Standard Australia's Case to the Australian Building Codes Board to Mandate the use of Photoelectric Smoke Alarms in Residential Accommodation

Version 2: 1 February, 2007

Explanatory Notes:

The following unedited nine page Preliminary Impact Assessment (PIA) document was prepared by the Australian Standards Committee FP-002 (Fire Detection, Warning, Control and Intercom Systems). Committee FP-002 is a committee of stakeholder experts who write all the fire detection and warning systems Australian standards including Australia's smoke alarm standard (AS3786-1993).

The PIA process is required by the Australian Buildings Code Board (ABCB) whenever there is a proposal to change any Australian Standard that is referenced within the National Construction Code. The following PIA document is the second PIA document submitted to the ABCB to put forward the basis on which FP-002 made its decision to change AS 3786 to require all smoke alarms, regardless of technology, to be required to pass the smoke obscuration test. The ABCB rejected both PIAs, and as such the intended amendment to the AS 3786 could not proceed.

This page has been prepared by the World Fire Safety Foundation for clarification purposes only. Further information regarding Australia and the US's flawed smoke alarm standards is available in the World Fire Safety Foundation's report, 'Can Australian & US Smoke Alarm Standards be Trusted?' www.SmokeAlarmWarning.org/standards.html

Australian Building Codes Board

PRELIMINARY IMPACT ASSESSMENT FOR BCA VOLUME 1 & 2 REVISION OF PRODUCT STANDARD AS 3786 —1993 *Smoke alarms*

Version 2: 1 February 2007

Nature and Extent of the Problem:

Standards Australia on behalf of committee FP-002 *Fire Detection, Warning, Control and Intercom Systems*, proposes to revise AS 3786 because of an identified anomaly in the current edition of the Standard. The current edition allows two pass criteria for the same product (i.e. smoke alarms), resulting in different performance outcomes. Table 3.1 of AS 3786 shows a light obscuration pass criteria for photoelectric type and a MIC-X value for ionization type. Australia is the only country that uses two different pass criteria, all other regional and international Standards use an acceptance criteria based on light obscuration.

Standards Australia technical committee FP-002 identified that the design fire within residential accommodation is statistically a smouldering fire. This, coupled with maintaining tenability within paths of travel to an exit, is a function of the level of light obscuration and toxic species.

CSIRO have reported to FP-002 that the different criteria result in significant differences in the performance of smoke alarms. Photoelectric smoke alarms, when tested in accordance with the requirements of AS 3786—1993, typically respond between 8% and 16% obscuration per metre (Obs/m) whilst ionization smoke alarms typically respond between 40% and 60% light Obs/m (0.25 to 0.6 MICX), with the majority of ionization smoke alarms operating at the least sensitive end of this range (See Appendix A, CSIRO test graph and explanation).

Under the current Standard, ionization smoke alarms are permitted to have a lesser response to obscuration, which results in a significant negative impact on the Available Safe Evacuation Time (ASET).

Australian and international research demonstrates that the highest number of fatalities in residential fires occurs between the hours of 8.00 p.m. and 8.00 a.m. when occupants are typically sleeping and these fires typically begin with a smouldering phase. Of principle concern is the impact of resultant smoke obscuration and toxic species on the occupants' ability to escape.

The Standards Committee FP-002 cites the following three points in support of the revision of AS 3786.

ONE
Australian and international research that indicates ionization smoke alarms have performance limitations in adequately detecting smouldering fires in time to provide adequate ASET before untenable conditions exist.

- The Australasian Fire Authorities Council report titled *Accidental Fire Fatalities in Residential Structures; Who's at risk*? (Oct 2005), gives the three major causes of fatal fires in Australia as, heater/open fire/lamp (27%), smoking materials/equipment (25%), and electrical fault (23%). These fires typically have an extended smouldering phase.

- Tom Chaplan, Head of UL's fire protection division – CBS News (July 24 2006), stated,

  > "In today's homes, the tendency for synthetics – like nylon and polyester in furnishings, fabrics and carpeting – is to smoulder for a long time, then burn faster than natural materials like wood and cotton which char as they burn. Synthetics melt and pool, then give off substantially more energy when they burn".

- From, *Fire Safety of Upholstered Furniture* – the final report on the CBUF research programme, edited by Bjom Sundstrom, European Commission Measurement and testing Report:

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Time Between Ignition and Discovery

(UK Statistics for 314 Fire Casualties*)

Time	# Casualties	% of Total
At ignition	**14**	**4.4%**
Under 5 minutes	**23**	**7.3%**
5-30 minutes	**78**	**24,8%**
More than 30 minutes	**194**	**61.8%**
Not Known	**5**	**1.5%**

<u>The table demonstrates that 88.3% of fatalities occur when the discovery time is more than 5 minutes. This is particularly relevant for sleeping occupants.</u>

- *Building Fire Statistics* 88-97 Norway, Directorate for Fire and Explosion Prevention, states,

  > "It is recognized that deadly fires and fires doing the most damage typically have a substantial undetected incipient stage while flame-ignited fires are typically intimate with awake people and connected to their activities. Hence, detection in order to alert is less important (in flaming fires)".

- The NIST Study *Technical Note 145*, suggests that the ASET may only be 3 minutes for an ultra-fast fire involving upholstery furniture. It concludes, "the placement of either alarm type on every level of the house provided the necessary escape time for the different types of fires examined". However, this is not supported by data from within the NIST report (pgs 242, 243), which shows that for smouldering fires in the living area, the ionization device provided less than the required safe evacuation time in two of the tests (-43s and -54s) or barely adequate time (+16s) in another test. This fire scenario i.e. smouldering fire in the living area was identified as the most common fatal fire scenario (pg. 60).

- Meland, Oysten, and Lonuik, Lars, "Detection of Smoke—Full Scale Tests with Flaming and Smouldering Fires", *Fire Safety Science, Proceedings of the Third International Symposium*, July, 1991, pp. 975-984, states the following,

  > "The ionization detectors detected smoke from a smoldering fire much later than optical (photoelectric) detectors. When the particular conditions during the fire development are taken into consideration there are reasons to indicate that this detection principle would not provide adequate safety during this type of fire."

- The "Residential Smoke Alarm Report" - Prepared by Special Automatic Detection Committee of the International Association of Fire Chiefs, *The International Fire Chief*, (September 1980) states,

  > "This test will show that most photoelectric detectors, operated by battery will detect smoke at about 1.5 - 3% smoke (*4.8 - 9.5% Obs/m*), which is good. The test will show that the photoelectric detectors operated by household current will activate between 2 and 4 %, (*6.4 – 12.5% Obs/m*) which is still

good. But, the test also will show that many ionization detectors will not activate until the smoke obscuration reaches 10-20% (*29 – 52% Obs/m*) and sometimes 25% (*61% Obs/m*). Therefore, because of the present state of the art in detecting smoke, the Subcommittee on Smoke Detectors can take no other course but to recommend the installation of photoelectric detectors."
(Note: Italics added by editor)

- R. Riley, K., and Rogers, S. in *A Study of the Operation and Effectiveness of Fire Detectors Installed in the Bedrooms and Corridors of Residential Institutions*, Fire Research Station, Fire Research Current Paper 26/78, Borehamwood, England, April 1978, concluded,

  "Ionization chamber type detectors, in the room of origin and the corridor, did not, in the smoldering fire tests, provide adequate warning that the escape route was impassable or that conditions in the room were potentially hazardous to life".

- The case of Jeanna Rodgers reported by consumer.org.nz illustrates the concern with the ability of ionization alarms to detect visibly dense smoke. On August 2 2006 a clothes dryer failed filling the house with smoke. There were three ionization alarms installed within the house and all failed to alarm. Whilst the report does not state that smoke was observed to have reached the ionization alarms it would be reasonable to assume with three installed it would have been the case. The alarm was raised by Jeanna's five year old son, Samuel, who sleeping on the top bunk was awoken when he started to cough from the smoke layer which had now descended to where Samuel was sleeping. When the three ionization smoke alarms were tested in situ by the attending fire service all three operated correctly.

- In 1988 UL, as a result of high level of nuisance alarms from ionization smoke alarms, decreased the sensitivity requirements from 7%obs/ft (*21.2% Obs/m*) to 10%Obs/ft (*29.2% Obs/m*) as a means of mitigating the problem. However as ionization detectors respond to fast flaming fires this potentially meant the detection of the fire at a more advanced flaming stage than previously. This may explain the significant changes in the number of fire fatalities that occur in fires where the smoke detector has operated. Detection at a later stage must impact on the ASET. The table below shows a disproportionate increase in the number of post alarm fatalities compared to the home coverage and number of fires.

	% OF FATAL FIRES WITH WORKING DETECTORS	**% OF HOMES WITH DETECTORS**	**% OF FIRES WITH WORKING DETECTORS**
1988	**9%**	**81%**	**38%**
1990	**19%**	**86%**	**42%**
1994	**19%**	**93%**	**49%**
1996	**21%**	**93%**	**52%**
1998	**29%**	**94%**	**55%**
2001	**39%**	**95%**	**55%**

Source: Joseph M. Flemming, Deputy Chief, Boston Fire Department, *Photoelectric and Ionization Detectors; A Review of the Literature Revisited.*

- A search of published studies and papers has produced no document that concluded that photoelectric detectors, with current "open" design, were inadequate for flaming or smouldering. This would appear to constitute "compelling evidence" that ionization detectors are not suitable for residential occupancies as stand alone devices, since a reasonable alternative is available as a Deemed to Satisfy solution. While it may be true that no single study is enough proof of this problem the totality of all of the studies provided considerable evidence that this problem is real.
  Source: Joseph M. Flemming, Deputy Chief, Boston Fire Department, *Photoelectric and Ionization Detectors; A Review of the Literature Revisited*

TWO
The critical *Performance Requirement* P2.3.2 of the BCA are not satisfied by ionization smoke alarms, on the basis of their inability to activate early enough in smouldering fires, before untenable conditions prevent the escape of occupants to a safe place.

THREE
Up to 31% of installed smoke alarms no longer operate.
This is shown in AFAC, *Accidental Fire Fatalities in Residential Structures Who's at Risk?,* October 2005.

Other international research, (NIST Technical Note 1455, *Performance of Home Smoke Alarms*, *Ionization and Photoelectric smoke alarms in Rural Alaskan Homes,* August 2000; Fleming, J.M., *Photoelectric v. Ionization Detectors - A Review of the Literature—Revisited*), .indicates that a major factor in the disablement of ionization smoke alarms by consumers is their demonstrated high incidence of 'false' activation due to cooking fumes, gas heaters and the like. The implementation of smoke detection based upon light obscuration provides the additional benefit of mitigating the incidence of 'false' activation due to the above causes. This potentially leads to a reduction in disablement by consumers thereby increasing the number of functional installed smoke alarms with a proportional increase in life safety.

Objectives:

The FP-002 committee seeks to:

1. Assure that smoke alarms when applied as a deemed to satisfy solution, meet the critical *Performance Requirement* P2.3.2 Volume 2 and EP2.1 and EP2.2 of Volume 1 of the BCA.
2. Establish a single acceptance criteria for AS 3786 based on light obscuration regardless of technology type.
3. Align AS 3786 with international practice of acceptance criteria based on obscuration.

Options:

1. Do nothing.
2. Amend the BCA to specify photoelectric smoke alarms in all areas where AS 3786 smoke alarms are required.
3. Amend AS 3786 to provide for smoke alarms suitable for general use, i.e. adequate for both smouldering and flaming fires, with performance criteria independent of technology type.

Impact Analysis:

1. **Do nothing:**

    - The research presented indicates that the installation of current ionization products will not meet the critical *Performance Requirement* P2.3.2 of the BCA.
    - Consumers will continue to be unaware of the significant difference in sensitivity and performance (i.e., life safety) of the two technologies complying with AS 3786.
    - There is a greater potential for litigation due to the lack of performance in providing life safety in real residential fires. (Litigation against manufacturers of ionization smoke alarms have been successful in the USA and further litigation is in progress).
    - This option will not address the identified shortcoming of the current product Standard.

2. **Amend the BCA to specify photoelectric smoke alarms in all areas where AS 3786 smoke alarms are required**

    - The mandating of photoelectric smoke alarms provides a detection technology suited to a broader range of fires experienced in residential applications and therefore provides the most suitable deemed to satisfy solution.

    - A review of the ActivFire listing and discussions with smoke alarms suppliers and manufacturers at a meeting called by the FPAA on the 31 March 2006, identified one Australian manufacturer that currently does not provide a photoelectric option. From data provided at the meeting, it is estimated this manufacturer provides less than 0.2% of the product supplied to the Australian market.

    - Currently photoelectric technology based smoke alarms are typically 10% to 15% more expensive than their ionization technology alternatives. Discussions with product manufacturers indicate that an increased manufacturing volume will see this price differential decrease. Some manufacturers have indicated that the increased volumes will result in no price differential.

3. **Amend AS 3786 to provide for smoke alarms suitable for general use, i.e. adequate for both smouldering and flaming fires, with performance criteria independent of technology type**

    - Amending AS 3786 to ensure products meet the acceptance criteria based on obscuration would result in the use of smoke alarms suited to a broader range of fires experienced in residential applications and would provide a deemed to satisfy solution that meets the performance requirements.

    - A review of the ActivFire listing and discussions with smoke alarms suppliers and manufacturers at a meeting called by the FPAA on the 31 March 2006, identified one Australian manufacturer that provides only products that might not meet the acceptance criteria of the revised Standard. From data provided at the meeting, it is estimated this manufacturer provides less than 0.2% of the product supplied to the Australian market.

    - Currently photoelectric smoke alarms (obscuration based technology) are typically 10% to 15% more expensive than their ionization technology alternatives. Discussions with product manufacturers indicate that an increased manufacturing volume will see this price differential decrease. Some manufacturers have indicated that the increased volumes will result in no price differential.

    - The revision of the Standard opens up the compliance of smoke alarms to any technology that meets the single acceptance criteria.

    - The acceptance criteria for smoke detectors installed in sleeping areas and paths of travel to an exit as part of an AS 1670.1 system required by Clause 4 Spec. E2.2a of the BCA is based solely upon obscuration. The amendment of AS 3786 will bring the acceptance criteria for smoke alarm products installed to Clause 3 of Spec. E2.2a into line with the acceptance criteria for products in Clause 4.

- To reflect the identified changes in fire behaviour in modern dwellings, Option 3 would provide product performance criteria suitable for general use in both the smouldering and flaming stages of fire development. The revision of AS 3786 seeks a single sensitivity criteria for smoke alarms based on the measurement of light obscuration resulting from a developing fire to evaluate the ability of smoke alarms to facilitate sufficient evacuation time to meet the critical Performance Requirement P2.3.2 of the BCA. All devices that meet the obscuration criteria, independent of technology, may be referred to as smoke alarms. The likely outcome of the AS 3786 revision is that photoelectric detection technology will meet the revised requirements and become the technology of choice over ionization technology.
- As an example of this pricing trend, smoke detection systems have, over the last decade, moved towards photoelectric technology. Today they typically employ 98% photoelectric technology, resulting in photoelectric smoke detector pricing reducing to the same or less than ionization.

Consultation:

- Audio Engineering Society
- Fire Services through representation of Australasian Fire Authorities Council
- Australian Chamber of Commerce and Industry
- Australian Electrical and Electronic Manufacturers Association
- Australian Industry Group
- Australian Institute of Building Surveyors
- Deafness Forum of Australia
- Department of Defence (Australia)
- Fire Protection Association Australia
- Institute of Security Executives
- National Electrical and Communications Association
- CSIRO Manufacturing & Infrastructure Technology division.

In addition to the above, formal discussions on the proposed changes have taken place with the Department of Planning NSW and all smoke alarm suppliers / manufacturers through an FPAA residential smoke alarm forum conducted on the 31st March 2006

Conclusion and Recommended Option:

Standards Australia identified an anomaly in the current edition of AS 3786 Smoke alarms. The current edition allows two acceptance criteria for the same product (i.e. smoke alarms), resulting in different performance outcomes. Research shows that the application of smoke alarms where the acceptance criteria is not based upon the detection of obscuration levels, will not provide an adequate level of life safety in residential occupancies and thereby does not meet the performance requirements set down in the BCA.

The provision of smoke alarms typically follows the deemed to satisfy path. The lack of awareness of the general community to the performance limitations of smoke alarms requires that AS 3786 be revised, to ensure that consumers are automatically provided with a product that is fit-for-purpose and the most appropriate deemed to satisfy solution.

Options 2 and 3 are credible options. Both options result in:

- the installation of smoke alarms suitable for general use i.e. adequate for both smouldering and flaming fires;
- the closing of current price gap between photoelectric and ionization due to increased usage of photoelectric;
- mitigation of nuisance alarms;
- decrease in disablement by consumers; and
- positive increase in life safety.

Option 2 would address the anomaly with respect to the BCA but does not address those situations where AS 3786 is directly referenced by other State or Territory legislation.

Option 3 would address both the anomaly with respect to the BCA and where AS 3786 is directly referenced by other State or Territory legislation.

Standards Australia committee FP-002 recognises that there will be fatalities within residential occupancies irrespective of the detection technology employed. However there is the inescapable responsibility, as the peak technical standards body, to provide an Australian Standard that results in the most appropriate product giving due regard to the end user and the application.

Implementation and Review:

If accepted, the Standard is planned for referencing in BCA 2008, which is to be adopted on 1 May 2008.

As a matter of policy, proposed changes to the BCA are released three months in advance of implementation to allow time for familiarisation and education and for industry to modify its practices as required accommodating the changes.

Within this context the ABCB remains committed to regular review of all the aspects of the Building Code of Australia and to amending and updating the Code as needed to ensure that building regulations meet changing community standards. The ABCB maintains regular and extensive consultative relationships with a wide range of stakeholders. In particular, a continuous feedback mechanism exists and is maintained through State and Territory building control administrations, industry and the Building Codes Committee. This constitutes an important means of ensuring that opportunities for regulatory reform are identified and assessed for implementation in a timely manner.

APPENDIX A

Explanation of attached CSIRO Pen recorder test chart for Ionization Smoke Alarms.

In AS 3786 photoelectric smoke alarms are tested for acceptance to light obscuration levels and ionization smoke alarms are tested for acceptance to a MIC X value.

IN CSIRO acceptance testing, photoelectric smoke alarms typically activate between 8 to 16% light obscuration per metre (2.5 to 5.2% per foot). However, ionization smoke alarms typically activate between 0.2 and 0.5 MIC X (a different property to light obscuration level). Light beam obscuration is about 40 to 60 % light obscuration per metre (14.4 to 24.4% per foot) when the MIC X value reaches between 0.2 and 0.6. The majority of ionisation smoke alarms operate towards the least sensitive end of the acceptance range as indicated on the attached Pen recorder test chart.

The attached document is a pen recorder test chart from a typical smoke sensitivity test undertaken on five ionisation smoke alarms tested in accordance with Clause 3.2 of AS 3786 (sensitivity). The data is confirmed by Peter Haggar a Materials Scientist from CSIRO, that the results on the attached copy of the pen recorder chart are typical of a large number of tests over many years on a range of ionisation smoke alarms in Australia.

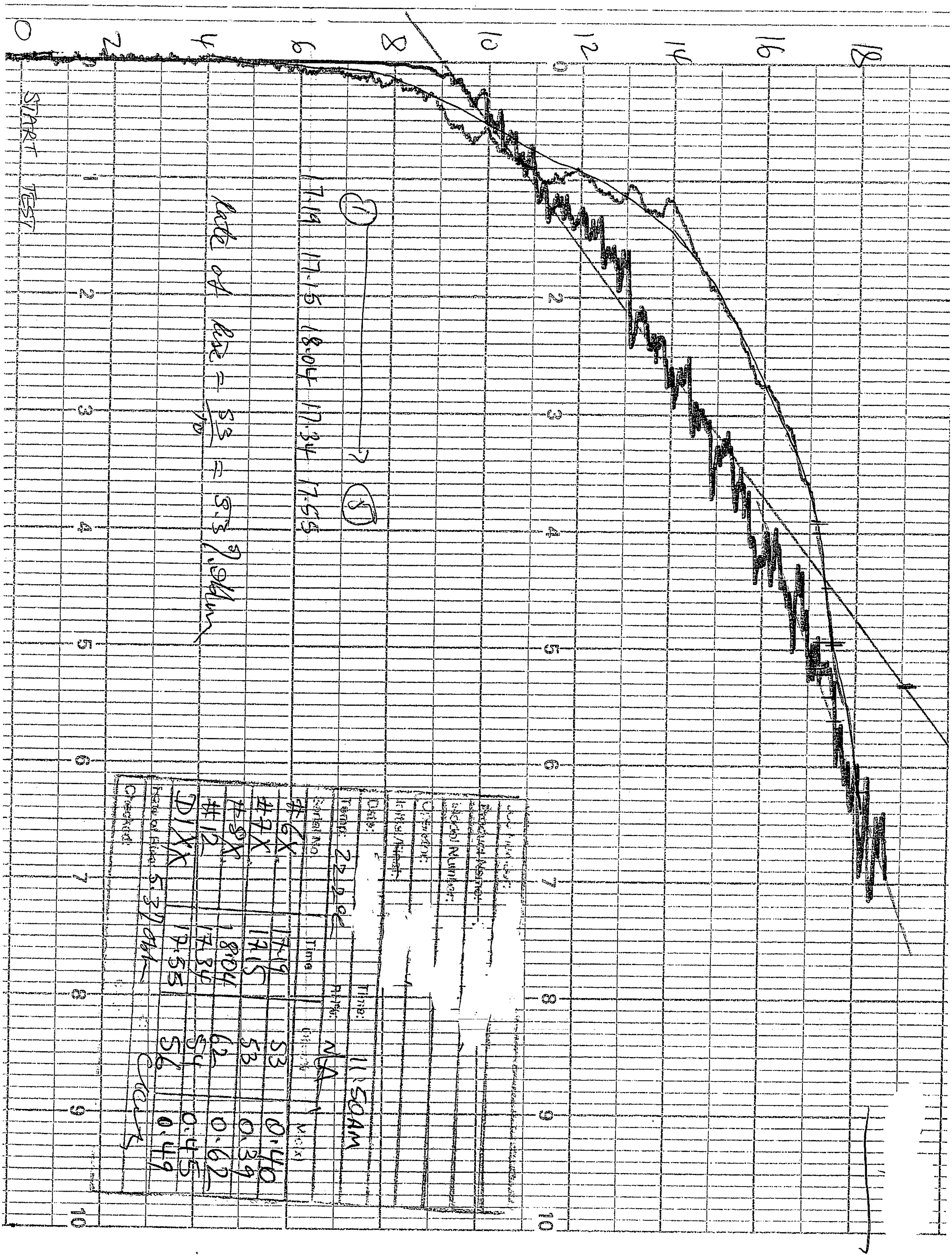
Please note that the test fire specified by the standard is a slowly developing smouldering fire which will inherently favour detection devices that detect visible smoke over ionisation type smoke alarms that do not detect smoke.

About the chart

- The rate of rise of smoke obscuration per metre is calculated over the first 30 % obscuration per metre and is represented by the straight line drawn on the chart dissecting the obscuration curve and in this case is calculated at 5.3% obscuration per metre per minute.
- The vertical axis represents the time of the test in minutes.
- The span 0 to 10 across the horizontal axis corresponds to 0 to 100% obscuration/metre and 0.00 to 1.00 MIC-X.
- The fuzzy line which approximates a straight line drawn on the chart represents obscuration per metre in the test room.
- The less fuzzy line which curves above the obscuration line represents the MIC-X level in the test room.
- Being a pen chart recorder, the obscuration lines and ion lines are offset by about ½ a minute.
- The smoke test started at 0% obscuration per metre and was stopped at 70% obscuration per metre.
- The smoke test started at 0.00 MIC X and finished at 0.64 MIC X.
- MIC-X in the test room is measured using a standard measuring ionisation chamber which is typically an ionisation detector chamber with air being drawn through it to measure the MIC X level.
- The obscuration in the test room is measured using an obscuration light beam.

For further information, please contact Peter Haggar at CSIRO on (03) 9252 6361.

APPENDIX A


START TEST
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#6X 17.19 53 0.40
#7X 17.15 53 0.39
#8X 18.04 62 0.62
#12 17.34 54 0.45
DIXX 17.55 56 0.49
Time: 11 50AM