1. SCOPE

This Technical Specification details requirements for evaluation of Visual Smoke Detection (VSD) systems for use in fire detection systems. ActivFire Technical Specification AF-TS003 supersedes SSL/CSIRO Appraisal Specification FAS-125.

This document also specifies the scope of evaluation to verify “fitness for purpose" of a VSD system, together with requirements for submittal data and documentation. The test procedures specified herein are based on those outlined in FM Approvals engineering examination of a VSD system, in conjunction with a system validation test.

While this specification relates directly to an FM Approval engineering examination of equipment, testing/assessment by other independent recognised testing authorities (such as UL, ULc, BRE etc.) could be considered within the scope of assessment by this specification.

This specification is an interim procedure pending publication of a relevant Australian Standard covering visual smoke detection systems.

1.1. Exclusions

Conformity of components with this specification does not imply or confer conformity to AS 7240-13 Fire detection and alarm systems – Part 13: Compatibility assessment of system components.

2. REFERENCED DOCUMENTS

Relevant parts of the following documents are referenced for the purposes of this Technical Specification.

FM Approvals Class Number 3230, January 2010	Approval Standard for Smoke Actuated Detectors for Automatic Alarm Signaling
FM Approvals 3230-3250, 2/76 2010	Smoke Actuated Detectors for Automatic Alarm Signaling (including October 2001 Addendum)
ANSI/FM Approvals 3260 February 2004	American National Standard for Radiant Energy-Sensing Fire Detectors for Automatic Fire Alarm Signaling
ANSI/FM Approvals 3260, 8/2000	Radiant Energy-Sensing Fire Detectors for Automatic Fire Alarm Signaling

3. EVALUATION FOR CONFORMITY

Evaluation to determine conformity with the requirements of this test specification shall reference selected physical test methods of FM Approvals Standard 3230 and FM Approvals Standard 3260.

3.1. Detection tests

This Appraisal Specification permits VSD equipment which has previously been evaluated to different sets of detection tests arising from different versions of FM Approvals evaluation criteria. Conformity with at least one of the optional detection test sets outlined below is required.

When tested in accordance with the requirements of this clause , the VSD shall respond within the specified limits.

3.1.1. Detection test set - Option 1

3.1.1.1. Baseline sensitivity test

Tests shall be performed in a 22 ft (7.62 m) wide x 36 ft (10.97 m) long with 10 ft (3.05 m) high drop ceiling, enclosed test room. The test area is not required to be climate controlled. The walls shall be painted white and floor constructed from concrete. Typical lighting consists of 16, 2 ft by 4ft fluorescent, Philips Universal T8 TL741 32 Watt Cool bulb fixtures. Exhaust ports are to be located at one end of the room opposite the entrance door and fire source.

The test room lighting has three calculated lighting conditions: 111.8 Fc +/- 27.6 Fc, 32.4 Fc +/-18.6 Fc, and zero illumination.

VSD equipment shall be tested using small-scale fires generated by a propane torch. The propane torch test is to be repeated after vibration, temperature exposure, etc.

Other fuels to be used are [shredded news] paper and wood crib. Determination of system response to the specific fuels shall be made to established baseline sensitivity and shown to be proportional to the full scale testing performed subsequently. Although the VSD equipment is not intended to be operated in this type of application, it serves as a baseline to compare the VSD equipment response to other more conventional detectors and known test criteria. The baseline test fire is intended for assessing flame rather than smoke response.

3.1.1.2. Paper Test [smoke generation]

For this test, shredded newspaper is to be burned in the test room as described in 3.1.1.1. Fuel loads are to be varied from one half (14 g) to one and a half ounces (42 g) of paper to match the smoke build up curves required by standard smoke detector test protocols. For this type of fire, the VSD equipment shall consistently indicated an ALARM condition well in advance of the conventional detectors. VSD equipment response shall be less than 150 s after ignition and before any smoke readings were obtained from the instrumentation in the room. This test establishes the VSD equipment's response to this type of fire.

3.1.1.3. Wood Crib test [smoke generation]

In this test, kiln dried fir strips, 154 x 19 x 19 mm (6 by ¾ inch) are to be burned in the test room as described in 3.1.1.1. Fuel loads are varied from 18 to 14 individual pieces to match the smoke build up curves required. For this type of fire, the VSD equipment shall indicate an ALARM condition in advance of standard smoke detection principles. VSD equipment response was observed to be not greater than 3 min. after ignition. This test establishes the VSD equipment's response to a very noticeable smoke pattern.

3.1.1.4. Toluene/Heptane Mixture test [fire generation]

In this test, a mixture of 25% toluene and 75% heptane are to be burned in the test room as described in 3.1.1.1. Fuel loads are varied from 100 to 50 mL (3.4 to 1.7 oz.) to match the smoke build-up curves required. For this type of fire, the VSD equipment shall indicate an ALARM condition in advance of standard smoke detection principles. VSD equipment response shall be less than 30 s after ignition. This test is to establish VSD equipment's response to a dark smoke pattern.

3.1.1.5. Smouldering test [smoke generation]

In this case, ponderosa pine sticks 76.2 x 25.4 x 19 mm (3 by 1 by ¾ inch) are to be burned in the test room as described in 3.1.1.1. Fuel loads are varied from 10 to 7 individual pieces to match the smoke build up curves required. VSD equipment shall respond to the smoke before a smoke obscuration level of 4%/ft was reached as demonstrated by alarming before an Approval X%/ft detector alarmed. This long term smouldering test produces no easily discernible smoke pattern with a general loss of visibility with the camera only seeing the room becoming grey. There is no defined edge or movement visible in the smoke pattern. Only average response from the VSD equipment to the smouldering test is expected. This is understandable given the video image detection algorithm capabilities at this point. The test provides application knowledge that is important towards understanding the system capabilities and limitations.

3.1.1.6. Smoke/Flame Response Sensitivity Test

Using an indoor test area that minimizes the effects of outside stimuli such as reflection of flame, wind conditions, and artificial lighting, the VSD equipment shall be subjected to large scale smoke and/or fire tests. For these tests, the performance based detection principles of FM Approval Standard 3260 are to be utilized to assist quantifying the VSD equipment's response. The VSD equipment flame response sensitivity performance are to be tested with a 25% toluene/75% heptane mixture as well as a wide range of fuel types, smoke generators [smoke response], and cardboard box/paper fuels. The alarms were monitored on the display monitor and relay outputs.

3.1.1.7. Cardboard Box Fire

Four 254 x 254 x 112 mm (10 x 10 x 4.4 in) boxes (ULINE part number S-4346) are to be arranged in two parallel rows, with the 10 x 10 in side facing the opposite row. Loosely fill the boxes with a 30 inch by 36 inch piece of crumpled packing paper (ULINE part number S-2210). A 25 mm (1.0 in.) flue space is to be arranged between the rows. The distance from the VSD equipment cameras to the fuel source shall be 30.5 m (100 ft.) The system shall alarm in less than 120 s for the 6.0 and 8.0 mm FOV and in under 300 s for the wider 2.8 mm FOV.

3.1.1.8. Smoke emitter

Place Regin HVAC Product 4 minute smoke emitters (part number S103) on a non-combustible surface. Ignite the open face of the emitter with a butane lighter. The distance from VSD equipment cameras to the fuel source shall be 22.9 m (75 ft). The average system shall be less than 60 s.

3.1.1.9. 1ft Pan Fire

Ignite 100 mL of fuel in a 1 ft (305mm) by 1 ft (305mm) steel pan using a match. The distance from the VSD equipment cameras to the fuel source shall be 100 ft (30.5 m). The system shall alarm in less than 15 s regardless of location within the FOV vertically or horizontally and fuel type. Fuels are to include heptane, JP-8, ethyl alcohol, isopropyl alcohol and unleaded gasoline.

3.1.1.10. False Stimuli Response Test

Subject the VSD equipment to the following false alarm sources: Direct Sunlight, Indirect Sunlight, Arcwelder, Resistive Electric Heater[FM1], Fluorescent light, Halogen light, Incandescent light. Record which stimuli produces alarm signals at the VSD equipment.

3.1.1.11. Flame Response Sensitivity

Exposed four samples of the VSD equipment to a series of test fires as described below along the centreline (0˚ viewing angle) or the sensor. Record the average alarm response.

Fuel	Distance	Fire Size	Avg. time (s)
n-heptane	100ft (30.5m)	1 ft x 1 ft (305 mm) pan	
JP8	100ft (30.5m)	1 ft x 1 ft (305 mm) pan	

The alarm response of detectors shall be below the 30 second response time specified by the manufacturer and that required by Class Standard 3260.

3.1.1.12. Field of View

The VSD equipment camera viewing angle shall be varied from the centre line up, down, left, and right. The camera shall be exposed to each of the test fires described in section 3.1.1.11 at a distance described in the table below. The recorded response time was shall be within the manufacturer's specification and the requirements of the standard.

Fuel n-heptane	Min. distance	Avg. Time (s)	Comments
0%-45%H	100ft (30.5m)		H=horizontal
0%-15%V	100ft (30.5m)		V=vertical

3.1.1.13. Switching

Verify that the maximum response time to any flame source was less than 30 seconds during all testing.

3.1.2. Detection test set – Option 2

3.1.2.1. Smoke response tests - Indoor

VSD systems shall reliably respond to at least one of the following conventional indoor fire tests using industry standard smoke generating sources in accordance with the October 2001 Addendum to FM Approval Standard 3230.

i. Paper Test - For this test, shredded newspaper are to be burned as described in Test A*. Fuel loads can be varied to match the smoke build up curves required. Document the VSD System's response to the test.
ii. Wood Crib Test - In this test, kiln dried fir strips, 154 x 16 x 19 mm are to be burned as described in Test B*. Fuel loads can be varied from 18 to 14 individual pieces to match the smoke build-up curves required. Document the VSD System's response to the test.
iii. Flammable liquid test - In this test, a mixture of 25% toluene and 75% heptane are to be burned as described in Test C*. Fuel loads can be varied from 100 to 50 ml to match the smoke build-up curves required. Document the VSD System's response to the test.
iv. Smouldering test - In this test, ponderosa pine sticks 7.62 by 2.54 by 1.9 mm are to be burned as described in Test E*. Fuel loads can be varied from 10 to 7 individual pieces to match the smoke build-up curves required. Document the VSD System's response to the test.

* Tests A,B, C, and E are described in October 2001 Addendum to FM Approval Standard 3230.

3.1.2.2. Smoke response tests - Outdoor

Subject the VSD system to outdoor full scale smoke tests. For these tests, the performance based principles of FM Approval Standard 3260 are to be utilised to assist in quantifying the VSD's response. A rolling lab cart, equipped with double lined metal trays; one to hold the test fuel and another to hold water provided cooling as well as containment means is placed in view of the VSD. These tests are to be conducted during daytime and minimal wind conditions. The VSD System's response to each test condition outlined below shall be documented.

i. Oil Soaked Rags - Two 28 x 40 cm cotton shop rags are to be soaked in 10-30 motor oil and ignited while contained in a 929 cm^2 pan. Test for response to oil at 30.5 m (100 ft) from source, and at 61 m (200 ft) from source.
ii. Diesel Fuel - 200 mL of diesel fuel is to be ignited while contained in a 929 cm^2 pan. Test for response to Diesel at 30.5 m (100 ft) from source and at 61 m (200 ft) from source.
iii. 90 wt Gear Oil - 200 mL of 90 wt gear oil fuel is to be ignited while contained in a 929 cm^2 pan. Test for response to Gear Oil at 30.5 m (100 ft) from source and at 61 m (200 ft) from source.
iv. Polypropylene - A 6.35 mm layer of polypropylene pellets is to be ignited while contained in a 929 cm^2 pan. Test for response to Polypropylene at 30.5 m (100 ft) from source and at 61 m (200 ft) from source.

3.2. Commissioning test

Commissioning tests for at least one (1) installed and operational VSD System shall be witnessed by CSIRO. Commissioning tests shall include tests for alarm operation and tests for rejection of non-fire phenomena (e.g. steam, exhaust fumes, etc.).

A commissioning test plan shall be prepared where the location and size of "test fires" (smoke sources) shall be selected by CSIRO and authorised by the submitting organisation.

The submitting organisation shall nominate whether alarm operation occurs and the time to alarm for each test in advance. Results of nominated performance and actual performance shall form part of the assessment.

3.3. Functional requirements

i. Normal Operation - The VSD system shall be tested to verify proper operation under normal conditions.
ii. Fault Signals - The VSD shall be capable of automatically transmitting fault signals when connected to fire alarm system control and indicating equipment (CIE). The VSD monitor shall also provide a visual indication of fault signals.
iii. Alarm Signals - The VSD shall be capable of automatically transmitting alarm signals when connected to fire alarm system CIE. The VSD monitor shall also provide a visual indication of alarm signals.

3.4. Circuit supervision

Circuit supervision principles of AS 1670.1 are to be applied to VSD systems. Equipment shall meet the following circuit supervision requirements:

i. The means of connection between VSD systems and CIE shall not permit disconnection of the VSD system without initiating a fault or alarm signal at the CIE.
ii. Video Signal Cabling – Where cables between each camera and the VSD controller form part of the automatic fire detection and alarm system, they shall be monitored for open and short circuit interruptions. A fault signal shall be generated when open or short circuit interruptions occur.
iii. Connection to Power Sources - Open or short circuit interruptions of camera power supply connections shall generate a fault signal.
iv. Power Supply Supervision - Interruption to power supply for the VSD system shall generate a fault signal.
v. Additional supervision Features of VSD – Fault signal shall be generated where the VSD includes additional conditions such as the following:
    − loss of video signal
    − attempting to make a virtual zone too small for proper operation
    − camera view that is either too dark, too light or of insufficient contrast

3.5. Stability

A VSD system comprising a controller and single camera shall be energised and tested to verify proper operation under normal, standby conditions. Continuous operation of these samples shall be monitored for 30 days in clean air (working office type); record any evidence of instability or false signals during that period.

3.6. Environmental tests

At least one sample of each VSD system component type shall be tested in each of the following environments:

i. Temperature of 0°C for a period of 4 hours.
ii. Temperature of 49°C for a period of 4 hours.
iii. Conditions of 38°C and 90% relative humidity for a period of 24 hours (Option A), or conditions of 90˚F±3˚F (32˚C ± 2˚C) and relative humidity of 93% ± 2% for a period of 24 hours (Option B).

Equipment shall operate properly before, during and after exposure to each of these environments.

3.7. Voltage range

Operation of the VSD system shall be monitored while the primary power source is supplied at minimum, nominal and maximum voltages. All VSD system components shall operate properly during this test without variation in system response.

3.8. Electrical safety

VSD system components where the working voltage exceeds extra-low voltage (ELV) shall comply with appropriate electrical safety standards. Examples of appropriate evidence include an electrical safety test report and/or a certificate of suitability or conformity from an appropriate regulatory authority.

3.9. Vibration Test

The camera and its housing mounted in their normal position shall be subjected to a vibration test of 4 hours duration with a 0.5mm displacement at a frequency sweep of 10 to 30 Hz. The equipment shall operate properly during and after the vibration test. There shall be no loosening of parts or permanent deformation as a result of this test.

3.10. Name Plate Rating

The maximum power supply load rating shall not be exceeded by the power supply requirements for VSD system components.

3.11. Extraneous Transients including RFI Protection (optional)

One VSD equipment sample shall be subjected to extraneous transients from sources that are described below.

a) Radio frequency transmissions with radiation power level equivalent to 20 V/m field strength in the 27 MHz, 150-174 MHz, 450-470 MHz, 850-870 MHz, and 900-920 MHz bands; one 30 s exposure at each frequency is required.
b) A sequential arc (Jacob's ladder) generated between two 15 in. (0.4 m) long, No. 14AWG (2.1 mm) solid copper conductors attached rigidly in a vertical position to the output terminals of an oil burner ignition transformer or gas tube transformer rated 120 volts, 60 Hz primary; 10,000 V, 60 Hz, 23 mA secondary. The two wires are to be formed in a taper, starting with a 1/8 in. (3.2 mm) separation at the bottom (adjacent to the terminals) and extending to 1.25 in. (32 mm) at the top;
c) Operation of an electric drill rated 120 V, 60 Hz, 2.5 A;
d) Operation of a soldering gun rated 120 V, 60 Hz, 2.5 A; and
e) Operation of a 6 in. (150 mm) diameter solenoid-type vibrating bell with no arc suppression and rated 24 Vdc.

The VSD equipment shall produce no false alarm or trouble signal in the presence of these extraneous transients, and it shall respond satisfactorily to the test fire source in the presence of the extraneous transients.

3.12. Surge transients (optional)

One powered sample of the VSD equipment shall be subjected to transient waveforms having peak levels of 100, 500, 1000, 1500, and 2400 Vdc, as delivered into a 200 ohm load. Each circuit is subjected to a total of 60 pulses: (2 at each voltage, plus and minus) referenced to ground (40 pulses) and two at each voltage between each circuit lead (20 pulses). This test applies to all field wiring terminals that have a possibility of being subjected to line-induced voltage (i.e., initiating device circuits, power circuits, and remote/auxiliary connections). Exception: circuits specified to be 20 ft (6 m) or less in length and in conduit. The device shall be required to perform satisfactorily at the conclusion of the test, and it shall not exhibit any instability such as alarm signals and non-restoring fault signals during testing.

3.13. Durability (optional)

One or more VSD equipment samples, shall be cycled through 500 power on/off cycles. Any detector susceptible to the wearing of parts (i.e. a mechanical relay) shall be cycled through 500 operate-reset functions under maximum rated load. The VSD equipment shall continue to operate and there shall be less than 10% shift in measured sensitivity based upon flame radiation distance at the conclusion of this test.

3.14. Stability (optional)

One or more VSD equipment samples, adjusted to maximum sensitivity, shall be energized for normal standby operation in a clean air (working-office type) atmosphere for a period of at least 30 days. There shall be no false signal, nor any evidence of instability.

3.15. Marking

The following information shall be clearly and indelibly marked on outside of the equipment enclosure:

i. Manufacturer's name
ii. Model number
iii. Electrical ratings
iv. Part number

4. SUBMISSION REQUIREMENTS

4.1. Submission Documents

The applicant shall supply a full sets of documentation for each VSD system variant proposed for assessment. Documents shall include listing/approval test reports (if any), drawings incorporating lists of all mechanical and electrical components, technical data sheets, electrical schematic diagrams, installation instructions, operating and maintenance instructions, and any sales literature. The electrical component lists shall specify the make and model of each component used in the VSD system. Alternatively, the electrical component lists shall include the listee's Part Number and description, and listee shall provide the performance specifications against which the components are procured. Changes to the components specifications are regarded as engineering changes, and shall notified to the evaluation agency prior to implementation.

4.2. Engineering Changes, and Model Designation

The VSD system design variants to be assessed shall each be permanently labelled/marked with a unique and distinctive model designation, which shall be as agreed to be published in the ActivFire Register. The evaluation agency shall be promptly notified of any engineering change proposed to be made to the VSD system. Engineering changes shall be assessed by evaluation agency as to the affect on function, performance, reliability, or durability, of the equipment. The outcome of the evaluation agency's engineering change assessment shall determine whether appropriate modification of the model designation is necessary.

4.3. Reference Samples

Sample of the VSD system (including each variant) shall be submitted, on request from the evaluation agency, for purposes of investigation and reference.

4.4. Evaluation Evidence

Existing listing, approval or component-recognition, of VSD systems by recognised listing/approval agencies such as Underwriters Laboratories Inc. (USA), Underwriters Laboratories Canada, Factory Mutual Research Corporation (USA), Building Research Establishment Ltd (UK), will be given due consideration in the assessment process, providing test requirements are appropriate for Australian Conditions.
Proper documentary evidence of such listing, approval or component-recognition and testing shall be included in any submission for assessment. The minimum evidence required by CSIRO is the recognised agency's letter of confirmation of the listing/approval/component-recognition of the VSD system, a copy of the relevant investigation report, and a copy of the relevant follow-up/post-listing surveillance agreement. All submitted test reports shall contain a description of the equipment tested (including Model and unique identification), the test procedures used, the results of the tests, and the applicable pass/fail criteria.

4.5. Documentation Language

All submitted documents shall be in English language. Document translations shall be in accurate "common use" technical English.

4.6. Assessment Criteria

The VSD system shall comply with all engineering examination requirements of a recognised listing or approval agency. Claimed equipment ratings and performance shall be substantiated by the results of testing which has been conducted and reported in a manner acceptable to the evaluation agency.

4.7. Identification of VSD system under investigation

Any VSD system assessed to this specification shall be uniquely defined. Documentation must include unique identification of:

i. components, sub-components, assemblies, sub-assemblies,
ii. software and firmware (especially version and version control),
iii. operators manual,
iv. Planning installation and commissioning manual,
v. configuration data, and
vi. any other information required to uniquely define the VSD system.

5. REPORTING

Test reports shall include the following:

i. Name and address of the testing organisation.
ii. Number, publication date, and amendment version, of any referred Standards.
iii. Date of report issue.
iv. Name of manufacturer or agent.
v. Trade name, model number, and revision level of VSD system components/software.
vi. Rating/performance information.
vii. Description of tested item and tested configuration.

In accordance with the following requirements, the evaluation report shall include all relevant information for the purposes of verification of conformity.

i. A statement of conformity with reference to this specification and unambiguous designation of the following.
ii. all models selected and evaluated by physical testing.
iii. All other information in accordance with the reporting requirements of Australian Standard AS ISO/IEC 17025-1999.