeholders. These resources include clear air and scenic vistas, drinking water/groundwater supplies, important habitats, open space, and tribal resources and traditional land uses.