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INDUSTRY ADVANCES IN FIRE DETECTION TECHNOLOGY

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ABSTRACT

Fire Characterization – Research & Application

The fire detection industry, independently and also in concert with research organizations, has long studied the concept of the characterization of fires; searching for scenarios enabling electromechanical sensors to mimic the ability of human senses to determine when, and when not, to initiate an alarm condition. We, in fact, are receiving progress reports of continuing work in this area at this conference. The use of these techniques in the field, however, has not been extensively realized to this point in time.

Industry advances in the recent past have been concentrated in several other areas encompassing all aspects of the fire detection system, including its role as a sub-system in total building control.. Many of these advances concern themselves with the same goal as that pursued by the application of fuzzy logic or neural networks – differentiation of the fire and non–fire environments.

The industry or "applied" technological advances the industry has made attack the problem at several levels, from the basic sensors used, through the communication paths within the system, to the integration of these systems within the building environment. At each level, the ability of the system to more precisely make the fire/non-fire determination in the face of real world environments was a key design goal.

Sensor Performance

Little change has occurred in the past several years in regard to basic sensing techniques in fire detection systems. In the research associated with fire characterization, other sensors, e.g., gas, chemical, etc. have been investigated. At this point in time, however, the ionization and photoelectronic smoke sensors remain the choice in reliable early detection in today's detection systems.

Therefore, recent advances within industry related to detectors have concentrated in applying signal processing techniques to remove or reduce unwanted sources of distortion of the desired information. These unwanted distortions include electromagnetic interference as well as non-fire environmental influences such as air borne dust, air gusts and moisture.

Sensor electromechanical design advances have made major contributions to the reduction of unwanted alarms, and must be given attention in any discussion of this topic. Recent advances in this area have concentrated in improved EMI rejection as well as significant improvement in the ability of smoke detectors to exclude insects and, in the case of the photoelectronic detectors, ambient or stray light. It is important to note that these improvements have been accomplished in the face of significant market pressure to decrease the profile dimension of these sensors.

While these electromechanical advances are no doubt of equal significance in improving fire alarm system performance, the spotlight has been captured in the past one or two years by advances in multisensor and signal processing developments. The downward migration of microprocessor power and technology to include sensors and other distributed modules has provided impetus for these developments. We have come, in a sense, "full circle" in fire detection decision making. We started with all of the decision making in the detector, moved toward a significant portion (if not all) of the alarm decision being made in the control unit, to today's systems which utilize "distributed intelligence". This has created much debate within the fire alarm system design community as to where and how the signal processing should be done.

Multisensor Technology

A discussion of multisensor technology requires that we first define the term. For the purposes of this discussion, we will define it as: a combination of fire sensors plus the associated signal processing and algorithms, regardless of the physical location of each of these elements within the fire alarm system. This definition is necessary if we are to include all points of view and design approaches currently in use in the United States, e.g. it includes the processing of information from spatially separated sensors. In general, however, the term is used to describe multiple sensors within a single spot-type detector housing.

Obviously the category does not attempt to restrict the type of sensors which can be combined, but as stated earlier, the combination of smoke and heat sensors is by far the most prevalent. The working group currently developing the ISO product testing standard for multisensor detectors, of which I am a member, spent a great deal of time on the question of scope. While the standard will allow for other combinations in the future, no specific requirements for other combinations will be included in the first version.

The combinations in use today generally include either one or two smoke sensors, a heat sensor used in either a supplemental or full voting fashion, plus the software containing the signal processing and combinational algorithms. The physical arrangement of the sensors in single housing units is also an important element in determining overall performance, as it can bias the relative signal strength from the individual sensors. If we examine the historical development of multisensor technology, we find first a combination of an ionization sensor and a photoelectronic sensor in a non-concentric arrangement coupled with an "or" logic circuit. While in the strictest interpretation of our

working definition this can be considered a "multisensor" detector, it is truly only two independent sensors within one housing. The same is, of course true of similar units using a smoke sensor and heat sensor so combined.

Today's units combine the individual sensors physically to provide, as nearly as practical, simultaneous sampling of the same sample volume, and utilize sophisticated signal processing techniques to improve signal to noise, long term drift compensation, and rejection of environmental short term effects (see Figures 4 & 5). In addition, they utilize algorithms which provide increased selectivity by the ability to "tune" the system to the individual application. One example is shown the attached Figures 1, 2, & 3. In this example of a multisensor unit having an ionization sensor, a photoelectronic sensor, and a thermal sensor, five level of sensitivity are included, all within the U.L. listing for the combined unit. The three signals can then be examined in both amplitude and time against an algorithm to ultimately arrive at the alarm decision.

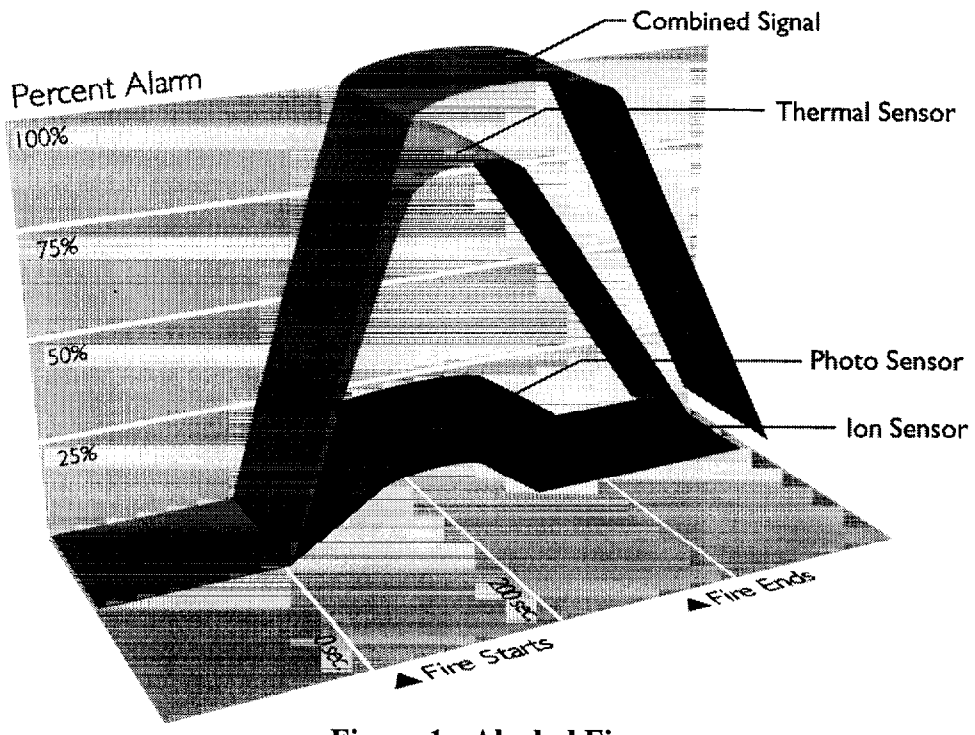

Figure 1 - Alcohol Fire

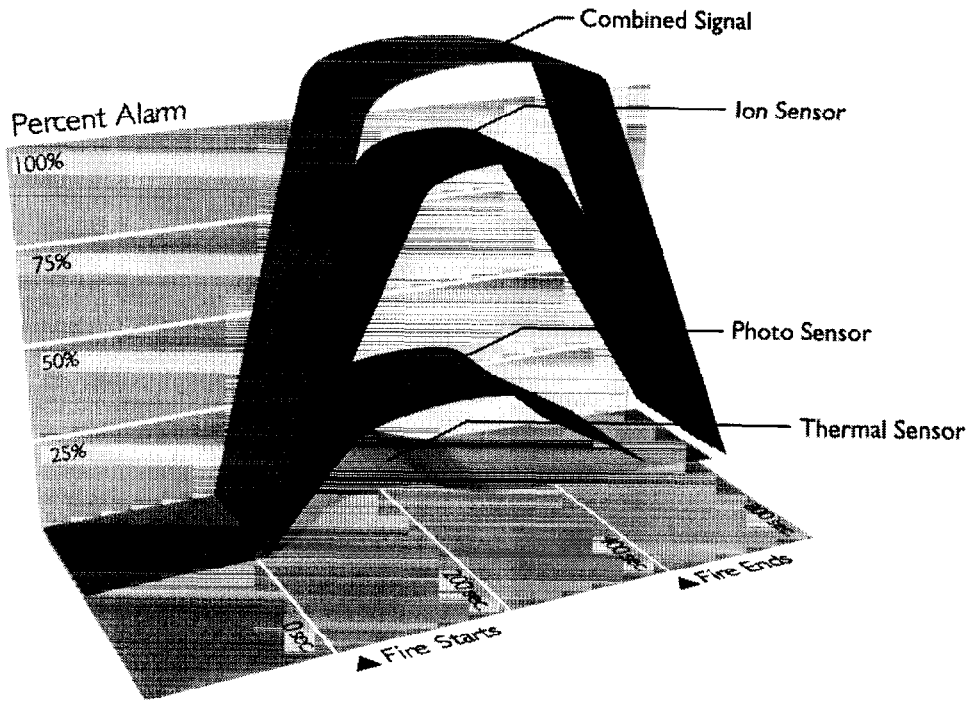

Figure 2 - Paper Fire

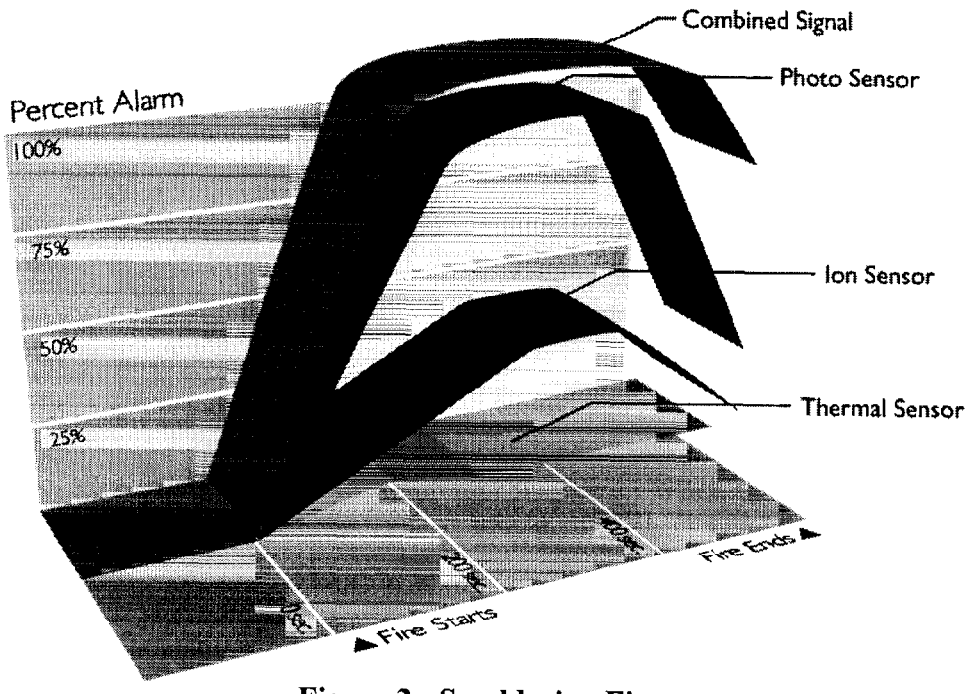

Figure 3 - Smoldering Fire

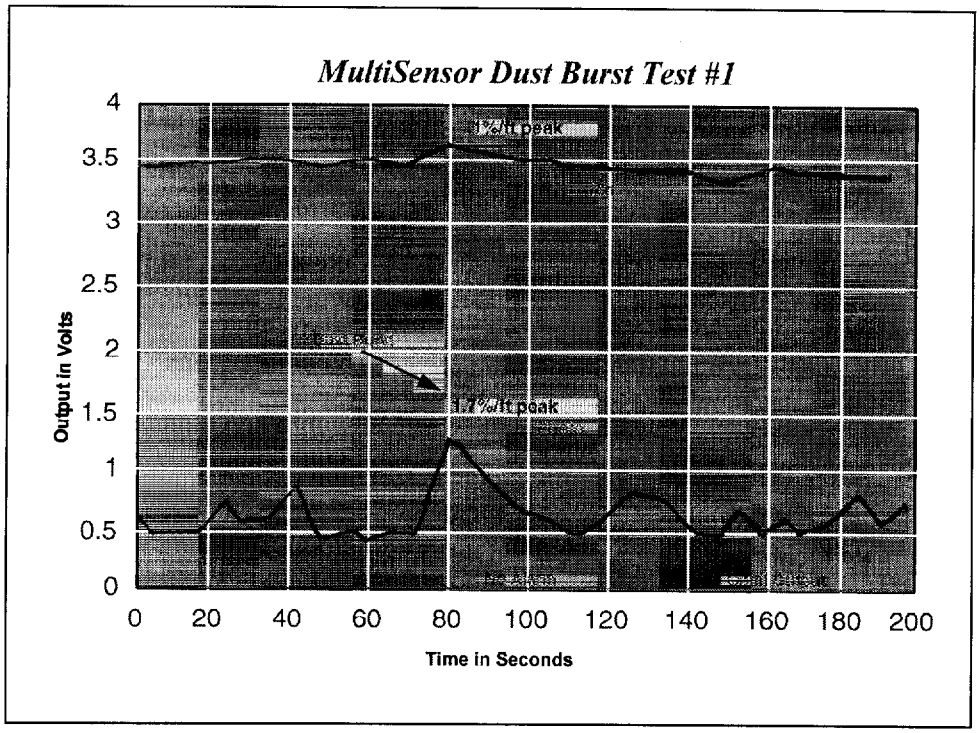

Figure 4

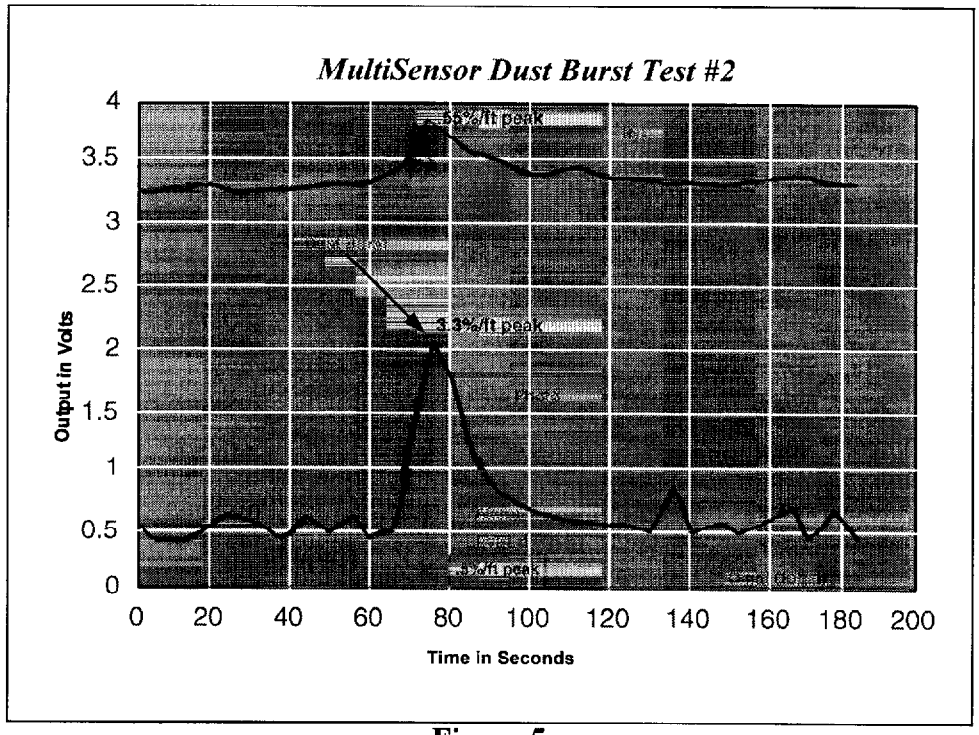

Figure 5

Discussion

Henri Mitler: My thought, along the lines of your suggestion, is that we want to approximate what a human sensor does. What a human sensor does is it smells something or hears something or sees something. It then investigates and therefore, it seems to me that if it were not cost inhibited, the detector which upon noticing something, should begin a search pattern.

Ronald Mengel: I couldn't agree more, and I think that's some of the work that Dr. Grosshandler mentioned in his paper. This is more or less the pre-fire condition sensor that I think we need to get into if we are going to realize that sort of capability.

Question: It seems to be that you've pointed out a weakness in the development in the detector technology and that is that the certification process only requires that you detect fires and that there's really nothing in either of the U.S. or the European standards that require that you cannot detect non-fires. Do you see any prospects for bringing another test of a similar nature in a CL or CDN type standard and are you prepared to recommend what those tests will be?

Ronald Mengel: Industry has spent a good deal of time and effort attempting to find repeatable non-fire equipment. To date, we haven't had a great deal of success, and this is why we see the reluctance of the European fire community to accept anything at this point.