MACKINTOSH ENVIRONMENTAL ARCHITECTURE RESEARCH UNIT THE GLASGOW SCHOOL OF ART

Investigation into the Environmental Condition of GSA Student Residences

BUILDING PERFORMANCE

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Commissioned by GSA's Sustainability in Action Group (SiAG)

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1.0 Introduction

MEARU were commissioned by GSA's Sustainability in Action Group (SiAG) to undertake a building performance study of the condition of the GSA student flats at the Margaret Macdonald Student Halls of Residence. This report seeks to identify causes of recurring problems at the Halls of Residence and suggest methods of improving the indoor air quality and levels of thermal comfort within the student living spaces.

The research findings will help to upgrade the existing housing provision and inform the design and future maintenance decisions of the proposed new GSA student accommodation.

2.0 Context

Margaret Macdonald House (MMH) is located on Buccleuch Street in the Garnethill area of Glasgow for Glasgow School of Art. The development was purpose built (in 1995) as student halls of residence for 115 GSA students. There are a total of 18 flats with a mix of en-suite and shared bathrooms.

Blocks A&B (en-suite): 6 no. 6 bedroom, 1 no 4 bedroom and 1 no 5 bedroom.
Blocks C&D (standard): 1 no. 6 bedroom, 2 no. 4 bedroom and 7 no 8 bedroom.
All flats have a shared kitchen/sitting room.

The development was built in 1995 in accordance with the 1990 Scottish Building Regulations.
It has 4 storeys to the North/South block and 5 storeys to the East/West block.

The development sits on the axis of Buccleuch Street and Garnethill st. It has an attractive sunny rear courtyard and parking area which many of the South and East facing rooms overlook. The North and West rooms look out onto the streetscape of Garnethill with traditional sandstone tenements.

	
Street Elevation to Buccleuch St (North Facing)	Rear Courtyard (South and East facing)

West and North elevations are close to the street edge and open windows on the ground floor pose a potential security risk. The rear courtyard is accessed through a pend with security gate so window

opening to South and East facades is more liberal. The room sizes are very compact- 9m^2 in most situations with bathrooms of 2m^2. Floor to ceiling heights are standard of new build residential developments (2.4 m). In keeping with the neighbouring tenements the development has quite large windows relative to floor area. In these restricted volumes (approx. room size 23m^3), ventilation and air quality are particularly relevant.

Typical Floor Plan Layout *(Better quality image to be sourced)*

The flatted block is constructed from structural timber frame with exterior brick facing. The windows are timber framed double glazed with a U value compliant with Building Regulations at the time of construction. No windows have been replaced and are therefore the original ones from 1995. The halls are managed and maintained by GSA's estate department who are responsible for day to day maintenance of the residences. The GSA estates team fix extract fans and general maintenance on request only rather than an annual maintenance check. The halls are used in the academic year (September- June) by GSA students. The students are a mix of ethnicity, age and socio and economic backgrounds. The rooms are all for single occupancy and students are discouraged from having anyone else staying in their rooms. The halls are then let out over the summer for short vacation lets. There is a 1 week period during the summer when external contractors are brought in to undertake necessary maintenance and re-decoration. During Christmas and Easter breaks the students will often be away and the accommodation is left uninhabited and unheated for up to 3 weeks during the coldest months of the year.

Typical Bedroom with en-suite within a flat

Typical Kitchen/Common Room

3.0 Methodology

A site visit to 3 typical flats which had recurring issues with dampness, condensation and high electricity costs was undertaken. After discussions with the residential manager to identify repeated problems and common student complaints, 3 flats out of the 18 in the development were selected for in-depth monitoring (these ones had received most complaints over recent years and some rooms were considered 'problems' - although many of the issues identified are typical of those experienced across the other flats to a lesser degree).
Background research into the construction typology and flat type layouts of the residential halls was then undertaken.
An A4 questionnaire was distributed to the residents of the 3 flats which were selected for monitoring. The questionnaire aimed to identify if there were any resident habits which may be affecting the environmental condition of their bedroom. Resident were asked how often they open windows, adjust trickle vents, shower usage, heating regime and expenditure on energy per week. A copy of the survey and full set of results are included in the appendices. Of the 15 questionnaires issued, 10 were returned fully completed. The residents had all been living in the accommodation for 8/9 months so their responses reflect their experiences from the months from Sept' 13- May '14.
Monitoring equipment was installed in the 3 flats which had been identified as suitable during initial site visit. Bedrooms and shared kitchens were monitored over a 2 week period in each flat (between February and April 2014). The equipment monitored CO_2, Relative Humidity and Temperature which all helped to assess the indoor quality within the flats. (Eltek RX250AL receiver (Squirrel) loggers. GD47 transmitters with sensors built in for RH, temperature and CO2 (0-5000ppm were used). The results of the monitoring data were analysed using Excel to identify and explain patterns and peaks.

Further monitoring was undertaken in the form of extract fan testing to assess the flow rates and ventilation extract rates in the bathrooms. During the monitoring period, questionnaires were issued to residents to gather more qualitative data regarding their heating use, ventilation awareness and other key air quality markers.
Conclusions from this building performance study aims to provide short and long term strategies for dealing with problems identified within the building and also make recommendations for the commissioning of new halls of residence by GSA.

4.0 Visual Observations + Resident Questionnaire responses

The interview and site visit with Residential Accommodation Manager (Fiona Sloan) and Halls Warden (Philippa Claude) was held on Monday 27th January and this included a site visit to 3 typical flats which had recurring issues with dampness, condensation and high electricity costs. Discussions with the manager and resident warden were a most informative part of this study as both having been dealing with student resident requests and complaints at MMH for many years.

Heating + Hot Water

Individual rooms are heated by electrical convector heaters. These have touch panels controls and boost setting to operate (auto switch off after 2 hours). Radiators are set to cut out at 23°C or after 2 hours- whichever is reached first. In selected rooms in AG block, it has been necessary to install additional convector heaters (paid for by GSA) to tackle problems of low temperatures particularly in winter months.

	
Electric panel heater with boost touch control as standard in bedrooms.	Additional electric convector heaters in flat AG.

When asked about the ease of operation of the heaters in the bedrooms in the resident survey questionnaire, 70% of students noted that the heaters were simple to operate however opinions were evenly divided regarding their effectiveness in heating the room. The recurring criticism was the inability to keep an even temperature in the room at night.

Each flat has a pre-paid electricity meter, which charges for the total electricity used in the flat (including the power used in each student's room). When asked about the cost of heating room to a comfortable level and affordability, 90% of students noted it was 'very expensive'. Residents were asked to make an estimation of weekly expenditure on energy cost (electricity) per person within the flat. 50% noted between £6-10 per week with 30% estimating between £11-20. The others admitted that they had no idea how much it was but found it prohibitively costly. Some students noted that this figure may be lower than £5 outwith winter months but most had only been resident for 9 months from Sept/Oct during the heating season.

The excessive power charges faced by students are in part due to the current rather complicated Comfort Plus electric meter system that MMH is currently tied to due to the presence of storage heaters in the common areas (x 18 in number). Due to this tariff ALL power in flats is charged at a rate of 18p a unit of electricity. If this was changed to domestic power meters and the storage heaters were removed and switched to domestic convector heaters then a more competitive energy tariff could be negotiated perhaps as low as 9p per unit. Switching meters and communal heating will have instant reduction in energy costs in the entire flat will allow students to heat their rooms for longer periods of time potentially reducing reluctance to ventilate bedrooms.

Students are advised not to plug in additional heaters (and other electrical appliances such as kettles and toasters) in their bedrooms, although there was some evidence that these habits may still take place.
Kitchen/ Common rooms are heated by white meter heating storage heaters which students share the cost of per flat as part of prepayment meter.

Hot water is supplied via a gas boiler located on the ground floor and is distributed throughout the development for showers and hot water taps in bathrooms and kitchens. The cost of hot water in covered in the resident's rent. Respondents all commented favourability on the supply of hot water in their bathrooms and 'good hot showers' was a recurring theme of responses.

The halls have a very complex heating system and given the very confusing system of tariffs provided by all energy companies, it is difficult to comment on whether a more effective tariff could be negotiated.

Ventilation

Extract fans (activated with light switch) in the en-suite bathrooms are on a timer with a 10 minute run-on period. Bathroom doors on shared bathrooms have metal door ventilation grilles and the doors themselves have self-closing devices (although not all these are functional). The ducted extract fans run up the central core of the building and outlet is at roof level. There are no additional extract grills visible on elevations.

Students are also requested not to shower with bathroom doors open as this may trigger smoke alarms.
Defective self-closing devices on en-suite doors let moisture migrate into the bedroom so the importance of an effective ventilation system in the bathrooms is paramount.

There are ceiling mounted extract fans in communal kitchens and charcoal filters in cooker hoods to remove cooking odours. On visual inspection extract fans in kitchens are dirty and possibly ineffective (although actual fan testing couldn't be undertaken in the kitchen due to the size of the fan units). Kitchens tend to be subject to high moisture levels with sometimes 8 people cooking in one evening, which will deliver a very large moisture load into the dwelling. Cookers have extract hoods for odours and grease but are not vented to the outside.

	
Extract fan in Common kitchen/lounge area	Extract fan in bathrooms (both en-suite and shared)

90% of residents noted that the extract fans in the bathrooms were not effective at removing steam from their room and resort to opening windows to remove excess moisture. One resident commented that this was problematic due to the security risk of leaving windows open when the room is vacant.

Students are discouraged from opening windows on ground floor when room is not occupied due to security risks. It was noticeable that the flats on the ground floor experienced greater dampness problems - this could be attributed to less frequent window opening. 100% of residents confirmed that they regularly opened their windows to ventilate their room and are encouraged to do so by the resident manager and wardens however, for security purposes students on the ground floor flats are discouraged from leaving windows open when they are not in their bedrooms. The window opener is the largest part of the window whereas if the window had a smaller hopper this could be opened for ventilation without security risk.

There are trickle vents on each bedroom window however, these are difficult to access as they are located on the window head approx. 2m off above floor level and many are concealed by net curtains. Some students have positioned their desk in front of the window therefore making access to trickle vent more problematic.

However only 20% regularly adjusted the trickle vents for ventilation with 60% having them predominantly closed.

	
Students are encouraged to keep bathroom doors closed	Students on ground floor are encouraged to keep windows closed whilst room unoccupied

Mould and dampness

Several flats visited were stuffy and had a strong smell of dampness and mould. Mould was visible in all of the bathrooms (both shared and en-suite). The shower surrounds themselves were free from mould given the PVC easy clean panels but mould was very evident on painted ceiling and adjacent wall surfaces. In addition, mould was present on every bathroom door due to the hanging of damp towels on a timber veneered door without a heat source or sufficient level of ventilation. In addition there was evidence of mould which had been painted over rather than washed down and removed prior to re-decoration.

Mould was also visible around most window frames. This is most likely due to surface condensation running down the window and gathering on the sill and net curtain.

Mould was also evident in the corners of rooms and behind furniture/ beds. These are areas which do not get any air movement and due to the restricted size of the rooms and the requirement for desk and storage, the capacity for air movement within rooms is very limited. During Christmas and Easter breaks the students will often be away and the accommodation is left uninhabited and unheated for up to 3 weeks during the coldest months of the year. Periods of un-occupancy without heating will cause the surface temperatures to drop leading to the formation of dampness and mould on cold spots of the building fabric.

	
Mould on painted surfaces in bathrooms	Mould growth spores above WC

90% of students have observed condensation in their room predominantly on windows after showering (30% noted condensation on common room windows whilst cooking).
90% of students have observed mould growth on the walls and surfaces within their flat- 60% noted mould within their bathrooms. 40% have mould growth on the walls and surfaces in their bedroom. 40% have mould growth on the walls and surfaces in their kitchen /common room.
This is a problem which students feel strongly about and have therefore written the following comments on the feedback questionnaires- ‘the vents are thick with mould’, ‘the mould in bathroom and bedrooms is really bad’, ‘the mould in severable bathrooms here is unacceptable- I’ve seen showers here coated in the stuff’

	
Mould and mildew on net curtains and window sill	Mould in corner of bedroom behind bed

Students are forbidden to dry clothes over the convector radiators due to fire risks however there is no heated towel rail to dry damp towels in bathrooms and during visual inspection it was evident that all rooms had damp towels draping over doors and/or furniture.

	
Towel draped over bathroom door	Mould growth due to damp towel hanging on bathroom door

The use of the communal laundry is encouraged to prevent students from clothes washing and drying within bedrooms and this facility appears to be well used but has a cost penalty and there was evidence of ad hoc drying in bathrooms and bedrooms. The questionnaire responses highlight a trend of washing clothes but failing to tumble dry all clothes due to prohibitive costs of a drying cycle. The laundry machines are supplied and maintained by an external contractor and cost £2 per wash cycle and £1 for 50 minute drying cycle.
90% of students use the communal laundry on a regular basis doing 2-3 loads on a monthly basis. However 80% of respondents admitted to ad hoc drying of towels, clothes or bedding within their bedroom either over the bathroom door, furniture or on a clothes airer. 30% (of those 80%) would keep their heating on (or increase the temperature) in the presence of wet clothes.

During discussions with the halls of residence manager and warden a number of occupancy habits were identified which may be a contributing factor. Despite their efforts and advice, habits are often socio or economic and are therefore very difficult to solve.

Observed issues/ habits with an impact on indoor air quality:

- Not opening/adjusting trickle vents
- Not opening windows after showering to remove steam from room
- Leaving bathroom door open allowing moisture to migrate into bedroom
- Drying towels and clothes in bedroom

Whilst these are some observed student habits which can exacerbate an already poor indoor environment there are several GSA operational issues which could help to alleviate many of these problems:

- Ensure extract fans are working to an effective extract rate to extract moisture from shower room.
- Ensure self closing devices in bathroom doors are operational to prevent moisture migrating to the bedroom.
- Provide a window which can be securely operated for ventilation purposes.
- Check that window trickle vents in rooms are working and accessible.
- Provide an effective means to dry a towel in bathroom.
- Ensure that the property has background heating on during mid-term and Christmas breaks.

5.0 Results and Analysis- Environmental Monitoring

Monitoring equipment was installed in the bedrooms of 3 flats over a 2 week period during the heating session. The 3 flats were different in their location within the block- Two were on the Ground floor (one with shared bathrooms on an East /West axis and one with en-suites with North/ South axis). The other flat was on an upper floor on the North/South orientation. The equipment monitored CO_2, Relative Humidity and Temperature which all helped to assess the indoor quality within the flats. The results of the monitoring data were analysed using Excel to identify and explain patterns and peaks.

Flat CG, 4 person Ground floor flat with shared bathrooms
All 3 monitored flats on the West elevation
26 February – 12 March (3 bedrooms monitored)

	Orientation	Temp (°C) Mean	Temp (°C)min	Temp(°C) max	CO^2 (ppm) Mean	CO^2 (ppm) min	CO^2(ppm) max	RH-% Mean	RH-% min	RH-% max
Room 1	West	18.7	9	23	2174.5	475	4741	62.5	31	74
Room 2	West	17.6	15	23	1108	407	3777	53.7	32	72
Room 3	West	16.3	12.4	22.9	1842	631	4890	62.5	30	75.7

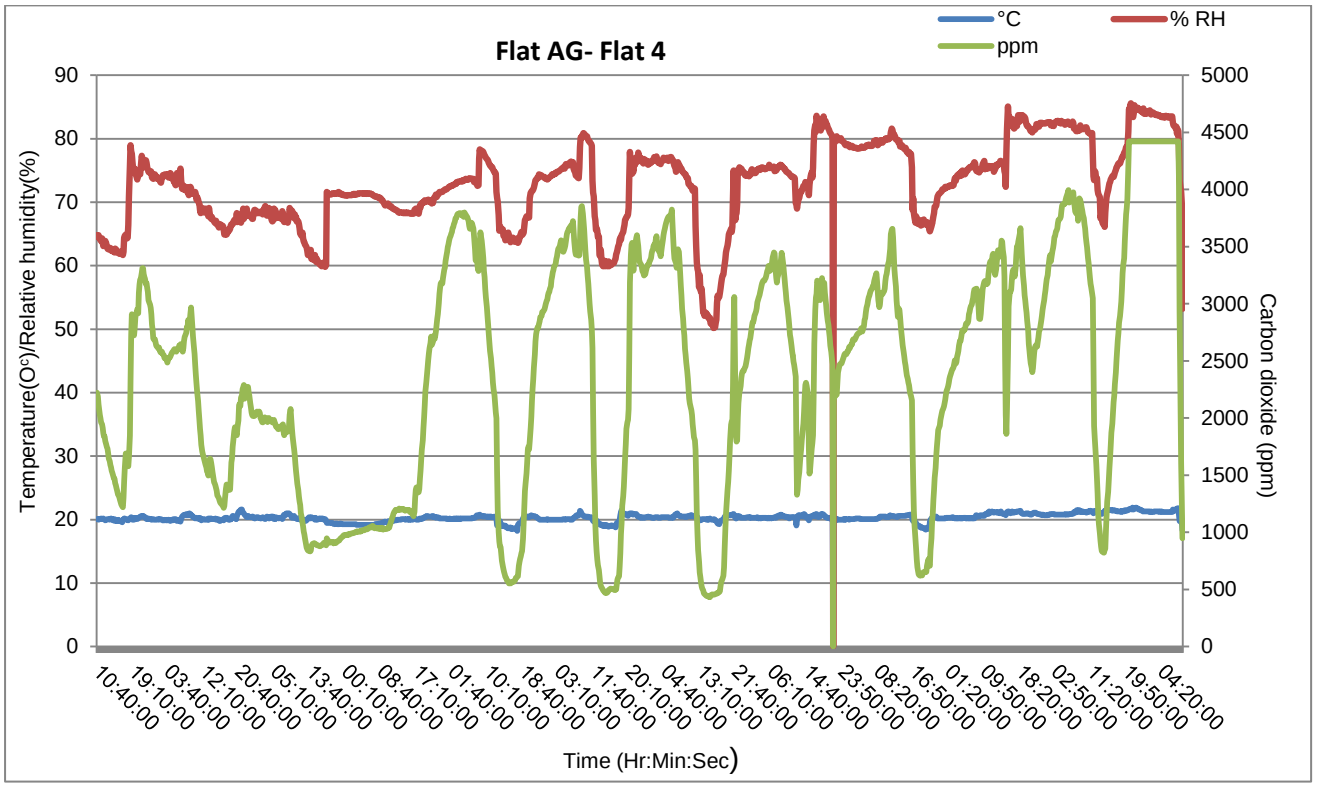
As these flats do not have en-suite bathrooms, the bedrooms should not be subject to migrating moisture from showers therefore the high moisture levels must be attributed to insufficient ventilation with high moisture levels possibly exacerbated by hair drying and drying clothes/towels.

CO^2 levels are very high suggesting that windows are not being opened on a regular basis. As all the rooms were in the West Facing elevation this is perhaps due to the security risk from being at pavement level. The West façade will also take the brunt of driving wind and rain within the elevated position of Garnethill which may also discourage window opening.

Flat AG, 5 person ground floor flat, en-suite
North/South orientation. East elevation adjoins existing tenement construction.
West elevation forms pend entrance to courtyard
31 March – 14 April
Each room has additional panel radiator funded by GSA

	Orientation	Temp (°C) Mean	Temp (°C)min	Temp(°C) max	CO^2 (ppm) Mean	CO^2 (ppm) min	CO^2(ppm) max	RH-% Mean	RH-% min	RH-% max
Flat 2	North	19.9	16.9	23.9	2443	528	4857	72.6	37.1	87.2
Flat 3	North	21.6	16.5	21.1	1231	493	3129	59.5	38.3	84.9
Flat 4	South	21.8	18.2	22.5	1405	433	4421	56.0	33.8	85.6
Flat 5	South	20.6	18.0	25.9	1454	401	3222	64.7	37	81.0
Common room	South	18.7	17.0	24.8	953	457	2705	62.4	35.2	90.1

CO^2 levels in all bedrooms in flat AG are at very high levels. This suggests that windows are not being opened on a regular basis - perhaps due to the security risk from being on the ground floor.

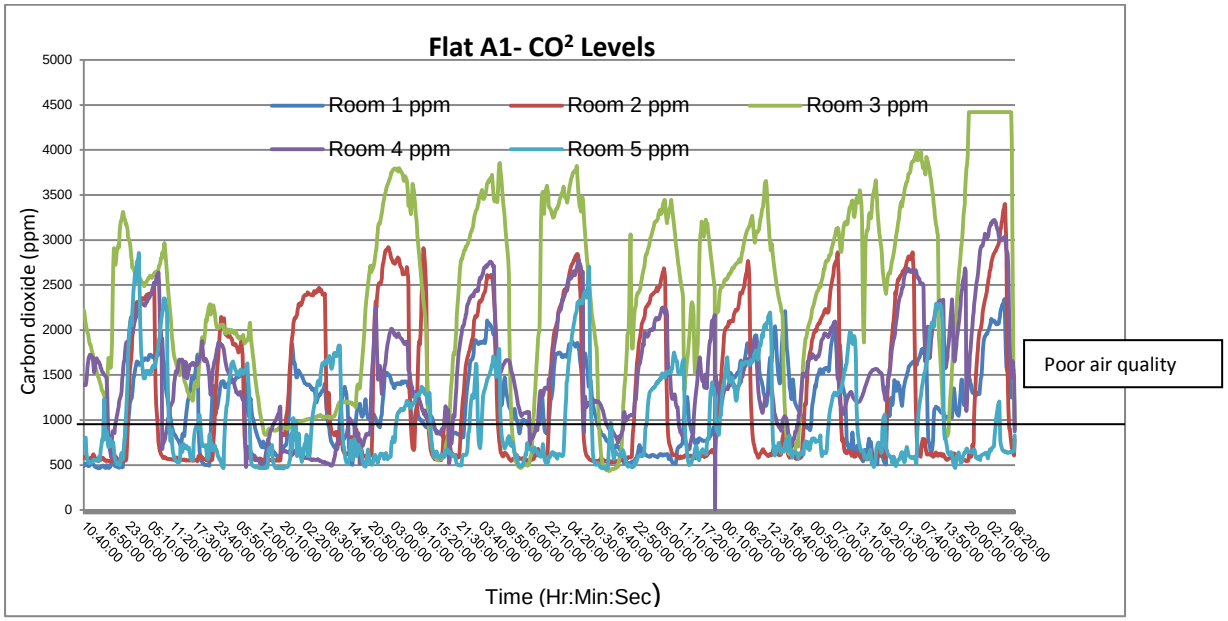


Average humidity levels are high however a key concern are the maximum levels of 87% in bedrooms- this indicates that steam must certainly be migrating from the shower room. These high levels also highlight that an effective fan is critical to remove the moisture.

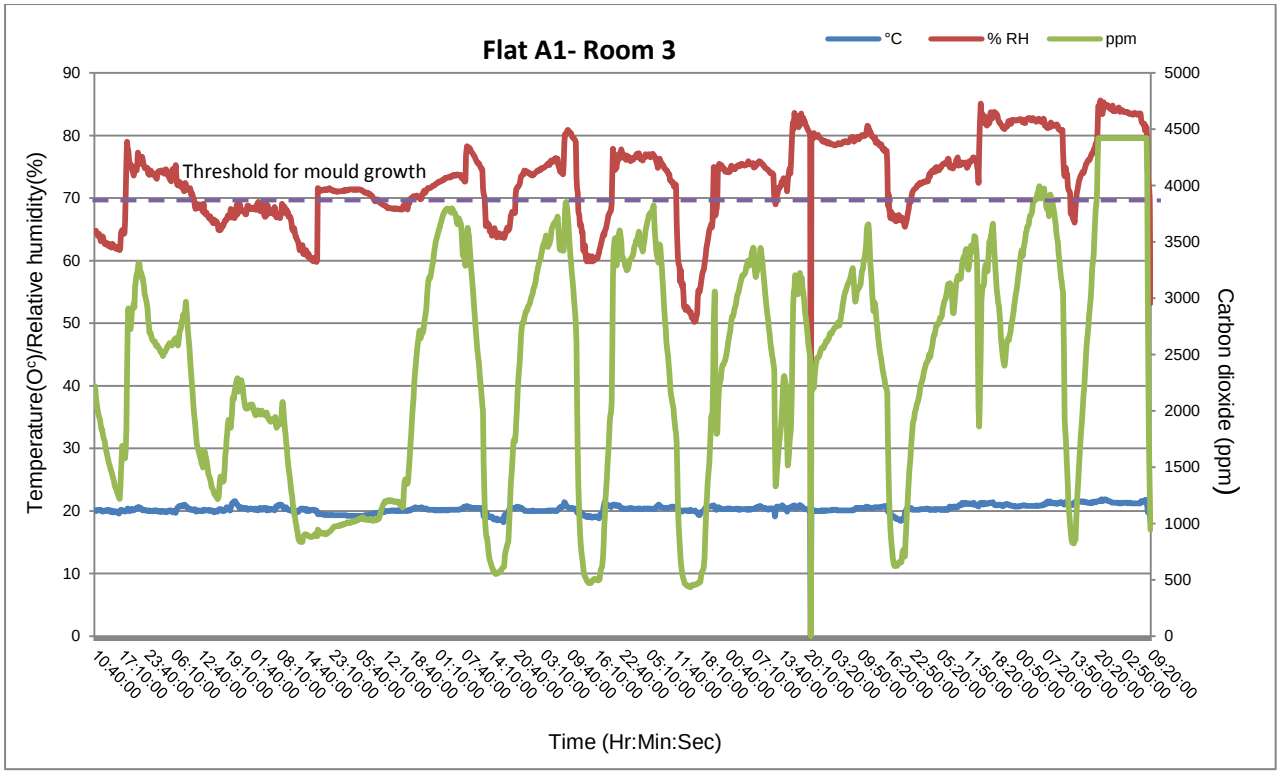
Flat A1, 6 person first floor flat, en-suite
14 April – 28 April
The common room in this flat was not monitored- during the visual survey the windows were open and it was bright and fresh with no obvious ventilation issues.

	Orientation	Temp (°C) Mean	Temp (°C)min	Temp(°C) max	CO^2 (ppm) Mean	CO^2 (ppm) min	CO^2(ppm) max	RH-% Mean	RH-% min	RH-% max

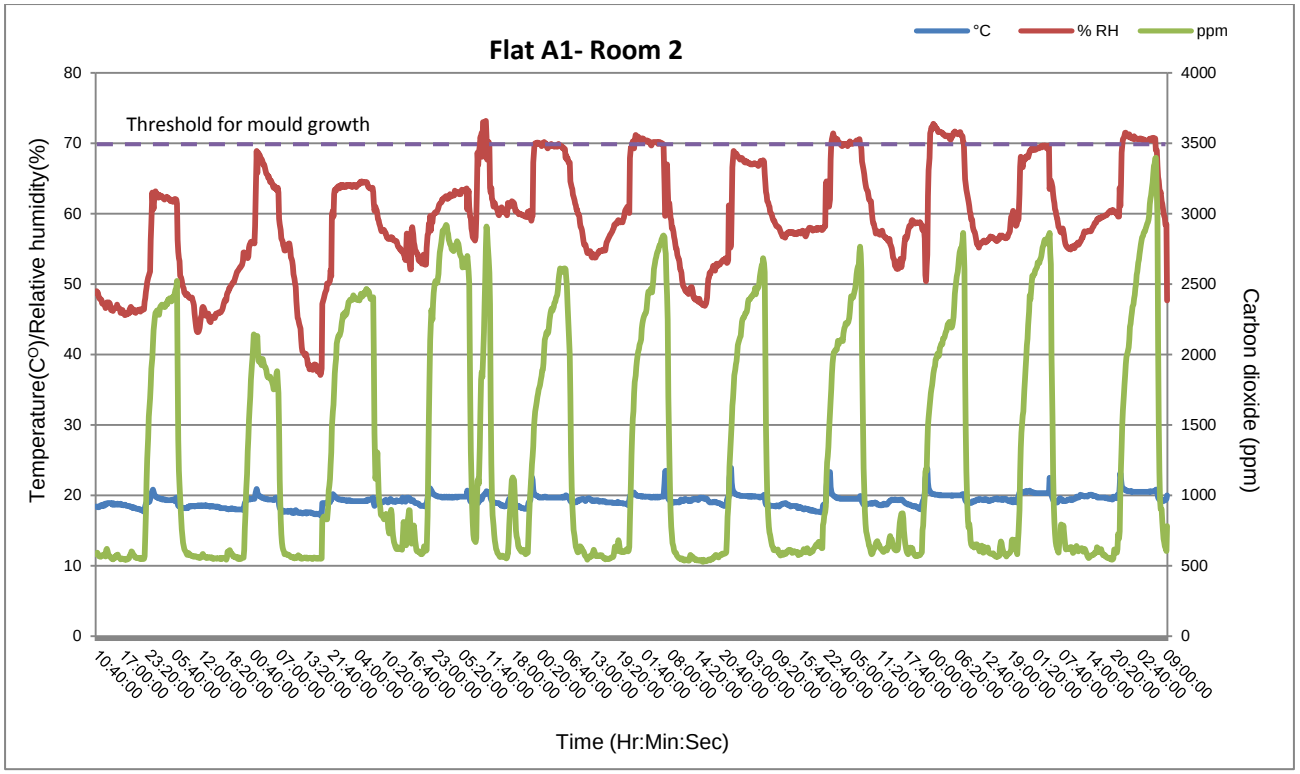
Flat 1	North	19.0	17.0	23.9	1165	528	3399	59.0	37.1	73.2
Flat 2	North	19.3	16.5	20.4	1286	462	2343	59.3	42.3	70
Flat 3	North	20.3	18.2	21.9	2397	433	4421	72.8	50.2	85.6
Flat 4	South	19.7	18.2	21.8	898	479	3222	65.9	48.4	81
Flat 5	South	20.26	17.0	23.0	989	457	2855	48.1	35.2	63.8



The CO^2 levels in flat A1 are very high despite being on the upper floor and having greater opportunity for more liberal window opening. Again average CO^2 levels are at very high levels in all rooms in this flat suggesting that there is insufficient fresh air entering the flat- despite survey responses indicating that windows are opened frequently. The black line indicates the value of 1000 ppm- this is the tolerable indoor air quality and above this level tiredness and lack of concentration can occur.



Room 3 (as above) has both extremely high CO^2 levels and spikes in RH levels. These reading are consistent with mould observed within both the bedroom and bathroom. The dotted line indicates the 70% RH threshold for mould growth. These high levels of humidity can cause both mould growth and dust mites both of which can trigger respiratory illness in susceptible individuals. To further investigate these results a fan test was undertaken to determine the efficiency of the bathroom extract fan. The reading of 2.4l/s as opposed to the required 15l/s was recorded which explains the excess moisture in the air.



The profiles for Flat A1 Room 2 indicate a clear diurnal cycle with CO^2 peaks at night time and temp peaks each evening.

Fan test- undertaken by MEARU on 19th May 2014

The objective of the testing was to ascertain whether the performance of the extract fans, located in bathrooms in each flat are operating in compliance with the Building (Scotland) Regulations. The building regulations under which the residences were built stipulated that extract fans in bathrooms must meet 15l/s (Part K 1990).

Volume flow rates were measured using the following instruments:

Observator Instruments	Automatic volume flow meter with pressure compensation
Type:	Diff Automatic
Cert No:	UK08111MN
Calibrated:	20th June 2013
Observator Instruments	Light extension hood
Type:	AT-242
Cert No:	UK08111MN
Calibrated:	20th June 2013

Apparatus used for flow measurements

The apparatus used, as noted in table 2.1, allows a measurement method using the "Unconditional Method" of measurement. The flow hood eliminates back pressure and places no additional restrictions on fans under test, therefore results displayed on the equipment can be taken as the correct without any further need to apply pressure drop correction factors.

The equipment was operated as per the manufacturer's instructions. Fans were switched to operate and three volume flow measurements were taken at each fan inlet (in litres per second), once the air flow had stabilised. The final result of the testing was an average of the three measurements taken.

Extract Fan Location	Fan Operation	Method of start	Fan Run on
En-suite Bathroom	Intermittent	Light Switch	10 minutes

Extract Fan Location	Fan Operation	Method of start	Fan Run on
Shared Bathroom	Intermittent	Light Switch	10 minutes

Dwelling	Fan Location	Manufacturer	Average Measured extract rate (l/s)	Design extract rate (l/s)	Pass/Fail Measurement test
AG					
Room 2	Bathroom	Nuaire	10.4	15	Fail
Room 3	Bathroom	Nuaire	9	15	Fail
Room 4	Bathroom	Nuaire	6.5	15	Fail
Room 5	Bathroom	Nuaire	0.0	15	Fail
A1					
Room 1	Bathroom	Nuaire	8.2	15	Fail
Room 2	Bathroom	Nuaire	2.9	15	Fail
Room 3	Bathroom	Nuaire	2.4	15	Fail
Room 4	Bathroom	Nuaire	12.6	15	Fail
Room 5	Bathroom	Nuaire	8.5	15	Fail
CG					
Communal Bathroom 1	Bathroom	Nuaire	3.2	15	Fail
Communal Bathroom 2	Bathroom	Nuaire	4.9	15	Fail

Air Flow Measurement of Extract Fans against Design Flow Rates.

The need for extract ventilation is to ensure that excess water vapour produced in sufficient quantities is extracted quickly and effectively at source, e.g. from bathing and cooking activities. This is to reduce the risk of creating conditions that are able to support germination and growth of mould, harmful bacteria, pathogens and allergies.

The testing was undertaken in 3 flats in this study to determine whether the installed systems had the required capacity to meet Building (Scotland) Regulations.

- Average of air flow through all fans tested is 6.86 l/s (as opposed to required 15l/s)
- 45% efficiency of that required by Building (Scotland) Regulations.
- Lowest working at 16% effectiveness
- One fan not working at all

It is evident from the testing undertaken that deficiencies exist with the current ventilation system-. Frequent under-performance of mechanical extraction units is most likely a major cause of the excess moisture and mould growth within the flats and this requires to be addressed urgently.

6.0 Summary and Conclusions

This building performance study of the Margaret Macdonald Student Halls of Residence has identified potential causes of recurring problems including those of dampness, mould growth and poor air quality.

There are high levels of moisture generated from within bedrooms due to inadequate ventilation provision not extracting moisture at source in the shower rooms; hairdryers and clothes drying within the bedroom and this moisture not being dispersed effectively either by underperforming extract fan; resident not opening windows on a regular basis (or for extended periods of time) and partly by ineffective trickle vents.
One of biggest moisture problems is triggered by the poorly performing extract fans which are not maintained on a regular basis. Those tested had an average performance of 6.86 l/s, well below the required efficiency. The rooms with the highest levels of humidity and CO_2 also had the least effective extract fans. This is leading to significant mould growth within both bathroom and bedrooms.

Other exacerbating factors include the very small room size and those rooms with extra furniture and /or clutter prohibit the circulation of air leading to mould formation on walls behind furniture/ beds etc.
Moisture and a musty smell is caused by the lack of a drying provision for towels- a provision must be made otherwise mould and mildew will form where the towel is left to drape.

CO_2 levels are much higher on those flats on the west and north elevations (facing the street). This suggests that windows are not being opened in these flats perhaps due to the security risk from being on the ground floor at street level and reinforced by GSA notices to this effect.

Trickle vents located in an awkward position in the window- too high up and often students are not aware of them. A replacement window system with open able hoppers and well designed trickle vents would significantly improve the supply ventilation to the flats.

It must be concluded that if investment in upgrades to windows, heating and ventilation systems could be made then the students would have healthier indoor environments and re-decoration costs could be substantially reduced.

The following chapter outlines methods of improving the indoor air quality and levels of thermal comfort within the student living spaces in both the short and long term.

7.0 Recommendations for existing Margaret McDonald Halls and GSA's future student accommodation

This report highlights several immediate actions which could be undertaken to resolve re-current issues of dampness and poor air quality in the existing halls. Whilst it is acknowledged that GSA may not desire to incur costs on accommodation which may soon become redundant if new accommodation is secured, there are several key actions which require immediate attention to address the current dampness and mould growth problem currently evident. If these are not addressed these could have significant longer term cost implications for GSA- not only in the maintenance/ re-decoration costs but also potential legal claims arising from the provision of unhealthy spaces. The following recommendations address initial responses to the findings of this study:

Immediate actions for Margaret McDonald Halls

- Extract fan grilles in require to be cleaned urgently. Fan ducts to be checked for any leaks and blockages in all locations including roof level. However the majority of these extract fans have reached the end of their life and would benefit from replacement extract fans with humidistat sensors. Given the intensity of use within the shared bathrooms these could be upgraded to 30l/s extract fans.

- Ensure self closing devices in bathroom doors are operational to prevent moisture migrating to the bedroom.

- A solution to reducing heating/power costs would be to remove the existing Comfort Plus electric meters. If these were changed to domestic power meters by replacement of storage heaters with domestic convector heaters then a more competitive energy tariff could be negotiated perhaps as low as 9p per unit. The outlay cost to GSA would be the price of replacing the 18 heaters & utility cost of switching meters – the existing electrical connections are in the correct location. The new energy company will charge a nominal sum for the replacement of meters. Switching meters and communal heating will have instant reduction in energy costs in the entire flat will allow students to heat their rooms for longer periods of time potentially reducing reluctance to ventilate bedrooms. Whilst the cost of heating is not met by GSA , this report highlights that inadequate heating and ventilation of the flats leads to significant ongoing maintenance costs for GSA and produces damp, mouldy unhealthy indoor environments which could potentially led to serious student complaints.

- Negotiate a reduction in cost for the dryers in the laundry room to allow students a more cost effective solution for ad hoc drying clothes out with their bedrooms.

- Provide a student welcome pack to give advice on heating and ventilation use, trickle and window opening, etc.

- Ensure that each room has background heating on during mid-term and Christmas breaks (running costs paid for by GSA).

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Longer term upgrades (within a 2 year period)

- Replace windows with high performance double glazed timber framed windows (U value 1.6) with trickle vents and operable hoppers which can be left open all day without a security risk.

- Provide an effective means to dry a damp towel in bathroom. Install electrical towel warmers in bathrooms set on a thermostat to provide low grade heat (running costs paid for by GSA).

Recommendations for new GSA halls of residence
(A more detailed breakdown of recommendations would be the scope of further study)

- Providing students with a baseline comfortable indoor thermal environment. The students can then be given the opportunity to enhance this if they so desire at their own cost. This solution would be the most sustainable option in terms of providing GSA's students with healthy living environments which should increase their well-being. This baseline might be heating a room to 18 degrees from 6-9am and 6-11pm. Students have the option to turn it off if they require or have it on at other times (or increase temp) at their own cost. Establishing some additional costs onto the rent to cover baseline heating, hot water and clothes laundering might seem like a generous outlay but actually these make the greatest contribution to dampness and mould growth which could have significant long term costs implications for GSA.

- At design stage, specify high performance double glazed timber framed windows (with U-value to meet current building regulations) with trickle vents and operable hoppers which can be left open all day without a security risk.

- At design stage, specify a reputable MVHR systems, supplied and installed correctly and serviced regularly. As with any mechanical controlled system correct installation and on-going maintenance is critical. During construction installation of fans to be checked with fan pressure test prior to handover. GSA estates then need to ensure extract fans in bathrooms to be serviced on a regular basis.

- Provide an onsite laundry facility which allows each student the credit of 1 wash cycle and 2 drying cycles per week. Any more than this would accrue a charge.

- Issue a student occupant guide providing simple advice on how to live comfortably in student halls and keeping energy bills low. Habitual behaviour is a very difficult one to tackle and everyone has very different levels of thermal comfort and sensitivity to fresh air but providing clear written guidance may help both international students and those living away from home for the first time.

8.0 Appendices

- Questionnaire
- Statistical analysis of questionnaire data

Questionnaire – Glasgow School of Art Student Housing Evaluation Survey

Please complete in **BLOCK CAPITALS**

1.	Property Details							
1.1	How long have you lived in your current student halls?						Years	Months
1.2	How many people live in your flat?							People
1.3	Which level is it on?							
	Ground	1st	2nd	3rd	4th			
1.4	Please indicate what times your home is typically occupied during the week – circle your appropriate							
		Morning		Lunch		Afternoon	Evening	Night
1.5	Please indicate what times your home is typically occupied during the weekend – circle your appropriate							
		Morning		Lunch		Afternoon	Evening	Night
1.6	Does your flat face North/ South/ East or West ?							
1.7	Please describe all of the following domestic appliances you own and regularly use in your room.							
	Appliance	Number						
	Television							
	Personal Computer							
	Hair dryer							
	Desk lamp							
	List the others in the column opposite							

2.	Lighting							
2.1	Does your room receive direct sunlight?						Yes	No
a)	If yes, at what time of day?							
	Morning	afternoon	evening					
2.2	Do you close curtains/blinds during the day						Yes	No
a)	If yes, please indicate the reason why…							
2.3	Do you require artificial lighting to be switched on during daylight hours in your room?						Yes	No

3.	Laundry Practice							
3.1	How many loads of washing would you typically do on a monthly basis?							
	1 or less	2-3	4-5	More than 6				
3.2	Do you dry towels, bedding, clothing or other laundry in the communal laundry?						Yes	No

3.3	Do you dry towels, bedding, clothing or other laundry indoors in your room?			Yes	No
a)	If yes, please describe how you do this… e.g. on radiators, clothes horse, over doors etc.				
3.4	Where do you dry your towel after taking a shower?				
	On the bathroom door	In your room	On a radiator		
3.5	Do you open any windows while drying laundry internally?			Yes	No
3.6	Do you turn up the heating or keep it on for longer when drying wet clothes in your room?			Yes	No

4.1	When is your heating normally on?											
	Morning		Daytime		Evening		Overnight					
4.2	How easy to operate are the control systems for the heating?											
	Very difficult	1	2	3	4	5	6	7	easy			
4.3	How effective are the controls at maintaining comfortable conditions in your room?											
	Ineffective	1	2	3	4	5	6	7	Effective			
4.4	For how many months of the year is your heating normally on? Tick the months the heating is on											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Additional comments on heating system…											

5. Affordability

5.1	How would you describe the cost of heating your room to a comfortable level?									
		Inexpensive	1	2	3	4	5	6	7	Very expensive
5.2	How much do you pay per week on electricity in the flat?									
		Less than £5	£6 - £10	£11-20	More than £21					

6. Water

6.1	Does the hot water system provide enough hot water when you require it?	Yes	No
6.2	If no, do you use another source for hot water? (e.g. boiling kettle)	Yes	No
6.3	How many showers are taken in your room per week?		Per week
6.4	What is the approximate time taken for showering?		Minutes
	Additional comments on your water system…		

7. Indoor Air Quality

7.1	How do you ventilate your room?							
		Opening windows		Trickle vents		Mechanical ventilation		
7.2	In the bedrooms, are the following open or closed while sleeping?							
		Windows		Window Vents				
		Open	Closed	Open	Closed			
7.3	In which rooms do you have mechanical extract fans?							
	Bathroom	Bedrooms	Dining Room	Hallway	Kitchen	Living Room	Utility Room	Other
7.4	How are these operated?							
	Manually	Boost switch	Humidistat	Light switch	Other			

7.5	If you have a mechanical ventilation system, is it efficient at removing steam from your room?	Yes	No
a)	If no, do you open windows to improve air quality? If no, why?	Yes	No
7.6	Have there been any visible signs of condensation within the property…?	Yes	No

a)	If yes, please indicate where in your room/ flat.							
	Bathroom	Bedrooms	Dining Room	Hallway	Kitchen			
7.7	Have you noticed any mould or mildew on your walls/surfaces?						Yes	No
a)	If yes, please indicate which rooms in the property.							

	Bathroom	Bedrooms	Dining Room	Hallway	Kitchen			

We would like to thank you for taking the time to complete this questionnaire