Comhairle Contae County Council

Sash Window & Fabric Upgrade

Harbour Masters Lodge

Dun Laoghaire

Co Dublin

Contents

Building Description

The Harbour Masters Lodge building in Dun Laoghaire is a protected structure, built 1820. The building has single pane original sash windows that are very inefficient from a heat loss perspective, the glass currently has u-value of 5.4W/m^{2}K and the frames also perform very poor from an air tightness point of view. Cathal Crimmins Conservation Architects and Maclyn Conservation Joinery have been appointed as the experts to improve the performance of the windows whilst maintaining the heritage of the building.

Proposal Works to be Completed

Sash Windows

Full restoration of the original sash windows and front doors, this will improve the air tightness of the building. Air tightness at present is 13.88 m^3/hr/m^2, a second test will be required to determine the effectiveness of the upgrade.

Installation of secondary glazing on all original sash windows and balcony doors to include decoration. Secondary glazing to have spring balances and 6.4mm laminate glass. This will reduce heat loss through the windows to a proposed u-value of 1.7 and have further positive impact on air tightness. Actual u-value testing will be conducted to determine the actual value.

"Tests, which were carried out in 2008 at Glasgow Caledonian University to determine how best to improve the thermal performance of heritage windows, showed that the use of properly installed secondary glazing provides levels of insulation which can often be more effective than double glazing. The window with secondary glazing achieved a U-value of 1.7 W/m2 K"

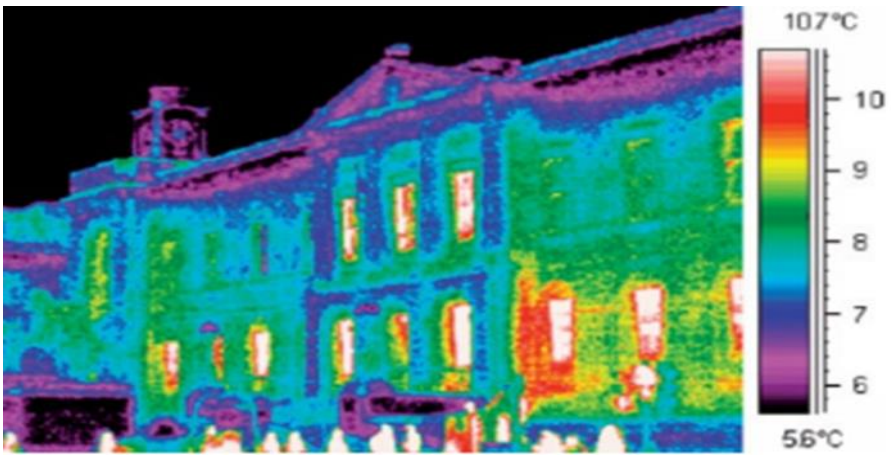

Figure 1 A graphic illustration of heat loss from a building in Edinburgh: most of the windows are single-glazed and are emitting more heat than the thermal imaging camera can record (the white areas); six windows on the top floor (the green areas) have secondary glazing and are cool.

Restoration Works – Maclyn Conservation Joinery Workshop

A site visit to Maclyn Conservation Joinery workshop was held on the 29th of November 2023 to gain an insight into the amount of work that goes into the refurbishment of protected timber windows with original glass. Also, the manufacture of the secondary glazing. The below bullet points give a brief indication of the process with images.

- Windows arrive in the workshop and are inspected for any visible rot and general condition.
- The frames are then placed into a steaming box for 7 minutes. The purpose of this is to soften the putty that holds the original glass in position.

Figure 2 Window for refurbishment & streaming box

- The softened putty is then carefully scraped out so the glass can be removed. Extra care must be given at this point as the original glass can be 2mm this or less in places and easily broken.
- Once the glass is removed, the layers of paint are removed with a heat gun and scraper. Great care must be given again at this point as to not damage the moulded profiles of the glazing bars.

Figure 3 Frames cleared of putty and original glass

- If the glazing bars or frames are rotting or damaged these will be replaced with Mahogany timber.

Figure 4 Frame & glazing bars repaired with Mahogany

- If the glazing bars need to be replaced and have an old obsolete profile, a bespoke router bit must be manufactured by a specialist steel manufacturing contractor to match the existing glazing bars.

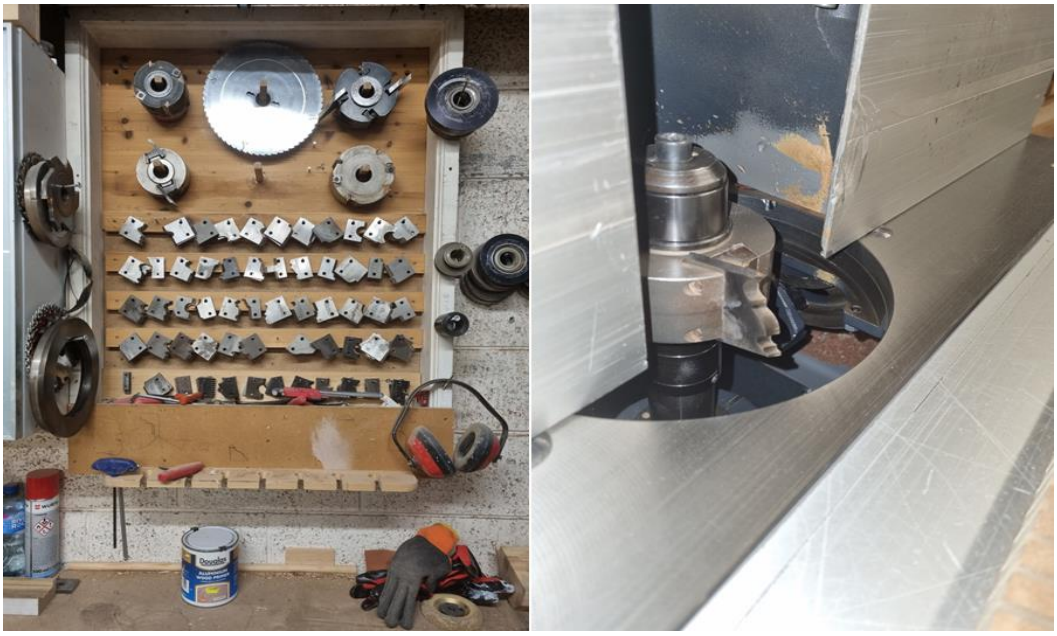

Figure 5 Routing machine with various profile bits

- Windows can be sanded and inspected for further repairs, fame, joints etc. and repaired with Mahogany.
- The frames can be painted without the glass installed.

Figure 6 Frames painted & ready for glazing

- The frames are ready to be reglazed with the original glass if possible. Linseed based putty is used to secure the glass into the frames and make an airtight and watertight seal. The putty takes approximately six weeks to cure before being painted.

Figure 7 Glazing installed with linseed putty

- The completed windows are weighed to determine the counterweights to balance each side of the sash for smooth opening and closing.
- The secondary glazing is manufactured from Poplar timber. The sash windows will have a spring tension balance to match the weight of the new windows.

Figure 8 Secondary glazing frames - unfinished

Insulation & Repairs

It is proposed to insulate behind various voids around the bay window areas as this will further reduce the current u-values and increase the efficiency and comfort of the protected structure.

Locations are shown in figure 2

- Voids behind radiators – varying depths
- Voids behind shutter boxes – varying depths
- Voids at the heads of bay windows – unknown depths

Figure 9 Void behind radiator exposed & behind shutter box marked in yellow

Implementation & Progress

Week one starting 13/11/2023

All sash windows removed from the boardroom and brought to Maclyn's workshop for repairs and refurbishment. The secondary glazing will be manufactured at the same time. The radiators have been removed and all panelling behind and to the sides of radiators exposed for inspection of the voids. Masonry was found to be in good condition and dry. However, there are varying depths in voids, this will have an impact on the thickness of insulation to be installed with slightly differing u-values. The bottoms of existing window frames were found to be rotten; these have been repaired with mahogany seen in the image below.

Insulation installed behind the radiators and side panels. Insulation type, Woodfibre and Pavacell db which were supplied by Soprema.

Note – all alarm sensors must be removed from the windows and to be reinstated by the alarm monitoring contractor as an extra, G4S have the maintenance contract at this time.

Figure 10 Bottoms of all window frames rotting and repaired with Mahogany

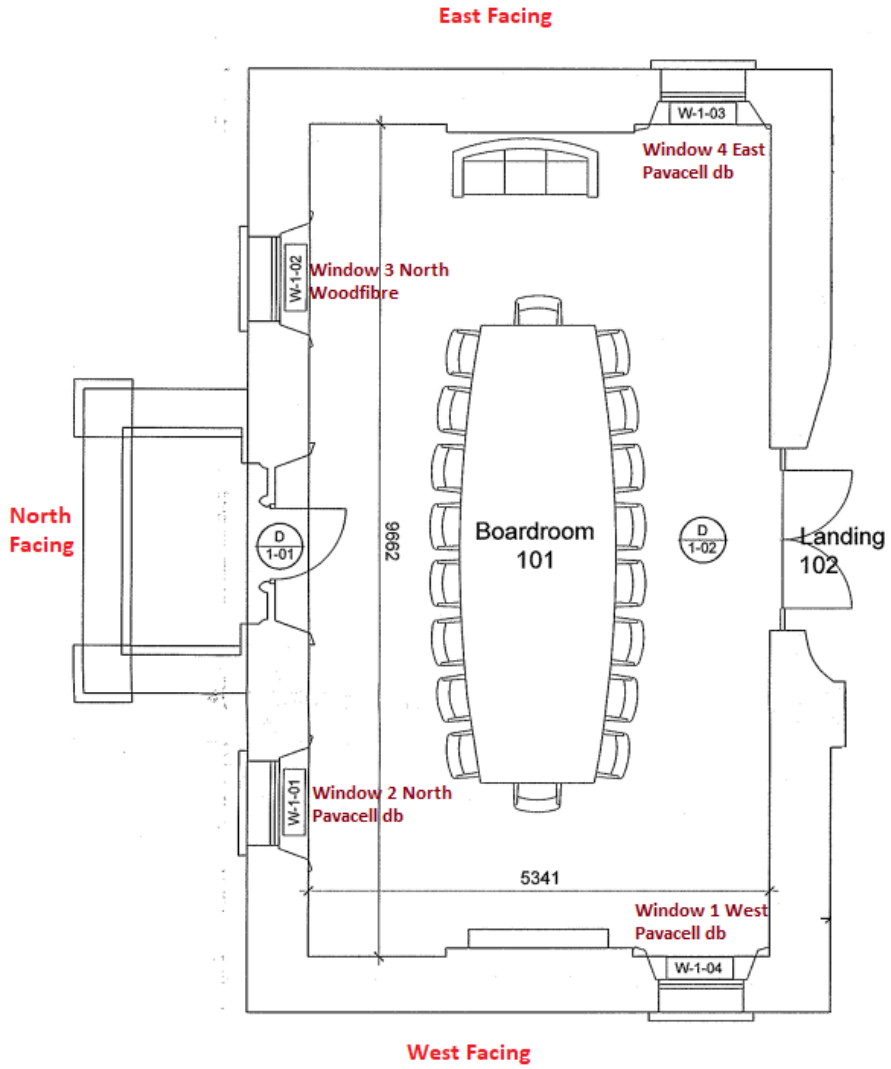

Figure 11 Boardroom window numbers with insulation types

Figure 12 Boardroom window 1 west insulated with 50mm Pavacell & panel reinstalled

Figure 13 Boardroom window 2 north insulated with 70mm Pavacell & panel reinstalled

Figure 14 Boardroom window 3 north insulated with 80mm Woodfibre & panel reinstalled

Figure 15 Boardroom window 4 east insulated with 50mm Pavacell & panel reinstalled

Week two starting 20/11/2023

Maclyn staff are not required on site. All planned works in the boardroom have been implemented while the windows are being refurbished in their workshop. All of the window have been identified and openings secured with 20mm ply wood.

Figure 16 Window openings secured with ply

Week three starting 27/11/2023

Original refurbished windows are being reinstalled as they arrive on site and painted.

Figure 17 Original refurbished windows reinstalled in the boardroom

Figure 18 Mock-up of the secondary glazing for visual purposes

Week four starting 04/12/2023

The stripping out works have begun in the downstairs offices and WC areas. The same works process as the boardroom, remove windows, remove alarm sensors, secure openings etc. The masonry was found to be in good condition, dry and free from rot. The voids behind the radiators were again found to be varying thicknesses, this impacts the u-value.

Figure 19 Office window opening secured & masonry exposed

Week five starting 11/12/2023

All window bay areas have been insulated in the downstairs areas and panelling reinstated. Pavacell dB has been used in the shutter box in all areas and behind radiator panels in the east and west facing windows, approximately 80mm of insulation. The downstairs north facing window bays which are to be u-value tested by the UCD team have hemp fibre insulation and rockwool both within the region of 70mm thickness behind the radiator panels. Windows outlined below. All the refurbished original sash windows have now been reinstated.

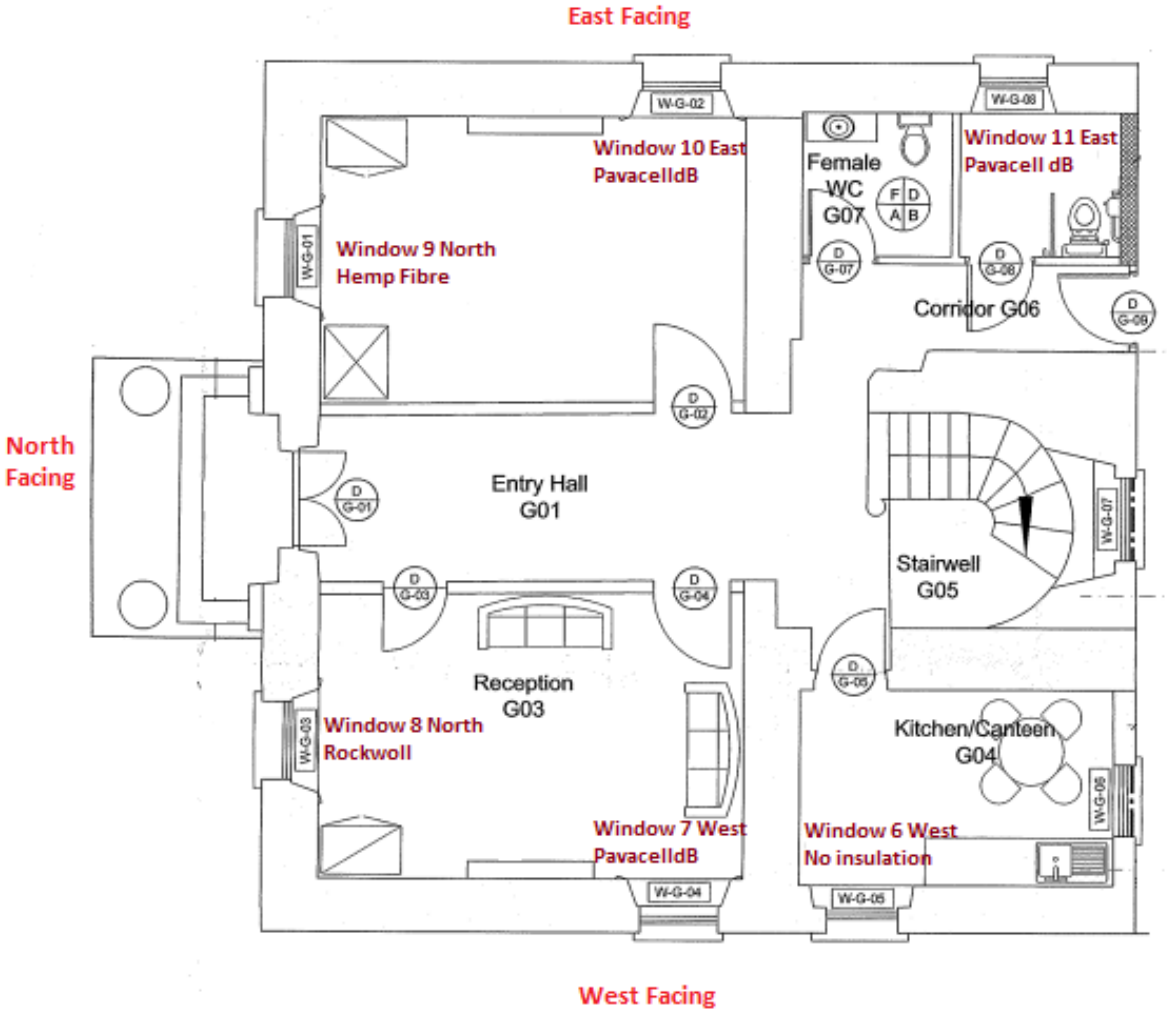

Figure 20 Ground floor window numbers with insulation types

Figure 21 View of original refurbished windows - inside & out

Week six starting 18/12/2023

All the radiator panels have been filled and painted, this is an additional extra and is required to facilitate the reinstallation of the radiators, which have also been completed. The main front double doors have been repaired at the base and new seals have been installed as an additional air tightness measure.

Figure 22 Slips installed on main double doors & retro seals

Week seven starting 08/01/2024

All the original sash windows will require a finish coat of paint on the inside and outside of the frames before the secondary glazing is installed. The correct process for painting sash windows is to remove the sashes from the frames and finish the painting out of position, this is done to ensure that the sashes don't stick to the frames and the seals don't get painted. This process will take approximately three weeks for all of the refurbished windows.

Secondary glazing installed in the downstairs offices. Window locks and handles to be changed to suit the new configuration of opening and closing the double sash setup.

Figure 23 Inside & outside view of secondary glazing complete on ground floor office

Double glazing panels are to be fitted to the first floor WC window, the was no scope to install secondary glazing

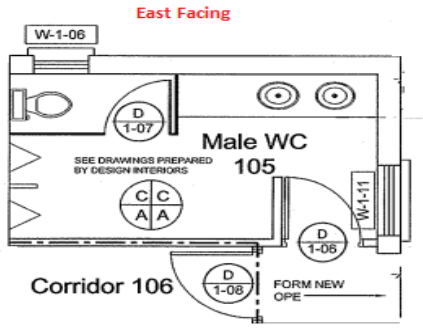

Figure 24 First floor WC sash window to be double glazed

One office window will require a solar and privacy blind, there has been a build up of pedestrian traffic since the new walkway has been constructed with the student apartments. The walkway is directly linked to the east side of the office in question and has a clear view into a DLR staff workstation and PC.

Figure 25 Blind to be installed on one window adjacent to pedestrian walkway

Week eight starting 15/01/2024

Painting the sash windows will continue through week eight and nine. The ironmongery is installed to the original and secondary sash windows, handles and locking mechanisms. The balcony doors to have bespoke brass framed double glazing panels fitted over the exposed existing single glass panels.

The frame for the balcony doors required two different repairs,

1. The frame was significantly cracked on the hinge side at the bottom, required to be cut out and replaced with mahogany.
2. Driving rain was getting into the right side of the frame where it meets the granite, this had live rot due to this.

Figure 26 Areas repaired at the balcony doors

Figure 27 Laminate glass glazing panels on balcony doors

Effectiveness Test Results

Thermal Imaging

The below thermal images were taken on January 16th, 2024, at 12pm on a north facing window in the downstairs office, the outside air temperature was 4 degrees. The pictures are depicting the same window with the secondary glazing open in the top image and closed in the lower image. The picture with the open glazing exposing the original single pane sash window has a minimum temperature of 4.7 degrees, when the secondary glazing is closed the temperature very quickly increases to 14.9 degrees, this is a temperature difference of 10.2 degrees or a 68% increase in surface temperature.

Figure 28 Thermal image with secondary glazing open

Figure 29 Thermal image with secondary glazing closed

New U-Value

A series of thermal performance tests on the building envelope of the DLR Harbour Master's Lodge were conducted. Results from the tests conducted on windows and Wainscot panels located behind the radiators are discussed below.

The test period for the single glazing achieved a U-value of about 5.4 W/m^{2}K. Irish Building Regulations- Technical Guidance Document Part L (TGD Part L) 2022 suggests an average U-value of a maximum of 1.60 W/m^{2}K for the retrofit of existing windows.

The test results with the secondary glazing in position gave a result of 3.24 W/m^{2}K and was conducted over a six-day period. These results do not align with TGD guidelines or test results from Glasgow Caledonian University which are stating 1.6 to 1.7 W/m^{2}K. However, a note from the test team in UCD states *"**Please note**: the results are not accurate as per ISO standards as the U-value fluctuations are too high. This is visible in the heat flux fluctuations when the **radiators below the windows were turned on** as represented in the graph. Actual U-values are expected to be lower".*

Using the result from the latest test period of 3.24 W/m^{2}K, this gives a U-Value reduction of 40% and will have a positive impact on energy efficiency and building comfort.

The below graph shows high fluctuations which indicates radiators being turned on through the six-day test period.

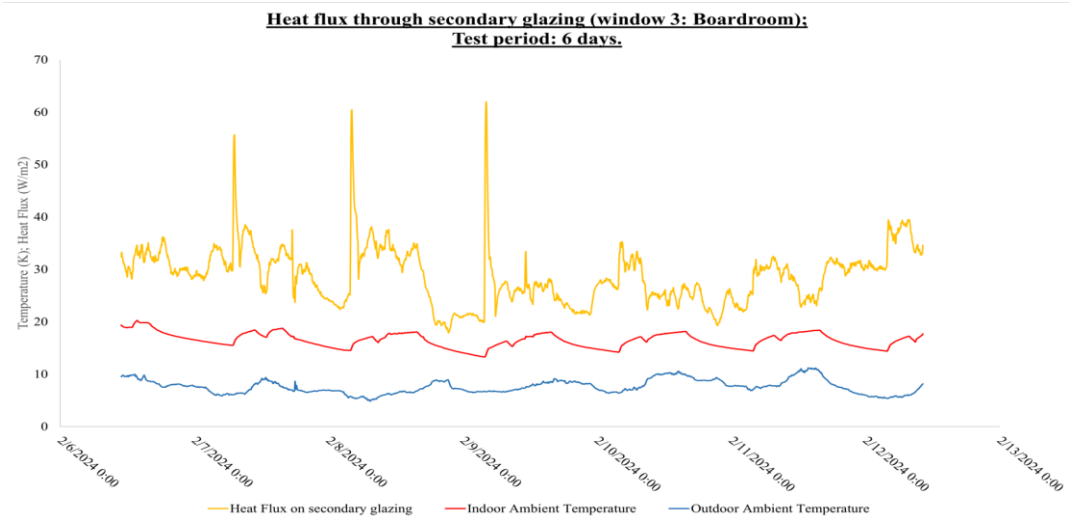

Figure 30 U-Value results graph on secondary glazing

Similarly to the window U-Value testing, the Wainscot panels behind the radiators were tested in conjunction with the windows.

The testing method for the Wainscot panels was conducted in several areas of the panels due to the unknown void depths. Irish Building Regulations – Technical Guidance Document Part L (TGD Part L) 2022 will not be applied here due to the unknown variables.

The results from the U-value tests conducted on the panel below the window 3 at the DLR Harbour Master Lodge's boardroom window. There were two test areas, the centre point and the bottom of the panel.

1. U-value at the centre of the wainscot panel – 0.85 W/m^{2}K
2. U-value at the bottom panel – 1.48 W/m^{2}K
3. Average U-value for both test areas – 1.16 W/m^{2}K
4. Average indoor ambient temperature – 19.5°C
5. Average outdoor ambient temperature – 16.4°C

Comment from the UCD test team – "*The U-values shall be treated as indicative only as the testing standards recommend a minimum of 10°C difference between the indoor and outdoor ambient temperature. Here we only have a 3°C difference.*"

The results from the U-value tests conducted on the panel below the window 3 at the Harbour Master Lodge's boardroom, post-retrofit U-value of 0.38 W/m^{2}K over a 6-day test period with 80mm thickness wood-fibre insulation. This is a 67% reduction in U-value in relation to the average and will have a further positive impact on the building energy efficiency and building comfort.

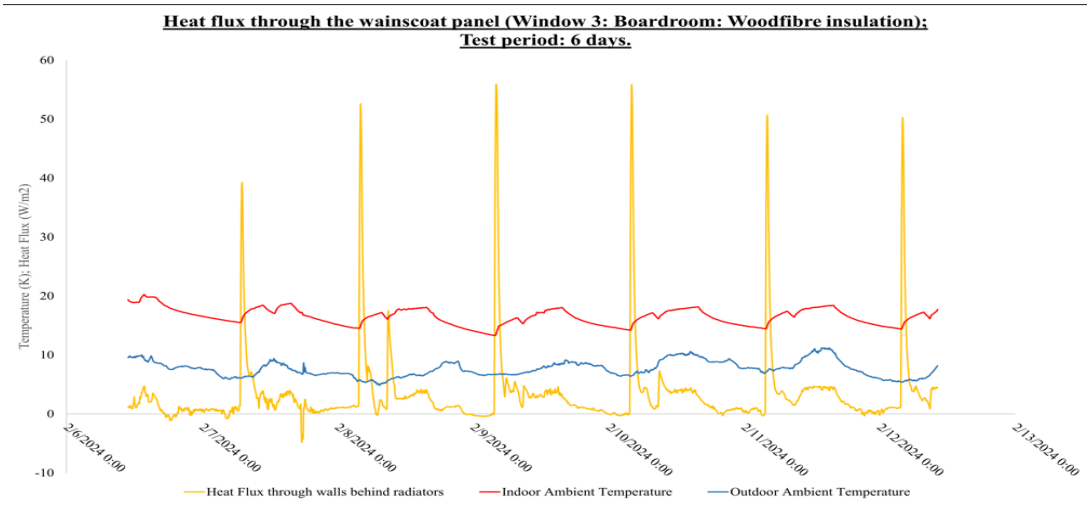

Figure 31 U-value result graph on Wainscot panel

Air Tightness

The pre-upgrade air tightness testing took place on 24/05/2023. The result for the whole building envelope air leakage rate was 13.66 $m^3/hr/m^2$ at an inside to outside air pressure differential of 50Pa (Pascals). The building envelope includes external walls, floors and ceilings. Building Regulations – Technical Guidance Document Part L – Conservation of Fuel & Energy in Buildings other than Dwellings advises that procedures will be put in place on site to achieve an air permeability of 5 $m^3/h.m^2$ @50Pa, if possible.

Results	
Air flow at 50 Pa, [m^3/h]	**12050**
Air changes at 50 Pa, n_{50} [/h]	**8.33**
Flow per Envelope Area at 50 Pa, [$m^3/h/m^2$]	**13.662**
Flow per Floor Area at 50 Pa, [$m^3/h/m^2$]	**54.108**
Effective leakage area at 50 Pa, [cm^2]	**3675**
Equivalent leakage area at 50 Pa, [cm^2]	**6030**
Leakage per Envelope Area at 50 Pa, [cm^2/m^2]	**4.164**
Leakage per Floor Area at 50 Pa, [cm^2/m^2]	

Figure 32 Pre-upgrade air tightness results

The post upgrade air tightness test took place on 07/02/2024. This test was broken into two parts to attempt to identify the effectiveness of the restoration work on the original windows and the result of the addition of the secondary glazing.

1. Secondary glazing sash windows open to test the restoration works on the original windows – results are 13.55$m^3/hr/m^2$.
2. Secondary glazing sash windows closed to test the entire upgrade works – results are 12.14 $m^3/hr/m^2$.

It is evident that the air permeability of the building does not align with TGD Part L recommendations of 5 $m^3/h/m^2$ after the after the secondary glazing upgrade. It is advisable that the envelope of the building should be inspected further to identify the excessive air infiltration as there is only an 11% improvement on air permeability.

Note from the air tightness assessor – *"Retests not good but an improvement. On the night of the retest one of the spotlights in the ceiling dislodged when we went to refit the light, there was an excessive amount of air flowing through the hole where the light had dislodged from."*

Conclusion

The sash window and fabric upgrade project at the Harbour Masters Lodge presents a minimally invasive plan to improve the building's fabric while preserving its heritage. The upgrade works, including the full restoration of original sash windows and the installation of secondary glazing, are aimed at enhancing the building's thermal performance while maintaining its historical integrity. Additionally, the progress schedule provides insight into the detailed approach taken to address issues such as insulation into available voids, original window restoration and secondary glazing installation. Overall, the secondary glazing and fabric upgrade project at Harbour Masters Lodge shows an appropriate blend of modern energy efficiency solutions with traditional architectural preservation. It provides a method for sustainable conservation practices and could set a benchmark for DLR future energy upgrades of historic buildings.