The effectiveness of domestic smoke detectors in waking children: a UK study

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By Dave Coss

A thesis submitted to the centre for Forensic Science, University of Strathclyde, in part fulfilment of the regulations for the Masters degree in Fire Investigation.

Signed…….

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Abstract

Following a fatal fire in Derby in 2012 where six children lost their lives, it was suggested that the children had not responded to the actuation of two hard wired, interlinked domestic smoke detectors which were fitted at both the base and head of the staircase in the property. In order to address this, a set of tests were devised, in which 34 children aged between 2 and 13 years (20 girls and 14 boys) were each tested on 6 separate occasions in their own home using the domestic smoke detectors fitted within their property where the smoke detector was sounded for 1 minute. A total of 204 tests were conducted.

The results obtained revealed that none of the 14 boys tested woke up at any time to any of the actuations of the detectors. Only 7 of the 20 (35%) girls woke on hearing the alarm with only 2 (both 10 years old) waking up on all 6 test occasions. The children's ability to wake did not appear to be affected by either the bedroom doors being open or closed or the proximity of the alarm to the bed.

A further set of tests were carried out using a low frequency (520 Hz) smoke detector, involving 6 boys and 6 girls. Once again none of the boys woke up for any of the actuations however this time all of the girls woke irrespective of age, with only one failing to wake on all 6 tests.

The research suggests that children under the age of 13 are unlikely to wake up to the operation of a standard domestic smoke detector with boys being especially at risk. This issue is not addressed for young males when a low frequency detector is used and an apparent difference between the response of boys and girls to such devices was suggested.

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Chapter 1 Introduction

In May 2012 Derbyshire Fire and Rescue Service attended a house fire in which six children died. This was a high profile event which attracted widespread media attention both at the time and during subsequent court proceedings. This event brought the total number of children killed in domestic house fires in Derbyshire to 12 between 2012 and 2012. In October 2012 an inquest in North London coroner's court into the deaths of a mother and five of her children in a house fire heard evidence that the mother woke the father to alert him that the smoke detector was sounding. Only the father and the eldest daughter aged 17 managed to escape the blaze [1]. A common trait in these specific cases were that where smoke detectors were known to have been in place, none of the children appeared to have responded to the operation of the detector.

Stevens and Lee [2] reported that a resident of the USA dies every 2 hours due to a fire related injury, and that children and older people are disproportionately affected. In recent decades successive UK governments have commissioned studies and enquiries into how to avoid fire fatalities. Such studies finally resulted in an amendment to the building regulations in 2000 requiring developers to include fire detection devices, normally smoke detectors in all new builds. This resulted in an increase in fire safety within the domestic properties however research work conducted as early as 1998 has suggested that occupants of properties fitted with working smoke detectors still failed to be roused from sleep when the detector activated. For several years the UK fire service has taken part in educational programmes within schools and local communities where they have actively engaged with children and families to provide information on what to do in the event of a fire occurring in the home. One of the issues they deal with is what to do in the

night if the alarm operates whilst they are asleep. The main guidance is for the family to create what has become known as a fire plan where all of the family are aware of what to do in the event of the alarm actuating and which bedroom they will gather the family in so that they can plan a rescue if the stairway has become untenable. Obviously this plan is totally dependent on the whole of the family becoming aware that the alarm is sounding and being awake enough for all of the family to make their way to the designated room.

A number of studies have specifically investigated this lack of response to smoke detectors across a range of age groups.[8,11,22,31,32] As a result, children, in particular young children have been identified as an at risk group in terms of lack of response.

1.1 Smoke Detectors.

1.1.1 Controls and Standards.

Over the past 30 years, the British government has come to recognise that fitting households with working smoke detectors will have a direct impact on the level of fire fatalities recorded. Palmer *et al* [3] stated that a working smoke detector reduces the risk of death from a residential fire by at least 50%. In 2004, the UK government commissioned a British standard, 5839 Part 6-2004 [4] which laid out the guidelines for the correct fitting and type of detectors in single private dwellings, and after much lobbying from across the sector, they finally updated Approved document B (fire safety) [5] which came into force in April 2007. This document *"made provision for suitable arrangements to be made in dwelling houses to give early warning in the event of fire".* These guidelines were a major breakthrough in fire safety terms as they had the effect of making it a requirement that provision was made for all new

builds to have fire detection, thus ensuring that all new properties would be fitted with hard wired smoke detection. This was the first time that private dwellings within England and Wales and Scotland would be sold to buyers with built in fire detection.

BS 5839 Part 6 [4] made provision that all new build properties consisting of no more than three floors with less than 200 square metres of floor space per floor should be fitted with a grade D LD2 smoke detection system. Grade D refers to the type of detectors required and are mains powered smoke and heat detectors with a battery back-up supply. LD2 referred to the coverage within the property – detectors fitted in escape routes and high fire risk areas such as hallways, landings, kitchens and main living rooms.

Building regulations Approved Document B [5] issued subsequently in 2007, recommended that BS5839 Part 6 should be followed but that the minimum requirement was reduced to a grade D LD3 system, where LD3 referred to detectors being fitted in escape routes only. This lower level of protection has subsequently become the default position for the provision of smoke detection systems within England, wales and Scotland and as such the actual building regulations are being implemented as a lesser standard than the British standard itself.

In the late 1980s and early 1990s the UK fire and Rescue Services, where the traditional role of the service was to attend calls and put out fires changed to include a more proactive role with community safety campaigns and intervention activities coming to the fore. Several brigades created large community safety departments and employed large numbers of civilian staff to peruse and develop this area.

This change of direction was also acknowledged and supported by the government of the day with directed funding towards proactive measures. Eventually, funding

was provided to supply smoke detectors to individual fire services to give out households. Most fire and rescue services evolved this process into what has become known as a home fire safety check.

This involves the fire service attending the address at the request of the occupier and talking to them about fire safety in the home and more important supplying and fitting at least one detector on each floor of the dwelling, although this did not meet the guidelines set out in BS5839 Part 6,[4] it did go some way towards meeting the already acknowledged fact that *"the installation of smoke alarms or automatic fire detection systems can significantly increase the level of safety by automatically giving early warning of fire"* Approved Document B [5]

1.1.2 Types of smoke Detectors on the UK market.

Within the UK market there are currently two main types of smoke detector supplied and fitted. These are optical (photoelectric) and ionisation type detectors.

Optical detectors work by using a light source fired into a receiver, if the smoke disrupts the flow of light then the alarm is actuated.

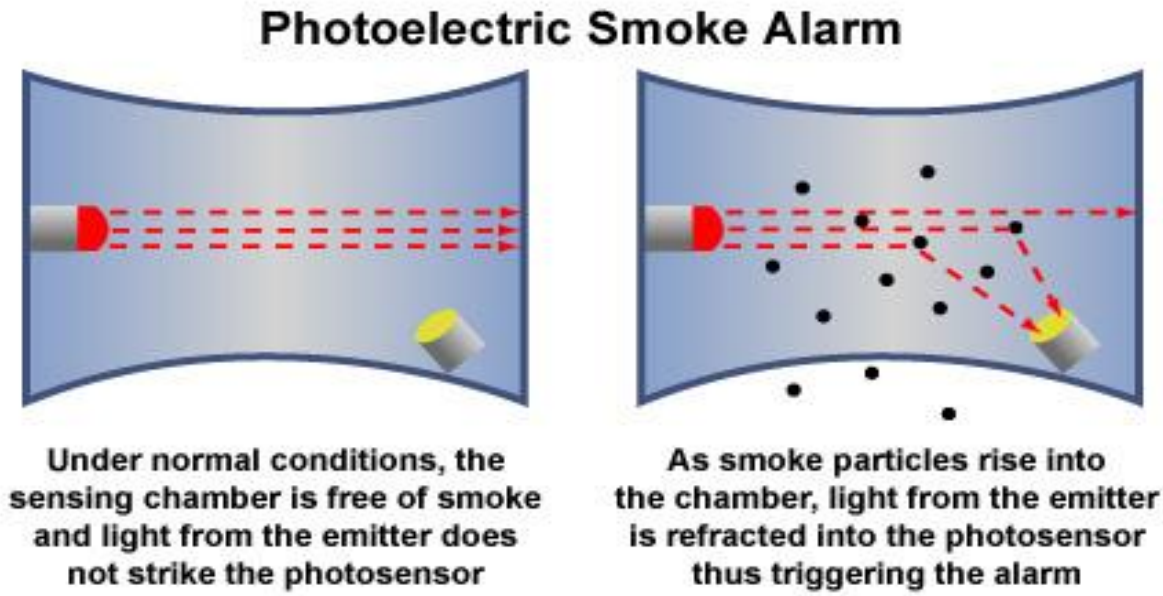

Figure 1 Optical smoke detector http:/www.simsburyfire.org

Ionisation detectors work by using a radiation source to positively charge atoms and create an electrical flow from positive to negative across the detection chamber, if smoke disrupts the flow then the alarm operates.

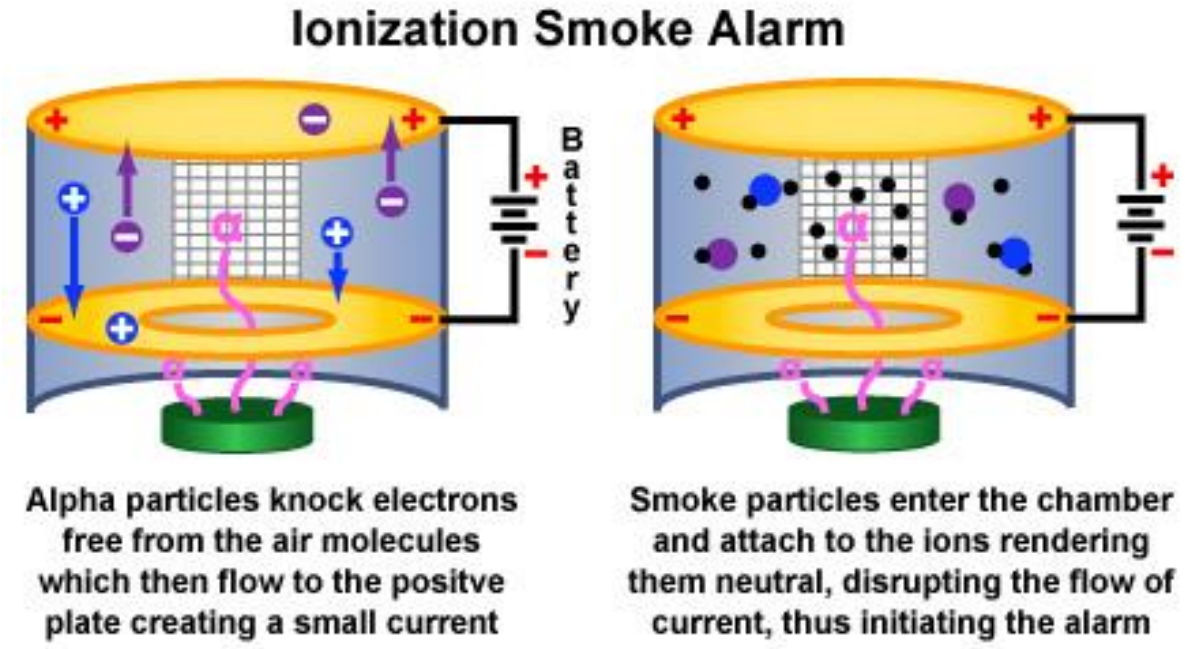

Figure 2 Ionization smoke detector http:/www.simsburyfire.org

BS 5839-part 6 [4] acknowledges that there are differences in the rate of detection between the two types of detectors where ionisation detectors react faster to the non-visible small products of combustion, (sometimes known as invisible smoke), which occur in the early stages of a fast flaming fire. This makes such detectors very susceptible to repeat false alarms caused by cooking fumes or toasters if they are placed in kitchens or hallways near to cooking areas.

Optical detectors on the other hand, are better at detecting slow smouldering fires due to their immunity to the small invisible particles of 'invisible smoke'. They are more responsive to the bigger thicker particles of smoke that are given off by a slow burning fire which produces far more smoke in its early stages. BS 5839 – part 6 gives guidance regarding the best locations for each of the detectors. It states that optical detectors should be used in circulation spaces within dwellings such as hallways and landing areas, with the optical detectors best suited for use in areas where there could be false alarms from things like tobacco smoke.

Reynolds [6] compiled a report for the home office fire research group where a comparison was made between the different reaction times of the different types of detectors when placed at set locations in a domestic property. These reaction times were measured using different types of fire from a smouldering ignition to a flaming fire. During these experiments, experts at the fire research station who conducted the tests were of the view that when the smoke reached an optical density of 0.10D/m within the property then the resulting reduction in visibility and the toxic effects of the smoke were at a sufficient level to effect the chances of any occupants escaping. This was deemed to be the hazard point and the time between the detector sounding to alert the occupants of a fire and the hazard point being reached could be identified as a critical time.

One of the conclusions of the study was that the response time of the different type of detectors could vary and that the type of fire would dictate the speed of response. The average optical density for all detectors was between 0.081 and 0.148 D/m and it was observed that, on some occasions, the smoke detector did not operate until after the hazard point had already been reached indicating that the occupants would already be in trouble by the time they were alerted to the fire. As such smoke could penetrate the property prior to actuation of the detector in some cases. Three specific conclusions were made.

1) *The position of the detector has a major influence on the ability of the detector to detect that smoke is being produced*. Regardless of the type of detector being used, if it is not sited in the flow of smoke as it is flowing through the dwelling then it will not register that there is an alarm. An example of this can be seen from a recent fire in a hospital in where the smoke development was captured on CCTV collecting on the ceiling but flowing underneath the detector and therefore not raising the alarm. (Derbyshire Fire and Rescue Service 2011 [7])

2) *Detectors placed on escape routes must go into alarm before the route becomes untenable for the occupants to escape safely.* By its very nature the detector can only operate if there is smoke entering the detection chamber. This means that the area or hallway that the detector is situated must already have smoke in it and that the situation may be becoming untenable.

3) *The amount of time that the occupants will have to escape once the alarm has actuated will directly depend on the type of fire that has occurred*. From previous evidence it can be seen that a slow smouldering fire although producing a lot of smoke will do so over a period of time giving the occupiers plenty of warning of the

need to leave the property. However a fast flaming fire, such as a candle setting fire to a curtain will produce smoke and flame very quickly therefore the amount of time left to escape will be dramatically reduced before the hallway becomes untenable. Therefore it must be accepted that once a smoke detector has operated the occupiers need to respond to it with the utmost speed with any delay being critical to a safe evacuation.

1.2 Previous studies relating to the effectiveness of smoke detectors in waking sleeping individuals.

Of 114 fatal fires, recorded across all age groups, studied by Bruck *et al* [8], 81% occurred at night and 86% of these were at a time when the fatality was sleeping. Ahrens [9] recorded that in the USA, 20.3% of residential fire deaths occurred in domestic homes where a working smoke detector was fitted. A number of factors come into play in determining the effectiveness of smoke detectors to fulfil their function in terms of alerting sleeping occupants. In particular, this will include factors such as the ease of rousing sleeping individuals, the level of decibel required to awaken an individual and the placement of the detector relevant to the sleeper.

1.2.1 Soundness of sleep:

Coenen [10], suggested that there was strong evidence that some processing of external information still occurred during sleep, resulting in a sleeper being aroused by stimuli that contained relevant information to the sleeper. Bruck [11], reported that *"contrary to popular belief the brain does not shut down during sleep. People continue to monitor the environment and selectively respond."* This was further evidenced by Portas *et al* [12] who carried out experiments using EEG and MRI which confirmed that parts of the prefrontal cortex were still active in processing information whilst the subject was asleep. Coenen [10] concluded that the brain

continued to monitor and evaluate the surrounding environment as a defence mechanism during sleep, requiring the body to wake up if a change in the surroundings or a perceived danger was identified.

Hasofer and Bruck [13], identified a gender difference in adults when reacting to fire cues. In their study, both male and females were subjected to different sounds associated with the development of a fire whilst asleep and found that, statistically, females had a higher probability than males of waking up to the low level sounds of a fire. They also concluded that, not only would females wake up more readily, they would do so in a shorter space of time.

Shai and Lupinacci [14] studied the fire fatalities amongst children in Philadelphia and identified that one of the high risk factors were households with more than one child. Also of note was that just under half (104) of all child fatalities (241) examined in the study were during the hours of midnight to 6am which would be the traditional hours of sleep. The children were most commonly found in the bedroom.

Several researchers have attempted to identify the sleep patterns of infants. Galland *et al* [15] reviewed the normal sleep patterns of infants and children, the data was collected via questionnaires and sleep diaries. The research looked into the sleep patterns of those aged 0-12yrs. The main purpose of this study was to set a bench mark for what could be considered as a normal sleep pattern and behaviour to which any perceived sleep problems could be measured. The study found that, as the infant developed, they started to adopt a night time routine and would migrate from several daytime naps to sleeping at night only. This was more affected when the infant started school as the start of the school day dictated the waking up time and thus became more self-selecting of bedtime. Using the weekday for consistency,

they found that the mean amount of sleep between 5 and 12yrs was around the 9 and a half hour mark, although the data was collected from parental reports rather than as direct data.

Sadeh *et al* [16] concluded from there study into sleep patterns in school age children that, "*although sleep schedules and sleep quantity vary with age sleep quality remains remarkably stable."* Gender was found to make a difference to the amount of sleep required with Epstein *et al* [17], concluding that girls slept for longer periods than boys of the same age.

1.2.2 Decibel levels of smoke detectors:

Over the years the standard sound of a smoke detector has become universally recognised and accepted by most people. However during sleep, it has been known for occupiers to not react to the smoke alarm when it has sounded. Kahn [18] carried out a study into the actual decibel (db) level at which a smoke detector would be most effective at and concluded that a detector sounding at 78db at the bed head consistently work the subjects under study, where as they repeatedly slept through an alarm sounding at 54db and 44db. Kahn also noted that background noise played a part in nullifying the sound of the detector and this could also have an effect on the sleeper. He concluded that in order to be successful in alerting occupants, the detector must produce a sound at the bed head which is at least 10db louder than the ambient noise levels within the room.

Bruck *et al* [8] investigated the ability of smoke detectors to wake children and the research team also examined various other methods of waking the children including that of the mother's voice. They considered that the actual level of the pitch that a smoke alarm is set at could make a difference and then compared this to the

actuation of a mother's voice. They found that there was a definite lack of response from children to a normal domestic smoke detector set at the international standard pitch of around 4000 Hz (most residential alarms emit a signal somewhere between 3000 Hz and 5000 Hz). They also determined that there was no significant difference between the mother's voice and a low pitch alarm signal of around 2,500 Hz, with the mother's voice waking the children 100% of the time and the low pitch alarm waking children on 96.4%. One major limitation of this research is that it has been wrongly interpreted by smoke detector manufactures worldwide. Bruck did not use a simple single low pitch (500 hz) in the alarm used in the tests but instead used a range of frequencies between 500 Hz to 2,500 Hz. This has led to an assumption that low pitch alarms will consistently wake up sleeping children.

Smith *et al* [19] compared the mothers voice theory against a conventional residential tone smoke detector set at 100db. In their study, 24 children between the ages of 6 and 12 years were subjected to both the residential tone and a personalised parental voice on the same night. The children slept in specially prepared hospital bedrooms and were allowed to go to sleep and be in stage 4 sleep before one of the test methods was selected and activated. After the test was completed the child was resettled and allowed to go back to sleep before the second actuation was initiated. Their results showed that, of the 24 children who took part, 23 (96%) successfully awoke to the parents voice whereas only 14 (58%) awoke to the residential tone. Ball and Bruck [8] corroborated these results.

1.2.3 Position of smoke detectors:

Grarbacz and Thompson [20] investigated the effectiveness of smoke detectors in waking occupants and concluded that there would be 45% fewer fire deaths if all

homes were fitted with working smoke detectors. This requires any smoke detection placed in a property to be both reliable and successful in firstly detecting and then waking the occupants in the event of a fire. Professional fire service personnel have also been in an exclusive position to identify the effectiveness of smoke detectors and commercial fire alarms from a placement perspective as they are constantly attending incidents where these alarms are fitted. Kahn [18] suggested that the position of the detector was an important factor in effective escape suggesting that if the detector is placed on an escape route then the detector sounding is evidence that the route is already filling with smoke and potentially untenable. He concluded that the time lapse between detection and the response of the occupant was critical in ensuring that they escaped safely from a property. This is further supported by fire safety guidelines that require the earliest possible detection of a fire in situations which are defined as having a sleeping risk.

Robinson [21] carried out several experiments into the degree of loss of sound that occurs as a result of placing the smoke detector in the hallway of a property. He concluded that as much as 15db could be lost if the door to a bedroom was closed during the operation of the detector increasing to 20db if the door was sealed. This suggested that even a signal of 90 dB at the detector could still not reliably attain 78db at the bedhead. Bruck [22] also raised concerns that smoke detectors placed in a communal hallway may not have the effect of waking children specifically and that the use of interlinked alarms should be promoted so that the alarm would be raised in the most effective place.

Bruck [22] carried out research into the non-responsiveness of children and adults to smoke detectors placed in the hallways of their own homes across two definitive age ranges 6yrs to 17yrs (the children) and 30-59yrs (their parents). The detector was

set so that it would provide a signal of 60db at the pillow. The study concluded that 17 out of 20 (85%) of the 6-17yr age participants failed to respond on one or both of the test actuations while 100% of the adults (30-59yrs) tested awoke within 32 seconds. Subsequently, Bruck and Bell [11] pointed out that one of the down falls of their research was that all of the participants in their study were pre warned of the experiments and therefore potentially primed to respond to the actuation of the smoke detectors when they sounded. They also suggested that any future experiments should take place over a longer period of time, although no suggestion as to the length this time period should be was made.

1.3 Aims.

The aim of this study was to set out a robust set of experiments that could be used to identify

1. Whether or not common smoke detectors would wake children under the age of 12 from sleep.
2. Whether there were sex or age related differences in children's response to smoke detectors.
3. Whether equivalent responses would be obtained with low frequency smoke detectors.

Chapter 2 Experimental method.

2.1 Introduction

The age parameters for the children to be studied were between 5 and 12yrs in line with previous research which appears to suggest that this age group are those most at risk to not responding to a smoke detector. They would also fit into the primary school age group which Galland *et al* [15] suggested was the best time in the child's development where they would fit into a standard sleep pattern of 9 ½ hours. Where possible, the tests were carried out on school nights ensuring that an average time from sleep to setting off the alarm would be achieved.

2.2 Subject recruitment

Full ethical approval was obtained for the study and participant information sheets and parental assent forms were prepared. These are presented in Appendix 1.

Subjects were recruited via an appeal in Derbyshire fire service literature and through word of mouth. The inclusion criteria was for children within the desired age range with normal hearing and without any sleep related disorders. Once initial interest was demonstrated, each family was provided with the participant information sheet and asked to complete the parental assent form. All subjects were given a reference number to maintain anonymity. In total 17 families with 34 children took part in the study.

2.3 Initial information

Each family were asked to complete an initial questionnaire, a copy of which is presented in Appendix 2. This was used to record details such as the number and types of smoke detectors fitted, distance from the nearest smoke detector to the

child's bed, details of the child's normal sleep pattern and identifying whether the child slept with a night light on or not.

2.4 Smoke detector testing protocol.

The study was completed by all participants between August and October 2012. The parents were instructed using a simple recording matrix to record the time the child went to bed, the time of activation of the smoke detector and the child's response. The parents were instructed to operate the smoke detector nearest to the child's bed by depressing the test button and allowing the detector to sound for one minute.

The parents were asked to observe the child's reaction to the sound of the smoke detector sounding and record the time after operation that the child woke. If after one full minute the child had not woken, then an X was recorded in the appropriate box on the proforma recording sheet.

The tests were repeated six times for each child over a period of two weeks. Three of the tests were carried out where the child's bedroom door open and three with the door shut. During the duration of the complete test the parents were requested not to discuss the tests with the children in order to minimise any external influence that could affect the test results.

The recorded data was anonymised and entered into a database using Microsoft excel 2007. In total 34 children were tested in the first test.

2.5 Low frequency smoke detector testing protocol:

A second smaller study was completed by participants between February and March 2013. The parents were instructed using a simple recording matrix, to record the time the child went to bed, the time of the actuation of the smoke detector and the

child's response. In this case low frequency detectors were supplied by Fire angel were used as follows. The parents were asked to stand in the same location as the detector that was used in the first set of tests and then holding the low frequency detector (520 Hz) in their hand operate the detector by depressing the test button and allowing the detector to sound for one minute. The parents were asked to observe the child's reaction to the sound of the smoke detector and record the time after operation that the child woke. If after one full minute the child had not woken, then an X was recorded in the appropriate box on the recording matrix. The tests were repeated six times for each child over a period of two weeks. As before three of the tests were carried out where the child's bedroom door open and three with the door shut. During the duration of the complete test the parents were requested not to discuss the tests with the children in order to minimise any external influence that could affect the test results.

The recorded data was anonymised and entered into a database using Microsoft excel 2007. In total 12 children were tested in the second study.

Chapter 3 Results and Discussion.

3.1 General overview.

40 individual families replied to the initial appeal for volunteers. These families were contacted and supplied with the initial questionnaire, ethical consent form, parental consent form and an explanation sheet detailing the exact requirements of the experiment in the form of an information pack. Once in possession of the information pack 23 families, (57.5%) decided not to take part in the experiment. The most common reasons cited by parents were that were very sure that their children would wake up to the sound of a smoke alarm sounding and that they did not want to disturb their child's sleep. Some parents also stated that they did not want to wake their children up so late at night on a school night or disturb their child's sleep at a weekend having spent a long time trying to get them to bed. Most parents when questioned, were of the opinion that their children would always wake up if the smoke alarm was sounded and could not be convinced otherwise. Most of the participants that they had either a "Fire angel" or Kiddie stand-alone type detector or their house was fitted with hard wired interlinked smoke. All of these detectors are current and meet the British standard for domestic smoke detectors (BS 1111), they all emit a standard sound with the same decibel level and pitch.

In total 17 families with a total of 24 children participated in the study.12 (70.6%) of the participants were recruited from within Derbyshire Fire and Rescue Service, both operational and non-operational staff. This may have been because of the interest with the participants following several high profile cases which involved multiple child deaths in Derbyshire within the previous two years, prompting the service to carry out several high profile campaigns in an attempt to promote fire safety in the home.

In total 34 children (20 females and 14 males), from 17 families were individually tested using six separate tests per child. This resulted in a total of 204 smoke detector actuations. Of the 17 families who agreed to take part in the study, 5 of the families (29.4%) had no work connection with the Fire Service. The overall breakdown of the subjects is provided in figures 3 and 4.

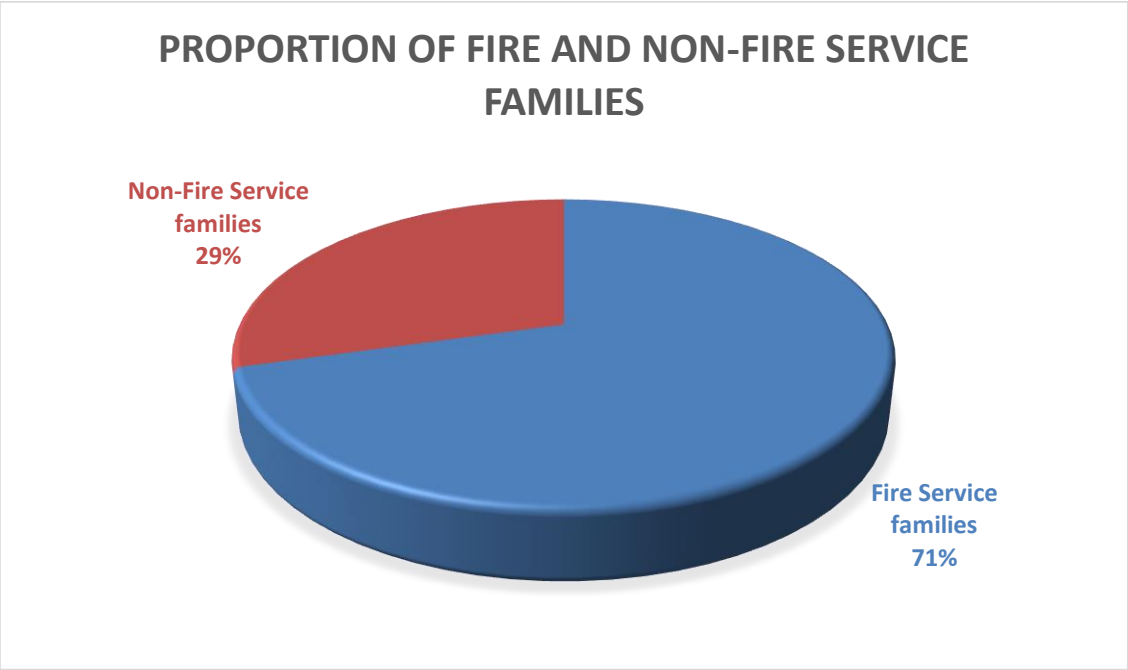

Figure 3 Number of families taking part in the study.

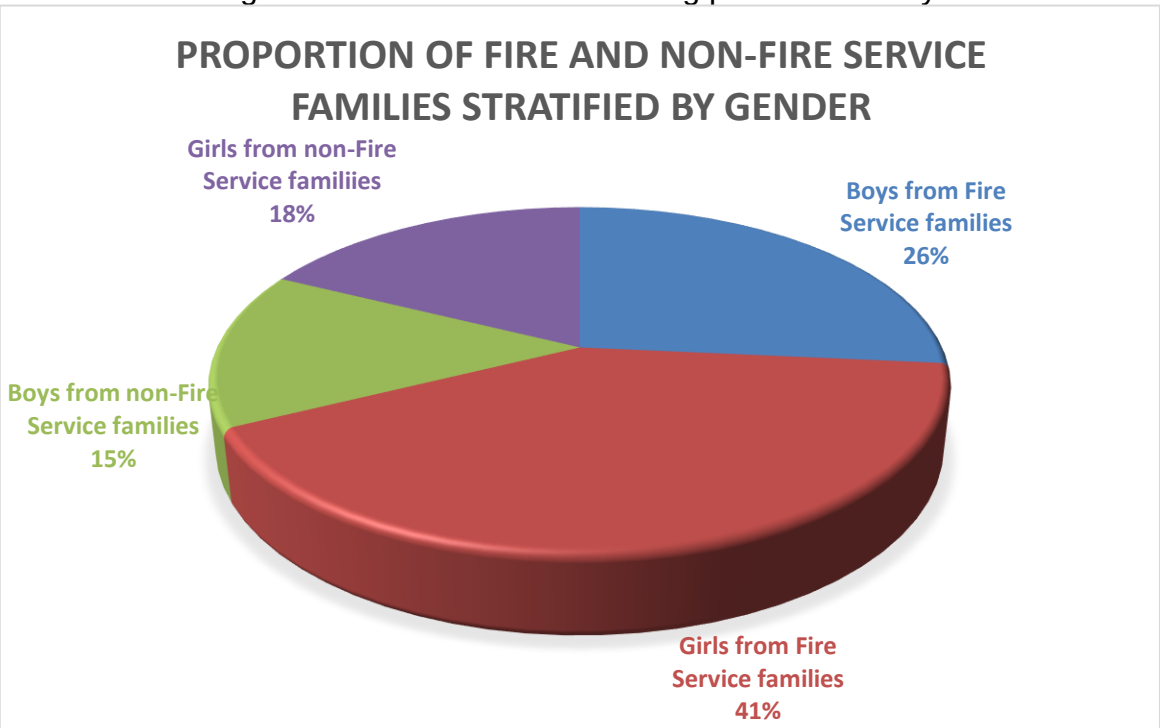

Figure 4 Breakdown of families by gender.

Most of the families who took part in the study had more than one child. 12 families had two children. 3 families who took part had three children and only two families had a single child. This data is summarised in figures 5 and 6

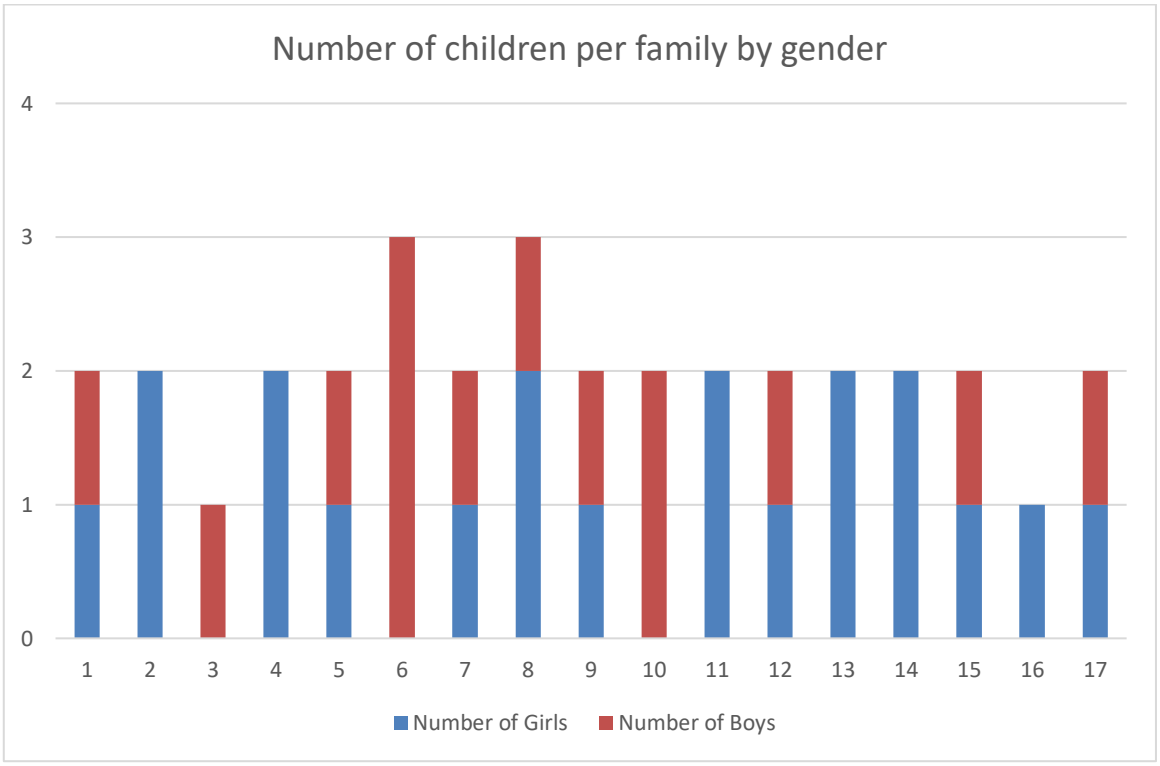

Figure 5 Number of children per family by gender

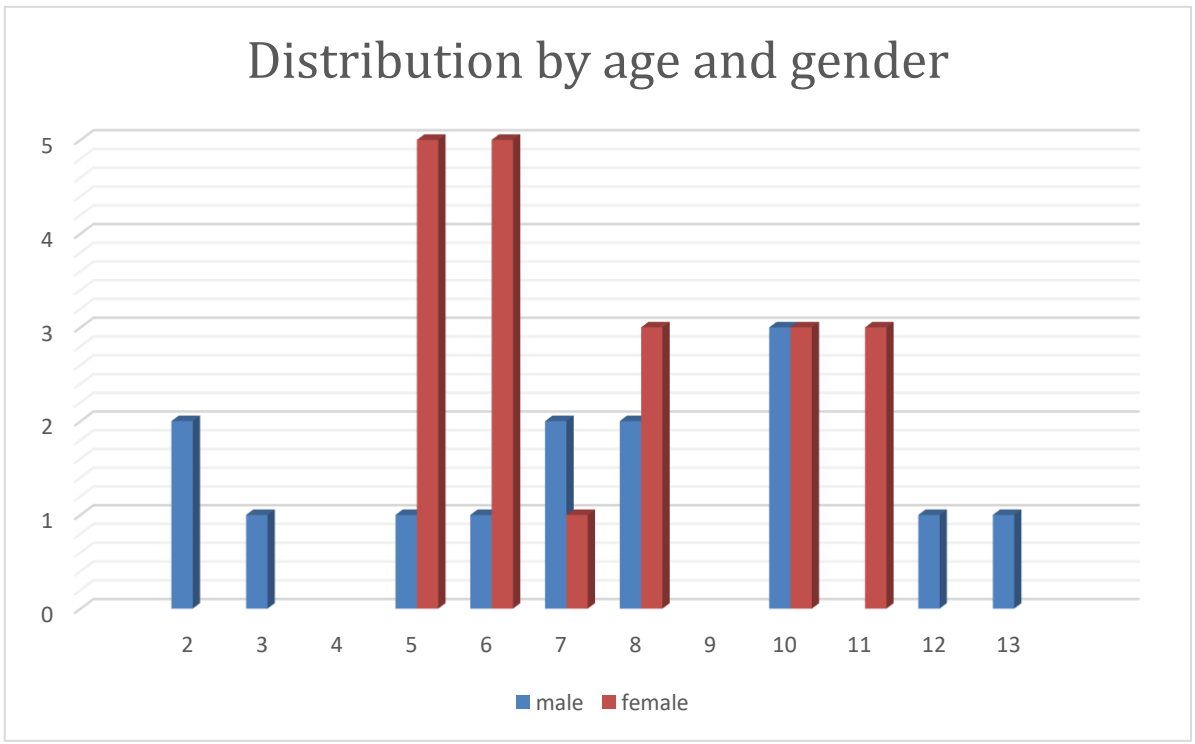

Figure 6 Distribution by age and gender.

The age range of the participants was spread out with most of the children falling within the 2 to 11 year age groups and all ages apart from 9 years were represented. The parents were not given a set time to carry out the test with no prescribed time to wait between the time that the children went to bed and the time that the parents activated the alarm. This resulted in a considerable variation in the time between sleep and test as illustrated in figure 7. A time span from as little as 40 mins since sleep to a maximum of 8 hours 30 mins was used with the mean time of 2 hours 49 mins. This appeared not to have any effect on whether or not the children woke.

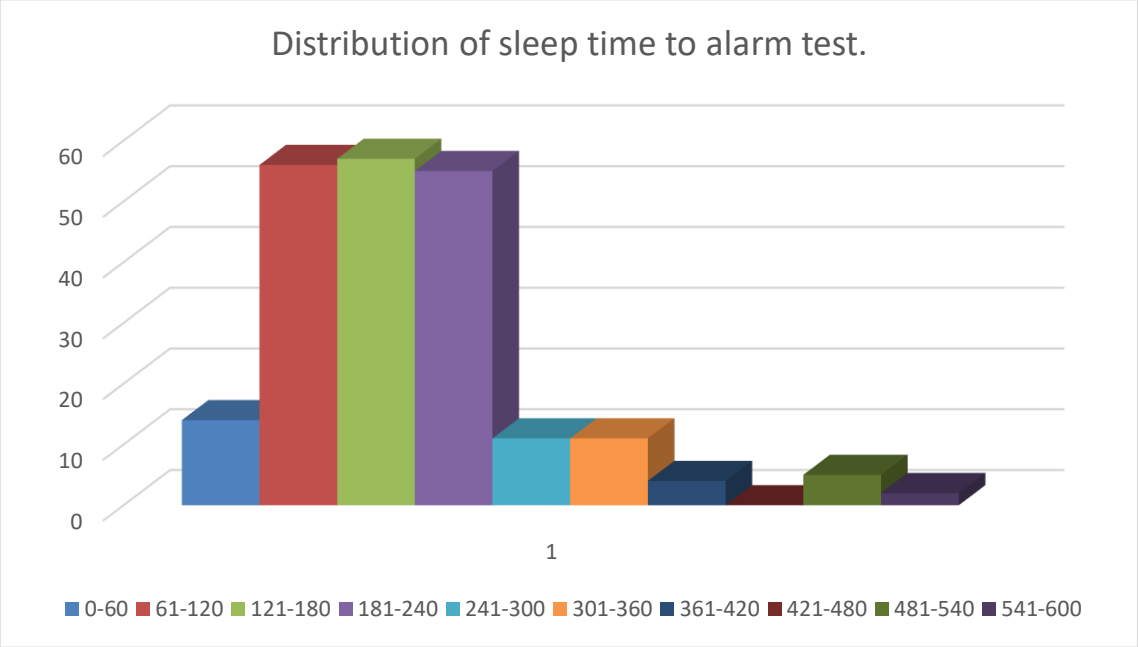

Figure 7 Average time in seconds between sleep and alarm actuation

In one of the tests, the detector was operated on three separate occasions during the same night. Although the test protocol was for the tests to be carried out over a period of two to three weeks, it was decided to include these results in the study. For this particular set of tests the parents had a conversation about the nights event's and the ten year old, the oldest child was fully conversant and knew exactly what had occurred on each of the actuations whereas the younger 7 year old child had not woken on any of the three actuations of the detector.

3.2 High frequency smoke detector tests.

An initial summary of the data is presented in tables 1 and 2 and illustrate that during the sounding of the smoke detectors none of the male children woke on any occasion. Of the female children, only 35% woke during any of the tests.

	Total no. of children	No. of children Waking up	No of children not waking up
Male	14 (100%)	0	14 (100%)
Female	20 (100%)	7 (35%)	13 (65%)
Total	34 (100%)	7 (5%)	27 (80%)

Table 1 Number of children waking up to the sound of a smoke detector.

	Total no. of tests	No. of times waking up	No. of times not waking up
Male	84 (100%)	0	84 (100%)
Female	120 (100%)	26 (21.66%)	94 (78.3%)
Total	204 (100%)	26 (12.7%)	178 (87.3%)

Table 2 Number of repetitive tests in which children woke up to the sound of a smoke detector.

3.3 Female children.

7 of the 20 female children (35%) woke during the tests. However the data suggests that the age of the children may be a factor in their responsiveness and data relating to the ages of all those who woke is presented in table 3.

Age (Years)	Number of female Children tested	Number of female children Who woke for any tests	% of tests children Woke (6 tests per child)
5	5	2	50
6	5	1	3
7	1	0	0
8	3	1	5
9	0	0	0
10	3	3	94
11	3	0	0

Table 3 Number of females who woke by age.

All of the female children aged 10 years woke 94% of the time on actuation of the detector. Each child woke for all tests apart from one child who woke 5 times out of the 6 tests. In each case these children were also the eldest child in the family.

Two 5 year old female children woke during three out of the six respective tests. One child woke on the last night of the 6 tests undertaken but her parents reported that it was her birthday the next day and she was very excited when she went to bed. The second 5 year old woke 3 times during the tests. It was revealed that this child's mother was profoundly deaf and the child had been taught to raise the alarm whenever the detector sounded, as her mother could not hear it.

One of the children aged 8 years, woke once during the six tests but the parents felt that they had not waited for the child to go to sleep fully before testing. It is worthy to note that the same child did not wake to any of the subsequent following 5 tests.

3.3.1 Time to waking.

During the initial set of tests 7 females woke up to the sound of the detector across a total of 26 tests. On all occasions the children woke within one minute with the fastest child waking in just 5 seconds and the longest taking 56 seconds giving a mean waking up time of 18.9 seconds. This data is presented in figure 8.

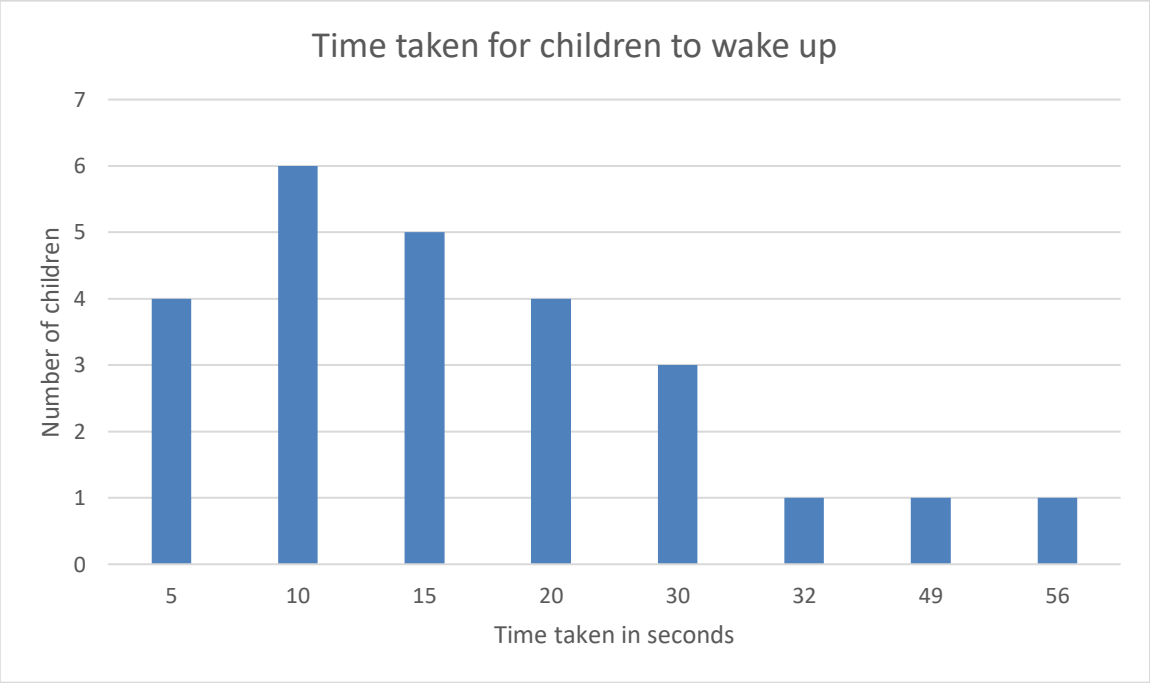

Figure 8 Time taken for the children to wake up.

3.3.2 Effect of the environment.

During each set of tests the parents were asked to carry out half the tests with the bedroom door open and the other half with the bedroom door shut. The results demonstrated that the position of the bedroom door made no difference to the reaction of the child (either male of female) when the detector was operated.

3.3.3 Distance between the detector and the child.

The British standard states that the optimum distance from the detector is 3 metres and that the detector should be producing at least 75 dB at this distance in order to achieve the kite mark.

In this study, the distance from the detector varied from being in the same room as the child to as far away as 8 metres with a mean distance between the child and detector of 3.8 metres. The distribution of distance from the detectors is presented in figure 9 and represents and approximates normal distribution.

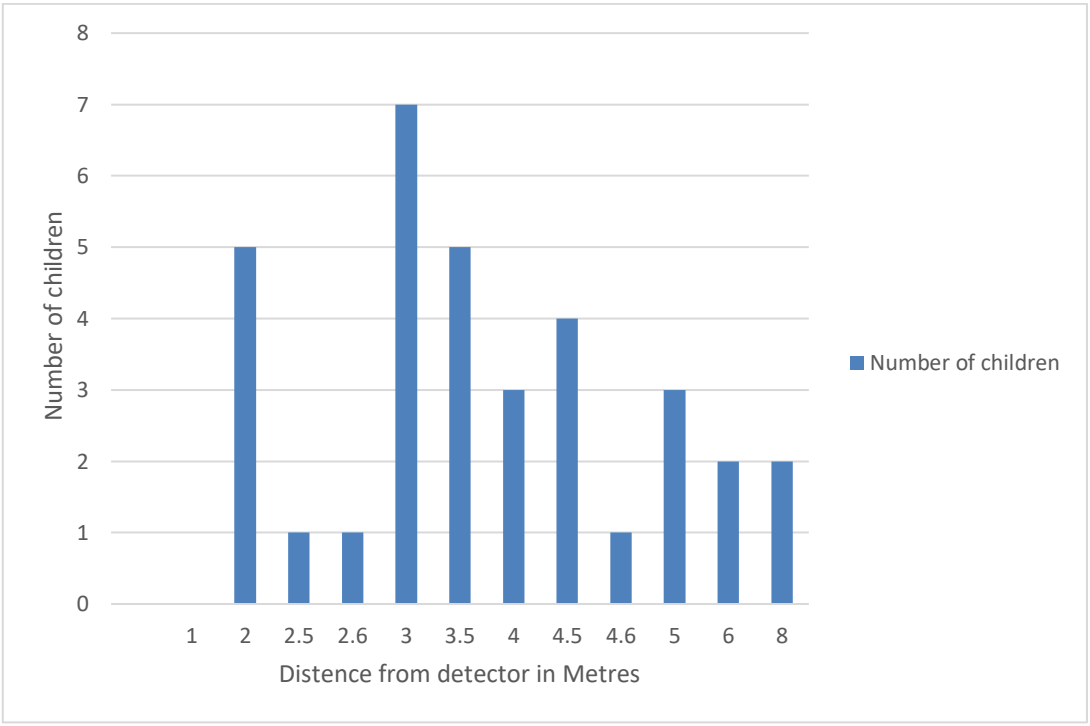

Figure 9 Distance of children from the smoke detector.

When compare with the 7 children who woke during the study the distance varied from 2 metres to 6 metres with a mean distance of 3.7 metres and is given as a histogram in figure 10.

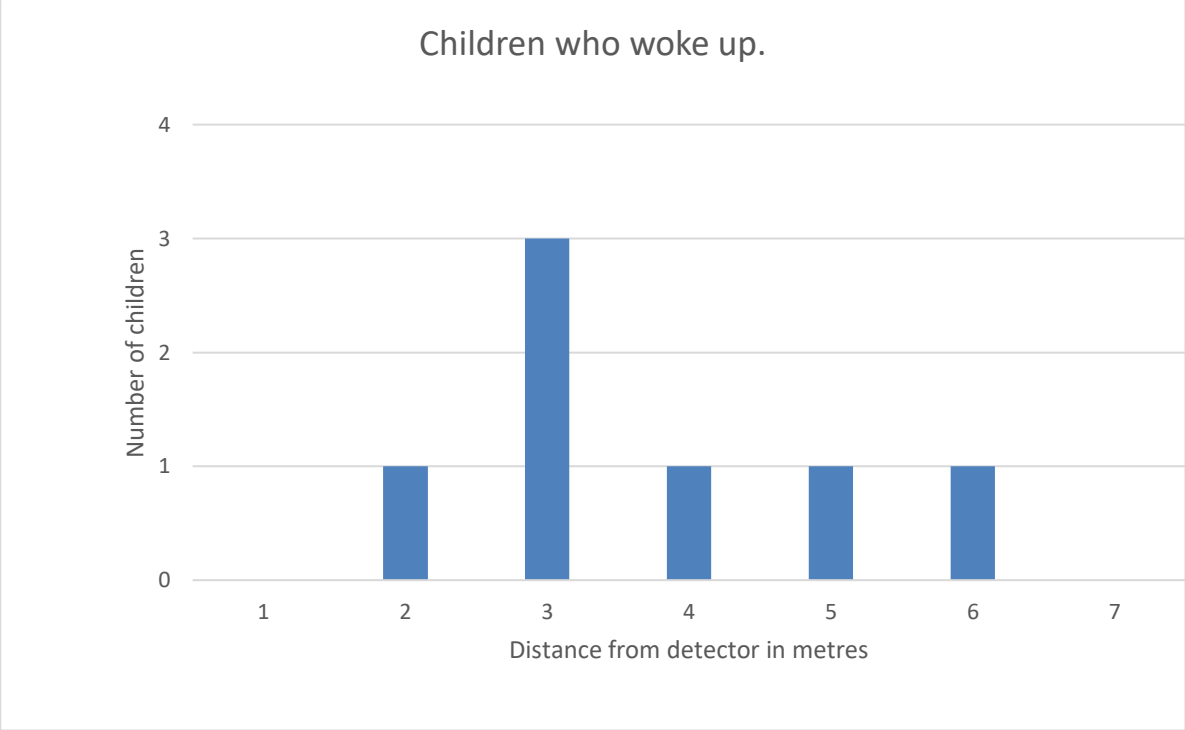

Figure 10 Distance from detector, children who woke.

The data suggests that the distance from the detector to the child appeared to have had no effect on whether or not the child woke up.

3.3.4 Night Lights.

Three male children and 1 female child were reported as sleeping with a night light on. During the study none of these children woke up to any of the actuations of the smoke detector. This would suggest that the use of a night light has no bearing on the ability of the child to wake up (figure 11)

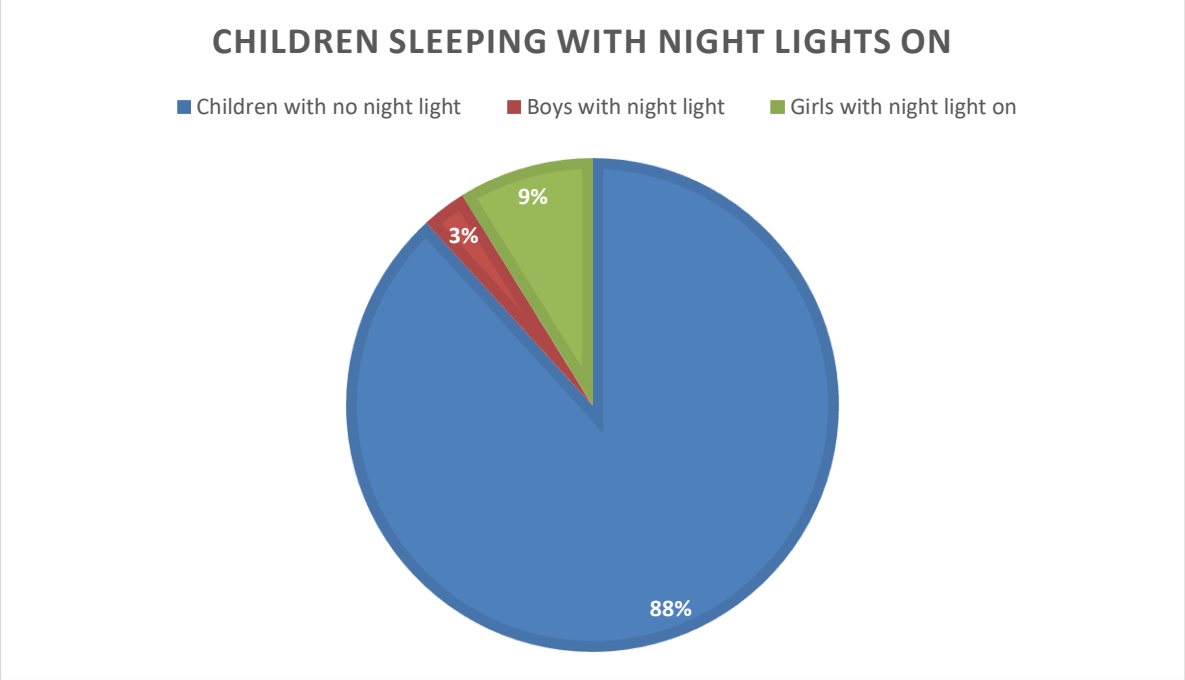

Figure 11 Number of children with night lights.

3.4 Low frequency test results.

Parents who carried out the set of tests with the low frequency detectors reported that of the 12 children (6 male and 6 female) none of the male children woke from sleep to the sound of the detector, however all of the female children woke up with 5 waking on every occasion and the sixth one waking on 5 of the 6 tests. These results are presented in tables 3 and 4 and figure 12.

	Total no. of tests	No. of times waking up	No. of times not waking up
Male	36(100%)	0	36(100%)
female	36(100%)	33(92%)	3(8%)

Table 4: No. of repetitive tests in which children woke up to the sound of a low frequency detector.

	Total no. of children	No. of children waking up	No. of children not waking up.
Male	6(100%)	0	6(100%)
Female	6(100%)	6(100%)	0

Table 5: No. of children waking up to a low frequency detector.

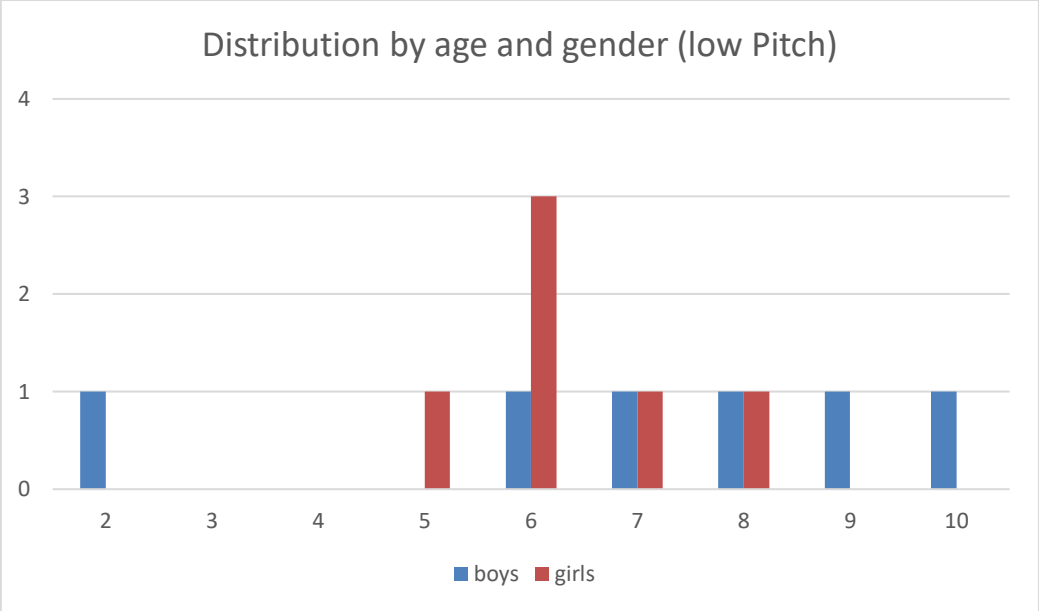

Figure 12. Distribution by age of children in low pitch study.

3.5 Discussion

The results obtained in this study clearly suggest that most children (80%) will not respond to the actuation of a standard domestic smoke detector within their own home environment. For those children that did react, all were female with clear age differences where a more consistent wakefulness across the tests was apparent in girls aged 8 years and over. During the low frequency study, 6 male and 6 female children who had not woken to a standard smoke detector were subjected to a low

frequency alarm under the same conditions and only the females woke up but did so in all cases and across an age range for 5 to 8 years.

When Bruck [22] carried out similar experiments to this study the results were that 17 out of 20 (85%) of subjects did not respond to the actuation of a normal smoke detector. Bruck tested children between the ages of 6 and 17 years each of which were subjected to 2 tests where the subjects were sleeping within a test environment.

This present study has used a larger population (n=34) and a more targeted age group of 5 to 12 years with each child being tested 6 times over a two to three week period in their own homes and the results appear to have mirrored those reported with a non-waking response in 84.5% of subjects.

There are a number of suggestions stemming from the childhood development literature which may be applicable to the results obtained.

Selective attention.

One possible theory put forward for this is that of Selective Attention. This is where the child has the ability to select which information to accept and which to ignore. In this case the theory would suggest that the children in this study have heard the smoke detector actuating but would have chosen to ignore it, Sanders *et al* [23] carried out experiments on the selective auditory attention of children by playing a different audio story into both the left and right ear at the same time and giving the child cues to one of the stories. They found that even children as young as 3 years of age showed signs under test conditions that they were capable of focusing on the story that they had been given the cues for by selectively disregarding the other

story. Driver [24] produced a comprehensive review of the research carried out by British psychologists into selective attention which although very in-depth did not deal with the issue of selective attention whilst the subject was asleep. There appears to be little if any published research addressing the ability of children to carry out selective attention whilst asleep.

Bruck *et al* [25] commented that in several studies carried out the children were given fire safety training prior to the actuation of the smoke detectors and that this appeared to have no bearing on the results suggesting that no selective attention had taken place. Similarly previous work did not suggest a difference in the selective attention abilities on the basis of gender, whereas this work clearly demonstrates that a gender difference is in evidence.

Although during this study the parents were requested not to communicate with the children regarding the tests until the final test was carried out, It should be noted that several of the parents of the children taking part in this study work for Derbyshire Fire and Rescue Service as either fire-fighters or support staff and as such their awareness of the need for family fire safety and training is at a higher degree than that compared to a normal family with several having spent much time talking to their children about fire plans and what to do if the fire alarm sounds. Several families reported their surprise at the test results citing many occasions that when the children were awake they responded to the smoke detector sounding.

Brain Development and the ability to identify risk.

Santostefano and Paley [26] tried to explore if a test could be devised that would be able to identify if the cognitive development of children could be assessed but failed to produce a simple and easy solution. Lewis and Stiebe [27] acknowledged that the

pre-frontal cortex of the brain appear to mediate cognitive control. It has long been established that the frontal lobes in a child develop at later stages and do not become fully grown until around the late teens to early twenties. Giedd [28] concluded that the part of the brain responsible for decision making and impulse control does not fully mature until the mid-twenties.

Further research has indicated that the frontal lobes of the brain in children has not sufficiently developed so as to allow them to identify danger.

This is sometimes referred to as the sleeping rabbit effect where the rabbit is asleep in a field and a fox walks into the field the rabbit's nose senses the fox's presence and sends a message to the brain. The brain then computes this information and the frontal lobes, (the area of the brain responsible for identifying danger) wakes up the rabbit in time for it to become fully awake and escape.

Burnett *et el* [29] studied the adolescent brain and acknowledged that the young have a greater propensity for risk taking due to the brain not being fully developed. Research has been carried out into the statistics behind young adult males being more at risk of involvement in car accidents than any other car user group with Clarke *et al* [30] suggesting that it was 2 and ½ times greater than the average. One of the suggested reasons has been that the prefrontal lobes contain the area of the brain where the calculation of risk is undertaken. As the young male's brain has not yet developed fully, their ability to identify the risk is greatly diminished and it is not a question of the driver taking excessive risks but more that the driver sees the risk but their brain cannot compute it and identify the danger. In this study it was clear that the one group of children that did not respond at all to the sound of the smoke alarm were boys where no male subject of any age woke. This is despite research by

Bruck [11] suggesting that humans do not stop monitoring their environment whilst sleeping.

The younger age females from 5 to 7 showed no response to the smoke alarms apart from one child who was excited due to her birthday the next day and may not have been asleep at the time, and one child whose mother is profoundly deaf and the child has been trained from a young age to alert her mother if the alarm sounds. Whereas the older females aged 8 and above awoke with some consistency. The suggestion may be that the older female child has begun to mature taking on some of the parenting roles for the younger children and as their frontal lobe development allows the recognition of the danger that the sounding of a smoke detector may produce.

Inner ear development – frequency of the smoke detectors.

An alternative explanation to the lack of response of the children to the smoke detectors is the frequency that the smoke detector signal is set to different frequencies of sound are detected at different points along the length of the inner ear (cochlea). The highest frequency sounds are detected by cells around the thinnest part of the basilar membrane in the base of the cochlea. Low frequencies are detected around the thick part of the basilar membrane at the (thin end) apex of the cochlea.

Research has been carried out into the ability of subjects to awaken if the frequency of the signal is set to a low frequency (around 500 Hz). Bruck [22] used a mixture of low to high frequency signals known as a temporal 3 (T3) in their research and this produced favourable results with all of the adult and child subjects waking up.

However the research paper has been cited by several alarm manufactures in their promotion of low frequency alarms only.

The results of the present study support the concept of frequency as a mitigating factor up to a certain point. Of the 12 children who undertook the low frequency study only 6 woke, again all females but in these tests the age distribution of the waking children included the lower age range than for the standard smoke detector (5 to 8 years). None of the male children woke in the low frequency tests. The difference between these results and those of Bruck [22] are highly suggestive of a variable rang of frequencies which are both age and gender specific, and the low frequency smoke detectors on their own are insufficient to wake all children.

4. Conclusions and further Work.

4.1 Conclusions

In total 204 tests were conducted involving 34 children, where each child was tested 6 times. The children, (20 girls and 14 boys), were all aged between 2 and 13 years and the tests were undertaken in the children's home using the standard domestic smoke detectors fitted within the property. The parents activated the smoke detectors continuously for 1 minute after the children had gone to bed and then recorded the time taken for the child to wake. The children were given no prior warning of any of the tests.

The specific results obtained were.

1. 80% of the children, including all of the male children, slept through the alarms on all 6 tests.
2. Of the 34 children tested, only 7 (all girls) woke during any of the individual 6 tests.
3. Only 2 children (6% of the total number tested), both girls aged 10 years, woke each time that the alarm was sounded during the individual 6 tests.

The children's ability to wake did not appear to be affected by either the bedroom doors being open or closed or the proximity of the bed (all detectors were between 2.5 and 8m from the bed).

A further set of tests were carried out using a low frequency (520 hz) detector. 6 boys and 6 girls were selected who had not woken in the standard alarm test. The same test protocol was followed. Again none of the boys woke up for any of the actuations however this time all of the girls woke, with only one failing to wake up on all 6 tests.

In conclusion, these experiments have shown that children under the age of 13 are unlikely to wake up to the operation of a standard domestic smoke detector whilst asleep with boys being especially at risk. This issue is also not addresses when a low frequency detector is used and an apparent difference between the responses of boys and girls to such devices was highlighted.

While the value of smoke detectors as a means of alerting people to fires is not in question and there is no doubt that smoke detectors save lives, the research results highlight an apparent inability of standard domestic smoke detectors to wake children under the age of 13 and in particular male children.

4.2 Further work

This study has concluded that it is highly unlikely that children will wake up to the actuation of a standard smoke detector. Further work is required to identify the exact reasons behind this. There are several possibilities that could be explored including the selective attention and frontal lobe development. During the low frequency experiment there appeared to be a definite change in the ability of the alarm to wake girls. Further research should be carried out in this area to systematically identify the threshold of frequency alarms as a function of age in both male and female children and whether a smoke detector that cycles through frequencies has a better effect in waking children.

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Appendix i: Participant information

Participant Information Sheet

Name of department:
Title of the study: Study into the effectiveness of domestic smoke alarms in waking children from sleep.

Introduction
My name is Dave Coss I am a post graduate student studying for an MSc in fire investigation at Strathclyde University. As part of my studies I am carrying out a research project into the effectiveness of smoke detectors in the domestic environment.

What is the purpose of this investigation?
The purpose of this investigation is to look at the effectiveness of domestic smoke detectors in waking children from their sleep. During recent years several fires have occurred where children have not woken up to the sound of a smoke detector operating. This investigation is attempting to determine if there is a direct link between the two events.

Do you have to take part?
You don't have to take part in the investigation if you don't want to; the decision to participate is entirely voluntary. If at any point during the experiments you feel that you want to stop or withdraw from the investigation then please feel free to do so.

What will you do in the project?
All that is required for this project is to allow the children to go to bed as normal and then some time towards the middle of the night you will push and hold the test button on the smoke detector for a period of one minute and record if the children woke up or not. In order to provide enough accurate data the test will need to be repeated for a total of six times over a period of at least two weeks. Participants should avoid carrying out the test on consecutive nights as the children may become accustomed to the event.

Why have you been invited to take part?
Participants have been invited to take part in this investigation if they have any children between the ages of 5 and 12 years. These ages were chosen due to children over the age of 12 being required to give there own consent and this could be seen as forewarning the children of what is going to happen.

What are the potential risks to you in taking part?
There are no potential risks to the participants. The only risk will be the potential disturbance of sleep to the children if they wake up.

What happens to the information in the project?
All of the data and information gathered during this investigation will remain confidential with all results being anonymised prior to being reported. Once the investigation has been completed all data will be securely destroyed using a confidential waste disposal system.

The University of Strathclyde is registered with the Information Commissioner's Office who implements the Data Protection Act 1998. All personal data on participants will be processed in accordance with the provisions of the Data Protection Act 1998. Thank you for reading this information – please ask any questions if you are unsure about what is written here.

What happens next?
If you are happy to be involved in the project you will need to read and sign a consent form confirming this and also allowing the data gained to be used.

Once all the data has been collected and collated, individual participants will be contacted and the results of the investigation will be explained to them. At this stage participants will also be informed if the results are to be published in any journals.

Researcher Contact Details:
The researchers full contact details are.

Dave Coss 35 Stella Street Mansfield Notts NG18 4AN

Telephone contact is 07786852850

email contact is Robert.coss@strath.ac.uk

Chief Investigator Details:
This should include the name of the Chief Investigator and the University of Strathclyde contact details (address, phone number and email address).

This investigation was granted ethical approval by the University of Strathclyde ethics committee.

If you have any questions/concerns, during or after the investigation, or wish to contact an independent person to whom any questions may be directed or further information may be sought from, please contact:

Secretary to the University Ethics Committee
Research & Knowledge Exchange Services
University of Strathclyde
Graham Hills Building
50 George Street
Glasgow
G1 1QE

Telephone: 0141 548 3707
Email: ethics@strath.ac.uk

Appendix ii: Parent consent forms

University of Strathclyde Glasgow

Consent Form

Name of department:

Title of the study: Study into the effectiveness of domestic smoke alarms in waking children from sleep.

- I confirm that I have read and understood the information sheet for the above project and the researcher has answered any queries to my satisfaction.
- I understand that my participation is voluntary and that I am free to withdraw from the project at any time, without having to give a reason and without any consequences.
- I understand that I can withdraw my data from the study at any time.
- I understand that any information recorded in the investigation will remain confidential and no information that identifies me will be made publicly available.
- I consent to being a participant in the project

(PRINT NAME)	I hereby agree to take part in the above project
Signature of Participant:	Date

Parental Assent Form

Name of department:

Title of the study: Study into the effectiveness of domestic smoke alarms in waking children from sleep.

- I confirm that I have read and understood the information sheet for the above project and the researcher has answered any queries to my satisfaction.
- I understand that my Childs participation is voluntary and that I am free to withdraw them from the project at any time, without having to give a reason and without any consequences.
- I understand that I can withdraw my Childs data from the study at any time.
- I understand that any information recorded in the investigation will remain confidential and no information that identifies me or my child will be made publicly available.
- I consent to my child being a participant in the project

(PRINT NAME)	I hereby agree to take part in the above project
Signature of Participant:	Date

Appendix iii: Initial test questionnaire

Test Questionnaire.

Please fill in questionnaire below as accurately as possible. All the information recorded will be treated as strictly confidential and will be destroyed using confidential waste disposal systems once the study is complete.

Childs Name	Childs Age	Gender	Any medical conditions (continue on extra sheet if necessary)	Does the child have a regular sleep pattern?

How many smoke detectors are fitted to your property……..

What is the make and model of the fire detector(s) ……...

……

……

Where are they located ?……

Are they hard wired (connected to the mains) ?……

Are they interlinked (if one operates they all do) ?……

What is the approximate distance from the nearest smoke detector to the Childs bed ? .

……

Are the doors to the Childs bedroom normally left open or closed ?……

Do any of the children sleep with a night light on ?……...

If so do you leave the light on all night ?……

The Test. – Please read carefully

At a set time (middle of the night) the parent will press and hold the test button on a smoke alarm for a period of one minute and then record if the child wakes or not. Awake is defined as alert and knowing that the alarm has operated and are capable of responding to the alarm (ie getting out of bed, following basic instructions).

You will need to record the time (in seconds) that it took for the child to awaken and become alert. Start recording the time once the alarm is activated. If the child does not wake after one minute stop the test and put an x in the appropriate space. If the children go to bed at different times please record the bed times for each child separately. If possible please complete half of the tests with the door open and half with the door closed.

	Date	Time of Test	Door open or closed	Time it took for child to become alert (time in seconds fro each individual child in the family)				
				Child 1	Child 2	Child 3	Child 4	Child 5
1								
Bed time								
2								
Bed time								
3								
Bed time								
4								
Bed time								
5								
Bed time								
6								
Bed time								

Please return all completed questionnaires to

Dave Coss, 35 Stella Street ,Mansfield, Notts

Robert.coss@btinternet.com or robert.coss@strath.ac.uk

Data: **Smoke Alarm test results.**

Candidate no.	Test No.	Date of test	Bedtime	Time of test	sleep time	age	M/F	dist to detector	Door pos.	Night light	HW/ single	No. of detectors	Make/ modal	results	Time taken to wake	Comments	Fire service employee
1	1A	30/06/2012	19:30:00	21.00.00	01:30:00	6	F	3M	Closed	no	HW	2		WOKE		Oldest of 2	YES
	1B	02/07/2012	19:30:00	03.00.00	07:30:00	6	F	3M	Closed	no	HW	2		X		Oldest of 2	YES
	1C	03/07/2012	19:30:00	01.00.00	05:30:00	6	F	3M	Closed	no	HW	2		X		Oldest of 2	YES
	1D	05/07/2012	19:30:00	04.00.00	08:30:00	6	F	3M	Closed	no	HW	2		X		Oldest of 2	YES
	1E	09/07/2012	19:30:00	00:00:00	04:30:00	6	F	3M	Closed	no	HW	2		X		Oldest of 2	YES
	1F	12/07/2012	19:30:00	23.30.00	04:00:00	6	F	3M	Closed	no	HW	2		X		Oldest of 2	YES
2	2A	03/09/2012	21:00:00	00:00:00	03:00:00	10	F	3m	closed	no	single	2	fireangel	Woke	30	Oldest of 2	YES
	2B	04/09/2012	21:00:00	00:00:00	03:00:00	10	F	3m	closed	no	single	2	fireangel	Woke	15	Oldest of 2	YES
	2C	05/09/2012	21:00:00	00:00:00	03:00:00	10	F	3m	closed	no	single	2	fireangel	Woke	20	Oldest of 2	YES
	2D	06/09/2012	21:00:00	00:00:00	03:00:00	10	F	3m	open	no	single	2	fireangel	Woke	10	Oldest of 2	YES
	2E	07/09/2012	22:00:00	00:00:00	02:00:00	10	F	3m	open	no	single	2	fireangel	Woke	30	Oldest of 2	YES
	2F	08/09/2012	22:00:00	00:00:00	02:00:00	10	F	3m	open	no	single	2	fireangel	X		Oldest of 2	YES
3	3A	03/09/2012	20:30:00	00:00:00	03:30:00	8	F	3M	closed	no	single	2	fireangel	X		Younger of 2	YES
	3B	04/09/2012	20:30:00	00:00:00	03:30:00	8	F	3m	closed	no	single	2	fireangel	X		Younger of 2	YES
	3C	05/09/2012	20:30:00	00:00:00	03:30:00	8	F	3m	closed	no	single	2	fireangel	Woke	5	Younger of 2	YES
	3D	06/09/2012	20:30:00	00:00:00	03:30:00	8	F	3m	open	no	single	2	fireangel	Woke	10	Younger of 2	YES
	3E	07/09/2012	22:00:00	00:00:00	02:00:00	8	F	3m	open	no	single	2	fireangel	Woke	5	Younger of 2	YES
	3F	08/09/2012	22:00:00	00:00:00	02:00:00	8	F	3m	open	no	single	2	fireangel	Woke	30	Younger of 2	YES
4	4A	06/09/2012	21:30:00	22:10:00	00:40:00	8	M	4m	closed	no	HW	2		X		Only child	YES
	4B	09/09/2012	21:00:00	22:40:00	01:40:00	8	M	4m	open	no	HW	2		X		Only child	YES
	4C	11/09/2012	20:45:00	22:30:00	01:45:00	8	M	4m	closed	no	HW	2		X		Only child	YES
	4D	12/09/2012	20:45:00	22:00:00	01:15:00	8	M	4m	open	no	HW	2		X		Only child	YES
	4E	14/09/2012	20:40:00	22:45:00	02:05:00	8	M	4m	closed	no	HW	2		X		Only child	YES
	4F	16/09/2012	20:50:00	22:30:00	01:40:00	8	M	4m	open	no	HW	2		X		Only child	YES
5	5A	05/09/2012	19:00:00	22:08:00	03:08:00	6	F	2.6M	closed	no	single	2	kidde	X		Oldest of 2	YES

	5B	07/09/2012	19:30:00	21:44:00	02:15:00	6	F	2.6m	open	no	single	2	kidde	X		Oldest of 2	YES
	5C	10/09/2012	19:10:00	22:45:00	03:35:00	6	F	2.6m	closed	no	single	2	kidde	X		Oldest of 2	YES
	5D	16/09/2012	19:30:00	02:52:00	07:22:00	6	F	2.6m	open	no	single	2	kidde	X		Oldest of 2	YES
	5E	17/09/2012	19:10:00	22:37:00	03:27:00	6	F	2.6m	open	no	single	2	kidde	X		Oldest of 2	YES
	5F	18/09/2012	19:15:00	22:06:00	02:51:00	6	F	2.6m	open	no	single	2	kidde	X		Oldest of 2	YES
6	6A	05/09/2012	19:00:00	22:08:00	03:08:00	6	F	4.6m	closed	no	single	2	kidde	X		Younger of 2	YES
	6B	07/09/2012	19:00:00	21:44:00	02:44:00	6	F	4.6m	open	no	single	2	kidde	X		Younger of 2	YES
	6C	10/09/2012	19:10:00	22:45:00	03:35:00	6	F	4.6m	closed	no	single	2	kidde	X		Younger of 2	YES
	6D	16/09/2012	19:30:00	02:52:00	07:22:00	6	F	4.6m	open	no	single	2	kidde	X		Younger of 2	YES
	6E	17/09/2012	19:10:00	22:37:00	03:27:00	6	F	4.6m	open	no	single	2	kidde	X		Younger of 2	YES
	6F	18/09/2012	19:15:00	22:06:00	02:51:00	6	F	4.6m	open	no	single	2	kidde	X		Younger of 2	YES
7	7A	04/07/2012	19:30:00	21:30:00	02:00:00	7	M	2M	open	no	single	6	fireangel	X		Oldest of 2	YES
	7B	10/07/2012	19:30:00	21:45:00	02:15:00	7	M	2M	open	no	single	6	fireangel	X		Oldest of 2	YES
	7C	20/07/2012	19:30:00	23:00:00	03:30:00	7	M	2M	open	no	single	6	fireangel	X		Oldest of 2	YES
	7D	22/07/2012	19:30:00	21:10:00	01:40:00	7	M	2M	open	no	single	6	fireangel	X		Oldest of 2	YES
	7E	03/08/2012	19:30:00	23:30:00	04:00:00	7	M	2M	open	no	single	6	fireangel	X		Oldest of 2	YES
	7F	06/08/2012	19:30:00	23:15:00	03:45:00	7	M	2M	open	no	single	6	fireangel	X		Oldest of 2	YES
8	8A	04/07/2012	19:30:00	21:30:00	02:00:00	5	F	2M	open	no	single	6	fireangel	X		Younger of 2	YES
	8B	10/07/2012	19:30:00	21:45:00	02:15:00	5	F	2M	open	no	single	6	fireangel	X		Younger of 2	YES
	8C	20/07/2012	19:30:00	23:00:00	03:30:00	5	F	2M	open	no	single	6	fireangel	X		Younger of 2	YES
	8D	22/07/2012	19:30:00	21:10:00	01:40:00	5	F	2M	open	no	single	6	fireangel	X		Younger of 2	YES
	8E	03/08/2012	19:30:00	23:30:00	04:00:00	5	F	2M	open	no	single	6	fireangel	X		Younger of 2	YES
	8F	06/08/2012	19:30:00	23:15:00	03:45:00	5	F	2M	open	no	single	6	fireangel	Woke	20	Younger of 2	YES
9	9A	31/08/2012	21:15:00	22:00:00	00:45:00	8	M	3.5m	Closed	Yes	Single	2		X		Oldest of 3	NO
	9B	05/09/2012	20:30:00	21:45:00	01:15:00	8	M	3.5m	Open	Yes	Single	2		X		Oldest of 3	NO
	9C	09/09/2012	20:15:00	22:45:00	02:30:00	8	M	3.5m	Open	Yes	Single	2		X		Oldest of 3	NO
	9D	11/09/2012	20:30:00	22:00:00	01:30:00	8	M	3.5m	Closed	Yes	Single	2		X		Oldest of 3	NO
	9E	13/09/2012	20:30:00	22:30:00	02:00:00	8	M	3.5m	Open	Yes	Single	2		X		Oldest of 3	NO
	9F	16/09/2012	20:30:00	22:15:00	01:45:00	8	M	3.5m	Closed	Yes	Single	2		X		Oldest of 3	NO

10	10A	31/08/2012	20:00:00	22:00:00	02:00:00	5	M	3.5m	Closed	Yes	Single	2		X		Middle of 3	NO
	10B	05/09/2012	20:30:00	21:45:00	01:15:00	5	M	3.5m	Open	Yes	Single	2		X		Middle of 3	NO
	10C	09/09/2012	20:15:00	22:45:00	02:30:00	5	M	3.5m	Open	Yes	Single	2		X		Middle of 3	NO
	10D	11/09/2012	20:30:00	22:00:00	01:30:00	5	M	3.5m	Closed	Yes	Single	2		X		Middle of 3	NO
	10E	13/09/2012	20:30:00	22:30:00	02:00:00	5	M	3.5m	Open	Yes	Single	2		X		Middle of 3	NO
	10F	16/09/2012	20:30:00	22:15:00	01:45:00	5	M	3.5m	Closed	Yes	Single	2		X		Middle of 3	NO
11	11A	13/09/2012	19:30:00	22:45:00	03:15:00	6	F	6M	Open	No	Single	5	Kidde	X		Oldest of 2	YES
	11B	15/09/2012	19:30:00	23:15:00	03:45:00	6	F	6M	Open	No	Single	5	Kidde	X		Oldest of 2	YES
	11C	16/09/2012	19:30:00	22:15:00	02:45:00	6	F	6M	Open	No	Single	5	Kidde	X		Oldest of 2	YES
	11D	18/09/2012	19:30:00	22:30:00	02:00:00	6	F	6M	Closed	No	Single	5	Kidde	X		Oldest of 2	YES
	11E	19/09/2012	19:30:00	22:30:00	02:00:00	6	F	6M	Open	No	Single	5	Kidde	X		Oldest of 2	YES
	11F	22/09/2012	19:30:00	23:00:00	03:30:00	6	F	6M	Closed	No	Single	5	Kidde	X		Oldest of 2	YES
12	12A	01/09/2012	21:30:00	23:55:00	02:25:00	11	F	4.5M	Open	No	Single	2	Kiddie	X		Middle of 3	YES
	12B	05/09/2012	21:00:00	23:30:00	02:30:00	11	F	4.5M	Open	No	Single	2	Kiddie	X		Middle of 3	YES
	12C	07/09/2012	21:30:00	23:45:00	02:00:00	11	F	4.5M	Open	No	Single	2	Kiddie	X		Middle of 3	YES
	12D	09/09/2012	21:15:00	23:15:00	02:00:00	11	F	4.5M	Closed	No	Single	2	Kiddie	X		Middle of 3	YES
	12E	11/09/2012	21:30:00	23:00:00	01:30:00	11	F	4.5M	Closed	No	Single	2	Kiddie	X		Middle of 3	YES
	12F	14/09/2012	22:00:00	23:20:00	01:20:00	11	F	4.5M	Closed	No	Single	2	Kiddie	X		Middle of 3	YES
13	13A	01/09/2012	20:30:00	23:55:00	03:25:00	5	F	4.5M	Open	No	Single	2	Kiddie	X		Younger of 3	YES
	13B	05/09/2012	19:30:00	23:30:00	04:00:00	5	F	4.5M	Open	No	Single	2	Kiddie	X		Younger of 3	YES
	13C	07/09/2012	19:30:00	23:45:00	04:15:00	5	F	4.5M	Open	No	Single	2	Kiddie	X		Younger of 3	YES
	13D	09/09/2012	19:00:00	23:15:00	04:15:00	5	F	4.5M	Closed	No	Single	2	Kiddie	X		Younger of 3	YES
	13E	11/09/2012	19:30:00	23:00:00	03:30:00	5	F	4.5M	Closed	No	Single	2	Kiddie	X		Younger of 3	YES
	13F	14/09/2012	22:00:00	23:20:00	01:20:00	5	F	4.5M	Closed	No	Single	2	Kiddie	X		Younger of 3	YES
14	14A	21/09/2012	20:30:00	22:40:00	02:10:00	10	F	6M	Open	No	HW	2		Woke	5	Oldest of 2	YES
	14B	23/09/2012	20:00:00	22:55:00	02:55:00	10	F	6M	Open	No	HW	2		Woke	20	Oldest of 2	YES
	14C	01/10/2012	20:40:00	22:40:00	02:00:00	10	F	6M	Closed	No	HW	2		Woke	15	Oldest of 2	YES
	14D	09/10/2012	19:50:00	22:40:00	02:50:00	10	F	6M	Closed	No	HW	2		Woke	10	Oldest of 2	YES

	14E	11/10/2012	19:40:00	22:30:00	02:50:00	10	F	6M	Open	No	HW	2		Woke	15	Oldest of 2	YES
	14F	13/10/2012	20:30:00	23:10:00	02:40:00	10	F	6M	Closed	No	HW	2		Woke	20	Oldest of 2	YES
15	15A	21/09/2012	20:30:00	22:40:00	02:10:00	6	M	2M	Open	No	HW	2		X		Younger of 2	YES
	15B	23/09/2012	20:00:00	22:55:00	02:55:00	6	M	2M	Open	No	HW	2		X		Younger of 2	YES
	15C	01/10/2012	20:40:00	22:40:00	02:00:00	6	M	2M	Closed	No	HW	2		X		Younger of 2	YES
	15D	09/10/2012	19:50:00	22:40:00	02:50:00	6	M	2M	Closed	No	HW	2		X		Younger of 2	YES
	15E	11/10/2012	19:40:00	22:30:00	02:50:00	6	M	2M	Open	No	HW	2		X		Younger of 2	YES
	15F	13/10/2012	20:30:00	23:10:00	02:40:00	6	M	2M	Closed	No	HW	2		X		Younger of 2	YES
16	16A	05/10/2012	20:30:00	23:00:00	2.:30	10	M	4M	Closed	No	HW	2		X		Oldest of 2	YES
	16B	08/10/2012	20:30:00	23:30:00	03:00:00	10	M	4M	Closed	No	HW	2		X		Oldest of 2	YES
	16C	12/10/2012	20:30:00	23:10:00	02:40:00	10	M	4M	Closed	No	HW	2		X		Oldest of 2	YES
	16D	15/10/2012	20:30:00	23:34:00	03:04:00	10	M	4M	Open	No	HW	2		X		Oldest of 2	YES
	16E	16/10/2012	20:30:00	23:00:00	02:30:00	10	M	4M	Open	No	HW	2		X		Oldest of 2	YES
	16F	20/10/2012	20:30:00	01:00:00	04:30:00	10	M	4M	Open	No	HW	2		X		Oldest of 2	YES
17	17A	05/10/2012	20:30:00	23:00:00	2.:30	7	M	2M	Closed	Yes	HW	2		X		Younger of 2	YES
	17B	08/10/2012	20:30:00	23:30:00	03:00:00	7	M	2M	Closed	Yes	HW	2		X		Younger of 2	YES
	17C	12/10/2012	20:30:00	23:10:00	02:40:00	7	M	2M	Closed	Yes	HW	2		X		Younger of 2	YES
	17D	15/10/2012	20:30:00	23:34:00	03:04:00	7	M	2M	Open	Yes	HW	2		X		Younger of 2	YES
	17E	16/10/2012	20:30:00	23:00:00	02:30:00	7	M	2M	Open	Yes	HW	2		X		Younger of 2	YES
	17F	20/10/2012	20:30:00	01:00:00	04:30:00	7	M	2M	Open	Yes	HW	2		X		Younger of 2	YES
18	18A	04/10/2012	19:30:00	23:30:00	04:00:00	6	F	3M	Closed	No	HW	2	Kiddie	X		Oldest of 2	NO
	18B	05/10/2012	19:30:00	23:30:00	04:00:00	6	F	3M	Closed	No	HW	2	Kiddie	X		Oldest of 2	NO
	18C	10/10/2012	19:30:00	23:30:00	04:00:00	6	F	3M	Closed	No	HW	2	Kiddie	X		Oldest of 2	NO
	18D	12/10/2012	19:30:00	23:30:00	04:00:00	6	F	3M	Open	No	HW	2	Kiddie	X		Oldest of 2	NO
	18E	13/10/2012	19:30:00	23:30:00	04:00:00	6	F	3M	Open	No	HW	2	Kiddie	X		Oldest of 2	NO
	18F	20/10/2012	19:30:00	23:30:00	04:00:00	6	F	3M	Closed	No	HW	2	Kiddie	X		Oldest of 2	NO
19	19A	04/10/2012	19:30:00	23:30:00	04:00:00	5	F	3M	Closed	No	HW	2	Kiddie	X		Younger of 2	NO
	19B	05/10/2012	19:30:00	23:30:00	04:00:00	5	F	3M	Closed	No	HW	2	Kiddie	X		Younger of 2	NO

	19C	10/10/2012	19:30:00	23:30:00	04:00:00	5	F	3M	Closed	No	HW	2	Kiddie	X		Younger of 2	NO
	19D	12/10/2012	19:30:00	23:30:00	04:00:00	5	F	3M	Open	No	HW	2	Kiddie	X		Younger of 2	NO
	19E	13/10/2012	19:30:00	23:30:00	04:00:00	5	F	3M	Open	No	HW	2	Kiddie	X		Younger of 2	NO
	19F	20/10/2012	19:30:00	23:30:00	04:00:00	5	F	3M	Closed	No	HW	2	Kiddie	X		Younger of 2	NO
20	20A	01/09/2012	21:30	23:55:00	02:25:00	12	M	4.5M	Open	No	Single	2	Kiddie	X		Oldest of 3	YES
	20B	05/09/2012	21:00	23:30:00	02:30:00	12	M	4.5M	Open	No	Single	2	Kiddie	X		Oldest of 3	YES
	20C	07/09/2012	21:45	23:45:00	02:00:00	12	M	4.5M	Open	No	Single	2	Kiddie	X		Oldest of 3	YES
	20D	09/09/2012	21:30	23:15:00	01:45:00	12	M	4.5M	Closed	No	Single	2	Kiddie	X		Oldest of 3	YES
	20E	11/09/2012	21:40	23:00:00	01:20:00	12	M	4.5M	Closed	No	Single	2	Kiddie	X		Oldest of 3	YES
	20F	14/09/2012	22:00	23:20:00	01:20:00	12	M	4.5M	Closed	No	Single	2	Kiddie	X		Oldest of 3	YES
21	21A	07/09/2012	20:00:00	00:10:00	04:10:00	5	F	5M	Open	No	Single	2	fireangel	X		Oldest of 3	YES
	21B	16/09/2012	19:30:00	22:45:00	03:15:00	5	F	5M	Closed	No	Single	2	fireangel	X		Oldest of 3	YES
	21C	24/09/2012	19:30:00	01:05:00	05:35:00	5	F	5M	Closed	No	Single	2	fireangel	Woke	56	Oldest of 3	YES
	21D	03/10/2012	19:45:00	22:30:00	02:45:00	5	F	5M	Open	No	Single	2	fireangel	Woke	32	Oldest of 3	YES
	21E	14/10/2012	19:00:00	23:45:00	04:45:00	5	F	5M	Open	No	Single	2	fireangel	Woke	49	Oldest of 3	YES
	21F	19/10/2012	21:00:00	00:20:00	03:20:00	5	F	5M	Closed	No	Single	2	fireangel	X		Oldest of 3	YES
22	22A	17/10/2012	21:30:00	22:20:00	00:50:00	11	F	5M	Open	No	Single	2		X		Oldest of 2	NO
	22B	19/10/2012	21:30:00	22:20:00	00:50:00	11	F	5M	Open	No	Single	2		X		Oldest of 2	NO
	22C	20/10/2012	22:00:00	23:00:00	01:00:00	11	F	5M	Open	No	Single	2		X		Oldest of 2	NO
	22D	24/10/2012	21:30:00	22:30:00	01:00:00	11	F	5M	Closed	No	Single	2		X		Oldest of 2	NO
	22E	27/10/2012	21:30:00	23:00:00	01:30:00	11	F	5M	Closed	No	Single	2		X		Oldest of 2	NO
	22F	30/10/2012	21:45:00	22:30:00	00:45:00	11	F	5M	Closed	No	Single	2		X		Oldest of 2	NO
23	23A	17/10/2012	21:00:00	22:20:00	01:20:00	8	F	5M	Open	No	Single	2		X		Younger of 2	NO
	23B	19/10/2012	21:00:00	22:20:00	01:20:00	8	F	5M	Open	No	Single	2		X		Younger of 2	NO
	23C	20/10/2012	22:00:00	23:00:00	01:00:00	8	F	5M	Open	No	Single	2		X		Younger of 2	NO
	23D	24/10/2012	21:00:00	22:30:00	01:30:00	8	F	5M	Closed	No	Single	2		X		Younger of 2	NO
	23E	27/10/2012	21:00:00	23:00:00	02:00:00	8	F	5M	Closed	No	Single	2		X		Younger of 2	NO
	23F	30/10/2012	21:45:00	22:30:00	00:45:00	8	F	5M	Closed	No	Single	2		X		Younger of 2	NO

24	24A	26/08/2012	20:45:00	00:30:00	03:45:00	10	F	4M	Open	No	HW	7		Woke	10	Oldest of 2	YES
	24B	07/09/2012	23:00:00	01:05:00	02:30:00	10	F	4M	Open	No	HW	7		Woke	15	Oldest of 2	YES
	24C	07/09/2012	01:10:00	01:45:00	00:35:00	10	F	4M	Closed	No	HW	7		Woke	10	Oldest of 2	YES
	24D	07/09/2012	01:50:00	02:10:00	00:20:00	10	F	4M	Closed	No	HW	7		Woke	5	Oldest of 2	YES
	24E	14/09/2012	20:30:00	23:00:00	02:30:00	10	F	4M	Open	No	HW	7		Woke	15	Oldest of 2	YES
	24F	30/10/2012	21:00:00	22:00:00	01:00:00	10	F	4M	Closed	No	HW	7		Woke	10	Oldest of 2	YES
25	25A	26/08/2012	20:45:00	00:30:00	03:45:00	7	F	2M	Open	Yes	HW	7		X		Younger of 2	YES
	25B	07/09/2012	23:00:00	01:05:00	02:30:00	7	F	2M	Open	Yes	HW	7		X		Younger of 2	YES
	25C	07/09/2012	23:00:00	01:45:00	02:45:00	7	F	2M	Closed	Yes	HW	7		X		Younger of 2	YES
	25D	07/09/2012	23:00:00	02:10:00	03:10:00	7	F	2M	Closed	Yes	HW	7		X		Younger of 2	YES
	25E	14/09/2012	20:30:00	23:00:00	02:30:00	7	F	2M	Open	Yes	HW	7		X		Younger of 2	YES
	25F	30/10/2012	21:00:00	22:00:00	01:00:00	7	F	2M	Closed	Yes	HW	7		X		Younger of 2	YES
26	26A	27/10/2012	19:30:00	23:00:00	03:30:00	10	M	8M	Open	No	HW	3		X		Oldest of 2	NO
	26B	28/10/2012	20:00:00	22:30:00	02:30:00	10	M	8M	Open	No	HW	3		X		Oldest of 2	NO
	26C	30/10/2012	20:00:00	00:00:00	04:00:00	10	M	8M	Closed	No	HW	3		X		Oldest of 2	NO
	26D	05/11/2012	20:00:00	00:30:00	04:30:00	10	M	8M	Closed	No	HW	3		X		Oldest of 2	NO
	26E	07/11/2012	20:00:00	22:30:00	02:30:00	10	M	8M	Open	No	HW	3		X		Oldest of 2	NO
	26F	08/11/2012	20:00:00	23:15:00	03:15:00	10	M	8M	Closed	No	HW	3		X		Oldest of 2	NO
27	27A	27/10/2012	19:30:00	23:00:00	03:30:00	5	F	8M	Open	Yes	HW	3		X		Younger of 2	NO
	27B	28/10/2012	20:00:00	22:30:00	02:30:00	5	F	8M	Open	Yes	HW	3		X		Younger of 2	NO
	27C	30/10/2012	20:00:00	00:00:00	04:00:00	5	F	8M	Closed	Yes	HW	3		X		Younger of 2	NO
	27D	05/11/2012	20:00:00	00:30:00	04:30:00	5	F	8M	Closed	Yes	HW	3		X		Younger of 2	NO
	27E	07/11/2012	20:00:00	22:30:00	02:30:00	5	F	8M	Open	Yes	HW	3		X		Younger of 2	NO
	27F	08/11/2012	20:00:00	23:15:00	03:15:00	5	F	8M	Closed	Yes	HW	3		X		Younger of 2	NO
28	28A	17/09/2012	20:45:00	22:00:00	01:15:00	11	F	3M	Closed	No	Single	2	Kiddie	X		only child	YES
	28B	22/09/2012	20:50:00	23:00:00	02:10:00	11	F	3M	Open	No	Single	2	Kiddie	X		only child	YES
	28C	28/09/2012	21:00:00	01:30:00	04:30:00	11	F	3M	Closed	No	Single	2	Kiddie	X		only child	YES
	28D	04/10/2012	21:00:00	00:00:00	03:00:00	11	F	3M	Open	No	Single	2	Kiddie	X		only child	YES
	28E	10/10/2012	21:00:00	02:30:00	05:30:00	11	F	3M	Closed	No	Single	2	Kiddie	X		only child	YES

	28F	14/10/2012	21:00:00	05:00:00	08:00:00	11	F	3M	Open	No	Single	2	Kiddie	X	only child	YES
29	29A	13/09/2012	19:30:00	22:45:00	03:15:00	2	M	3.5M	Open	Yes	Single	5	Kiddie	X	younger of 2	YES
	29B	15/09/2012	19:30:00	23:15:00	03:45:00	2	M	3.5M	Open	Yes	Single	5	Kiddie	X	younger of 2	YES
	29C	16/09/2012	19:30:00	22:15:00	02:45:00	2	M	3.5M	Open	Yes	Single	5	Kiddie	X	younger of 2	YES
	29D	18/09/2012	19:30:00	22:30:00	02:00:00	2	M	3.5M	Closed	Yes	Single	5	Kiddie	X	younger of 2	YES
	92E	19/09/2012	19:30:00	22:30:00	02:00:00	2	M	3.5M	Open	Yes	Single	5	Kiddie	X	younger of 2	YES
	29F	22/09/2012	19:30:00	23:00:00	03:30:00	2	M	3.5M	Closed	Yes	Single	5	Kiddie	X	younger of 2	YES
30	30A	31/08/2012	20:00	22:00:00	02:00:00	2	M	3.5m	Closed	Yes	Single	2		X		
	30B	05/09/2012	19:45	21:45:00	02:00:00	2	M	3.5m	Open	Yes	Single	2		X		
	30C	09/09/2012	19:00	22:45:00	03:45:00	2	M	3.5m	Open	Yes	Single	2		X		
	30D	11/09/2012	19:15	22:00:00	02:45:00	2	M	3.5m	Closed	Yes	Single	2		X		
	30E	13/09/2012	19:00	22:30:00	03:30:00	2	M	3.5m	Open	Yes	Single	2		X		
	30F	16/09/2012	19:00	22:15:00	03:15:00	2	M	3.5m	Closed	Yes	Single	2		X		
31	31A	01/09/2012	21:30	23:55:00	02:25:00	13	M	4.5M	Open	No	Single	2	Kiddie	X	Oldest of 3	YES
	31B	05/09/2012	21:00	23:30:00	02:30:00	13	M	4.5M	Open	No	Single	2	Kiddie	X	Oldest of 3	YES
	31C	07/09/2012	21:45	23:45:00	02:00:00	13	M	4.5M	Open	No	Single	2	Kiddie	X	Oldest of 3	YES
	31D	09/09/2012	21:30	23:15:00	01:45:00	13	M	4.5M	Closed	No	Single	2	Kiddie	X	Oldest of 3	YES
	31E	11/09/2012	21:40	23:00:00	01:20:00	13	M	4.5M	Closed	No	Single	2	Kiddie	X	Oldest of 3	YES
	31F	14/09/2012	22:00	23:20:00	01:20:00	13	M	4.5M	Closed	No	Single	2	Kiddie	X	Oldest of 3	YES
32	32A	30/06/2012	19:30:00	21.00.00	01:30:00	3	M	3M	Closed	no	HW	2		X	younger of 2	YES
	32B	02/07/2012	19:30:00	03.00.00	07:30:00	3	M	3M	Closed	no	HW	2		X	younger of 2	YES
	32C	03/07/2012	19:30:00	01.00.00	05:30:00	3	M	3M	Closed	no	HW	2		X	younger of 2	YES
	32D	05/07/2012	19:30:00	04.00.00	08:30:00	3	M	3M	Closed	no	HW	2		X	younger of 2	YES
	32E	09/07/2012	19:30:00	00:00:00	04:30:00	3	M	3M	Closed	no	HW	2		X	Younger of 2	YES
	32F	12/07/2012	19:30:00	23.30.00	04:00:00	3	M	3M	Closed	no	HW	2		X	younger of 2	YES
33	33A	31/08/2012	21:15:00	22:00:00	00:45:00	2	M	3.5m	Closed	Yes	Single	2		X	younger of 3	NO
	33B	05/09/2012	20:30:00	21:45:00	01:15:00	2	M	3.5m	Open	Yes	Single	2		X	younger of 3	NO
	33C	09/09/2012	20:15:00	22:45:00	02:30:00	2	M	3.5m	Open	Yes	Single	2		X	younger of 3	NO

	33D	11/09/2012	20:30:00	22:00:00	01:30:00	2	M	3.5m	Closed	Yes	Single	2		X	younger of 3	NO
	33E	13/09/2012	20:30:00	22:30:00	02:00:00	2	M	3.5m	Open	Yes	Single	2		X	younger of 3	NO
	33F	16/09/2012	20:30:00	22:15:00	01:45:00	2	M	3.5m	Closed	Yes	Single	2		X	younger of 3	NO
34	34A	03/02/2013	21:00:00	23:10:00	02:10:00	10	M	3.5M	Closed	No	HW	4		X	Oldest of 2	NO
	34B	10/02/2013	21:00:00	22:50:00	01:50:00	10	M	3.5M	Open	No	HW	4		X	Oldest of 2	NO
	34C	12/02/2013	20:30:00	00:05:00	03:35:00	10	M	3.5M	Closed	No	HW	4		X	Oldest of 2	NO
	34D	19/02/2013	22:00:00	00:30:00	01:30:00	10	M	3.5M	Open	No	HW	4		X	Oldest of 2	NO
	34E	22/02/2013	21:30:00	00:00:00	02:30:00	10	M	3.5M	Closed	No	HW	4		X	Oldest of 2	NO
	34F	24/02/2013	20:30:00	23:40:00	03:10:00	10	M	3.5M	Open	No	HW	4		X	Oldest of 2	NO
35	35A	03/02/2013	21:00:00	23:10:00	02:10:00	8	F	2.5M	Closed	No	HW	4		X	Younger of 2	NO
	35B	10/02/2013	21:00:00	22:50:00	01:50:00	8	F	2.5M	Open	No	HW	4		X	Younger of 2	NO
	35C	12/02/2013	20:30:00	00:05:00	03:35:00	8	F	2.5M	Closed	No	HW	4		X	Younger of 2	NO
	35D	19/02/2013	22:00:00	00:30:00	01:30:00	8	F	2.5M	Open	No	HW	4		X	Younger of 2	NO
	35E	22/02/2013	21:30:00	00:00:00	02:30:00	8	F	2.5M	Closed	No	HW	4		X	Younger of 2	NO
	35F	24/02/2013	20:30:00	23:40:00	03:10:00	8	F	2.5M	Open	No	HW	4		X	Younger of 2	NO

Data: Low Frequency Smoke Alarm test results

Candidate no.	Test No.	Date of test	Bedtime	Time of test	sleep time	age	gender	dist to detector	Door pos.	Night light	HW/ single	No. of detectors	Make/ modal	results	Time taken to wake
1	1G	12/02/2013	19:30:00	23:00:00	03:30:00	6	F	3M	Closed	No				woke	30
	1H	13/02/2013	19:30:00	00:00:00	04:30:00	6	F	3M	Open	No				woke	40
	1I	14/02/2013	19:30:00	01:30:00	06:00:00	6	F	3M	Closed	No				woke	15
	1J	15/02/2013	19:30:00	23:30:00	04:00:00	6	F	3M	Open	No				woke	30
	1K	18/02/2013	19:30:00	23:45:00	03:45:00	6	F	3M	Closed	No				woke	25
	1L	19/02/2013	19:30:00	00:10:00	04:40:00	6	F	3M	Open	No				woke	30
4	4G	11/02/2013	20:50:00	23:40:00	02:50:00	8	M	4M	Closed	No				X	
	4H	12/02/2013	20:45:00	22:30:00	01:45:00	8	M	4M	Open	No				X	
	4I	13/02/2013	20:40:00	22:15:00	01:35:00	8	M	4M	Closed	No				X	
	4J	14/02/2013	20:50:00	22:40:00	01:50:00	8	M	4M	Open	No				X	
	4K	15/02/2013	20:45:00	22:30:00	01:35:00	8	M	4M	Closed	No				X	
	4L	16/02/2013	20:30:00	23:00:00	02:30:00	8	M	4M	Open	No				X	
5	5G	11/02/2013	19:30:00	23:00:00	03:30:00	6	F	2.6M	Open	No				woke	25
	5H	12/02/2013	19:15:00	23:00:00	03:45:00	6	F	2.6m	Closed	No				woke	30
	5I	13/02/2013	19:30:00	22:30:00	03:00:00	6	F	2.6m	Open	No				woke	27
	5J	14/02/2013	19:30:00	22:45:00	03:15:00	6	F	2.6m	Closed	No				woke	32
	5K	15/02/2013	19:30:00	22:30:00	03:00:00	6	F	2.6m	Open	No				woke	30
	5L	16/02/2013	20:00:00	23:45:00	03:45:00	6	F	2.6m	Closed	No				woke	26
6	6G	11/02/2013	19:30:00	23:00:00	03:30:00	6	F	4.6m	Open	No				woke	28
	6H	12/02/2013	19:15:00	23:00:00	03:45:00	6	F	4.6m	Closed	No				woke	30
	6I	13/02/2013	19:30:00	22:30:00	03:00:00	6	F	4.6m	Open	No				woke	28
	6J	14/02/2013	19:30:00	22:45:00	03:15:00	6	F	4.6m	Closed	No				woke	32
	6K	15/02/2013	19:30:00	22:30:00	03:00:00	6	F	4.6m	Open	No				woke	25
	6L	16/02/2013	20:00:00	23:45:00	03:45:00	6	F	4.6m	Closed	No				woke	30

7	7G	04/03/2013	19:30:00	22:30:00	03:00:00	7	M	2M	OPEN	No		X	
	7H	05/03/2013	19:30:00	23:00:00	03:30:00	7	M	2M	OPEN	No		X	
	7I	07/03/2013	19:30:00	22:30:00	03:00:00	7	M	2M	OPEN	No		X	
	7J	11/03/2013	19:30:00	22:45:00	03:15:00	7	M	2M	OPEN	No		X	
	7K	12/03/2013	19:30:00	22:00:00	02:30:00	7	M	2M	OPEN	No		X	
	7L	14/03/2013	19:30:00	22:50:00	03:20:00	7	M	2M	OPEN	No		X	
8	8G	04/03/2013	19:30:00	22:30:00	03:00:00	5	F	2M	OPEN	No		woke	25
	8H	05/03/2013	19:30:00	23:00:00	03:30:00	5	F	2M	OPEN	No		woke	20
	8I	07/03/2013	19:30:00	22:30:00	03:00:00	5	F	2M	OPEN	No		woke	30
	8J	11/03/2013	19:30:00	22:45:00	03:15:00	5	F	2M	OPEN	No		woke	25
	8K	12/03/2013	19:30:00	22:00:00	02:30:00	5	F	2M	OPEN	No		woke	30
	8L	14/03/2013	19:30:00	22:50:00	03:20:00	5	F	2M	OPEN	No		woke	27
9	9G	10/02/2013	20:00:00	22:00:00	02:00:00	9	M	3M	Open	Yes		X	
	9H	11/02/2013	20:00:00	22:00:00	02:00:00	9	M	3M	Closed	Yes		X	
	9I	12/02/2013	20:00:00	22:00:00	02:00:00	9	M	3M	Open	Yes		X	
	9J	13/02/2013	20:00:00	22:00:00	02:00:00	9	M	3M	Closed	Yes		X	
	9K	14/02/2013	20:00:00	22:00:00	02:00:00	9	M	3M	Open	Yes		X	
	9L	15/02/2013	20:00:00	22:00:00	02:00:00	9	M	3M	Closed	Yes		X	
10	10G	10/02/2013	20:00:00	22:00:00	02:00:00	6	M	3M	Open	Yes		X	
	10H	11/02/2013	20:00:00	22:00:00	02:00:00	6	M	3M	Closed	Yes		X	
	10I	12/02/2013	20:00:00	22:00:00	02:00:00	6	M	3M	Open	Yes		X	
	10J	13/02/2013	20:00:00	22:00:00	02:00:00	6	M	3M	Closed	Yes		X	
	10K	14/02/2013	20:00:00	22:00:00	02:00:00	6	M	3M	Open	Yes		X	
	10L	15/02/2013	20:00:00	22:00:00	02:00:00	6	M	3M	Closed	Yes		X	
28	28G	18/02/2013	20:50:00	22:30:00	01:40:00	11	F	3M	open	no		woke	20
	28H	19/02/2013	20:45:00	23:00:00	02:15:00	11	F	3M	closed	no		woke	15

	28I	21/02/2013	21:00:00	23:30:00	02:30:00	11	F	3M	open	no		woke	23
	28J	22/02/2013	21:30:00	23:00:00	01:30:00	11	F	3M	closed	no		woke	25
	28K	25/03/2013	21:00:00	23:45:00	02:45:00	11	F	3M	open	no		woke	18
	28L	26/03/2013	21:00:00	23:30:00	02:30:00	11	F	3M	closed	no		woke	20
30	30G	10/02/2013	20:00:00	22:00:00	02:00:00	2	M	3.5m	Open	Yes		X	
	30H	11/02/2013	20:00:00	22:00:00	02:00:00	2	M	3.5m	Closed	Yes		X	
	30I	12/02/2013	20:00:00	22:00:00	02:00:00	2	M	3.5m	Open	Yes		X	
	30J	13/02/2013	20:00:00	22:00:00	02:00:00	2	M	3.5m	Closed	Yes		X	
	30K	14/02/2013	20:00:00	22:00:00	02:00:00	2	M	3.5m	Open	Yes		X	
	30L	15/02/2013	20:00:00	22:00:00	02:00:00	2	M	3.5m	Closed	Yes		X	
34	34G	04/03/2013	21:30:00	22:40:00	01:10:00	10	M	3.5m	Closed	No		X	
	34H	06/03/2013	20:30:00	00:45:00	04:15:00	10	M	3.5m	Open	No		X	
	34I	07/03/2013	21:00:00	23:20:00	04:48:00	10	M	3.5m	Closed	No		X	
	34J	08/03/2013	21:30:00	23:30:00	02:00:00	10	M	3.5m	Open	No		X	
	34K	11/03/2013	21:00:00	23:00:00	02:00:00	10	M	3.5m	Closed	No		X	
	34L	12/03/2013	21:00:00	23:30:00	03:30:00	10	M	3.5m	Open	No		X	
35	35G	04/03/2013	20:30:00	22:40:00	02:10:00	8	F	2.5m	Closed	No		Woke	25
	35H	06/03/2013	20:30:00	00:45:00	04:15:00	8	F	2.5m	Open	No		Woke	20
	35I	07/03/2013	21:00:00	23:20:00	04:48:00	8	F	2.5m	Closed	No		Woke	58
	35J	08/03/2013	21:30:00	23:30:00	02:00:00	8	F	2.5m	Open	No		Woke	30
	35K	11/03/2013	21:00:00	23:00:00	02:00:00	8	F	2.5m	Closed	No		Woke	30
	35L	12/03/2013	21:00:00	23:30:00	02:30:00	8	F	2.5m	Open	No		X	