SEERTECHNOLOGY®

SEE WHAT CAN'T BE SEEN
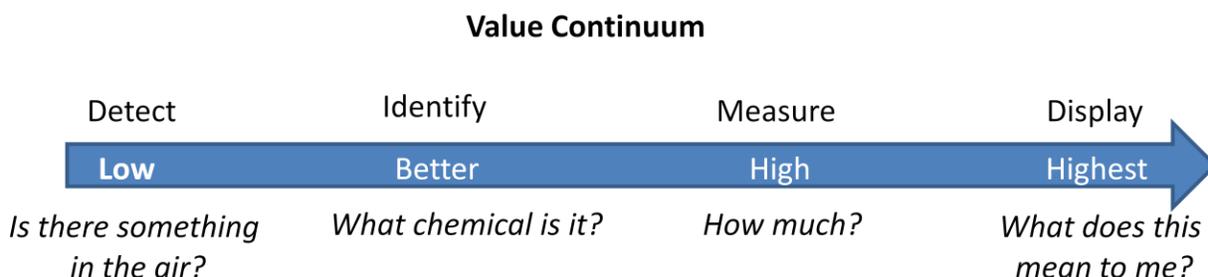
AccuSense® Technology, Methodology, Outcomes

May 2010

AccuSense® Chemical Detection Capabilities

The value of a detection event is determined by the capability to identify the detected compound(s), measure their concentration levels, and display this data in a context meaningful to the end-user in a short time frame and with a high level of accuracy.

Value Continuum

Detect	Identify	Measure	Display
Low	Better	High	Highest
Is there something in the air?	*What chemical is it?*	*How much?*	*What does this mean to me?*

AccuSense Detection Technology

In the chemical detection world today, detectors can be classified into one of the following categories:

- **0 Dimensional** – A detector can detect *if* chemicals are present, but cannot identify *which* chemicals are present
- **1 Dimensional** – A detector can detect, identify and provide concentration information for a particular chemical
- **2 Dimensional** - A detector can detect, identify and provide concentration information for multiple chemicals

The following is a real-world analogy of the problem at hand:

> *In a room full of people you are tasked with finding Ted. You are told that he is 6'3" tall. You look around the room and you see that there are 3 people that you estimate are 6'3" tall, however, with this limited description information, you cannot tell with certainty which one is Ted. You then receive another piece of information. Ted has black hair. You search again, but you find that 2 of the 6'3" gentlemen have black hair.*

It is easy to see that the more information that is provided about "Ted", the easier it is to separate him from others in the room. Additional information leads to better separation capability and therefore increased certainty in identifying the person (or chemical) of interest.

The problem of separating different chemicals to obtain a unique signature, or graphical representation of those chemicals, with a maximum degree of certainty is similar:

- To identify 2 or more chemicals with 1 common nearly identical parameter is easy
- To identify 2 or more chemicals with 2 common nearly identical parameters is very difficult
- To identify 2 or more chemicals with 3 common nearly identical parameters is incredibly difficult

AccuSense is a 2-Dimensional Detector

AccuSense utilizes Dual Hyphenated Gas Chromatography (DHGC) technology to obtain a more effective separation of chemicals and hence performs its data analysis on two independent parameters (Polar vs. Non-Polar). Additionally, a third parameter is currently in the research and development phase.

- **Parameter 1** – *Polarity*
  - While this is often a good initial separation technique, it is sometimes not enough, as, for example, Acetone and Phosgene have very similar dipole moments of 2.91D and 1.17D, respectively
- **Parameter 2** - *Boiling Point*
  - By obtaining additional information from a second parameter (boiling point), Acetone (133°F) and Phosgene (47°F) are more easily separated
- **Parameter 3** – *Pre-Concentrator Packing Material*
  - Still in R&D, but very feasible with AccuSense architecture

Upon gathering hundreds of data points related to the parameters listed above, proprietary neural network algorithms analyze matrices of these data points and develop unique chemical signatures for each chemical. By taking the two independent variables and creating a third dependent variable, the AccuSense 3D Signature is created. The more unique the parameters for a particular chemical are, the easier it is for detection, identification, and quantification of that chemical. The 3D mathematical representation of the chemical signature for Methyl Ethyl Ketone (MEK), which is done through the utilization of MATLAB® software on a Cray® supercomputer at SEER offices, is shown below:
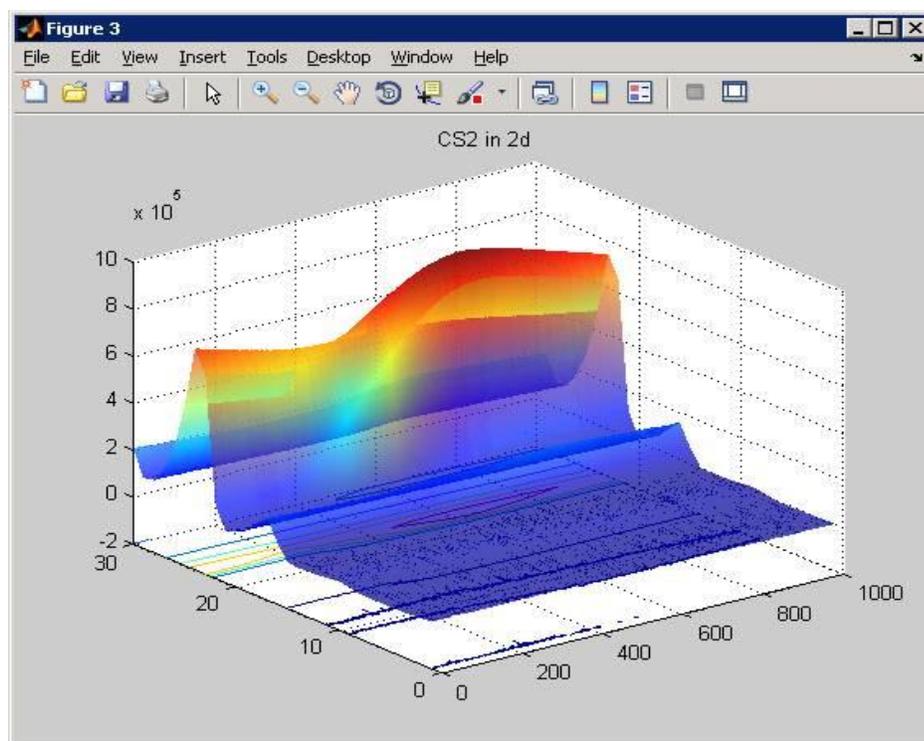
3D Representation of MEK

These chemical "signatures" are collected with known chemicals at known concentrations at the SEER laboratory facility, run through the neural network training process, and are ultimately stored on the AccuSense PC in the chemical signature database. Chemical signature database updates will occur on a quarterly basis and will not require hardware updates.

AccuSense Chemical Signature Database

There is a theoretical limit of 32 chemical signatures per AccuSense database, but multiple databases can be loaded and searched in a fashion that is transparent to the user. There may be additional variables such as storage, processing, and communications limitations that could be a factor when running multiple units and searching multiple serial databases. Note also that each version of the AccuSense is designed with internal hardware to detect and identify chemicals that fall within certain physical properties, i.e., within a range of boiling points.

A single AccuSense device will never detect and identify ALL chemicals, rather a single AccuSense will detect and identify many chemicals with certain or similar properties and another version of AccuSense will detect and identify many chemicals with other differing characteristics. Due to its ability to detect, identify, and quantify organic and inorganic chemicals, AccuSense is a broad-spectrum Chemical Recognition System, but not a single solution for all chemicals.

The initial production version of AccuSense is geared towards the detection of Toxic Industrial Chemicals (TICs). SEER chose 21 of the most readily available and hazardous TICs, eight of which are included on the "High Hazard TICs" list according to the NATO International Task Force 25 (ITF-25), which ranked chemicals according to their hazard index and potential use as chemical weapons. Why did SEER choose only 21? We had to start somewhere. SEER has presented the AccuSense Chemical Recognition System in front of many diverse audiences across multiple applications, none of whom could identify the number or which specific list of chemicals that would satisfy their applications. SEER is currently conducting a field survey of what chemicals, dangerous or otherwise, have been most typically encountered during HAZMAT responses over the past 3 years. Upon compilation of the list, signatures will be gathered for additional chemicals to be incorporated into the AccuSense chemical signature library.

Chemicals that the AccuSense Architecture Cannot Detect

The AccuSense gas columns (GCs) use conditioned ambient air as an elute gas source. This proprietary technology eliminates the need for consumables and enables AccuSense to be deployed in a fixed network where it can function without human intervention. Since the surrounding atmosphere serves as the elute gas, however, this means that fixed gases such as nitrogen (N_2), oxygen (O_2), and carbon dioxide (CO_2) will not be part of the universe of chemical gases detected by the AccuSense unit.

Resistance to Typical *Environmental Confusers*

Due to the separation capability inherent to the DHGC technology, *environmental confusers* that are typically a nuisance to users of competitive products using out-of-date technology are insignificant to AccuSense. Often times, common household substances such as Windex or commonly introduced fumes such as diesel exhaust cause detectors to alarm with false positives. The money spent on unnecessary response due to a false positive reading can be devastating. With that in mind, SEER engineers devised a way to separate chemicals efficiently and only look at the chemicals of interest in the background neural network algorithms. This way, if an *environmental confuser* is present along with chemical(s) of interest, the *confuser* signature is essentially thrown away and only the chemical(s) of interest are displayed to the user.

The AccuSense Graphical User Interface (GUI)

The AccuSense GUI is yet another differentiator that helps AccuSense stand out from other chemical detection systems. AccuSense is a very sophisticated lab quality piece of equipment that just happens to be portable and field deployable. This would not be very useful if you had to drag a Ph.D. around with the device to interpret the results. A representation of the AccuSense GUI Unit Reports tab is shown below:
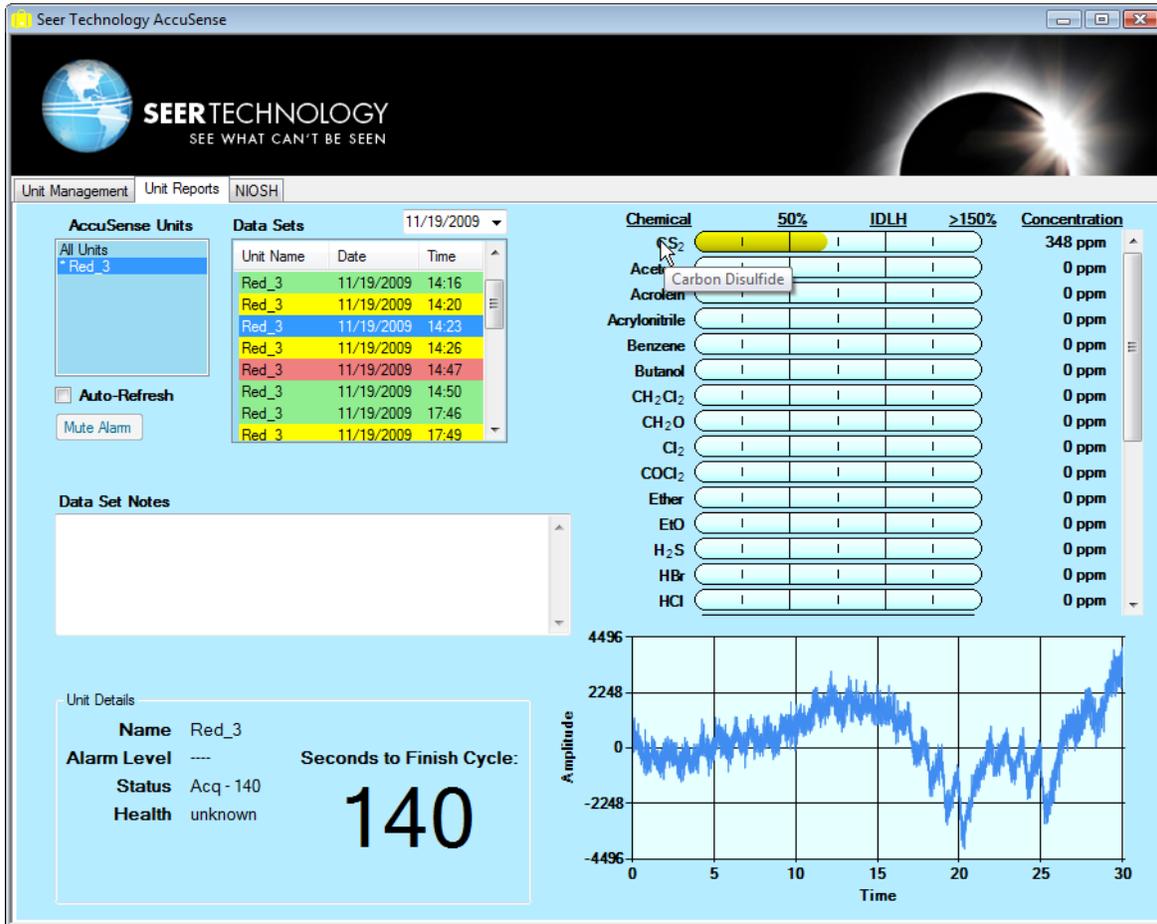
AccuSense Graphical User Interface Unit Reports Tab

AccuSense presents analysis information in a clear, concise, and understandable fashion. Features of the software include:

- **Unit Health Status** – continually monitors variables of individual units and warns user if out of specification
- **Chemical Concentration Display** – displays chemical concentration levels and automatically ranks the chemicals detected based upon their hazard level
- **Sliding Bar Scale** – visually represents the concentrations of chemicals detected relative to published Immediately Dangerous to Life and Health (IDLH) values
- **Color-Coded Data Sets and Unit Names** – allow the user to quickly identify when a device or particular data set is of concern
- **NIOSH Pocket Guide Drill-Down** – automatically links the user to the Pocket Guide to Chemical Hazards and provides additional information related to personal protection equipment, chemical and physical properties, etc.

Like the AccuSense hardware platform, the GUI software architecture is flexible and easy to modify to enhance its usefulness in other detection applications such as Time Weighted Average (TWA) or any other notification level of interest.

The AccuSense was built with the end-user field personnel in mind and the GUI was designed for that audience as well with accurate and useful information presented in a clear and concise manner.

What can AccuSense do for me?

AccuSense 3D Signatures enable a chemical detection paradigm shift from "Is there X in the air?" to "The air contains A, B, C... ...X, Y, Z at these concentrations." AccuSense brings end-users high-value decision information generated by multi-dimensional analysis of chemical composition against a universal database of high-integrity AccuSense 3D Signatures.

Product Comparison Matrix based on Dimensionality:

Technology	Manufacturer	Product Example	# of Dimensions
PID	Photovac, Inc	2020gasPRO	0
FP	Proengin SA	AP2C	0
IMS	Smiths Detection	LCD 3.3	1
PID/EC	RAE Systems, Inc	AreaRAE	1
FTIR	Smiths Detection	GasID	1
GC/MS	Inficon	HapSite ER	2
DHGC	**SEER Technology**	**AccuSense**	**2**

A different look at Chemical Detection Systems:

Chemical Detection System Comparison Matrix

		SEER Technology	Smiths	Inficon	RAE Systems	ICx	MSA
		AccuSense	**Gas ID**	**HAPSITE ER**	**AreaRae Steel**	**ChemSense 600**	**SafeSite MTX**
Detection Technology		DHGC w/Thermal Detection	FTIR	GC/MS	PID and Electrochemical Sensors	MS/MS	PID, Electro Chemical Sensors, and SAW
Detector Dimensionality	ANALYTICAL	2	1	2	1	2	1
Displays Concentrations of Chemicals	ANALYTICAL	X		X	X	X	X
Displays Concentrations of *Multiple* Chemicals	ANALYTICAL	X		X		X	
Organic AND Inorganic Chemicals Detected	ANALYTICAL	X		X		X	
Resistant to Confuser Chemicals	ANALYTICAL	X		X		X	
Neural Network Data Analysis	ANALYTICAL	X					
No Consumables	USABILITY	X					
Point Detection AND Fixed-Site	USABILITY	X		X	X		X
Upgradeable Chemical Database	USABILITY	X					
Light Training Burden	USABILITY	X			X		X
Minimal Maintenance Required	USABILITY	X					
Wireless Communications	OPERATIONAL	X		X	X		X
Battery Life 16-Hrs	OPERATIONAL	X					
Customers		Government, HAZMAT, Law Enforcement, Petrochemical, Domestic & International	HAZMAT, Law Enforcement, Military	Military, HAZMAT, Government	Petrochemical, HAZMAT, Government	Building and facility monitoring	HAZMAT, Government, Petrochemical

DHGC = Dual Hyphenated Gas Chromatography

FTIR = Fourier Transform Infrared

PID= Photoionization

MS = Mass Spectrometry

SAW = Surface Acoustic Wave

RDK = Rapid Deployment Kit

Summary

The AccuSense Chemical Recognition System from SEER Technology offers a field-portable or fixed-site 2-Dimensional chemical detection solution that can detect, identify and provide concentration levels of multiple gases simultaneously from a single sample. The initial implementation of AccuSense is for TICs detection, which targets the most readily available and harmful to human health chemicals. With its flexible design architecture that allows for multiple communications platforms and the addition of chemicals to its database, AccuSense is truly extraordinary in its capability to provide laboratory-quality information to the field at a price point that makes it the most well-rounded chemical detection instrument on the market today.