A Comparison of Aspirated Smoke Detectors

Honeywell FAAST Detectors and Xtralis VESDA VLF (Laserfocus)

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And

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FIRE TESTING AND EVALUATION CENTER
DEPARTMENT OF FIRE PROTECTION ENGINEERING

Aspirated Smoke Detection Experimental Summary

1.0 OVERVIEW

In this experimental series, the Honeywell FAAST aspirated smoke detection (ASD) system was compared to the Xtralis VESDA VLF (LaserFOCUS) aspirating smoke detector through a series of three types of experiments. The testing was performed at the Fire Testing and Evaluation Center, part of the Fire Protection Engineering Department at the University of Maryland. The scenarios consisted of a large room with smoke from wire insulation, an enclosed box with directional airflow circulating fine dust, and an enclosed box with directional airflow circulating fine dust and smoke from wire insulation. The response time to alarm state of each system was recorded. The obscuration due to dust or smoke inside of the box was recorded for the second and third scenario. Three Honeywell FAAST machines (H1, H2, and H3) and three Xtralis VESDA machines (V1, V2, and V3) were compared in groups of two: H1 was tested with V1, H2 was tested with V2, and H3 was tested with V3. Each group was subjected to the same three scenarios. Three trials were conducted per group per scenario. Obscuration was measured for the box experiments only. Obscuration is a measure of the particle percentage per foot. A smoky room with 100%/ft obscuration is full of smoke and no light can be transmitted through the smoke. These experiments were designed to have an obscuration around 1.0%/ft.

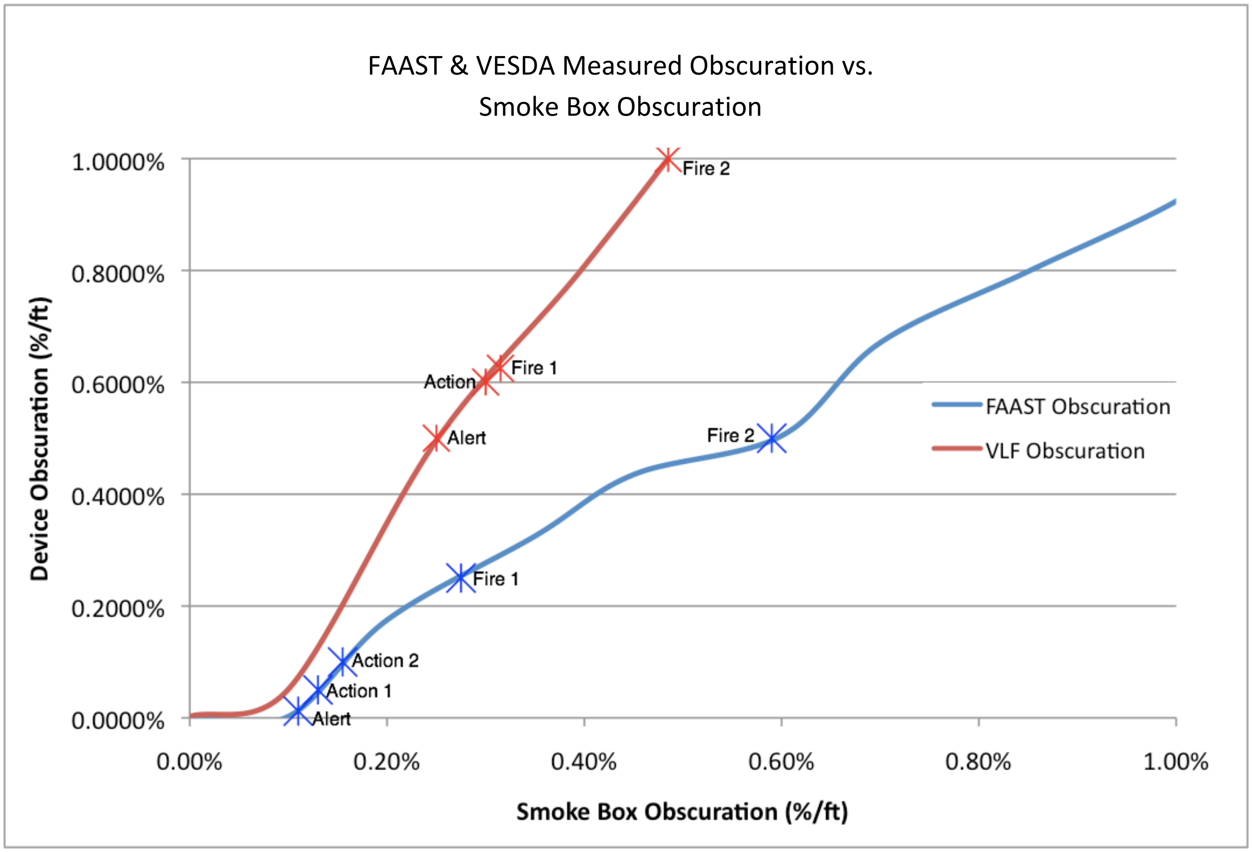
Note: The V# and H# labels correspond to the following existing labels found on the systems:

V1: VLF 5	H1: Chamber 32
V2: VLF 6	H2: Chamber 12, 9
V3: VLF 7	H3: Chamber 23, 25

The results of each test are defined by the various responses of the Honeywell FAAST and Xtralis VESDA VLF units. The FAAST systems have five alarm levels and ten particulate levels. The alarm levels are Alert, Action 1, Action 2, Fire 1, and Fire 2. The particulate levels are numbered one through ten. As particles are detected, the levels illuminate on the display. Each level represents a 10% increase in the particulate level necessary to reach the Alert alarm level. In other words, when particulate level 10 is reached, the Alert alarm level has been reached. The FAAST units are set to Alert: 0.012%/ft, Action 1: 0.05%/ft, Action 2: 0.10%/ft, Fire 1: 0.25%/ft, and Fire 2: 0.50%/ft.

The Xtralis VESDA systems have four alarm state indicators and ten additional smoke level indicators. The alarm levels are Alert, Action, Fire 1, and Fire 2. The smoke level indicators are comparable to the ten particulate levels found on the Honeywell FAAST systems. However, the 10 particulate levels are tied to the Fire 1 alarm level. In other words each particulate level corresponds to approximately 10% of the Fire 1 alarm level. The Xtralis VESDA units are set to Alert: 0.5%/ft, Action: 0.6%/ft, Fire 1: 0.625%/ft, and Fire 2: 1.0%/ft.

The graph below summarizes the above information. What is important to note is that each device has its own internal obscuration measurement that is tied into the measured “actual” value as obtained in the smoke box. Thus, the device obscuration measurements are not directly comparable; they must be normalized to the smoke box obscuration. The alert and action levels can be compared when looking at the smoke box obscuration measurements. For instance, the Xtralis VESDA detector reaches its Alert level at approximately 0.23%/ft obscuration while the FAAST detector reaches an Alert level at approximately 0.10%/ft obscuration.

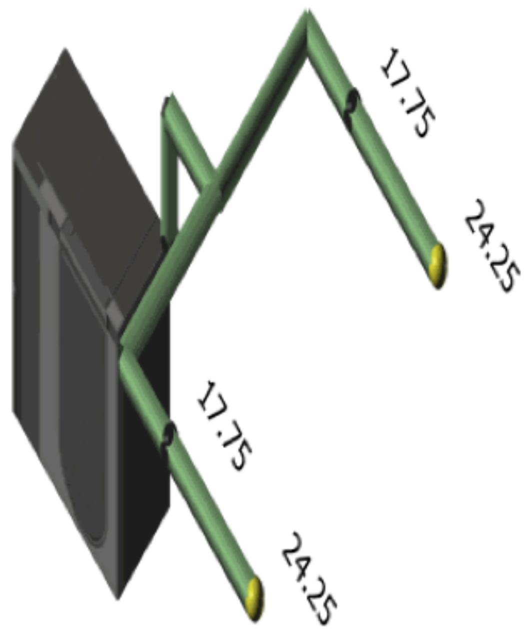


2.0 ROOM DETECTION TEST

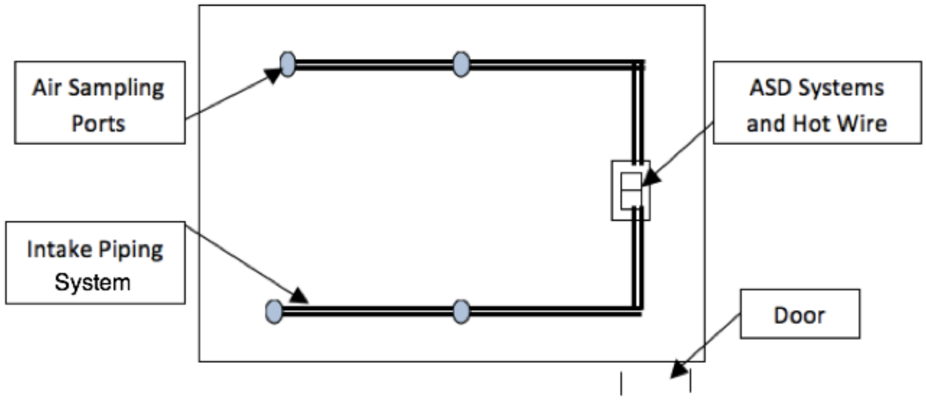
2.1 Set-up

The detection test was conducted in a large room with the ASD systems located inside the room. The room had minimal ventilation to ensure mechanical vents did not interfere with the experiments. Each system was connected to its own pipe network for smoke intake. The pipe networks were parallel to each other and the sampling ports were less than an inch apart. This ensured the same sample of air was received by each system. The branch pipes were each 24.25 feet long. The connecting pipe was 14 feet long, with the ASD system intakes centered at 7 feet. The air sampling ports were located at 17.75 feet and 24.25 feet in the branch pipes. Four ¼" diameter ports were located at 17.75 feet in each pipe. The ports were set every 90°

around the circumference of the pipe. One ⅛" diameter port was located at 24.25 feet in each pipe. This port was drilled into the end cap of the pipe. Each ASD system had a total of ten ports (five on each side). The maximum transport time for this configuration was calculated to be 10.63 seconds. The systems were allowed to exhaust back into the room. Schematics for the ASD systems and their locations within the test room are shown below.



Sampling port locations for ASD systems



Layout of piping and configuration of the test room

The smoke came from smoldering wire insulation in compliance with the hot wire test from NFPA 76[1] and UL 268. A two-meter long wire was coiled around a one-inch diameter pipe. The coiled wire was connected to a variable AC power source. The wire was subjected to a high current at a low voltage, which resulted in the production of smoke from the smoldering wire insulation. The wire was located on a cart below the VESDA and FAAST systems. The closest sampling ports for each system were equidistant from the wire. The test began when the wire power was connected for 30 seconds at the beginning of the experiment. After 30 seconds, the power to the smoldering wire was turned off and the wire remained in the room. The video camera was connected to a closed circuit television for monitoring the system status. The test was allowed to continue until the systems alarmed.

2.2 Results

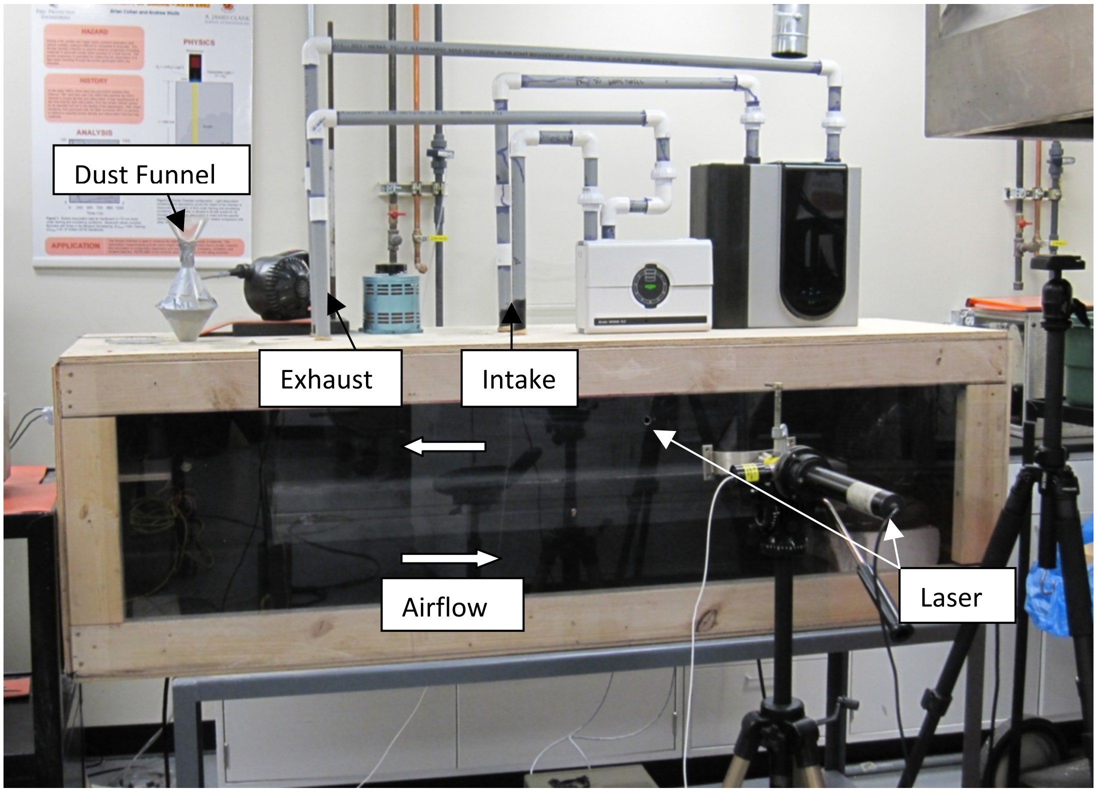
Overall, the FAAST and VESDA ASD systems alarmed with the presence of smoke. In all cases, the VESDA system alarmed first. The FAAST systems would generally alarm within one to two seconds after the VESDA systems. The following chart summarizes the reaction of each machine for each trial. The times listed represent the time from when the power was supplied to the wire. The wire began to smoke about 4-6 seconds after time zero. Note that a fault signal and flow warning occurred in all trials for H1.

Trial	ASD Systems	Alarm Time (sec)	Average Times (sec)
Trial 1	V1	40	V1: 43.3 seconds H1: 45 seconds
	H1	42	
Trial 2	V1	41	
	H1	42	
Trial 3	V1	49	
	H1	51	
Trial 1	V2	38	V2: 37.3 seconds H2: 39.3 seconds
	H2	39	
Trial 2	V2	32	
	H2	36	
Trial 3	V2	42	
	H2	43	
Trial 1	V3	48	V3: 44.7 seconds H3: 49.3 seconds
	H3	49	
Trial 2	V3	45	
	H3	51	
Trial 3	V3	41	
	H3	48	

3.0 BOX WITH DUST TEST

3.1 Set-up

The box with dust test had the ASD systems located outside of the box with intake and exhaust piping connected to the inside of the box. A fan was placed in the box to direct the airflow in a counterclockwise direction. Portland cement dust entered the box for four minutes to simulate nuisance particles. The dust was dropped into a funnel equipped with an air compressor. The compressor agitated the dust into fine particles, which then fell through a screen into the box. Intake pipes were positioned next to each other in the box to ensure the same sample of air was taken by each system. These pipes were oriented in the direction of airflow in the top portion of the box. This orientation allowed only airborne dust particles to be sampled. The time delay for the particles to reach the detection systems was the same for the FAAST and the VESDA systems. After analysis, the sampled air was returned to the interior of the box through exhaust piping. A video camera recorded the response of the ASD systems. The obscuration (%/ft) of the dust was also measured. A laser diagnostic was used to measure the obscuration of the air directly before it entered the intake (as seen in the following image). This laser was positioned in the top portion of the box close to the ASD system intake tubes but far from the air re-entry and dust entry locations. Throughout all of the trials, the obscuration varied from 0.07%/ft to 0.9%/ft. The following image shows the overall set-up. Note the laser for obscuration measurements and the funnel to drop the dust into the box.



3.2 Results

In most trials, the VESDA ASD systems alarmed for the dust while the FAAST ASD systems did not. The table below describes the alarm state for each system throughout the trials. The maximum signal threshold notes the particulate level (1-10) reached by each system during testing. In some trials, the ASD systems did not reach 100% by the end of the experiment. The obscuration provided is an average over the course of each trial. Additionally, the response to dust is noted. Generally, the FAAST systems did not reach an Alarm state when only nuisance dust was present in the box.

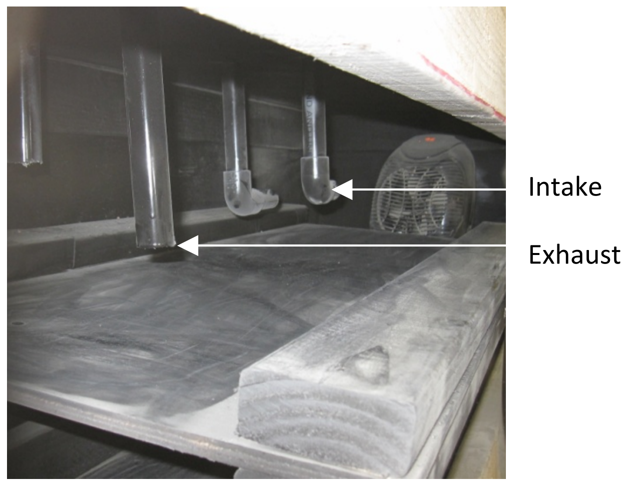
Trial	ASD Systems	Alarmed for Dust?	Maximum Signal Threshold (%)	Dust Obscuration %/ft
Trial 1	V1	Yes	80	0.18
	H1	Yes	100	
Trial 2	V1	Yes	90	0.11
	H1	Yes	100	
Trial 3	V1	Yes	100	0.96
	H1	Yes	100	
Trial 1	V2	Yes	80	0.51
	H2	No	60	
Trial 2	V2	Yes	80	0.07
	H2	No	60	
Trial 3	V2	Yes	100	0.25
	H2	No	40	
Trial 1	V3	Yes	100	0.13
	H3	No	40	
Trial 2	V3	Yes	100	0.40
	H3	No	50	
Trial 3	V3	Yes	100	0.25
	H3	No	20	

4.0 BOX WITH DUST AND SMOKE TEST

4.1 Set-up

The box with dust and smoke had the same set-up as the box with dust experiments. After the dust was inserted into the box for four minutes, smoke from smoldering wire insulation was introduced. The smoldering wire was in compliance with NFPA 76[1] and was identical to the set-up used in the room detection tests. The smoldering wire is comparable to UL 268, which used cotton lamp wicks to introduce "gray" smoke into the box[2]. A slightly lower current and voltage than the room detector tests were used in order to achieve smoke obscuration levels of less than 1%/ft. The wire was allowed to smolder for 20 seconds, then power was cut off from the wire for 30 seconds. This on/off pattern was repeated throughout the test. This pattern was experimentally discovered to maintain a constant obscuration from the wire. The dispersion of smoke in the box was driven by the counterclockwise flow. After 30 seconds of no power (no smoke production), the obscuration in the box began to decrease. A steady obscuration behavior is preferred over an obscuration that increases and decreases as a function of time. In order to keep the obscuration constant, additional smoke needed to be introduced inside the box, therefore the power was turned back on. This was necessary to maintain an obscuration of 0.7 %/ft due to smoke inside of the box. The on/off pattern occurred until both systems alarmed. In cases where one system alarmed due to the presence of dust, the smoke was introduced until the second system alarmed. Throughout all of the trials, the obscuration of the dust varied from 0.8%/ft to 2.6%/ft and the obscuration of the wire was constant around 0.7%/ft. A video camera recorded the response of the ASD systems throughout the test. The following images show the inside of the box. The hot wire is seen on the left. The intake and exhaust ports for the ASD systems are seen on the right.

This test methodology is similar to a test developed by the National Institute of Standards and Technology[3]. In the NIST experiments, titled *Fire-emulator/detector Evaluator Experiments*, a smoke source is introduced at one side of a narrow box. The NIST smoke source used wood sticks on a hot plate, intended to produce smoke gray in color. The box is equipped with a fan to direct the airflow. The detectors are located at the top of the box. A laser is directed through the box at the height of the detectors slightly ahead of the detector inlets. The light extinction of the laser is measured throughout the experiment. Dust (clay particles) is also inserted into the box to test the detector response to nuisance sources. The dust is injected into the box by passing it through a small air jet, similar to the set-up used in the experiments at the University of Maryland FireTEC lab.



4.2 Results

The first portion of this experiment had the same results as the box with dust only experiments. The VESDA systems alarmed with the presence of dust and the FAAST systems in most cases did not. When the smoke was introduced into the box, the FAAST systems that did not alarm for dust alarmed. This behavior is summarized in the following chart. When the VESDA systems alarmed for dust, the alarm remained with the noted signal threshold until the end of the experiment. The dust obscuration measurements are slightly higher for this experiment. In most cases, the FAAST ASD still does not alarm for these elevated levels of dust.

Trial	ASD Systems	Alarmed for Dust?	Alarmed for Smoke?	Maximum Signal Threshold (%)	Dust Obscuration %/ft
Trial 1	V1	Yes	Yes	100	0.8
	H1	Yes	Yes	100	
Trial 2	V1	Yes	Yes	100	0.9
	H1	Yes	Yes	100	
Trial 3	V1	Yes	Yes	100	1.4
	H1	Yes	Yes	100	
Trial 1	V2	Yes	Yes	100	1.2
	H2	No	Yes	100	
Trial 2	V2	Yes	Yes	100	0.8
	H2	No	Yes	100	
Trial 3	V2	Yes	Yes	100	2.4
	H2	No	Yes	100	
Trial 1	V3	Yes	Yes	100	1.5
	H3	No	Yes	100	
Trial 2	V3	Yes	Yes	100	1.1
	H3	No	Yes	100	
Trial 3	V3	Yes	Yes	100	2.6
	H3	No	Yes	100	

5.0 CONCLUSIONS

The room detection tests displayed that the Xtralis VESDA and Honeywell FAAST ASD systems have similar alarm times when subjected to smoke from wire insulation. The progression of alarm levels was comparable between the two as the systems detected smoke. In the box tests, it was observed that the Honeywell FAAST ASD system generally did not alarm in the presence of a nuisance source (dust) while the Xtralis VESDA system alarmed almost immediately. Once smoke was introduced into the box, the Honeywell FAAST systems that did not alarm for dust alarmed. Therefore, it can be concluded that the Honeywell FAAST ASD system has a higher capability to discriminate against nuisance sources, thereby lowering the frequency of nuisance alarms when compared to the Xtralis VESDA system.

6.0 REFERENCES

1. *NFPA 76: Standard for the Fire Protection of Telecommunications Facilities,* National Fire Protection Association, Quincy, MA, 2002.
2. *UL 268: Standard for Smoke Detectors for Fire Protective Signaling Systems*, Underwriters Laboratories, Inc., Northbrook, IL, 1989.
3. Cleary, T., W. Grosshandler, and A. Chernovsky, *Smoke Detector Response to Nuisance Aerosols,* National Institute of Standards and Technology, Gaithersburg, MD, 1999.