Development and Conduct of Structured Demonstration of an Open-Path Detector of Threat Chemicals

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The ChemSight® is an open-path chemical detector that was developed for long term, multi-chemical, long line of sight monitoring of large facilities, perimeters and building ventilation systems. It includes an eye-safe IR source that projects a collimated spectrally-broad beam towards the detector where the beam is analyzed spectroscopically. Chemicals intercepting that beam absorb portion of the energy and are detected by matching their IR absorption spectrum against signatures stored in the detector's digital library. Both the detector and the IR source can be mounted indoors or outdoors. Unlike point detectors, an open-path detector does not require direct contact with the detected chemical. By avoiding air sampling it can provide fast detection and recovery (1 sec), months - or even years - of continuous operation with no consumables and only minimal and infrequent maintenance. On the other hand, the optical absorption by the detected chemicals over an extended line of sight (<45 m) precludes longitudinal resolution. In addition, the measured signal depends on the optical density of the detected chemicals, *CL*, rather than their concentration *C* where *L* is the optical path of the IR beam through the chemical cloud. Consequently, outputs of an open-path detector are reported in units of *ppm-m* or mg/m^2. By contrast, outputs of chemical point sensors are reported in units of the concentration (*ppm* or mg/m^3) of the detected chemical at the sampling port.

As the ChemSight was prepared for commercialization, this fundamental difference presented a challenge when designing tests both in-house and independently to compare its performance to other detectors and to available standards. Clearly, both its reported output and methods of testing were not consistent with existing practices. To illustrate, if the required minimum detectable level (MDL) of a certain chemical is *1 ppm*, a point sensor can be tested by simply presenting at the sampling port a swab wetted by that chemical. On the other hand, to demonstrate similar sensitivity by an open path detector, the entire optical path *L* must be filled with the same chemical at a uniform and verifiable concentration of *1 ppm* or, alternatively, a fraction of the optical path *L/n* must be filled by a uniform concentration of *nC*. Neither test can be accomplished by evaporation of a wetted swab

Most tests and trials required demonstration of the detection sensitivity, specificity and robustness. In preparation for these trials a dedicated test facility was developed in-house and utilized to develop absorption signatures of key toxic industrial chemicals (TICs), evaluate MDLs and specificity. Similar facility was later duplicated elsewhere to test for certain chemical warfare agents (CWA). All tests could be controlled to allow testing of the challenge chemicals alone, mixed in air at specified humidity and in the presence of interferants and masking agents. In addition, procedures were developed for long term trials in deployment conditions. These procedures included methods to determine response to challenges as well as confirmation of detection.

The in-house test facility and testing methods will be presented and discussed.

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