

Performance Based Testing of Video Image Detection Devices

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ABSTRACT/SCOPE

Video Image Detectors (VID's) provide smoke and fire detection capabilities that exceed traditional detection test protocols while introducing a multitude of new problems for the fire protection specialist.

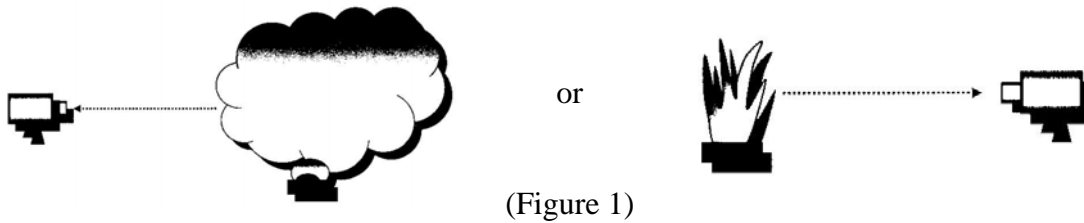
This presentation provides insight on how the redundancy, reliability and supervisory principles of NFPA 72 can be applied to Video Image Detectors as well as the performance based approach to verification of a VID's detection capabilities.

Special Note: This discussion is based on current knowledge, past practice and experience, but does not introduce any information from the ongoing Fire Protection Research Foundation -VID projects.

INTRODUCTION

The intent of this paper is not to debate how this type of technology may or may not be appropriate for any particular application or protection scenario. That's a wholly separate issue for discussion at another time. It also is not intended to be a complete test outline covering all of the aspects required for a product certification. What I hope to accomplish with this paper and subsequent presentation, is to relate how this new technology actually fits within the existing and underlying principles and philosophies of NFPA 72⁽¹⁾, as well as the appropriate portions of product test standards currently available today.

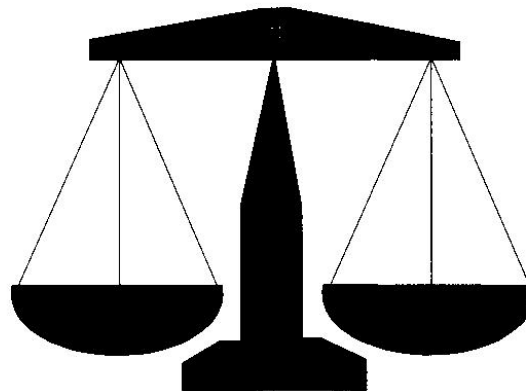
In this discussion, we will talk more about the use of VID's for the recognition of a smoke signature vs. that of a flame signature (See Figure 1); there may be considerably less confusion when a VID is configured to detect a flame source, but I could be wrong on this assumption.



The first realization one must have is that a VID is a line-of-sight device which differentiates it from all other forms of smoke detection currently available today and aligns it more closely with the operation of a radiant energy-sensing detector, often times simply referred to as a flame detector.

Because of this line-of-sight characteristic, it does not have to wait for the smoke (or fire) signature to travel into its sensing chamber like other spot type, open path or line type smoke detectors. It also does not rely on, nor is it encumbered by the mechanical systems of an aspirating system. Instead, what it requires is a good, clean quality video image, an unobstructed view of the area to be protected, an understanding of the normal uses and activities expected in the monitored area and finally, the use of proper equipment, suitable and reliable enough to use as a fire detection device with life safety capabilities.

Compared to typical smoke detection, a VID is devoid of the usual time delays associated with the transportation of smoke particles from the fire to the detection chamber and instead, the information is transported for all practical purposes, instantly. This instantaneous detection capability is arguably is one of the greatest advantages of the VID technology; it also can be its worst enemy. Many will agree that while it is relatively easy to build a detector, the difficult part is to build one that does not provide false or nuisance signals that reduce the credibility of the overall detection system or installation. (Figure 2) If the goal is early detection, how much is enough and how much is too much?



FALSE SIGNALS

or

BETTER DESCRIMINATION

(Figure 2)

In actuality, a detector's ability to screen out nuisance sources from a real fire source is a balancing act and presents yet another form of reliability that must be considered when evaluating these systems. I have to admit, this remains partially unresolved and still open for further discussion, but again at a different time. Some common nuisance sources for a VID image smoke detector would be; an existing smoke stack or flare, lift truck operation or normal workers or people within the field of view of the VID.

TEST PROTOCOL

When you consider detector test standards currently available and in use, as well as what would be most applicable or appropriate, you'll find a problem. Because a VID may be labeled as a smoke detector, most would automatically assume that the traditional ANSI smoke detector standard⁽²⁾ would be the most appropriate. Why not? It's been used successfully by the industry for years and it has been arguably flexible enough that it has been applied to other new detection technologies (linear beam and aspirating detectors) if not as a whole, at least in part.

Performance Verification - Some would argue that the fire scenarios envisioned with the ANSI smoke detector standard are not well suited or even applicable to a VID's capability. I agree; the prescriptive well defined source fires of the ANSI document are well suited for room type detectors and do a fine job at governing detection thresholds for residential or dwelling unit detectors. However, they simply do not translate well to this long range, line of sight detector.

To date, the VID's available today (both smoke and flame signature types) have been intended and are more suitable for industrial/commercial applications and not that of dwelling units. They represent a detection capability and level of protection that is not available with other technologies. I see the current guidance provided in NFPA 72⁽⁴⁾ for both smoke and flame signatures as not incorrect, but limited and suggest that they could benefit if they more closely followed the performance based guidelines established for radiant energy-sensing flame devices⁽⁵⁾.

Approaching this problem along more of a performance or application based series of tests, we can derive guidelines from NFPA 72 and other line of sight detection devices, i.e. flame detectors and their more appropriate ANSI standard. Incorporating the basic four smoke room tests from the ANSI smoke detector standard provides additional information on how these devices compare to conventional smoke detection benchmarks. These two standards, when used together, address many of the requirements and intentions of NFPA 72. By measuring the VID's performance against the traditional four smoke room tests, we gain an insight as to how this new technology differs and compares against the traditional smoke detector.

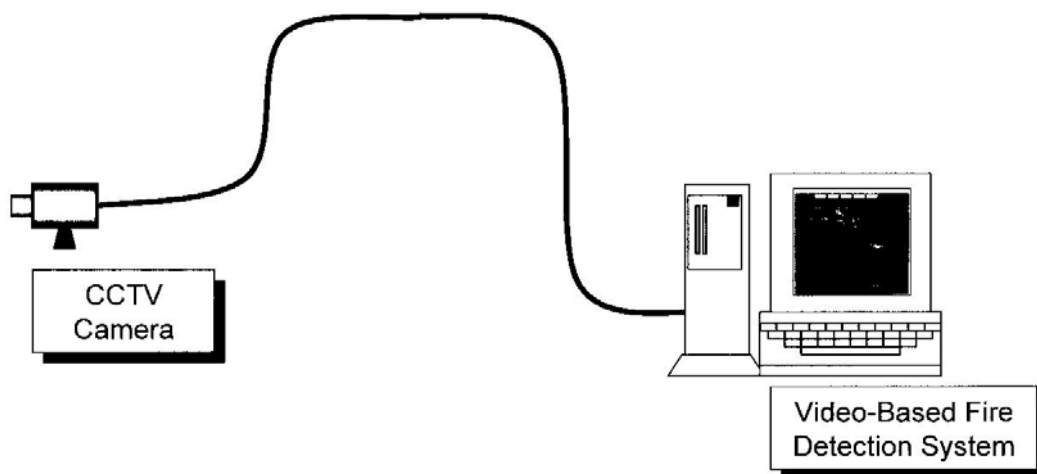
What we realize is that the detection capability of a smoke signature VID is not that well defined by subjecting them to the four traditional smoke room tests. The true detection capability is better defined via a performance based approach. Test techniques employed for years on radiant energy detectors, flame, ember and spark types work well here due to the similarities of the line-of sight operation. By properly defining the parameters of the test source and conditions such as: the fuel used, the size of the source, the distance from the source, the field of view, presence of and effects of interference sources, the environmental limitations, including lighting requirements. All combine to provide the end user and designers with sufficient information so that the detection goals and the desired level of protection or response time can be properly addressed.

Understanding the intent as well as the limitations of the VID system itself, are pre-requisites to a successful installation and operation of the VID.

In addition to their detection capability, there are certain types of fuels and surroundings that might not provide adequate detection and this needs to be considered. As examples, clean burning fuels [i.e. alcohol] provide very little smoke signature, a light colored smoke on white background [e.g. the ANSI smoldering fire] or even dark burning fuels [plastics and some fuels] on dark surfaces all need to be considered.

Monitoring for Integrity and Reliability – The basic requirements for supervision in NFPA 72 cover the circuits or wiring that connects peripheral devices to the control equipment. The peripheral devices themselves are supervised for physical placement into a base or socket and for circuit continuity, but whether they are operational or not, is simply not covered or required per NFPA 72. If a detector becomes inoperable or fails to operate, the only way we know it is through testing. Addressable or analog devices provide some improvement on this, but for the most part are not supervised for total operation.

To address this issue, a statistical reliability study is an integral part of the ANSI smoke detector standard and for good reason. If you are not supervising the device, you should be ensured that the device maintains a certain level of reliability.



(Figure 3)

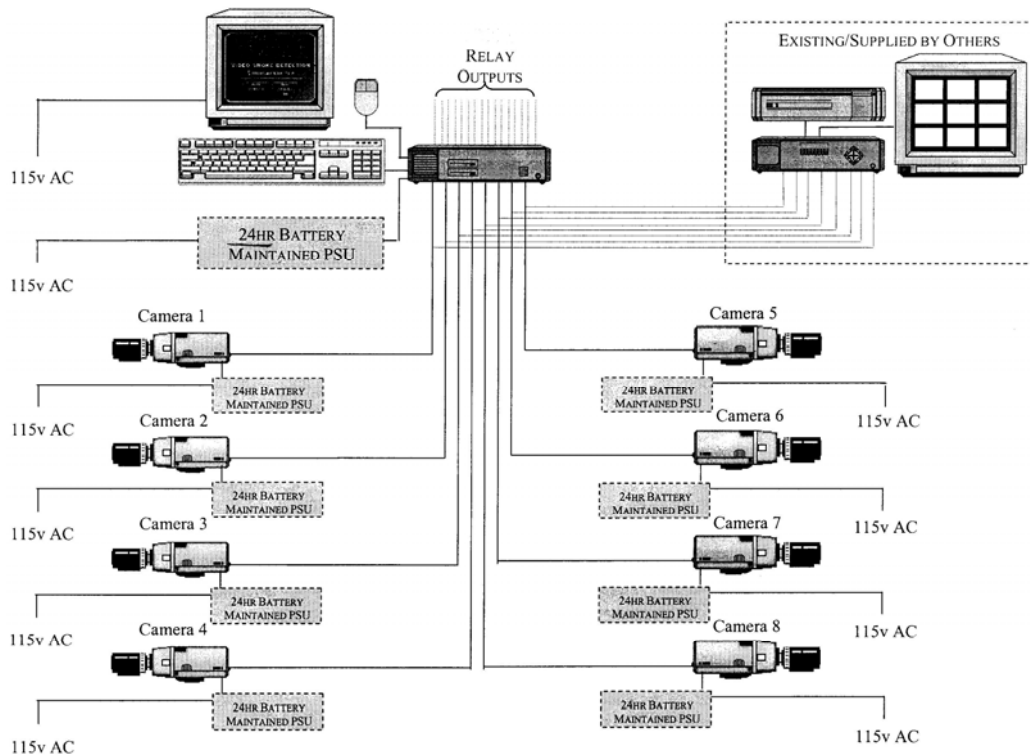
For a device like a VID, it's possible that you have complete end-to-end supervision of the system. Not only is the wiring from the control equipment to the VID supervised, but with proper signal interpretation, things like image clarity, contrast and just the fact that the video image is still present, provides equipment as well as transmission path supervision. This requires a certain level of image supervision be built-in to the analyzing software, but is critical to the device's operation. Without it, the statistical reliability study would be appropriate for the VID detectors, and I'd have to guess that would be a daunting task.

A VID device that exhibits this level of end-to-end supervision would be exempt from the idea of the statistical reliability study necessary for the un-supervised spot type smoke detector. In actuality, the supervision capability of the VID exceeds the minimum requirements established in NFPA 72.

Power Supply Reliability – For most cases, 24 hours standby power operation is required in the event of a primary power failure for a fire alarm system and it connected devices. This most certainly would apply to a detection system and that includes a VID system. This means maintaining the overall integrity of the detection equipment itself, as well as the area being monitored so the smoke detection capability is not compromised.

For VID smoke detection systems evaluated to date, that typically implies that a mains UPS is provided for the processing equipment and separate battery backed supplies for the cameras (dc operated) as a minimum. In some cases, depending on the overall design of the detection systems performance, it might be required to maintain certain minimum lighting levels and that can get difficult, not to mention expensive.

As a result, a whole systems approach (Figure 4) has been employed on VID Approvals or listings where the critical components of the VID system are defined and tested for compatibility of the complete system. Specifications and power requirements are considered for the cameras and the computers so that proper supervision is maintained and the stand-by power is sized properly. The idea that a VID system is a software only solution capable of working with existing cameras has not proven to be the case and place too much burden on local AHJ's to make the determination if the system meets the intend of NFPA 72.



(Figure 4)

Environmental Conditioning – Following NFPA 72 minimum guidelines, operation at temperature ranges from 0°C (32°F) to 49°C (120°F) can be expected and must be confirmed through testing. A VID smoke detector has the additional burden that it must be capable of seeing the smoke in order to detect it. While cameras continue to improve and are capable of operation at very low ambient lighting levels, there is a minimum threshold that must be maintained in the area being monitored in order to expect reliable detection. With the total systems approach, cameras and detection algorithms can be verified at each environmental extreme. This information is provided in the installation manuals of each VID system.

PROBLEMS & GENERAL OBSERVATIONS:

- While a traditional radiant energy-sensing detector has sensitivity that varies following the inverse square law, a VID is governed by a more proportional or linear sensitivity rule. Sensitivity varies in proportion to the distance change.
- Maintaining lighting levels above certain minimum requirements is an environmental concern and critical to detectors operation.
- For the first time, the area being monitored is visible and understandable by those accessible or viewing the screen or monitor. No more guessing on the field of view, is the detector aligned properly, is there a blockage in the monitored area, is there a signal that needs to be screened out?

- To date, all testing has been verified through actual smoke and fire testing and involves the entire system. It is envisioned that “partial” system verification could be run using a video image either captured during the initial testing or an existing reference library.
- The ability to store and retrieve fire data image files is a significant resource for troubleshooting and investigation purposes.

SUMMARY

This technology has great potential with much still needed to be learned and improved upon. To date, the certification process has involved a “systems” approach. That includes the cameras, processing equipment, primary and secondary power supplies as well as the software that drives them. From an NFPA certification standpoint, the idea that a VID system is a “software only” application that can be run only any processor or any camera or hardware is simply not possible at this time.

The only way that a VID can be designed, installed and tested correctly is by understanding the equipments capability, its limitations, following the manufacturer’s guidelines, and using equipment that is Approved or listed for the application.

ACKNOWLEDGEMENTS & REFERENCES

- (1) NFPA 72, National Fire Protection Association, National Fire Alarm Code (2007 ed.)
- (2) ANSI/UL 268, American National Standards Institute, Underwriters Laboratories, Smoke Detectors for Fire Protective Signaling
- (3) ANSI/FM 3260, American National Standards Institute, Radiant Energy-Sensing Fire Detectors for Automatic Fire Alarm Signaling, (2004 ed.)
- (4) NFPA 72, National Fire Protection Association, National Fire Alarm Code (2007 ed.) para. 5.7.6 & 5.8.5
- (5) NFPA 72, National Fire Protection Association, National Fire Alarm Code (2007 ed) section 5.8