2023 Research Report

A Study into Fire Alarm Systems with Consideration of People with Sensory Sensitivities

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Contents

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2 INTRODUCTION

The report considers four different S.E.N (Special Educational Needs) schools and in each case study compares their fire alarm system to the published FIA guidance on fire alarm design and people with Sensory Sensitivities. The aim of these case studies is to provide real life examples and demonstrate how to reduce the possibility of individuals having adverse reactions to the fire alarm, as well as considering how we can reduce the risk of fire alarms being falsely or maliciously activated.

The report will provide a brief overview of the school and its current fire alarm system.

This report will investigate four different aspects of each school's fire alarm system:

How the fire alarm is activated.

How resilient is the system from malicious and false activations.

How does the fire alarm notify people of the need to evacuate.

How does the system affect the students and what that looks like.

The report will then offer a gap analysis to identify how well the systems achieve the goals mentioned above.

This document concludes with results of the above and how the systems could be improved to meet the needs of the occupants and better comply with the guidance document.

3 TERMS AND DEFINITIONS

Terms used within this case study and their definitions:

3.1 Meltdown (Autism)

Where a person becomes completely overloaded by their current situation, causing them to temporarily lose control of their behaviour. This loss of control of their behaviour can be expressed by verbally (shouting or crying, etc.) and/or physically (kicking, biting, lashing out, etc.).

During a meltdown, the person becomes completely dysregulated and unable to make reasonable decisions. To help a person calm down quicker during a meltdown the following can help: Reducing loud sounds, reducing bright lights, providing them with a safe space. A meltdown can take significant time to conclude (in some cases 30-60 minutes). A meltdown should not be considered the same as a temper tantrum. It is not a person behaving badly or naughtily. It is a person finding it hard to appropriately regulate their emotions and/or becoming overwhelmed. Full details

3.2 Sensory Overloaded (Autism)

Sensory overload is where a person is overloaded by their senses; smell, sight, hear, touch, taste, vestibular (body movement), proprioception (body awareness) and interoception (internal body awareness). Each person has their own limit on how much they can process of each type, one person may be able to deal with smells better than another person. A person who has sensory sensitivities often has a lower threshold (1/2 or more normally) of what they can cope with compared to a person who does not have sensory sensitivities.

3.3 Meltdown (ADHD)

Where a person becomes emotionally overloaded which can cause similar action of a meltdown like Autism, but unlike Autism these are not officially linked with ADHD. These meltdowns can cause shouting, crying, kicking, and lashing out etc. Full details

3.4 Hyperactivity and Impulsive behaviour (ADHD)

Where a person with hyperactivity and impulsive ADHD might act without thinking which can mean if someone suggests something which may be prohibited the person may do it because they did not think before acting. Hyperactivity and Impulsive ADHD can cause people to have little or no sense of danger which can affect their decision making. Full details

3.5 Special Educational Needs and Disabilities (SEND)

SEND refers to people who require additional help with education, this can because of a variety of needs which require additional support, with their; behaviour or ability to socialise, reading and writing, ability to understand things, concentration levels, or physical ability. Full details

3.6 Social Communication Needs

Social communication needs refers to people who struggle to interact with other people. Some find it difficult to understand what is being said, others can find it hard to express themself, a person can struggle with both. Some may not make eye contact or gestures, struggle with their facial expression or speech patterns. Full details

3.7 Education Health & Care Plan (EHC Plan)

An education, health and care (EHC) plan is for children and young people aged up to 25 who need more support than is available through mainstream education. EHC plans identify educational, health and social needs and set out the additional support to meet those needs. Full details

3.8 Addressable Fire Alarm Systems

Addressable fire alarm systems use digital technology; computerised systems which identify each item on the fire alarm system by a number. They have the ability to control each device and perform different actions for each device. They have the ability to re-check devices and delay a specific device activation.

3.9 Conventional Fire Alarm Systems

Conventional Fire Alarm Systems are run using electronics; these systems run off resistors and low voltage electricity. The system is split into zones with a single cable run out to all the devices for that zone. When the system is activated it sends power down the alarm circuits which activates the devices on that circuit, and a LED illuminates on the panel to inform the user that a single device or multiple devices on that wire has activated. These systems are less complex than addressable and cheaper but are very limited in what they can do.

3.10 AFD (Automatic Fire Detection)

AFD are devices which automatically detect fire. The most common of the type are heat detectors, smoke detectors and multi-sensors.

3.11 Smoke Detectors

Smoke detectors are devices which detect smoke. These devices are often relatively basic, using light to detect smoke particles. When smoke enters the chamber, light particles are reduced, and the alarm activates.

3.12 Heat Detectors

Heat detectors are devices which detect heat. These devices are very basic, measuring the current temperature of the room and activating if the temperature rises suddenly (Rate of Rise), or if the temperature reaches a threshold often between 50-100 degrees.

3.13 Multi Sensors

Multi sensors are devices which contain multiple detection sensors in a single housing. The most common type of multi sensor incorporates both a heat detector and smoke detector. They often have the ability to switch between detection modes or use both modes simultaneously to help filter out false alarms.

3.14 MCP (Manual Call Points)

Manual call points are devices which people can use to activate the fire alarm system. Some devices can be key activated which prevent malicious/false activation.

3.15 MCP Covers

MCPs installed after 2017 require a cover to help reduce false alarms. These covers can be located on the MCPs or screwed directly into the wall. Covers located on MCPs are often flimsy and are only suitable for light foot traffic area. Covers which are directly screwed into the wall are often larger and more secure; they are better at reducing false alarms and can come with a built-in sounder which activates when the cover is lifted – this is a design deterrent to prevent people activating the call point maliciously.

3.16 Sounders

Sounders are devices which notify people in the vicinity that they need to take action. As well as an audible alarm, they can include a flashing light (VID or VAD). They are often louder compared to a sounder base and are bigger. Some sounders have output sound level variability.

3.17 Sounder Base

Sounders bases are sounder devices which allow a detector to be mounted on them. Their purpose is to notify people in the vicinity that they need to take action. As well as an audible alarm, they can include a flashing light (VID or VAD). They are often quieter than a sounder and are often smaller. Some sounders have output sound level variability.

3.18 VIDs

VIDs are a type of flashing light which provides a visual indicator to people of an alarm. The light output level is often dull and has not been tested. VIDs are often used as a secondary means of notification, in conjunction with an audible alarm.

3.19 VADs

VADs are another type of flashing light, which visually indicates an alarm to people. The output level of the light is often very bright, which can cause people with epilepsy to have a seizure. Because of this, VADs have a minimum height at which they must be mounted to reduce the risk of a person with epilepsy from having seizure. VADs have been tested for a certain room size to ensure anyone located within the furthest part of the room can see the light. These are often used as a primary means of notification and can replace the use of sounders. They can flash between 30-120 flashes a minute; they act very much like a strobe light.

3.20 ARC (Alarm Receiving Centre)

An ARC or Alarm Receiving Centre is a centre which receives an alarm signal and contacts the fire brigade. Depending on the set up they may communicate to the site manger there is an alarm before calling the fire bridge; they may also be able to alert the site manager there is a fault.

3.21 Audibility

The sound level at which people will hear the alarm, often measured in decibels (dB)A.

3.22 Variation

A variation is a deviation from the British Standard in terms of the installation. These are permissible where it is unreasonable to follow the requirements and where a suitable alternative can be identified instead. Variations are documented on the commissioning certificate and need to be signed off by relevant people.

3.23 Zone Plan

A floor plan of the building, showing the division of the building into fire alarm detection zones.

3.24 Alarm Verification

When the fire panel re-checks a device after a certain amount of time to see if it is still activated. These verifications may or may not be displayed on the fire panel.

4 CASE STUDIES

The case studies looked into four S.E.N schools across the south of England:

1. Austen Academy a newly constructed special school specifically designed solely for students with autism, it partly opened in Spring 2021 to a small cohort of students and is likely to be fully operational in 2024-2025. Located in Basingstoke, with a capacity of just under 130 students, it will cater for Year 1 (age 4) to year 11 (age 16). We visited Austen Academy in late August of 2022.
2. Henry Tyndale School - a SEN school catering for students with a wide variety of disabilities including those in wheelchairs and non-verbal students. It opened around 1990 with an extension added around 2010 to allow the school to have a post-16 unit. The school caters for nursey (age 2) to sixth form (age 19). The school has just over 140 pupils and is located in Farnborough.
3. Limpsfield Grange is a SEN school in Surrey; it is the only school in the UK solely for girls who have autism. It is in an old Victorian building which has had extensions and upgrades over the years. It is the only school which we visited which had a boarding provision. It caters for around 90 girls in a green and leafy area of Limpsfield.
4. Baycroft School is a secondary school (Years 7 (age 11) to year 11 (age 16)) for children with learning difficulties, autism, sensory and language challenges. It has around 185 students. Located in Fareham, it was the largest school studied.

4.1 AUSTEN ACADEMY

Austen Academy is a newly-built SEN (Special Education Needs) school in Basingstoke, Hampshire. It has

capacity for 128 full time pupils ranging from Year 1 (age 4) to Year 11 (age 16). It is the first purpose-built school in Hampshire for pupils with Social Communication Needs (SCN) associated with Autism. As such only pupils with an EHCP relating to SCN associated with Autism attend the school. Students attending Austen Academy are unlikely to have challenging behaviour nor will they likely have intensive therapeutic support. At the time of writing, the school is currently oversubscribed in all class groups.

4.1.1 Building Overview

Austen Academy is a newly built school, opened in April 2021 at a cost of £10.1 million. The building is two-storey with the Primary (Year 1 to 6) and Secondary (Year 7 to 11) classes separated. Secondary occupies the whole first floor and two classrooms on the ground floor, with the Primary classes occupying the rest of the ground floor. Each class accommodates approximates seven students.

The building has a main corridor running through the middle of the building on both first and ground floor. There are stairs located at each end of the corridor. The building has a platform lift located at one end of the building. On the ground floor there is also a corridor running the length of the building from the front entrance to the rear exit onto the field.

The school has a sports hall which is used by all age groups of students. The double-height sports hall runs the length of the school. It is split with a partitioning wall with one third having the ability to be turned in a dinner hall and the two thirds still in use as a sports hall. The building also has a range of specialist rooms, which include a design technology room, science lab, sensory room, soft playroom, art room, food tec room and life skills room with kitchenette. Many of the standard classrooms (both primary and secondary) have smaller break-out rooms where students can work individually or in small groups of two to four. These break-out rooms are accessed either via the central corridor or from the classroom, with an internal window either into the corridor or classroom.

The building has no communal toilets; instead, there are individual toilets for students to use, located off the main corridor and one found within each changing room. Changing rooms for PE are located off the main corridor, with separate male and female changing rooms, as well as an accessible changing room.

All primary classrooms and both sides of the sports hall have final exits to outside. The corridor has multiple bi-secting doors breaking the corridor into smaller sections, on both floors. All doors into the building except the primary classrooms have access control on, as well corridor doors have access control. The access control system at the school does not use push to exit buttons, instead swipe cards (which all staff have) must be presented on either side of the door for it to release. This is to prevent students from wandering the corridor without a member of staff. All emergency break glasses for the doors are key operated.

The site is secure – the front entrance door requires authorisation from reception to enable entry. The front of the site has shared access with a nursery. All final exits from the building other than the front entrance lead to the school field at the rear of the site, with fencing and/or gates preventing people from accessing the front of the site.

The evacuation strategy within the building is an immediate evacuation upon any alarm activation. The system appears to have L1 detection level. It is run by a single panel located in the reception which is at the front of the building. The system notifies people via both audible sounders and visually via VADs. The fire assembly point is located at the rear of the building on the field. There is a disabled refuge system, with refuges located in either stairwell.

- Opened in April 2021.
- 128 Student with an EHCP relating Social Communication Needs (SCN) associated with Autism.
- 2-storey building with a main corridor running the width of the building of both floors and a corridor along the length of the building.
- Heavily access controlled, with RFID cards needed to pass through either side.
- Fire alarm has an L1 level of detection.
- Immediate evacuation upon an alarm activation.
- Sounders and visual alarm devices used.
- Disabled refuges located within the stairwells.
- Individual toilets.
- Multiple rooms which could generate smoke and/or steam from experiments or cooking.
- Multiple small and sensory rooms which would be very quiet.
- DT room with noise-generating equipment and machinery.

4.1.2 Existing system design

The current fire alarm panel within the building is an Advanced MxPro 5, 4 loop panel. It is running Apollo XP95/Discovery Protocol. The devices on the system are Intelligent; Manual Call Point Input/Output Modules, XP95; Smoke, Heat, Multi, VAD Base Cat O, Sounder VAD Base Cat O, DIN-Rail Mini Switch Monitor Module, KAC Keyswitch Devices.

Notes: There may be other devices within the building - this survey was only conduced within student areas.

The current system is not used for lockdown or class change; it is only used to denote activation of the fire alarm. The school conducts termly fire drills during school hours, as well as a weekly test outside of school hours.

AFD is used throughout the building meaning the system appears to be L1. The predominant device being used within the building is the XP95 Optical smoke detector. These are used within all standard classrooms as well as within some specialist rooms, the sports hall and in each individual toilet. XP95 multi sensors are located within the DT room, Science Lab, and Food Tec Room. XP95 Heat detectors were found located within the school's commercial catering kitchen.

MCPs are located at every final exit, at each stairwell entrance and in the middle of the corridor on each floor. Primary school classrooms have a final exit which has a call point associated with it. The current call points used are Intelligent Manual Call Points within staff areas. KAC keyswitch devices are located within student areas with these being connected to a DIN-Rail Mini Switch Monitor. Keyswitch call points were not originally fitted within student areas but, after a false activation by a student within the first few months of the new school opening, it was decided to replace all call points with Keyswitch call points.

VADs are used throughout the building, with nearly every AFD device being mounted on one of the two VAD bases used withing the building. The whole building uses white flashing VADs. The non-sounder version, XP95 VAD Base, are used within every individual toilet. During the site visit no VAD was found to display a sign informing of what the flash means. Base VADs were also located within the double height sports hall and the double height entranceway.

Sounders used within the student areas of the building consist solely of Apollo XP95 Sounder VAD Base. These devices have a maximum output of 95 dB with a variability of 40dB by the use of a dip switch (20dB change for high and low) and a dial to lower the volume further. Sounder VAD Bases were used within the sports hall. Some small rooms did not have Sounder VAD Bases, only a VAD Base. dB levels were recorded throughout the building (documented below).

Other Devices used on the system are interfaces which disengage all access control doors within the building, which otherwise would delay or even inhibit evacuation.

No	Title	Info
1	Panel	Advanced MxPro 5 (Model 5400)
2	Notification Devices	Apollo XP95 Sounder VAD Base CAT.O (White Flash) – Isolating 45681-705APO, Apollo XP95 VAD Base CAT.O (White Flash) – Isolating 45681-709APO
3	Average sound audibility level in standard classroom	The average decibel in a standard classroom was 76 dB A, with all classrooms having VAD.
4	Average sound audibility level in corridor	The average decibel level in the corridor was 71 dB A with all devices having VADs as well.
5	Average sound audibility level in stairwell	The average decibel level in the stairwells was 82 dB A with all devices having VADs as well. These areas are also disabled refuges with emergency communication systems.
6	Highest sound audibility level in building	The highest sounder audibility level was recorded in the changing rooms - these rooms have hard surfaces which bounce the sound. The recorded level was around 96 dB A.
7	Lowest sound audibility level in building	The lowest sounder level recorded was in a sensory room at 46 dB A - this area contained a base VAD but no sounder base.
8	Average sound audibility level in hall	The average sound level within the hall was 72 dB A. Rooms off the hall (including a large cupboard) had much higher levels at around 87 dB A.
9	Average sound audibility level in toilets	80 dB A - the toilets also had VADs located within them.
10	False alarm reduction measures	False alarm reduction measures with the building consist of key-operated call points to prevent students from falsely activating them and heat detectors in the main kitchen. However, there is an XP95 multi Sensor in the food tec room & another in the science lab which could potentially cause false alarms as these devices are not able to differentiate between heat and smoke and therefore could activate on smoke or steam from cooking or experiments. There is also a smoke detector within the life skills room which has cooking equipment and therefore could potentially cause false alarms because of smoke or steam from an oven or kettle.

(Standard classroom is a room which does not have equipment which would generate any substantial noise, heat, or steam from intended activities)

The building layout plan with recorded decibel levels is shown below:

A red number shows: Significantly louder than necessary.
An amber number shows: Lounder than necessary.
A Green number shows: Appropriate for the location within the building.
A black number shows: No sounder within the room (Austen academy only)
Notes: This is specific to each room depending on and DB levels can be okay in one room and not in another, this can be because of the objects within the room (soft furnishing absorbing sound) or the location/number of sounders.

4.1.3 Gap Analysis

The existing system could be improved in line with the guidance document – fire alarm design for people with sensory sensitivities. The existing system could also be improved to help prevent false alarms from occurring. This would ensure that students are subjected to less impromptu activations and have less negative reactions, thereby reducing time they are unable to undertake learning.

One of the things which could be undertaken is the reduction in sound level from the existing sounders in all the classrooms, corridors and break out spaces which currently are set to high. This can be done by turning the dip switch in each base to the lower setting. This would reduce the dB A output of the device by about 20 dB A, which could still achieve the required 65 dB A in nearly all the rooms as the sounders appear to be no more than five metres away from the corners of each room (a reduction of 2 dB A per metre is common within most rooms). In addition, a reduction in stairwell sounders and rooms no more than 60 m^2 (break out spaces) would be permissible under BS 5839-1 to drop to 60 dB A as these are less likely to have a high background noise level for a constant period of time.

False alarm reduction can be achieved by removing the XP95 Multi sensor and replacing them with either a single heat detector or a Discovery multi sensor. A heat detector may take longer to responded to a fire and therefore consideration could be given to installing a Discovery multi sensor. These can detect whether smoke or heat has activated the alarm, because of its ability to identify both smoke and heat. The system can then be programmed to only respond (for example) to heat activations Monday to Friday 9am-3pm and respond to either heat or smoke activation the rest of the time. This can help prevent false alarms and reduce the longer activation time of a heat detector. The same can be said for the life skills room, removing the XP95 smoke and replacing it with either a heat detector or Discovery multi sensor and implementing the above programme.

No	Title	Info
1	Panel	The panel appears to operate okay. The loop current is significantly high because of the number of VADs. Unable to know the complete capacity because of the device type.
2	Devices	Remove current XP95 Multi Sensor and replace with Discovery Multi Sensor. Program it on day/night mode to help prevent false alarms.
3	Average sound audibility level in classroom	Sound levels are 15dB A higher than necessary. Many of the classrooms have been put on the high dip switch meaning they output a minimum of 75dB A and likely to be 90dB A. Classrooms would only need 70dB A to alert people. Reduce sound levels through adjusting the dip switch and dial.
4	Average sound audibility level in corridor	Sound levels are 10dB A higher than necessary. The corridor sound levels could be reduced. However, because of the way the sounders are positioned it would be challenging to achieve the minimum 60dB A throughout. Since people within the corridor are unlikely to be stationary, this could be an agreed deviation, or devices could be reduced to allow for the minimum 60dB A throughout.
5	Average sound audibility level in stairwell	Sound levels are 20dB A higher than necessary because of the sounder bases. These could be reduced to a suitable level to allow for 60dB A or removed and have only VADs within the stairwells to enable communication at the disabled refuges.
6	Highest sound audibility level in building	The highest sound level in the building was in the changing areas, with a reading of 96dB A. This was because of the hard surfaces which means sound is less likely to be absorbed within the room. The sound level within the room should be reduced to around 60dB A - this would be sufficient for the small size of the room. Additionally, students are changing so are less likely to evacuate promptly. Being in this room for an extended time with a loud noise could cause individuals to have a meltdown.
7	Lowest sound audibility level in building	The lowest reading was recorded within a sensory room because there was no sounder. There is a VAD to alert occupants of an evacuation. Alternatively, occupants would hear the noise from a sounder in the corridor.
8	Average sound audibility level in hall	A reading of 70 dB A was recorded in the sports hall. This is a good sound level as it is a large open space; the noise would be sufficient to alert people in the event of an activation when the hall is in use but is not loud enough that it could cause distress to a significant number of students.
9	Average sound audibility level in toilets	The sound level within the toilets is over 20dB A higher than it should need to be in order to comply with BS 5839-1. These areas also contain a VAD which would be sufficient to alert people within the toilet of an evacuation therefore removing the need for sounders. The VADs do not have labelling to indicate that they are to indicate activation of the fire alarm. VADs can be overstimulating to some people therefore consideration should be taken between the risk of a hard of hearing person remaining within the area for an extended amount of time and a person who could become overloaded because of the VAD and excessive sound levels. Reducing the sound levels in the toilets and removing the VADs would be an appropriate recommendation given the special needs of the students relate to autism rather than to hearing loss.
10	Potential false alarm reduction measures	Replace the XP95 multi sensors in the food tec and science rooms with Discovery multi sensors on day night mode (with

		the smoke aspect disabled during the day) or replace with heat detection. Removal of the smoke detector within the life skills room since this has equipment which could generate smoke from cooking. Potentially replace with either a Discovery multi sensors as above or with heat detection. To reduce the risk of false alarms even further, consideration could be given to removing the smoke detection in toilets. Vaping is becoming a significant problem across schools, both mainstream and many SEN schools. This could lead to false alarms from activation of smoke detectors within the toilet areas. The Standard notes that toilets are deemed to have little to no associated fire risk.

4.1.4 Conclusion

Of the 4 buildings assessed, this new building is significantly better than some of the other buildings in these case studies.

Overall, the biggest issue is that the Austen Academy building has a large amount of devices which could be suitable for people with sensory sensitivities but are not set to a sound level setting which would be best suited to people with sensory sensitivities.

The following measures could be taken to improve the fire alarm provision for occupants:

- Adjustment of sound level settings in all detectors throughout the building to achieve 65 dB A and no more. Changing rooms and toilets to be set at 60 dB A.
- Removal of sounder VAD bases within stairwells or replacement with VAD-only bases
- Adjustment of sounder VAD bases throughout the building to a lower volume setting via the dip switches and dial
- Replacement of XP95 multi sensors with either Discovery multi sensors on day night mode (with the smoke element off during the day) or with a heat detector.
- Removal of smoke detectors and sounder VAD bases from the toilets. Risk assess in relation to students with hearing loss and (if appropriate) install VAD only bases.

4.2 HENRY TYNDALE SCHOOL

Henry Tyndale school is a SEN school located in Farnborough, Hampshire. The main school was constructed around 1998 and caters for approximately 140 students, supported by 100 members of staff. Students age from early years (nursery) to post 16 (College). The school has two separate sites and the early years site did not form part of this case study. On the school site, the main building caters for year R to Year 11 and the other building caters for post 16 (College). Both of these buildings were assessed as part of this case study.

4.2.1 Building Description

- The buildings were built in the late 1990s.
- School has around 140 pupils, all of whom have varying SEN needs, both visible and invisible. Disabilities range from students with physical disabilities using wheelchairs to students with social communication needs.
- Both buildings are ground floor only, with a central corridor running through the length.
- Access control is installed on most doors entering the buildings and the corridors. These require swipe cards to exit and enter through the doors. (Key-operated call points isolate access control magnets but it is unknown if keys for the system are kept available).
- The school has a therapy swimming pool with adjacent changing rooms.
- Hoist equipment was located within classrooms, swimming pool and disabled toilet to cater for students with very limited mobility.
- The fire alarm has at least an L4 level of detection, with detection located in the means of escape and most rooms off but not all. (The local County Council's own standard is L2/P2)
- Sounders were found to be the only means of fire alarm notification.
- Both buildings on site run from a single fire alarm panel with a loop base repeater within the post 16 building.
- The evacuation strategy for both buildings is immediate simultaneous evacuation on any activation. There is no investigation period.

4.2.2 Existing fire alarm system design

The current system is a Gent Vigilon system, 3 loop with integrated sounders and detectors on the loop. The loop also has sounders, MCPs and relay models. Loops 1 and 2 appear to mainly support system 34000 devices with a replacement Squad device located on loop 1. Loop 3 is connected to the main building which consists of S3 sounders, system 34000 devices and a loop-based repeater panel. The entrance door to the main building is on a swing free device. However, due to the nature of the devices, we were unable to identify what kind of detections are found within the rooms. During the audible test we were able to identity detectors which contained working sounders by process of elimination. The system is intended to be connected to an ARC to satisfy the P2 requirement. However, at the time of survey it had been disconnected. On speaking to members of staff, they reported that during fire drills and false alarms the Fire Service has never turned up nor do they put the system on test. This suggests that the fire alarm system is not connected to an ARC. The main notification devices within the buildings are sounders and integrated detector sounders. These are located throughout the building, but sounders are mainly located in corridors and classrooms. Most of the devices on the system have now become obsolete and are no longer available. This means that upgrades have to take place whenever an item becomes faulty – this is costly.

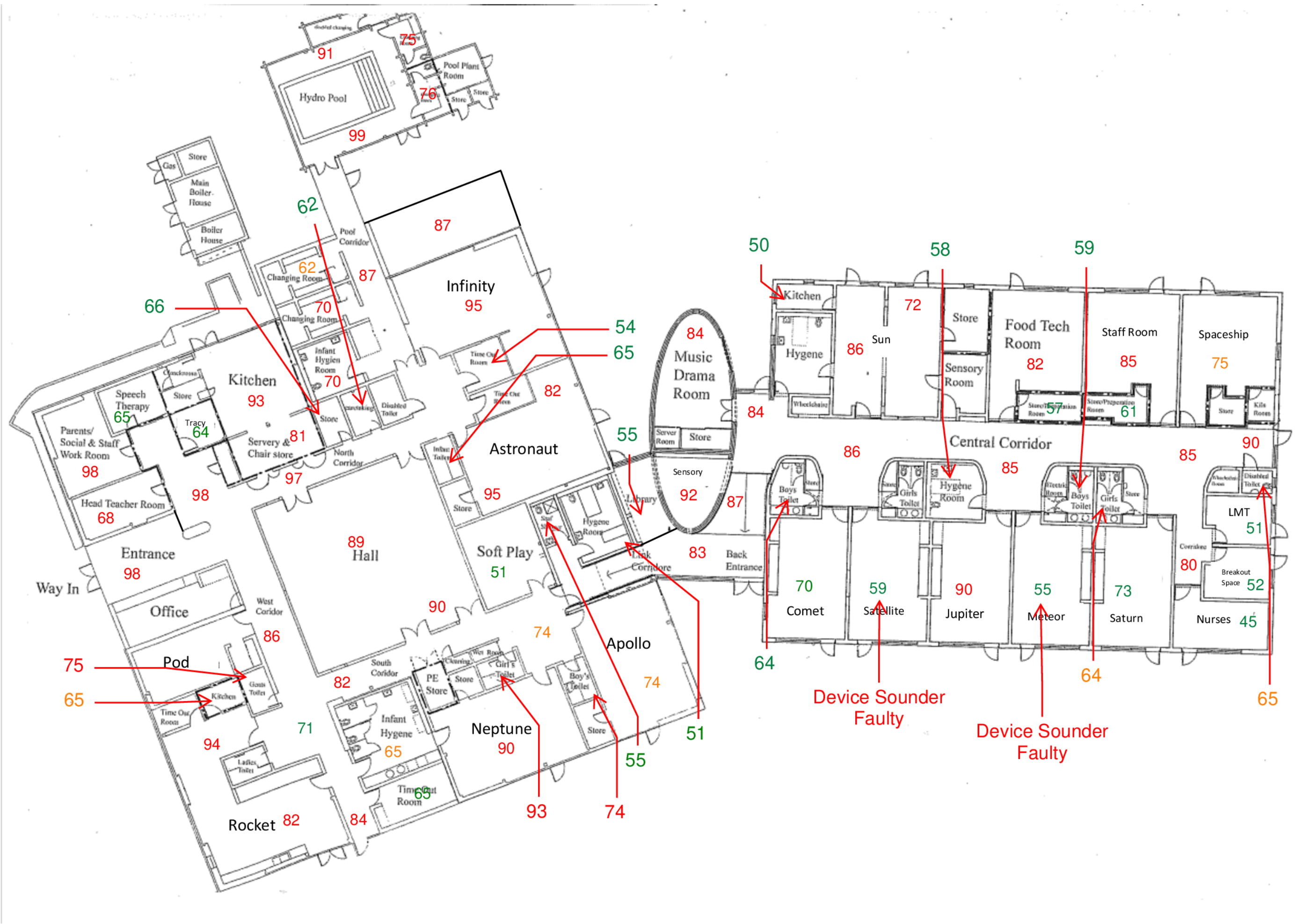
During the site visit we were able to speak to members of staff and ask what impact the fire alarm has on students, as well as how frequently the fire alarm gets activated and how they find navigating the fire alarm panel. The system gets activated infrequently for false alarms for various causes. Some of the causes are students activating call points. We were also informed of another incident where a student was having a meltdown and removed the radiator from the wall, causing steam from the radiator to activate the smoke detector. Members of staff reported that students tend to be unable to learn for the remainder of the day once the fire alarm has sounded. It was also reported that students find the fire alarm sounder tone to be fast and can struggle to process the sound easily. Staff confirmed that there can be a drop in behaviour of students because of the disruption caused by fire alarm activations. Members of staff who investigate the alarm activation reported they struggle to understand the fire panel and find the sounder tone and level of noise a lot to process when trying to understand where the alarm has activated. During the site visit we saw how complicated the system is to operate - there are no zone LEDs, and all devices are just numbered and must be located on an orange sheet of paper which is located within the fire panel. This sheet is not in numerical order and it is hard to understand with locations not being in a logical order. While walking around site, we found devices held on the wall by duct tape. This appears to be because students have grabbed hold of the device (during a meltdown) and pull the screws/fixings out of the wall. (The sound levels recorded within these areas could be associated with the devices not working correctly).

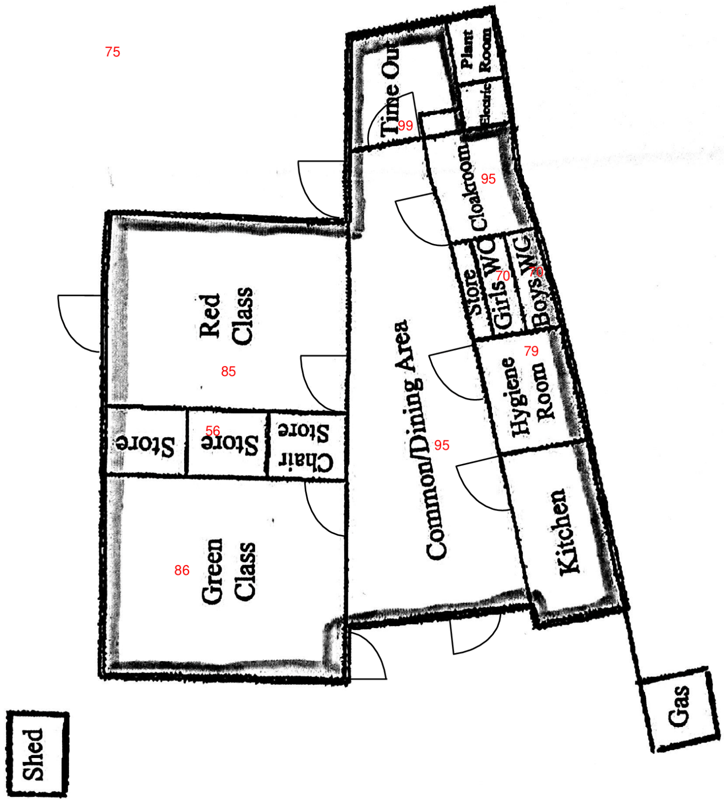
Number		
1	Fire alarm Panel	Gent Vigilon 3 loop with printer.
2	Notification Devices	Systems 34000 (Mixture of horns style and integrated detector sounders (in main building) and S3 sounders (Post 16).
3	Average sound audibility level in classroom	The average sound level recorded was 80dB. Many rooms had open area sounders installed, which are inappropriate for indoor rooms. Sound levels of 80 dB is 15dB above what is recommended within BS 5839-1.
4	Average sound audibility level in corridor	The average sound level recorded was 86dB. Many corridors had sounders that should only be used for large open areas. Sound levels of 86 dB are more than 21dB over what is recommended in BS 5839-1. In one corridor, there were multiple sounders which were not syncing meaning at some points there were two or three different tones playing at a single time. This is likely to exacerbate students' adverse reactions.
5	Average sound audibility level in other areas students use.	The average sound level recorded was 71dB. However, many rooms did not have sounders within them. Where rooms had sounders installed, sound levels were around 15-20dB higher than the average.
6	Highest sound audibility level in building	99dB was the highest sound level recorded. It was recorded twice during the survey - in the post-16 time out room and within the hydro pool area. These levels are 39dB over what is recommended within BS 5839-1.
7	Lowest sound audibility level in building	The lowest sound levels recorded within student-occupied areas of the buildings were the nurses' room, LMT and soft play. These areas did not have any sounders and were recorded at 45dB, 51dB and 51dB, respectively. These levels are below the standard but the alarm was clearly audible within all rooms.

8	Average sound audibility level in hall	90dB was the average recorded within the hall. This room contained a single sounder, located around 2m above the floor and next to an exit door. The sound level was 25 dB over what is recommended within BS 5839-1. The hall was small enough that sounder bases/sounders integrated in detectors would have been sufficient for the room and not create excessive decibels.
9	Average sound audibility level in toilets	68dB was the average sound recorded within the toilets. All toilets apart from in the post-16 centre did not have sounders within them (Sounders within the toilets were not working at time of site visit, although no fault reported). Many toilets did, however, have sounders located outside or on the escape route from the toilets. These were generally outputting around 90+dB, which is 25dB more than recommended within BS 5839-1.
10	False alarm reduction measures	Because of the limited information we could gain from detectors, we were unable to comment on false alarms based on detection type. There were found to be little to no false alarm reduction measures within the building, apart from a few call points found to have wooden boxes installed. The boxes allow them to be accessible from the front but are unable to be tested unless the wood is removed. This can help prevent things such as balls falsely activating the call point.

The building plan with recorded decibel levels:

A red number shows: Significantly louder than necessary.
An amber number shows: Louder than necessary.
A Green number shows: Appropriate for the location within the building.
Notes: dB level are specific to each room; levels can be affected by the objects within the room (soft furnishing absorbing sound) or the location/number of sounders.
Due to the significant amount of sounders within the building the DB level does not always represent the sound level accurately, the sound level reading could be significantly lower than the standards require but sound to the human ear as if it was within the standards, as it is clearly audible.





Top image, main building

Bottom image, sixth form building.

4.2.3 Gap Analysis

The current fire alarm system is old and would require a large amount of work to bring it up to current Standards, both for fire alarm and in line with the fire alarm design guidance for people with sensory sensitivities. The system has parts which are discontinued and there is limited information publicly available about the devices and panel. The software for the system is restricted to companies which are specifiers. Therefore, potential upgrade recommendations for the current system are limited. The County Council owns the building and it is understood that there are plans to replace the fire alarm system with an open protocol panel when it reaches end of life. Therefore, improving the existing system may not be beneficial and it may be more appropriate to consider full system replacement.

The current system does not have sufficient measures to reduce false alarms. In any replacement system, key-operated call points would be recommended throughout the building. The removal of all sounders that are not detector base would also be recommended, as well a reduction in output sound levels to the minimum of the British Standard (65/60 dB A). Design based on lower sounder output levels would prevent a single point with a higher decibel reading, instead having multiple points with lower decibels. This would potentially reduce adverse reactions amongst students. The tone would be unable to be changed with the existing panel, based on the current settings. An alternative would be to replace all sounders with either conventional sounders or a new addressable system. The latter would be better value for money given that the system is nearing end of life.

The current post-16 facility has an external sounder located near the fire assembly point. This significantly increases the time students are exposed to the alarm. No distinguishable need for this sounder could be identified. Its removal would reduce the time students were affected by the sound of the fire alarm, and potentially reduce adverse reactions.

It should be noted that decibel readings do not always represent whether or not a sound is able to be sufficiently heard within a room. During the site visit, we noted many sounders which were not outputting any, very little or only intermittently outputting sound. However, the fire alarm sound was still very audible because of the large amount of sounders throughout the buildings.

Number		
1	Panel	The complexity which staff report in using the panel is concerning. This could delay their response to an actual alarm activation, but could be rectified by correctly naming all devices on the panel, adding zone indicators and zone chart, or even redoing the device location sheet into numerical order. In addition, more training would be recommended for staff.
2	Notification Devices	Multiple notification devices were failing to sound correctly. These should be replaced to achieve compliance.
3	Average sound audibility level in classroom	Sounders should be reduced to output around 70dB maximum. Open area sounders should be removed from classrooms and replaced with sounder bases/integrated sounder detectors to allow more even dispersal of sound.
4	Average sound audibility level in corridor	Sounders should be reduced to provide sound levels of 65dB maximum in corridors. Open area sounders should be removed from corridors and replaced with sounders bases/integrated sounder detectors to allow more even dispersal of sound. Sounders should be spaced further apart to allow better syncing of sounders.

5	Average sound audibility level in other areas students use.	The average audibility level in other areas varied massively, ranging from around 50 dB to almost 100dB. The system should aim to have a dB level of 65dB within the room with no sounders designed for open areas, with sounder bases only outputting 75, 70 dB, at middle and near exits, respectively.
6	Highest sound audibility level in building	The areas which contain the highest sound levels are areas where students could potentially already be distressed or take extended time to evacuate. Sound levels within these areas should be reduced to minimum requirements for small rooms - 60dB (or even lower if allowed by deviation). Beacons/VIDs rather than sounders should be considered for the pool area.
7	Lowest sound audibility level in building	The lowest sound levels were in areas where students may be having a meltdown or be unwell. Sound levels in these areas should remain low, but are below standard level and therefore would require deviation.
8	Average sound audibility level in hall	Sounders should be reduced to output around 75dB maximum in the hall. Removal of open area sounders from the hall and replacement with sounder bases/integrated sounder detectors would allow more even dispersal of sound.
9	Average sound audibility level in toilets	The average audibility within the toilets was 68db. This covers washrooms and changing rooms, where people will need assistance to go to the toilet and areas where they will be getting change respectively. These areas should have low sound levels as people within these areas are not able to evacuate immediately and will most likely become anxious because of this. Sounders outside these rooms should be removed or reduced and sounders within bathroom and should be replaced with beacons/VIDs in a visible location (Wall mounted) with a sign saying fire alarm.
10	False alarm reduction measures	The site does not appear to have any false alarm reduction measures. There have been previous false alarms. Currently, the site is not connected to an ARC. Due to the impact of the fire alarm on students, a delay or verification of detection activation could be added to the system to reduce false alarms. Key-operated call points could also be considered to prevent malicious activation. (This has already been implemented for the emergency egress button on the access control doors to prevent students from activating them).

4.2.4 Conclusion

This building has a fire alarm system which is ageing, is becoming costly to support and is no longer up to modern Standards. The system's design does not appear to have taken occupants' needs into account nor would the system be able to if updated without significant spend for customisation of device tone. As such, the main recommendation would be to replace existing devices with devices which are equally or better at removing false alarms, as well as installing key-operated call points to replace MCPs. Additionally, sounder bases used throughout should have their sound levels adjusted according to the room type and occupants' needs within that room - the devices should output 550hz for 0.5 sec followed by 825hz for 0.5 sec and repeated. Consideration should be given to implementing a delay or automatic panel verification of detectors to reduce false alarms further. Overall, the system should be considered in the very near future for replacement and any future design should carefully consider the needs of the occupants.

4.3 LIMPSFIELD GRANGE SCHOOL

Limpsfield Grange school is a SEN school located in Oxted, Surry. It is the UK's only school for autistic girls. The school building is a Victorian manor house, which has been extended in recent years. The school officially opened in the early 2000s and caters for around 90 students with boarding provision for around 15-20 students. Students age from 11 (Year 7) to 16 (Year 11). "The school leads on research nationally in the field of female autistic spectrum disorder. Leaders train other professionals. … Autistic spectrum disorder in girls present very differently to the same need in boys. Additionally, the majority of girls at Limpsfield grange experience very high levels of anxiety and poor mental and emotional health," Ofsted 2018 inspection.

4.3.1 Building Description

- Built in the Victorian era, with various extensions in the past 5-25 years.
- There are also additional, small, separate buildings: the chalet, bungalow, porta cabin and pool building. All of these are used as teaching spaces.
- School accommodates 90 students, all of whom have autism. The boarding provision has capacity for around 15-20 students.
- The Victoria building is a three-storey building, with ground floor being used for classrooms, kitchen, and dinner hall as well as reception. The first floor contains bedrooms, lounge, and kitchen/dining room for boarding, with the second floor containing a flat for the site manager. There is a corridor running through the ground floor. There are 2 internal staircases in the building, although only one of these extends to second floor level. There is also an external staircase from first floor to ground.
- All classrooms in the extension are located on the ground floor. The extension wraps around the courtyard and has a first floor, which is used for a staff room and offices. The extension part of the building is connected to the main fire alarm.
- The pool building does not have a fire alarm system and was not included within this case study.
- The chalet has its own fire alarm panel, which is connected to the main fire alarm system via input/output modules. The bungalow is connected to the main fire alarm. The portacabin has its own fire alarm, which is not linked to the main system. All of these buildings are ground floor only and have direct access to outside.
- There is access control on the building door entrances, which does not release on the fire alarm.
- The evacuation strategy for the building is immediate, simultaneous evacuation on any activation. There is no delay or investigation period.

4.3.2 Existing system design

The current system comprises of three conventional fire alarm panels, located within; main building, chalet, and porta cabin. The main building and chalet are linked together. The main system was installed in August 2007. It is a 12 Zone HAES conventional fire alarm panel. The system has repeater fire panels located on the first and second floors of the building. There are various call points, most of which do not have the covers or covers which correctly fit. The system uses Apollo series 65 detectors. The sounders used on this system are Roshni sounders and Fulleon Askari sounders; Fulleon sounders are mainly used within the bedrooms with the Roshnis being located in most classrooms and corridors. Some toilet/shower areas did not have sounders within them, and not all classrooms contained sounders within the main Victorian building. The panel can output up to four sounder circuits, with a maximum output of 2.5 amps. The chalet has a conventional panel which is a FireTec panel running Series 65 detectors. The sounders used were Cranford Controls open area sounder VTG; there was also a Cranford controls signal beacon VXB installed. The porta cabin had a Fike Twinxflex pro fire panel. This panel is not linked and has about six devices connected to it comprising of; one MCP, three ASD detectors within integrated sounders, one external Hi point sounder and one domed Flash Point.

During the site visit we were able to speak to the site manager and ask about false alarms and student reactions. False alarms are not common; the school previously had a large amount due to the age of the smoke detectors, which subsequently got replaced and false alarms were reduced. There has been only accidental activation of MCPs through bumping into them etc. There have been false alarms because of students in the bedrooms generating steam. Otherwise, the system does not get many other false alarms. The site manger did inform us that some students do not like the fire alarm and can react badly when the alarm goes off.

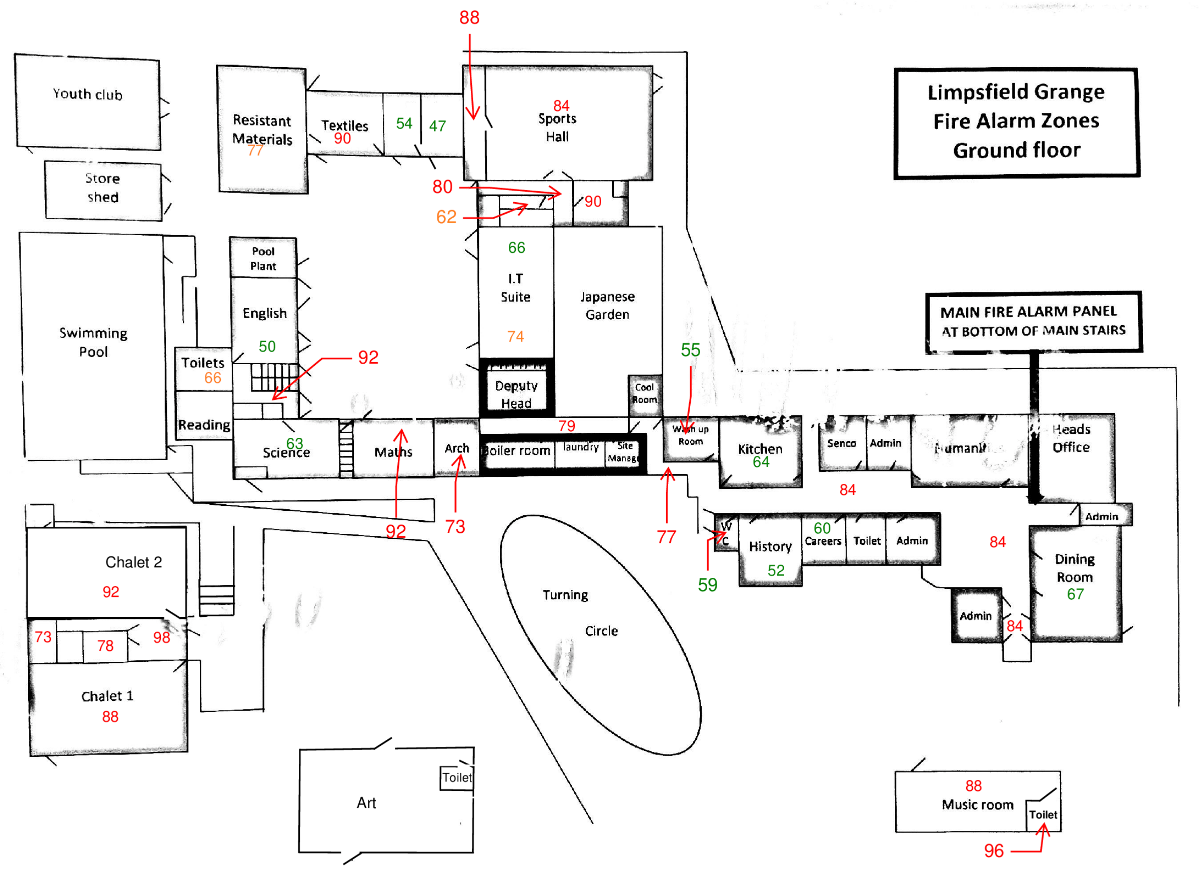
Because of the vast number of different types of devices, the sounder tones across the site vary significantly, with 5 different tones recorded during the site visit. These compose of medium sweep and continuous from the Roshni sounders, fast sweep from the Fulleon Askari sounders and Cranford Controls sounders and alternating from the Fike Sounders. During the walk around, with the alarm sounding in the main building extension first floor (not shown in floor plan), it become very clear that the sounders which were far away from the panel were struggling to activate correctly. We identified that the system was not drawing enough current from the panel, which has most likely reached it maximum capacity to be able to operate correctly. The sweep was stuttering or failing complete. Throughout the rest of the building, the sounders were outputting a lower DB reading because of the lack of current.

Number		
1	Panel	HAES conventional SURVEYOR EXCEL 12 Zone, Fike twin wire Twinflex Pro, Firetec conventional
2	Notification Devices	Roshni sounders (Medium Sweep and Continuous), Fulleon Askari and Cranford Controls VTG Sounders and VXB Beacon (Fast Sweep), Fike Hi point sounder & domed flash point & ASD detector with sounder (Alternating)
3	Average sound audibility level in standard classroom	The average sound level in a standard classroom from the fire alarm sounders is 72dB A. Some of the classrooms do not have sounders in them and use the corridor sounders for means of notification, while others have sounders located within them.
4	Average sound audibility level in corridor & stairwell	The average sound level in the corridors and stairwells from the fire alarm sounders is 84dB A. Many of the corridors had open area sounders, which were providing a means of notification within adjacent classrooms meaning higher sound levels were required.
5	Highest sound audibility level in building	The highest recorded sound level within the building was in one of the bedrooms recorded at 102 dB A. This room had a sounder located within it.
6	Lowest sound audibility level in building	The lowest recorded sound level within the building was within the history room which was 52 dB A. This room did not have a sounder located within it and the closest sounder was down the corridor. With the classroom door shut, this significantly reduced the sound level.

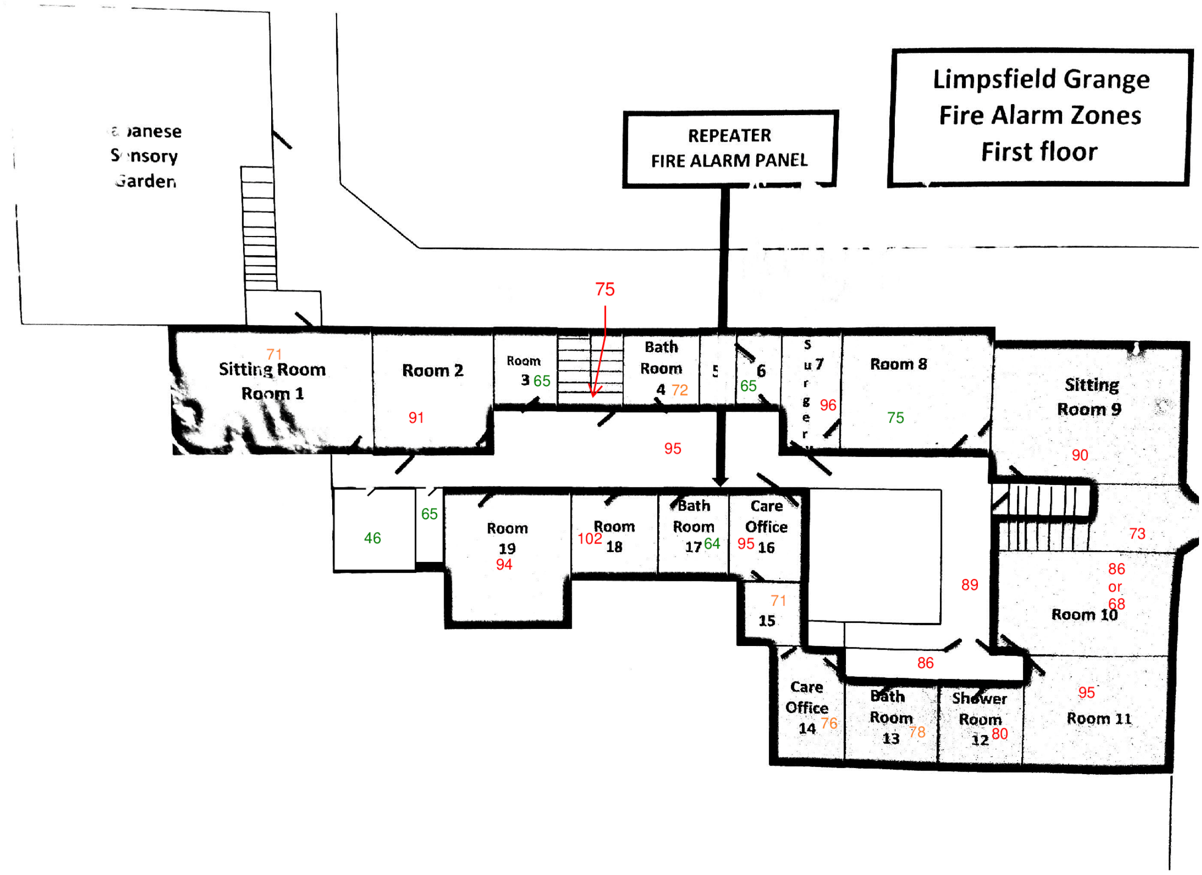
7	Average sound audibility level in hall	The sports hall was recorded at 82 dB A in the middle of the hall. This room had an open area sounder located within it.
8	Average sound audibility level in toilets & shower rooms	The average sound level recorded within the toilet and shower rooms was 73 dB A. Many of these rooms did not have sounders within them but directly outside them.
9	Average sound audibility level in bedrooms	The average sound level within the bedrooms is 84 dB A. All bedrooms had sounders located within them.
10	Average sound audibility level in other student area	The average sound level within other student areas was 73 dB A. Some of these rooms had their own sounders meaning they recorded significantly higher while others were using the corridor sounders meaning they recorded significantly lower.
11	False alarm reduction measures	There are few to no false alarm measures. This has caused the system some false alarms compared to a more modern system for that type of building. The main two false alarms reported were accidental activation of manual call points and smoke detectors activating from steam in the dorms.

The building plan with recorded decibel levels:

A red number shows: Significantly louder than necessary.
An amber number shows: Lounder than necessary.
A Green number shows: Appropriate for the location within the building.
Notes: This is specific to each room depending on and DB levels can be okay in one room and not in another, this can be because of the objects within the room (soft furnishing absorbing sound) or the location/number of sounders.
Due to the significant amount of sounders within the building the DB level does not always represent the sound level accurately, the sound level reading could be significantly lower than the standards require but sound to the human ear as if it was within the standards, as it is clearly audible.



Limpsfield Grange
Fire Alarm Zones
Ground floor
MAIN FIRE ALARM PANEL
AT BOTTOM OF MAIN STAIRS
Youth club
Store shed
Resistant Materials
77
Textiles
90
54
47
88
84
Sports Hall
80
62
90
Swimming Pool
Pool Plant
English
50
Toilets
66
Reading
92
66
I.T Suite
74
Japanese Garden
Deputy Head
55
Cool Room
Science
63
Maths
Arch
Boiler room
laundry
79
Wash up Room
Kitchen
64
Senco
Admin
Heads Office
84
92
73
77
History
52
60
Careers
Toilet
Admin
Admin
84
Dining Room
67
59
Admin
84
Chalet 2
92
73
78
98
Chalet 1
88
Turning
Circle
Art
Toilet
88
Music room
Toilet
96



Limpsfield Grange
Fire Alarm Zones
First floor
REPEATER
FIRE ALARM PANEL
75
71
Sitting Room
Room 1
Room 2
91
Room 3
65
Bath Room 4
72
5
6
65
7
96
Room 8
75
Sitting Room 9
90
95
46
65
Room 19
94
Room 18
102
Bath Room 17
64
Care Office 16
95
73
86 or 68
Room 10
89
71
15
86
Care Office 14
76
Bath Room 13
78
Shower Room 12
80
95
Room 11

4.3.3 Gap Analysis

The current fire alarm system is ageing but, for the most part, is still suitable for the building. The current fire alarm system within the main building is sufficient but the proper type of covers should be installed on the call points to prevent false alarms. The smoke detectors would be hard to replace/change without making the system addressable. As such, a more appropriate solution may be to replace the panel with a 12 zone Alarm Sense panel with smoke detectors installed with verification switched on. This would require all the zones affected to be replaced with Alarm Sense devices. The porta cabin currently has more detection and sounders than necessary. This document is not here to inform whether or not a fire detection and alarm system is needed but since the system is not linked to the main building and the current system provides no benefit to the users for safety or insurance purposes, it could be queried whether a fire alarm system is required in the porta cabin. The sounders located on site are from four different manufacturers and all could be changed to create the same tone across the whole site. The sounders all have the ability to sound as a continuous alternative or fast sweep. The guidance document recommends alternative at 1hz (500ms^{-2} a second on tone 1 and 500ms^{-2} a second on tone 2) as this is more predictable and at a slower speed, which allows people to process information. All sounders on the system have the ability to do this by changing the dip switches within each device. This would allow the building to conform to a recommendation in the current version of 5839-1 for a single tone to be used for the fire alarm system across a building. (Due to the nature of manufacturers, the hertz which the tone is played (frequency) may be different between companies but unless two devices are placed next to/near each other, people are unlikely to notice).

The current problem with the sounders not being provided with enough current is a complicated issue to resolve, perhaps requiring additional fire alarm panels and power supply. It is likely that the devices are only slightly exceeding capacity – it should be considered whether other sounder circuits have spare capacity. This would help sort the issue if it is related to the single line power supply. If the problem relates to the panel not supplying enough power to the four sounder circuits because of its 2.5 amp limit, then the issue would be more complicated to sort, and may require re-wiring of sounder circuit, with additional fire panels added.

The current sound levels within the buildings are excessively higher than what the Standard requires. In some areas, it is 500+ times louder by hearing (every 3 dB A increase sounds twice as loud to the human ear). The guidance document does not recommend that bedrooms go below the set dB A level in this case. Sounders within bedrooms should be reduced to allow them to meet 75 dB A at the furthest bed head but the current sounders provided little ability to reduce the sound only by a high and low dip switch. Sounders within the corridor of the building should be recommended to also be reduced but this would create another risk as the rooms off the corridor do not currently reach the requiring dB A reading. As such, adjustment of sound levels within the corridors would further negatively impact these rooms.

The current panel and system have extreme limitations when it comes to sounders. The panel has been overstretched beyond what is reasonably possible in relation to sounder circuits. As such, the current system is unsuitable for the site. The main recommendation would be to replace the current system with a modern fully addressable system, possibly networked across to the buildings. Addressable smoke detectors could then be located across the site, with cover-protected MCPs. Sounder bases should be installed throughout the building, instead of open area sounders. Some addressable systems give the ability to reduce the sound output by sounders during the daytime using cause and effect, this would be sensible to prevent sounders outputting more dB A than is necessary during the daytime. Many systems now also allow for verification of smoke detectors - this would be sensible to further reduced the risk of false alarm. Due to the age and ornate nature of plasterwork in the main building, running surface mounted cable may not be acceptable and using celling voids could be challenging. A wireless system could be considered but these have significant drawbacks compared to wired systems. For instance, periodic battery replacement would need to be considered in the cost. Many wireless systems do not allow for digital programming (for instance digital setting sound levels) instead they only report when in alarm or fault to save on battery power. Therefore, they require to be physically set to specific settings which reduce control of the device and ability to change dB A levels and sensing capabilities.

Number		
1	Panel	Not being able to provide sufficient current to sounders, nor had correct battery size, given the size of the system in main building. Most likely not necessary for the type of building in the porta cabin.
2	Notification Devices	The devices are mostly sounders which are designed for open areas meaning they output a very high dB and are often unable to go to lower dB levels.
3	Average sound audibility level in standard classroom	The average sound level recorded was 72 dB A which is around what could be expected inside a standard building without any considerations, but this is an average; some classrooms were much louder while others were much quieter. Working on the average, this is 10 dB over what the classroom could be without deviation. The current system installed would not be able to provide this, even with additional works. The only way of achieving a low dB within classrooms and corridors would be installation of a new system.
4	Average sound audibility level in corridor & stairwell	The average sound level recorded was 84 dB A which is almost 20 dB A over what is recommended. This can mean that when students exit their classrooms/bedrooms during an evacuation they are met with a significantly louder sound level which can be overwhelming, adding to the current anxiety, shock and change in routine. This could cause a meltdown for some students. It could be possible to reduce the sound level within stairwells but since corridor sounders are used to notify people within classrooms it could not be deemed safe to reduce the corridor sounders. As such, the recommendation would be to replace the current system with a system which has adjustable sounders within classrooms.
5	Highest sound audibility level in building	The highest sound level recorded within a room was 102 dB within a bedroom. This is significantly higher than what it could be; an output of 82 dB A would be more than sufficient to reach the required 75 dB A at bedheads. The sounder level being 20 dB A higher than needed equates to almost 128 times louder. This device should be replaced with a device which has an adjustable sound level, suitable for internal use.
6	Lowest sound audibility level in building	The lowest sound level recorded within the building was a history classroom which did not have a sounder within it and was using the sounders in the corridor to notify people within the room. The level recorded

		was 52 dB A, which is significantly lower than what is required. This can mean people get a sudden shock when they open the door to evacuate due to the increase in sound level. It should be considered whether a sounder is necessary in the history classroom, to be able to reduce the corridor sounder and create a more even sound level.
7	Average sound audibility level in hall	The average sound level within the hall was 84 dB A. This is still much louder than what is required. Consideration should be given to reducing to around 70/75dB A, which would be around 25 times quieter. This would still be sufficiently loud to notify people doing sports within the hall, without overloading occupants.
8	Average sound audibility level in toilets & shower rooms	The average sound level recorded within the toilets and shower areas was 73dB A, which is much louder than recommended. Many toilets and shower areas did not have sounders in them and instead were using the corridor sounders for notifications. However, some did have open area sounders within them, which massively increased the reading. Toilets should be considered as areas where people do not stay a long time and would not likely need notification during an alarm at a loud dB level. It should be aimed to achieve a maximum of 65 dB A since these can be confined spaces where sound can reverberate off walls. The recommendation would be to remove all sounders from toilets and install sufficiently rated IP sounders within the shower areas at a max output of 69dB A (given room sizes).
9	Average sound audibility level in bedrooms	The average sound level recorded within bedrooms was 84 dB A. All bedrooms used open area sounders which were outputting full or near full volume and were located at one end of the room (normally need the corridor exit door). It would be recommended to have sound levels reduced and sounders relocated to the centre of the room to provided more even distribution of sound. This would mean student would not have to walk past them to evacuate. The sounds should be turned down to reduce the sound output to around 80/85 dB A as this would still provide sufficient audibility level to awaken people while not being completely overloading. It should be considered for them to slowly come on/slowly increase sound output level over 3 to 5 seconds to make it less sudden. It could also be

		recommended to put in a system where the sound output is digitally set on the device and can change during different times of the day, for instance using day night mode/time clock, when the clock is on/day mode the sounder is set to achieve 60dB A in bedrooms and during night mode/clock off the sounder achieves 75 dB A, while making it fail safe so if day night mode is switched off, the sounder would output the latter louder one.
10	Average sound audibility level in other student areas	The average sound level in other student areas such as changing area or outdoor spaces was 73 dB A. Because of the vastly different types of areas, it should be considered in more detail on an individual basis but the impact on many areas is sufficiently louder than what is required. For instance, an outdoor sounder in a courtyard area which is not required for notification in compliance and may only provide class change. Therefore, it should be recommended this device be on its own system to allow it to only operate during class change.
11	False alarm reductions measures.	There are few false alarm reduction measures within the system. It would be recommended to have call point covers on all call point to prevent false activation. Similarly, smoke detectors within bedrooms would be strongly recommended to have verification (displayed/notified at panel only) to help reduce false alarms for things such as deodorant and aerosols.

4.3.4 Conclusion

The current fire alarm system is old and ageing. The panel is no longer manufactured, which has created challenges during expansion as the sounder circuits are now at their limit and no more zones are available. It is apparent that the system has been overstretched in terms of sounder circuits. It would therefore be strongly recommended for the size of site, that as part of any future refurbishment, building expansion or changes to the system that it be replaced with a fully addressable system. Both detection and notification should be addressable, with predominantly sounder bases used throughout the building.

4.4 BAYCROFT SCHOOL

Baycroft school is a SEN school located in Stubbington, Hampshire. The school was built around 1965 and caters for approximately 190 students, supported by 90 members of staff. Students age from year 7 to year 11, accommodated in two buildings and two porta cabins. The two buildings comprise an older two-storey building and the main building (which houses the majority of the school), which is two-storey with an internal staircase and an external staircase from the first floor.

4.4.1 Building Description

- The main building was constructed in the 1960s. The smaller other building is thought to be Victorian.
- The school caters for 190 students with moderate learning difficulties, autism, sensory and/or language challenges.
- There is a central main corridor running through the ground floor which splits at the end of the building into two corridors creating a T Shape, with the other end leading to the hall and reception, and a staircase which leads upstairs. It appears that the T-shaped section of the building is an extension of the original school. Upstairs has a basic open area with classrooms off, with one end leading to the stairwell and the other leading to classrooms. Off one classroom is an external stair fire escape. During the site visit, the upstairs was being refurbished and as such new fire alarm devices were being added.
- The smaller Victorian building has doors which lead directly to outside or lead to short corridors outside. It has a small first floor area, which has a single internal staircase leading to a final exit.
- The building's external doors feature access control and lead directly outside of the school fences. The rest of the site is fenced in. The over-rides for emergency exit buttons are key operated rather than break-glasses.
- The porta cabins are outside of the school's fenced area. Both have a similar layout, with 3 rooms - left, central and right. The left and right rooms are classrooms, while the central room in one cabin is toilets and the other is an additional learning room. One section of the building is set up with secure classrooms, this area has a panic alarm system which sounds a sounder in the corridor. There are closed-circuit cameras within classrooms.
- Fire exits from the porta cabins classrooms are magnetically locked. It is presumed but not confirmed that these release on the fire alarm. They have green key-operated emergency exit over-ride switches next to them.
- The assembly point for the school is the playground.
- The evacuation strategy for the building is immediate, simultaneous evacuation on any activation. There are no investigation periods or delays.
- *Note: During the site visit, significantly more people were on site than originally planned. This was due to building works being undertaken. Because of this, we were unable to sound the alarm for a significant period. This meant that only decibel readings were taken in specific area of the site which were of interest.*

4.4.2 Existing system design

The current fire alarm panel running the site is an Advanced Mx4, running 3 Apollo XP95/Discovery Loops which covers the main building, Victorian building, and both porta cabins. The devices connected to the loop consist of XP95; smoke, heat, sounder bases, open area sounders, waterproof open area sounders and VADs.

The system is currently also used for lesson bells. It would not be able to be used for a lockdown alarm because of device limitations.

AFD used throughout the buildings appeared to provide an L2 level of coverage and possibly L1. Optical detectors were predominantly used throughout the buildings, consisting of XP95 optical smoke detectors. Individual toilets which open onto corridors did not have AFD within them, communal toilets (multiple toilet and multiple sinks) did have sounder bases with smoke detection within them, consisting of optical smoke detector. *It was not noted whether the science lab or food tec lab had heat detectors installed.*

MCPs are located throughout the building, often in many classrooms since they have direct access to outside. Call points are not key operated nor are many of them dual action (covers). The fitting of covers would provide additional protection against false alarms. Emergency door release points are located alongside call points at final exits. These are magnetically locked, or access controlled via key switches. It is interesting that call points are not are not key-operated.

VADs are in all sanitary areas which have been refurbished or newly installed. Many toilet rooms have cubicles where the door/walls do not reach the celling height, leaving a 50cm gap. Because of this and loop address/power consumption limits, VADs have only been installed in the sink area. In the porta cabins VADs have been installed in central rooms, including each toilet cubical which has a door extending to the celling. No VADs have signs indicating their purpose.

Sounders used throughout the buildings are addressable XP95 sounders. These have the ability to play alternating and intermittent sounds only. Helpfully, they have a dial which can adjust the sound output. Some sounder bases and sounders were sounder/sounder base VIDs. The sounders are used for class change, which limits the ability if they need to be used as part of a lockdown system because of the ability to only play two different tones. Inside the building there are predominantly sounders bases, apart from the hall which had an open area sounder. Individual toilets which open onto corridors did not have sounders within them, whereas communal toilets (multiple toilets and multiple sinks) did have sounder bases. There is an external sounder VID directed at the playground.

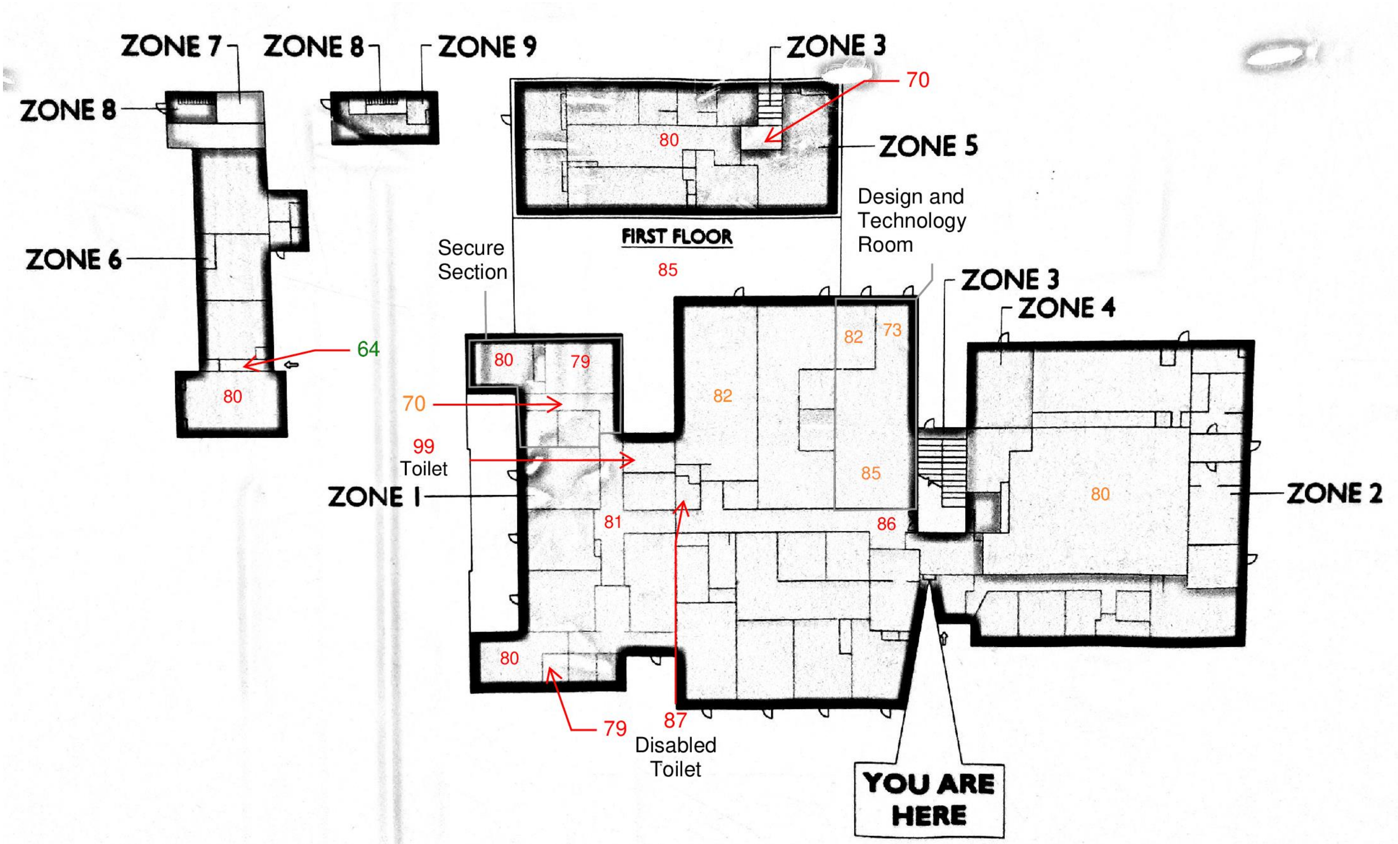
Number		
1	Fire Alarm Panel	Advanced Mx4 Running 3 Apollo XP95/Discovery loops.
2	Devices	XP95 sounder base/sounder VID base used through the majority of the site with XP95 sounder VID used in the hall and external towards the playground.
3	Average sound audibility level in classroom and stairwell	The average sound level recorded within classrooms was 80 dB A. All classrooms had sounder bases within them.
4	Average sound audibility level in corridor	The average sound level recorded within corridors and stairwells was 75 dB A. Most parts of corridors had base sounders within them, but some sections did not.
5	Average sound audibility level in other areas students use (Playground).	The average sound level recorded in other student areas was 85 dB A, recorded on the playground. This area had an external open area sounder.
6	Highest sound audibility level in building	The highest sound level recorded within the building was the communal toilet area with a reading of 97 dB A. This room had a sounder base and hard surface to walls which reverberate sound.
7	Lowest sound audibility level in building	The lowest sound level recorded within the building was the short corridor in the Victorian building, with a reading of 64 dB A. The corridor had no sounder base within it, and the doors to classrooms

		(which did have sounder bases in them) were open at the time of assessment. Sound levels would have been significantly lower in the corridor with the doors shut.
8	Average sound audibility level in hall	The average sound level within the hall was recorded at 80dB A. This room had a single open area sounder VID within it.
9	Average sound audibility level in toilets	The average sound level recorded within the toilets was 92 dB A. Toilets where readings were taken had sounder bases within them. Many of the new toilets (areas being refurbished on the first floor and the porta cabin with toilets) did not have sounder bases, only VADs.
10	False alarm reduction measures	False alarm reduction measures within the building consist mainly of covers on MCPs. However, not all MCPs had covers.

The build plan with recorded decibel levels:

A red number shows: Significantly louder than necessary.
An amber number shows: Lounder than necessary.
A Green number shows: Appropriate for the location within the building.

Notes: This is specific to each room depending on and DB levels can be okay in one room and not in another, this can be because of the objects within the room (soft furnishing absorbing sound) or the location/number of sounders.
Due to the significant amount of sounders within the building the DB level does not always represent the sound level accurately, the sound level reading could be significantly lower than the standards require but sound to the human ear as if it was within the standards, as it is clearly audible.



4.4.3 Gap Analysis

Number		
1	Panel	The panel is running a large amount of devices over a long distance, it unlikely to be able to manage many more devices on the system or have many more VADs installed.
2	Devices	Devices are mainly sounder bases and VADs located throughout the building.
3	Average sound audibility level in classroom and stairwell	The average audibility level within classrooms was 80 dB A, which is more than required. It would be recommended to be reduced within normal classrooms to 60 dB A.
4	Average sound audibility level in corridor	The average audibility level within corridors was 75 dB A, which is more than required. It would be recommended to be reduced to 60 dB A.
5	Average sound audibility level in other areas students use (Playground).	The average audibility level of the playground sounder was 85 dB A. This is an additional device but could be replaced with a VAD or beacon to indicate fire. Alternatively, if it is only needed for class change then the settings could be changed to only activate during class change.
6	Highest sound audibility level in building	The highest audibility level was recorded within the main building's ground floor toilets at 96 dB A, which is more than the needed 65 dB A. It would be recommended to be reduced or removed as there is a VAD which could be used as primary means of notification. As the room will be quiet, anyone within the room should be able to hear the alarm from the corridor, even with a reduction allowed for doors being closed. Because the room has a large amount of hard surfaces, the sound reverberates off the hard surfaces limiting its ability to be absorbed.
7	Lowest sound audibility level in building	The lowest audibility level within a corridor was 64 dB A within the Victorian building. The corridor had no sounders/sounder base within it. The corridor was short at about 3 metres and leads from outside into a classroom. It could be said that no sounder is need since there is little to no risk of people being in the corridor for an extended amount of time and not hear the alarm. The dB A level was recorded with the classroom's doors at the end of the corridor open.
8	Average sound audibility level in hall	The average audibility level within the hall was 80 dB A which is more than required and would be recommended to be reduced to output 75 dB A which should be enough to alert people even during busier and nosier times.

9	Average sound audibility level in toilets	The average audibility level within the toilets was 92 dB A which is more than required. It would be recommended to be reduced to a lower level or not at all (as mentioned above). The level is much higher than the recommendations require and therefore it should be considered for reduction because of the adverse effects on the occupant group of loud noises.
10	False alarm reduction measures	False alarm reduction measures throughout the building vary with some call points having covers while other do not, either because they have not been installed or they have fallen off. When speaking to the site manger it was noted that there are not significant false alarms. Therefore, it should be considered to help prevent accidental false alarm activation from people pushing call point by placing covers and installing heat detectors within rooms which could generate smoke if they have a smoke detector.

4.4.4 Conclusion

The building's existing fire alarm system functions, it provides the level of life safety required within the building and is not likely to be subject to malicious activation. However, the means of notification could cause unnecessary disruption to students because of the excessive sound levels. The main recommendation would therefore be to reduce the sound level across the building to as low as practical/safe to do so.

5 CONCLUSION

We assessed the fire alarm provision at four different SEN school sites in terms of suitability for occupants. Across all the sites we visited, most of the fire alarm systems were suitable and complied to modern regulations, even though some systems were aged. The systems were able to function in a suitable manner, but there was a common thread across all the sites that installers had not given adequate consideration to the occupants of the building. Overall, installers appear to have followed the Standards and taken care to reduce false alarms with newer equipment where system was replaced or changed overall. However, in all the sites we visited, sound levels were significantly higher than required in BS 5839-1 and could be reduced without the need to deviate. This is particularly significant given that exposing the students to excessively loud noise is likely to create adverse reactions.

The guidance document on fire alarm design for those with sensory sensitivities recommends the use of voice sounders/PAVA. However, this type of system can be expensive and would only be beneficial if more than two means of notification is required or a non-standard tone. Tones used across sites varied significantly, with some sites even having multiple tones for evacuation. No singular tone provides benefit to everyone, but the Standard Apollo Evacuation tone was one of the most frequently found in use at the case study sites and is recommended in the guidance document. It is a clear and predictable tone which does not change tone at a fast rate. This allows occupants to process each tone before changing, which can make the difference between a meltdown and a safe evacuation.

To conclude, all the systems did not fully follow the recommendations of the guidance document and did have room to improve and become more compliant. The most common problem found amongst sites when compared to the guidance document was the level of sound which was significantly higher than needed. The main recommendation would be to take the extra time to reduce the sound levels to a level which follows the regulation (if deviation is not allow) but is not excessively over the requirements, this would provide constant benefit to occupants considering most school perform three fire drills a year (one per term) and for some even more frequently when used for class change.