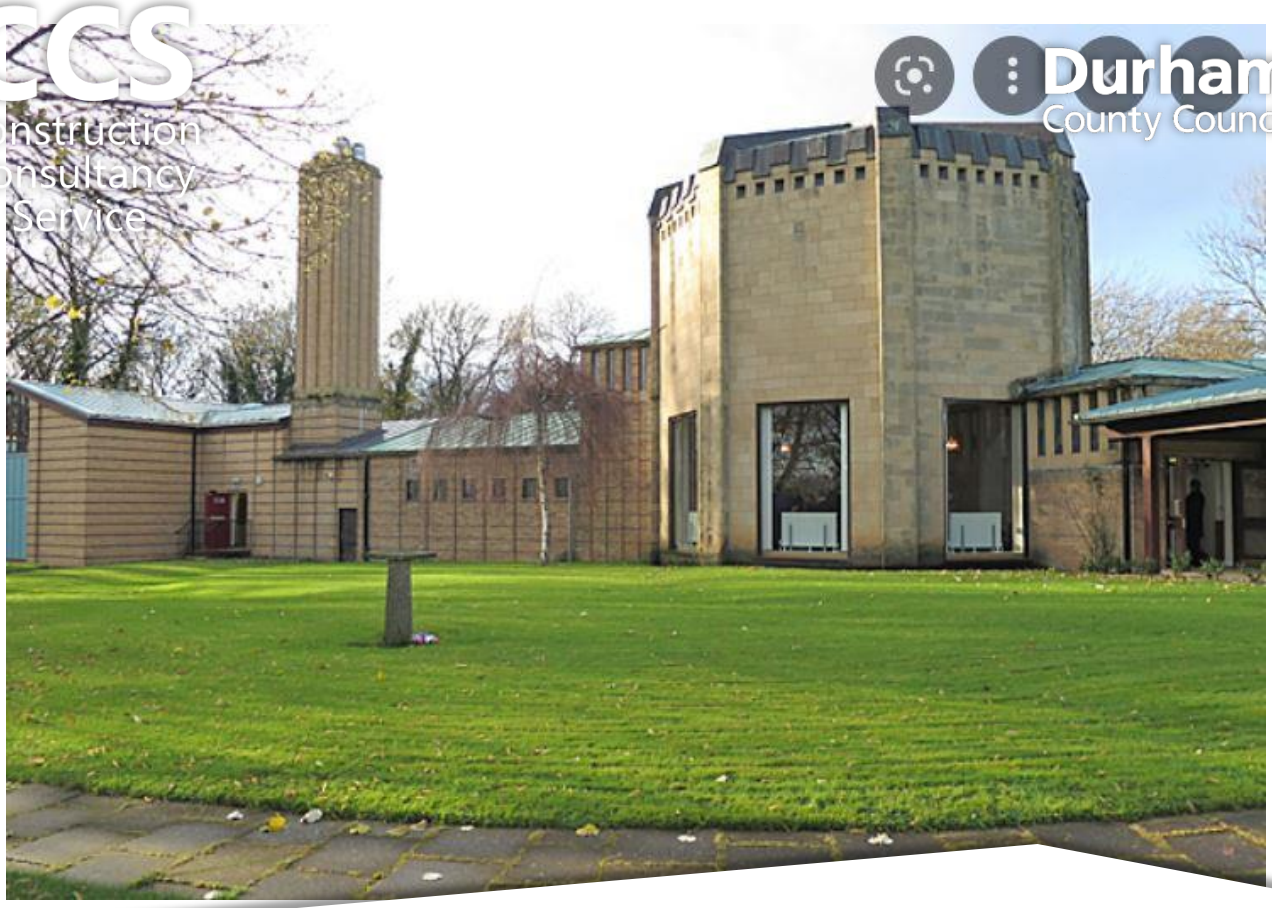

Stage 1 Report

Durham Crematorium

Using excess heat to produce electric generation and very high indoor air temperatures

Project Ref.	50060/0020
Author	Tony Rutter
	Section Manager, Mechanical & Electrical
Date	August 2022
Version	1.0

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Document history

Job number:					
Revision	Purpose description	Originated	Checked	Authorised	Date
Rev 00	Stage 1 Report	Tony Rutter	Gary Johnson	Tony Rutter	26.08.22

Contents

1.0 Introduction

1.1. Project

Investigate if excess heat in the Cremator Room can be harnessed and turned into electrical energy. Also investigate very high internal summer time temperatures.

1.2. Brief

The study has been commissioned by Graham Harrison Bereavement Services Manager, to provide an Inception Study for works listed below at Durham Crematorium:

- Using excess heat from cremators in order to produce electric generation
- Investigate high internal summer time air temperatures

Durham Crematorium holds 3 No cremators to the rear of the building. These cremators, use large amounts of gas to maintain them at high operating temperatures. The excess heat radiating from the cremators, is creating two issues. Firstly, excess heat is being transmitted through the whole building causing high internal temperatures. Secondly, can this excess heat be harnessed and then transformed into either electrical or cooling energy.

This report will investigate each option and then calculate budget costs for the appropriate solutions, then make recommendations.

1.3. Project Budget

A Client budget has not been provided. The budget for these works is to be set as part of this report.

1.4. Client / Project Sponsor

Graham Harrison
Bereavement Services Manager & Registrar
Durham County Council
South Road
Durham
DH1 3TQ

Email: Graham Harrison Graham.Harrison@durham.gov.uk

1.5. Consultees

The following people were involved in the preparation of this document: -

1.5.1. Durham County Council Building Design Team

- Section Manager Mechanical and Electrical, DCC - Tony Rutter / 03000 268381
- Senior Asbestos Officer, DCC - Sean Durran / 03000 261217
- Tom Bray, Carbon Officer DCC - Tom Bray

1.5.2. Durham Crematorium

- Bereavement and Services Manager & Registrar DCC - Graham Harrison

2. Project development

During a site meeting on 19th July 2022 with the Building's staff, we discussed the reasons why the 50060 Durham Crematorium commission was raised. The original building and its services were constructed in the 1960's, an extension was added in around 2013. This report will investigate the excess heat issue within the Cremator Room. In addition and whilst onsite, very high internal air temperatures within the Cremator Room and office area of building and the lack of ventilation within the Control Room were witnessed. This will also be discussed in this report.

3. Excess heat, high internal air temperatures & lack of ventilation

3.1 Cremator Room and Charging Room

The 3 No cremators within this room expel an enormous amount of heat energy to the room environment. This excess heat is not being removed from this room and as a result, is making the internal room air temperatures reach unsafe high temperatures. During the time of my survey, the internal air temperature reached 54ºC.

The was a clear lack of air movement, which meant the heat generated from the cremators, isn't being removed from the internal space and instead is just building up over days to cause extremely high internal air temperatures.

The temperatures I witnessed would be classified by the H&S executive to be unsafe to work in. It must be noted that although the outside temperature was around 29ºC, this doesn't mean the internal temperatures of 54ºC would be reduced significantly if the external air temperature was lower.

Any temperature over 32 ºC is deemed unsafe to work in according to CIBSE, who guide the H&S Executive on maximum internal air temperatures. Although this is not statute, it is strongly recommended guidance.

To add, staff did mention to me, they felt uncomfortable with these temperatures. This is understandable, as it would be recommended to limit internal air temperatures to 28ºC. To add, it has been scientifically proven, that when occupants are very hot they will not work to the best of their capabilities and have higher sickness rates.

It is advised this is rectified immediately.

3.2 Large and Small Offices

The West facing Office and Meeting Room are positioned so they attract solar gains from the sun from around 1pm to 7pm during the summer periods. This solar gain has a significant impact on the building structure by heating the building i.e. roof and external walls. This heat energy is then transmitted through the building fabric into the internal air environment.

In addition, the windows within the Large and Small Offices, are located right next to the Entrance area to the Crematorium. Visitors to the Crematorium, are experiencing severe trauma and when they are attending services, they wait in a queue and stand right next to the windows to the Office and Meeting Room. As a

result, Office staff feel it is inappropriate to have the windows open to prevent them from hearing in on conversations/grief from these visitors in the queue. So these rooms also suffer from a lack of ventilation, which would have the ability to cool the rooms down.

Heat from the Cremator Room also travels via conduction and convection into the Large and Small Offices. So adding solar gain, closing of windows and heat gain from the Cremators, combines to create a very uncomfortable internal air temperature. During the time of my survey, the internal air temperature reached 39ºC at a time of around 4pm, which is not the peak time for solar gain.

The temperatures I witnessed would be classified by the H&S executive to be unsafe to work in. It must be noted that although the outside temperature was around 29ºC, this doesn't mean the internal temperatures of 39ºC would be reduced significantly if the external air temperature was lower.

Any temperature over 32 ºC is deemed unsafe to work in according to CIBSE, who guide the H&S Executive on maximum internal air temperatures. Although this is not statute, it is strongly recommended guidance.

To add, staff did mention to me, they felt uncomfortable with these temperatures. This is understandable, as my recommendation would be to limit internal air temperatures to 28ºC. To add, it has been scientifically proven, that when occupants are very hot they will not work to the best of their capabilities and have higher sickness rates.

It is advised this is rectified immediately.

3.3 Controls Room and Crematory Office

These rooms did not have any form of ventilation, which is illegal. They also suffered from high internal heat gains as a consequence of lack of ventilation.

During the time of my survey, the internal temperature reached 35ºC.

The temperatures I witnessed would be classified by the H&S executive to be unsafe to work in. It must be noted that although the outside temperature was around 29ºC, this doesn't mean the internal temperatures of 35ºC would be reduced significantly if the external air temperature was lower.

Any temperature over 32 ºC is deemed unsafe to work in according to CIBSE, who guide the H&S Executive on maximum internal air temperatures. Although this is not statute, it is strongly recommended guidance.

To add, staff did mention to me, they felt uncomfortable with these temperatures. This is understandable, as my recommendation would be to limit internal air temperatures to 28ºC. To add, it has been scientifically proven, that when occupants are very hot they will not work to the best of their capabilities and have higher sickness rates.

The Controls Room also requires a ceiling tile replacer to allow natural light from the light well above.

It is advised this is rectified immediately.

4. Recommended Installations

4.1 Cremator Room and Charging Room

2 no large (1m diameter) axial blade extract fans to be wall mounted at high level on the East facing wall. These fans will be set to temperature control, say 27ºC so will only operate, should the internal room air temperature reach this set point. The external doors shall be full louvred to assist in the process of cross flow ventilation. During summer periods, this should provide adequate mechanical ventilation to cap maximum summer time temperatures.

In providing these 2 No large (1m diameter) axial fans within the Cremator Room, this should help reduce internal air temperatures within the Charging Area aswell. In future, should additional mechanical ventilation be required within the Charging Room, then 1 No wall mounted axial blade extract fan (to include external dampers) could be located on the East facing wall. **This fan won't be priced in section 9**.

To be installed as soon as possible.

4.2 Large and Small Offices

To prevent overheating in these rooms, mechanical ventilation would not lend itself to easily and it would end up costing significant amounts of money to install and probably not be fit for purpose due to the low ceiling heights, building roof structure (plant would be visible and need planning approval) and works would have to be done on a weekend.

It is therefore proposed to install a small single split air conditioning unit (dx) per room. This would encompass, 2 No wall mounted indoor units per room and 1 No outdoor unit per room. These could be set at maximum indoor air temperatures of say 27ºC and so would only run infrequently. Works could be done during normal working hours.

The cost of air conditioning versus mechanical ventilation would be 1/10. In addition, mechanical ventilation would only work 80% of the time.

To offset the electrical energy/carbon usage caused by the air conditioning units, it is recommended the Carbon Team fund the installation of additional PV panels on the roof/wall. Costs not provided in this report.

To be installed as soon as possible.

4.3 Controls Room

A small ceiling mounted MVHR (mechanical ventilation heat recovery unit) to be located in ceiling/roof space, that would provide adequate fresh air from outside into the internal environment. This would satisfy Building Regulations in terms of adequate ventilation and would also prevent overheating.

To be installed as soon as possible.

4.4 Other options explored

4.4.1 Solar Shading

To provide external solar shading. It would be recommended, the Carbon Team fund this measure. This would reduce heat gains to internal rooms via the external walls. Ceilings and floors would not be covered

with solar shading, so heat gains would still enter the rooms. This option would only marginally reduce maximum internal air temperatures.

4.4.2 Electricity Generation by Waste Heat Recovery

Electrical generation produced by waste heat recovery is a solution that was first proposed around ten years ago. It was discounted then for cost reasons.

However to try and put this type of system into context, for a medium coffin weight in a gas fuelled cremator, approximately 500kWh are released, higher coffin weights will increase this. Unfortunately the waste heat is not available continuously during a cremation but fluctuates strongly from 150kW to peaks of >1000 kW.

Assuming an energy content of 400-600kWh per cremation (coffin with content + cremator fuel), the heat distribution in our large cremators fluctuates in the course of the cremation between 150kW to 1000 kW.

If two cremators are operated in parallel with staggered charges, the heat distribution evens out somewhat and thus leads to a better loading of the ORC plant. The average value of the available energy volume therefore will probably not be much more that 600kWh even when two cremators are operated in parallel; a less optimistic estimate is closer to 450kWh – 500kWh per operating hours, since there is probably also going to be some idle time for the cremators.

The electric net capacity after deducting the auto-energy consumption of the ORC plant and the required pumps is very much dependent on the outside temperature.

At 0 – 10°C approximately 35-50kWh per operating hour are possible with the assumed waste heat volume.

At 10 – 20°C it is only 20-35kWh per operating hour.

At 20 – 30°C the net capacity drops further – the shut-off points may be expected at 28 – 33°C outside temperature.

All of these factors above need to be taken into account for the design of a suitable plant. Past installation costs from specialist contractors, have an expected cost of between £400,000 to £500,000 for Durham Crematorium. The estimated payback period would be in excess of 40 years.

It is with this reason, we wouldn't recommend this type of system.

4.4.3 Mechanical Ventilation

Mechanical ventilation was discounted for the reasons below:

- Plant on roof of building so would be seen by visitors
- Ducted into rooms, limited space in ceiling spaces
- Will not prevent overheating
- Will only work 80% of occasions
- Highly disruptive and risky when in use
- Expensive to install say £200k min
- Installation limited to weekend works
- Outdoor units unlikely to get planning approval

4.4.4 Solar PV Panels

To offset the electrical energy/carbon usage caused by the air conditioning units, it is recommended the Carbon Team fund the installation of additional PV panels on the roof/wall. **Costs not provided in this report.**

5. Statutory requirements

The following Statutory requirements have been considered:

- Planning approval – will be required for PV panels
- Building control approval – will not be required for the proposed works
- Ecology approval – will not be required
- Conservation approval – the site is not within a Conservation area
- CDM - will apply to the project and the works but will not be notifiable to the HSE

The parts of this building were built before 2000. There is a need to check for asbestos.

Within the Asbestos Management Report for his building, it mentions, the building is free of asbestos where our works are planned. However, an R&D survey would need to be carried out prior to any construction works. A risk sum of £5,000 is to be included in these costs to make an allowance for any asbestos removal.

6. Outline programme

Based upon recent projects of this type, the following time periods should be allocated for the design, tender, mobilisation and construction phases of the project:

Commissioning and allocation of design team	2 weeks
Design	3 weeks
Tender period and appointment of contractor	4 weeks
Planning	12 weeks
Mobilisation	4 weeks
Asbestos Removal	1 weeks
Construction on site	4 weeks
Total	**30 weeks**

7. Risk Management

Before any project is carried out all relevant designer's risk assessments and contractor risk assessments and method statements (RAMS) must be reviewed by a competent person.

Ref No	Risk	Probability	Impact	Action/Mitigation	Owner	Risk Cost
Risk 1	Asbestos	Low	Medium	Allow a provisional sum	Client	£5,000
Risk 2	Carbon Team funding of roof mounted PV. This would reduce electrical	Medium	Medium	TBC	Client	Carbon Team to clarify

	demand of proposed A/C system					

RISK 1 PRICES ABOVE ARE INCLUDED IN PRICES IN SECTION 9

8. Preliminary budget allocation

8.1 Costs explained

All estimated costs for the recommended works should be included in this section in the format of a table.

All estimated costs for the works are approximate only and are based upon assumed specification. No detail measurements or competitive quotations have been obtained. No allowances have been made for VAT or professional fees. All costs are based on market rates current at the date of the feasibility study.

8.2 2 No wall mounted axial fans and 2 No split system air conditioning units

Budget Costs Option One	Item Cost	Sub Totals
Asbestos	0	
Supply and install 2 No 10 kW split a/c systems	15,000	
Supply and install 2 No wall mounted axial fans, controls	10,000	
Supply and install 2 No ceiling mounted heat recovery units	10,000	
Builder works for new pipework and fans	20,000	
Boxing for new pipework	2,500	
Draining down of existing system, filling, recommission	2,500	
Total for works		£60,000
Preliminaries (5 weeks) @ £600	£3,000	
Sub Total 1		£63,000
Contingencies @ 10%	£6,300	
Risk (contingency) see section 8, Option 1	£5,000	
Sub Total 2		£74,300
Professional fees stage RIBS Stages 2 - 4 (11.54%)	£8,574	
Sub Total 3		£82,874
Asbestos demolition survey	£1,000	
Asbestos Analyst fees	£0	
Bat Surveys	£0	
Site Investigation Survey	£0	
Planning fee	£0	
Building control fee - plan review	£0	
Building control fee - inspection	£0	
Grand Total	**£83,874**	

8.3 Recommended option

It is recommended the following is installed as soon as reasonably practicable:

- 2 No large diameter wall mounted axial fans with external dampers and controls are installed at high level within the Cremator Room. External doors to be fully louvred.
- 2 No split system d/x air conditioning units are installed within the Large and Small Office. 1 No per room.
- 2 No mechanical ventilation heat recovery units within ceiling void in Crematory Office and Controls Room
- PV panels are installed to Crematorium roof/wall to offset electrical consumption from air conditioning (to be funded by Carbon Team)

9. Client Action

Should you wish for the scheme to proceed to an investigative or Feasibility Stage, please complete a Project Request Form template to initialise the scheme and send to the below email address:

ProjectsSupport@durham.gov.uk

For further guidance please contact:

- Katherine Beattie (Tel: 03000 261123)

Appendix A - Glossary

Asbestos – Control of Asbestos Regulations 2012

Under the control of Asbestos Regulations 2012, Regulation 4 'Duty to Manage' there is a responsibility on all building owners, landlords and agents to manage the risk from asbestos containing materials within their premises.

The duty holder has the responsibility to:

Identify any ACM's present
Assess the risk posed by ACM's
Prepare a detailed written plan on how to manage the risk of asbestos (To be kept on site)
Implement the plan
Review and monitor to ensure compliance
Inform those who need to know of the location and condition of the ACM's

There are two types of asbestos survey:

Asbestos Management Survey - All buildings that are suspected to contain Asbestos containing materials should have had an asbestos management survey undertaken and an asbestos management plan should have been produced showing the locations of all asbestos.

Refurbishment and Demolition Asbestos Survey - Any proposed works to the building (alteration/ demolition) would require a refurbishment and demolition asbestos survey.
For further information regarding asbestos refer to http://www.hse.gov.uk/asbestos/index.htm

Accessible Facilities – Equality Act 2010

Under the Equality Act 2010 an employer cannot discriminate against a person with a disability and must make 'reasonable adjustments' in a workplace to avoid a disabled person being at a disadvantage to other employees.

The design of the building should be in accordance with Document M of the Building Regulations and BS 8300. Document M and BS 8300 set out the acceptable design standards for access to all areas of a building, and the facilities required within a building, this includes:

Car Parking
Accessible Entrances
Ramps
Elevators
Corridor and Door Widths
Lifting Platforms
Accessible WC Facilities
Switches, Outlets and Controls

For more information on Accessible Facilities required within buildings refer to
http://www.planningportal.gov.uk/uploads/br/BR_PDF_ADM_2004.pdf

Statutory Approval

Building Control

The approved documents are the minimum allowable standards when constructing a new building or extending an existing property. The Building Regulations is made up of 14 approved documents, the documents are listed below:

A Structure
B Fire Safety
C Resistant to contaminants and moisture
D Toxic Substances
E Resistance to sound
F Ventilation
G Sanitation, hot water safety and water efficiency
H Drainage and Waste Disposal
J Heat Producing Appliances
K Protection from Falling
L Conservation of fuel and power
M Access to and use of buildings

The above documents must be complied with for all new works and the majority of refurbishment works to achieve Building Control Approval. Below is a link to all of the approved documents:

http://www.planningportal.gov.uk/buildingregulations/approveddocuments

The application and approval process can take between 5 and 8 weeks from submission of full plans.

Planning – Town and Country Planning Act 1990

To gain Planning Permission the Town and Country Planning Act 1990, along with any local plans from the respective Local Authority must be complied with. The Local Authorities planners will look at a proposal and decide on the proposal's suitability paying particular attention to:

Size of the proposal (Scale of the building/s, proposals for the site etc.)
Suitability of the proposal with regards to the surrounding area
Materials to be used (how the building is going to look, does it fit with the appearance of the area?)
Effects the proposal will have on the surrounding area and any neighbouring properties (Increase in traffic, flooding, loss of light to neighbour's property etc.)
Position of the proposed building on the site (distance from boundaries, overlooking neighbours etc.)
How new services will be introduced to a site (Drainage, Gas, Electric, Water) and connected to a new building

Not all projects require planning permission and many minor projects may be undertaken without the need for an application. Minor projects that do not require Planning Permission are known as Permitted Development. The Local Authority's Planning Department should be consulted for advice on permitted developments.

http://www.planningportal.gov.uk/planning/applications/

The application and approval process can usually take between 8 and 12 weeks from submission of full plans for minor and intermediate sized projects. The timescale may be greatly increased for more complex projects.

Listed Building Consent

Listed building control is a type of planning control, which protects buildings of special architectural or historical interest. These controls are in addition to any planning regulations which would normally apply. Listed building status can also result in the requirement for planning permission where it wouldn't ordinarily be required - for example, the erection of means of enclosure.

This special form of control is intended to prevent the unrestricted demolition, alteration or extension of a listed building without the express consent of the local planning authority or the Secretary of State.
The controls apply to any works for the demolition of a listed building, or for its alteration or extension, which is likely to affect its character as a building of special architectural or historical interest.
There are three different categories of listed buildings, they are:

- Grade I - buildings are of exceptional interest, sometimes considered to be internationally important. Just 2.5% of listed buildings are Grade I.
- Grade II* - buildings are particularly important buildings of more than special interest. 5.5% of listed buildings are Grade II*.
- Grade II - buildings are nationally important and of special interest. 92% of all listed buildings are Grade II.

Ecology

As part of a Planning Application it is often requested that an ecology survey be undertaken on a site that may contain protected species. Protected species include bats, newts, and certain types of nesting birds etc.

An ecology survey will determine the likelihood of any of these species being present on the site or surrounding areas. If any of these species are present, then a development could be stopped until the species is removed from the site in a suitable manner. This can be a very expensive process.

Fire Safety – Regulatory Reform (Fire Safety) Order 2005

A responsible person is defined as an employer, owner, landlord or occupier of business or other non-domestic premises and is responsible for fire safety. Duties placed upon the responsible person with regards to fire safety in a workplace include:

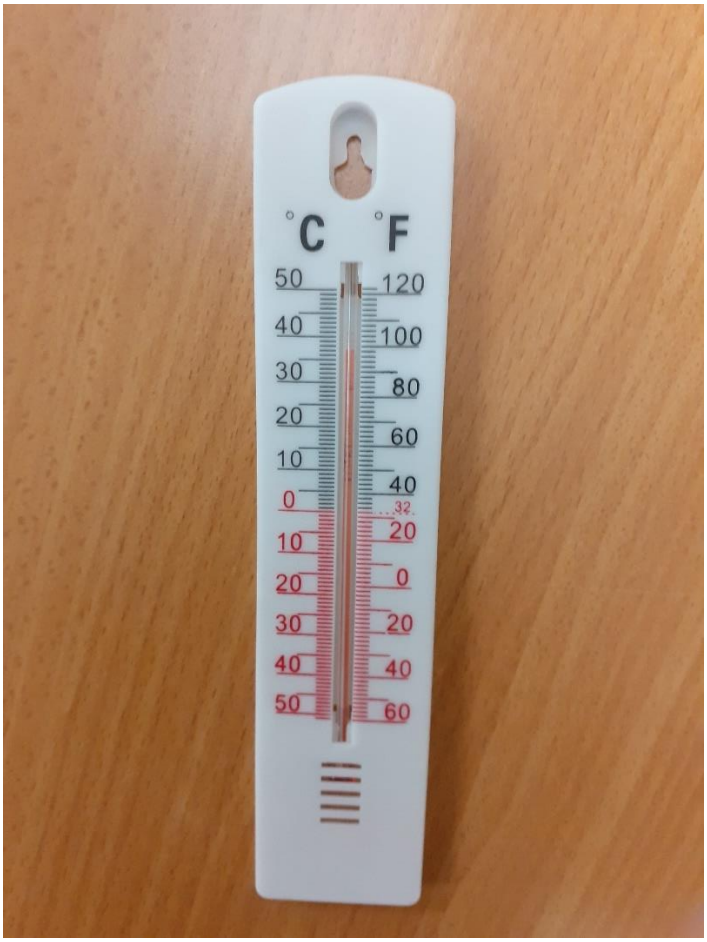
- Carry out a fire safety risk assessment
- Keep sources of ignition and flammable substances apart
- Avoid accidental fires, (e.g. make sure heaters cannot be knocked over)
- Ensure good housekeeping at all times, (e.g. avoid build-up of rubbish that could burn
- Consider how to detect fires and how to warn people quickly if they start, e.g. installing smoke alarms and fire alarms or bells
- Have the correct fire-fighting equipment for putting a fire out quickly
- Keep fire exits and escape routes clearly marked and unobstructed at all times
- Ensure workers receive appropriate training on procedures they need to follow, including fire drills
- Review and update your risk assessment regularly

With regards to the design of a building it must be designed in accordance with Document B of the Building Regulations and BS 9999 – Code of practice for fire safety in the design, management and use of buildings. Document B and BS 9999 – Set out the acceptable design standards for Fire Safety within a building, they include:

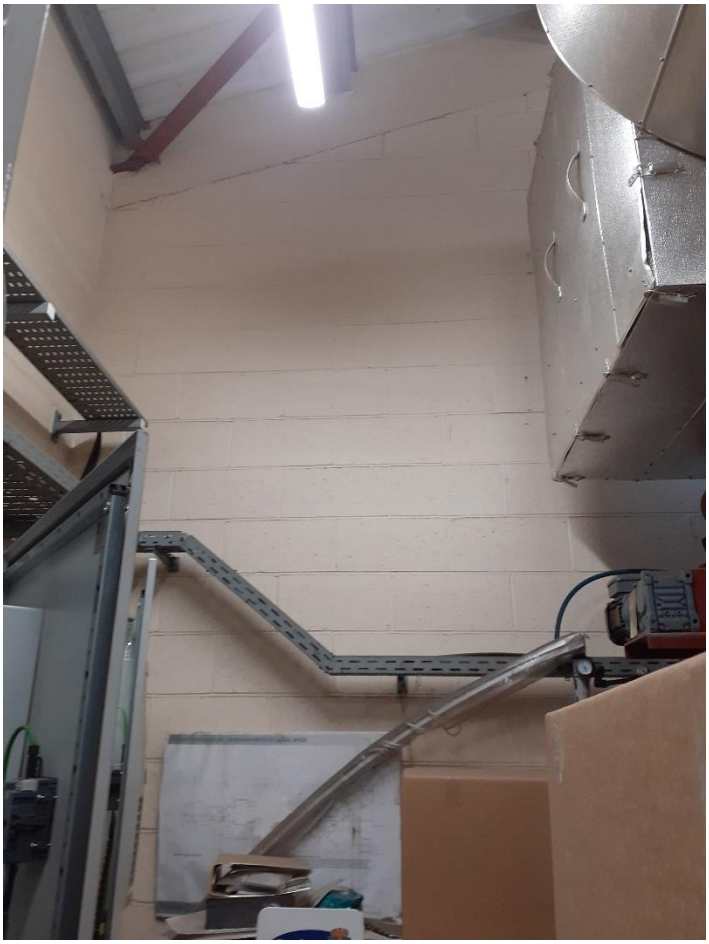
- Number of escape routes
- Maximum travelling distances for escape routes
- Limiting fire spread
- Suitable Materials
- Means of warning and alarm
- Access and Facilities for the Fire Service

Appendix B - Photos

Photograph 1: Office room where windows can’t be opened



Photograph 2: Office room indoor air temperature reading at 37ºC



Photograph 3: Cremator Room location of wall mounted axial fans 1 at each side of wall

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