Does the positioning of a convection-based pew heater make a difference to its effectiveness?

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Introduction

This is a question that came about following a visit to a church in early 2024 and hearing how they weren't finding their under pew heaters (which they've had for around 20 years) very effective, and they were turning them on around 3 hours before a service to take the chill off. The heaters had been mounted on the back of the pew, rather than underneath the pew seat. The reason for this positioning was that this is the location of the previous tubular heaters, so the cable runs were already established, and there would be no need to repair any damage from the previous installation. But the manufacturers of the pew heaters suggest that they should only need a few minutes to warm up.

The testing that was undertaken on that day showed that there was no significant change in the air temperature around a person sitting on the pew, and the temperature of the pew seat did not increase, however there was an increase in the temperature of the pew back, above where the heater was mounted. This raised the question of how large is the column of warm air created by an under pew heater, and how much of a difference does the mounting position of the heater make? What follows is a summary of findings from several different trials and experiments, and thanks go to all those at All Saint in Sandon, particularly Leigh Smith, for assisting and providing a church for the initial tests, and Emma Critchley for prompting those original comparison tests specifically to demonstrate the impact.

You'll be pleased to know that most of the rest of the report is pictures which hopefully tell their own story, but if you're the type to skip to the end of a book then there's no need. **If you have convective under pew heaters such as those from BN Thermic or Electric Heating Solutions, make sure they're located under the pew seat if they can be. They will be more effective, and cheaper to run than positioning them elsewhere.**

Findings

The photos below show the arrangement of the pew heaters, mounted to the pew backs. The heaters are from BN Thermic, rated at 300W, and installed around 2006. The right hand image was taken with a thermal imaging camera and shows where the wooden pew backs have been heated by the flow of warm air. It can be seen that the pew seat remains cold, although there is an indication that where the seat base and back meet there is some warming taking place. During this trial in March 2024 the air temperature was around 7C.

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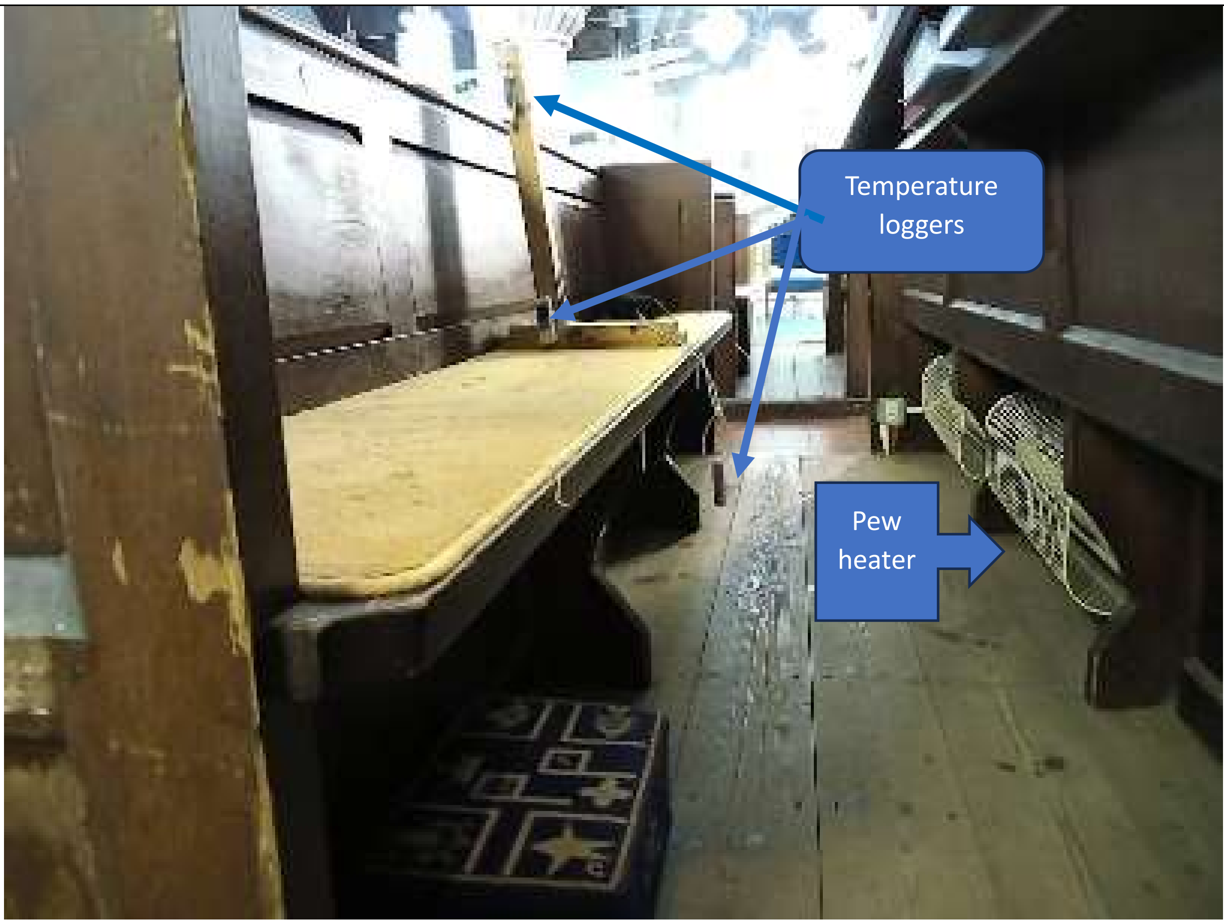
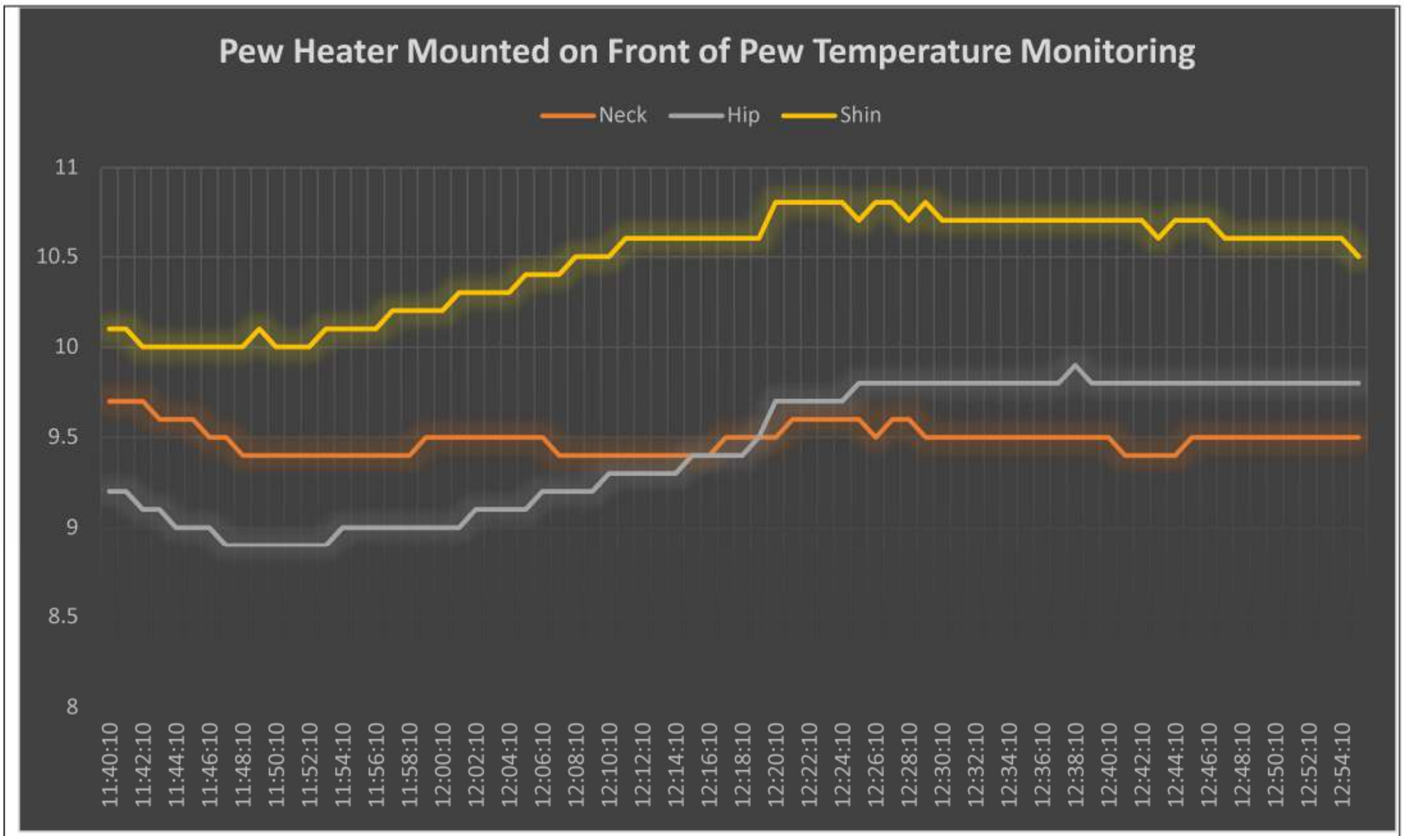
The next photos show the pews from a different angle and 40 minutes later show that the pew back has been warmed, but the seat base is still relatively cold. The pew runners could be preventing some of the heat from showing through as they would be working as an insulator.

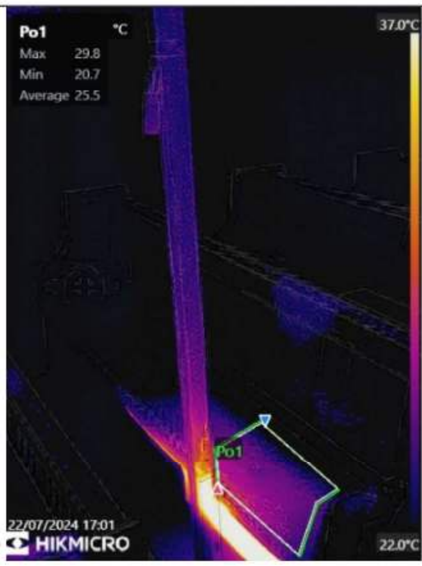
Please note that the colours in these thermal images MUST NOT be used to compare with the thermal images in the following tests because the temperature scales are different. This is partly because the images were taken at different times of year, and the background temperatures are substantially different. All of temperatures shown above are below the temperatures shown in the images captured in the following trials.

The chart of the air temperatures for someone sitting on a pew are shown below, and cover a period of around 75 minutes. It can be seen that there were negligible rises in temperature experienced by any body part, with the maximum temperature rise being around 1C.

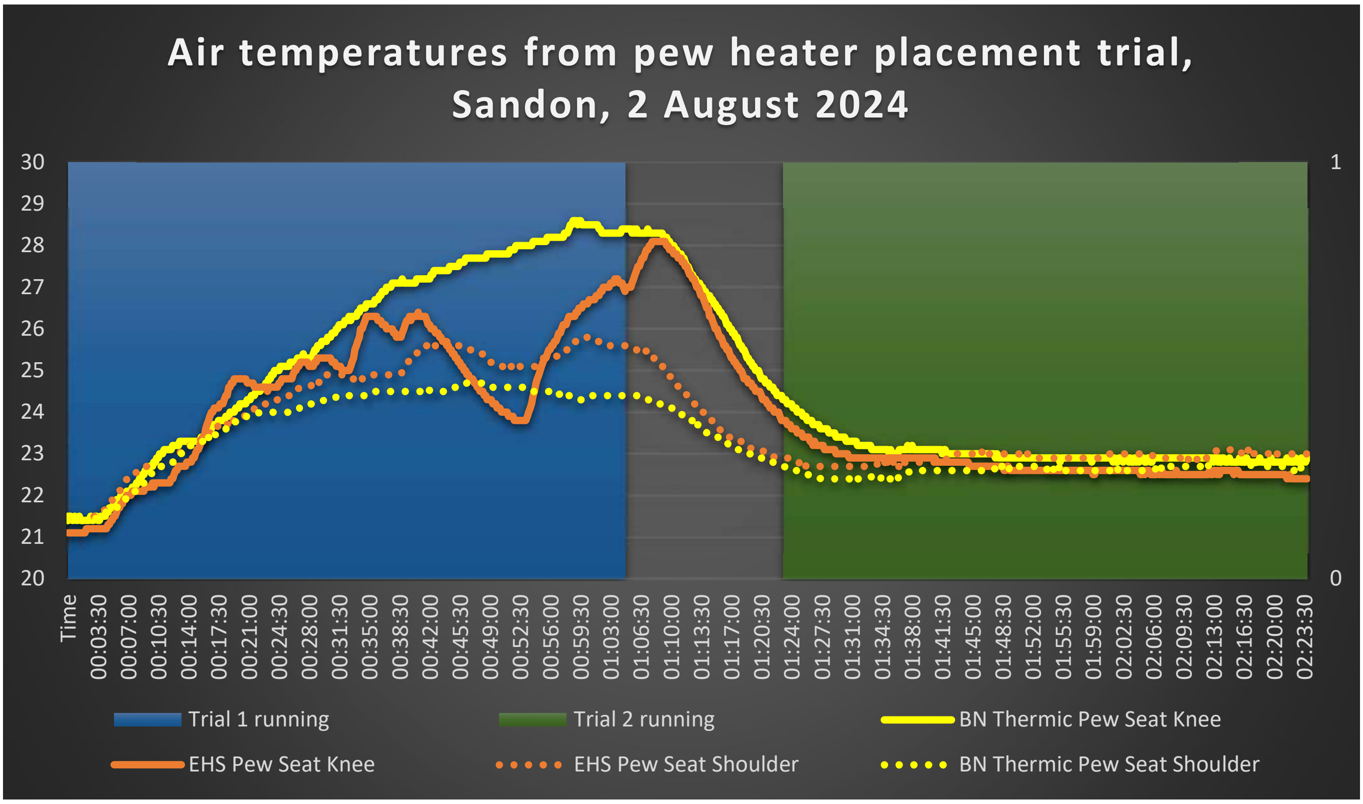




The images below were captured during a comparative heating trial in Sandon. This was run using an Electric Heating Solutions under pew heater mounted on a temporary stand underneath the pew seat. The thermal image in the middle shows the seat temperature (20.8C) at the start of the test. The thermal image on the right shows the pew seat temperature (25.5C) at the end of the test, around 75 minutes later. It should be noted that this trial was run in mid August. During winter the rate of heat transfer to the wooden pew would potentially be faster. During this trial in August 2024 the air temperature was around 23C.



The graph below shows the air temperatures from trialling positioning pew heaers from BN Thermic and Electric Heating Solutions under the pew seat (Trial 1, blue box), and against the back of the pew in front, similar to the church where the potential problem was identified (Trial 2, green box) with a 20 minutes cool down period (which ideally would have been longer). While additional measurements were taken, the results below show quite clearly that there was negligible air temperature rise experienced be someone standing uring the second trial, but notable temperature increases at both knee and shoulder height in the initial trial with the heaters placed as intended.



It can be seen that there was a drop in the knee temperature from the EHS heater after around 40 minutes. It is unclear what caused this, but may have been an internal thermal cut-out in the heater.

Determination of the size of the warm air plumes

The images in the next section were obtained to simulate placing under pew heaters from both BN Thermic and Electric Heating Solutions in different mounting positions, and to show how the mounting position will impact on where the warm air flows. Markers have been placed on to a piece of black corrugated polypropylene. The right hand row are aligned with the ‘front’ of the pew. The middle row are 150mm (6”) in front of the pew. The left hand row are 300mm (12”) from the front of the pew.

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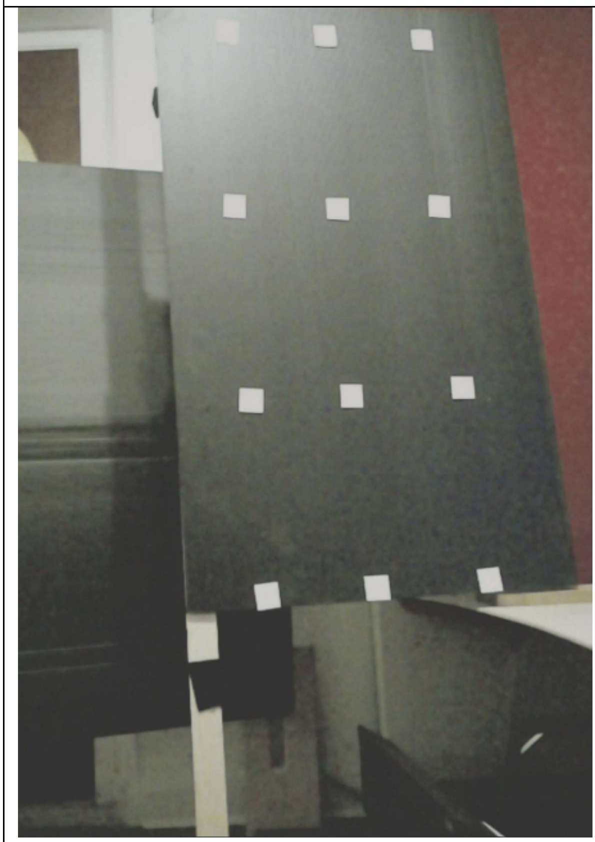
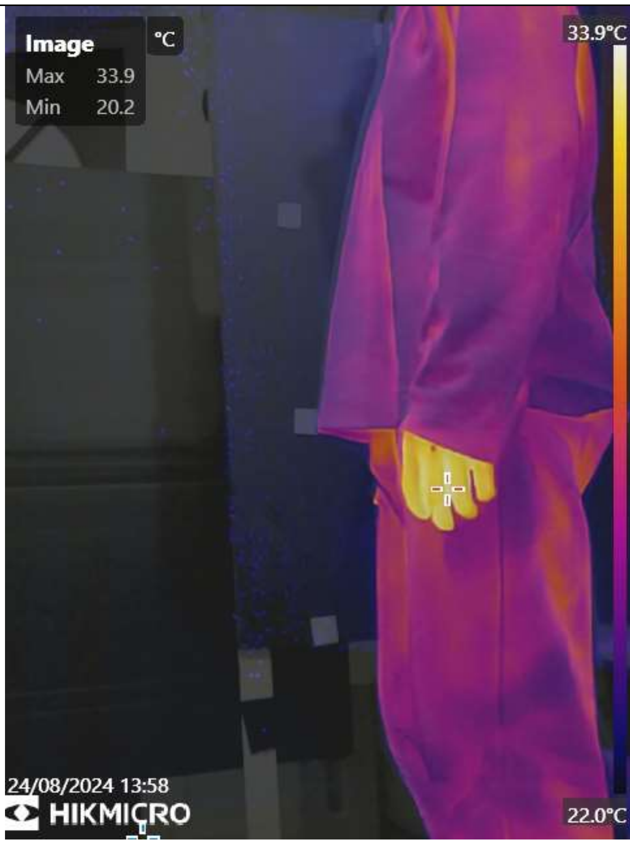
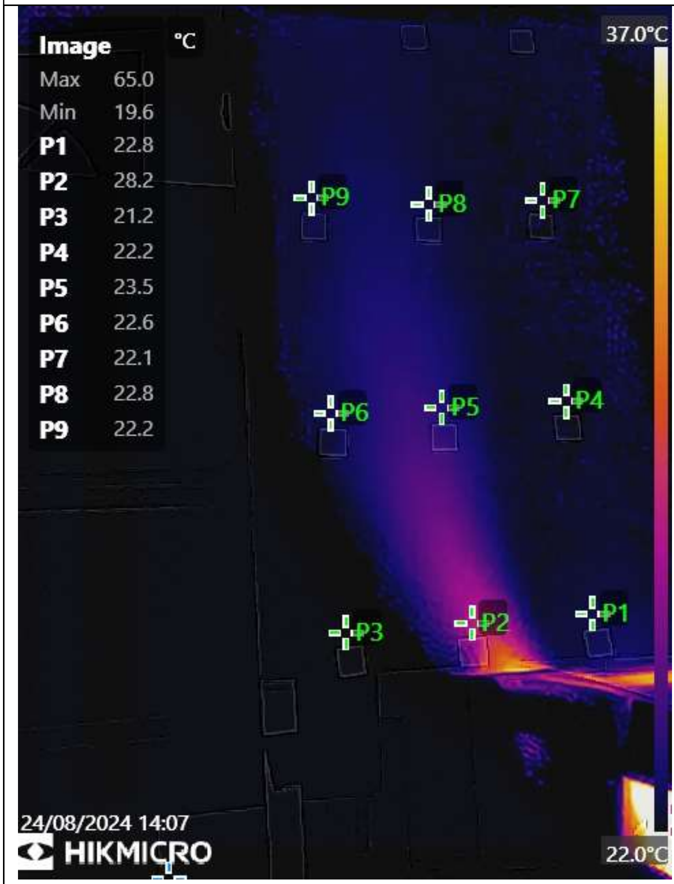
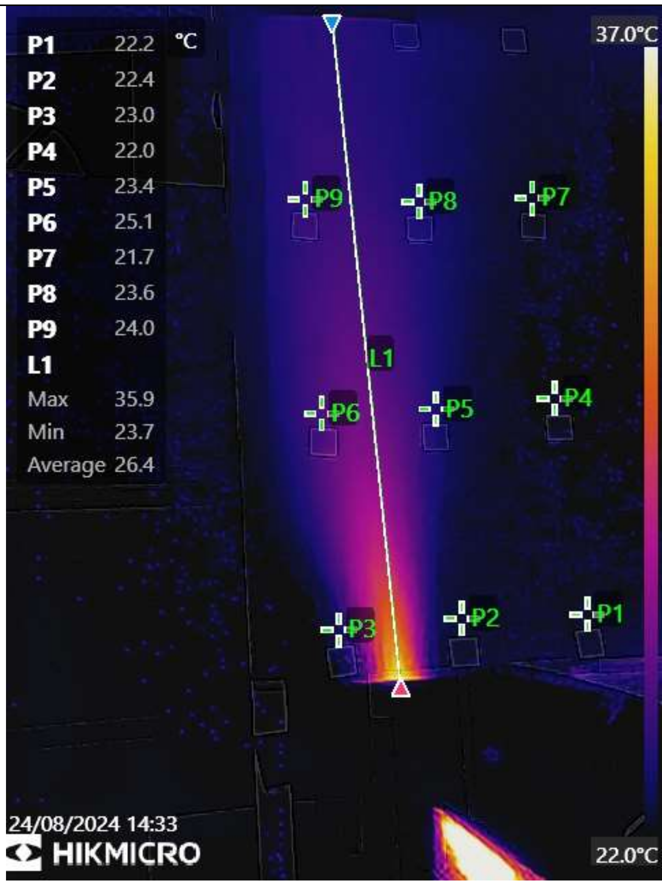


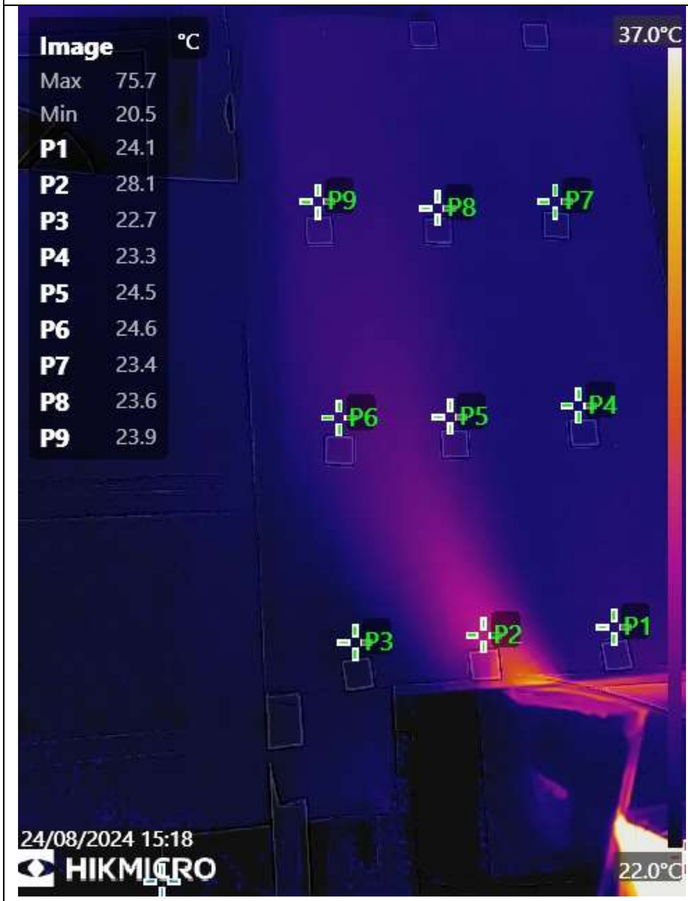


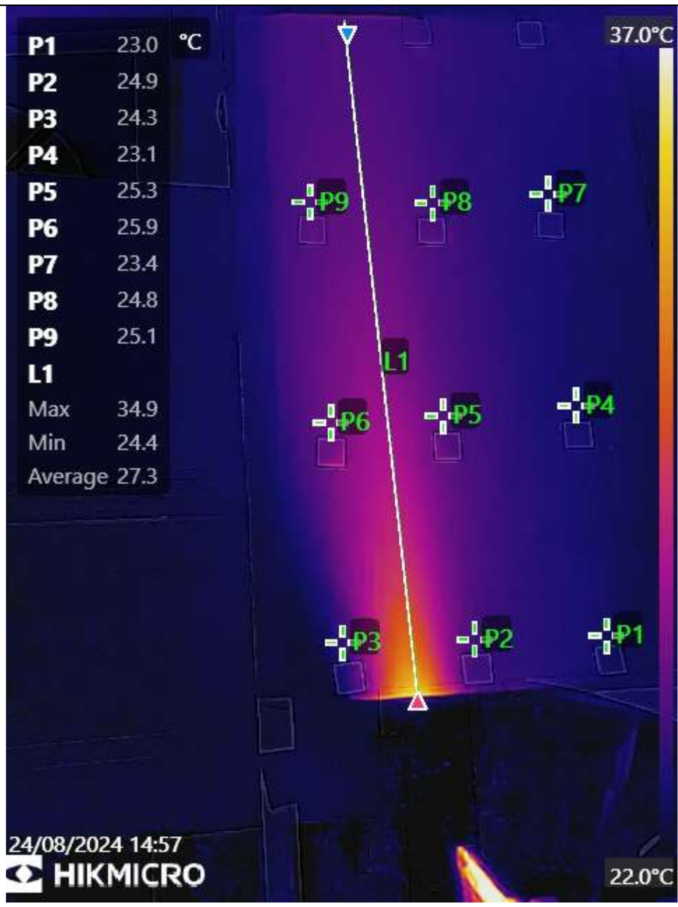
These images are of a BN Thermic under pew heater. In the left hand image the heater is mounted on floor mounts at their maximum height, with the front of the pew heater 200mm behind the pew front. The warm air peaks around 150mm from the pew front, and travels diagonally upwards. In the right hand image the front of the heater is in line with the middle row of markers. The warm air flow is much closer to vertical, with the line of the warmest air being only slightly in front of the heater.





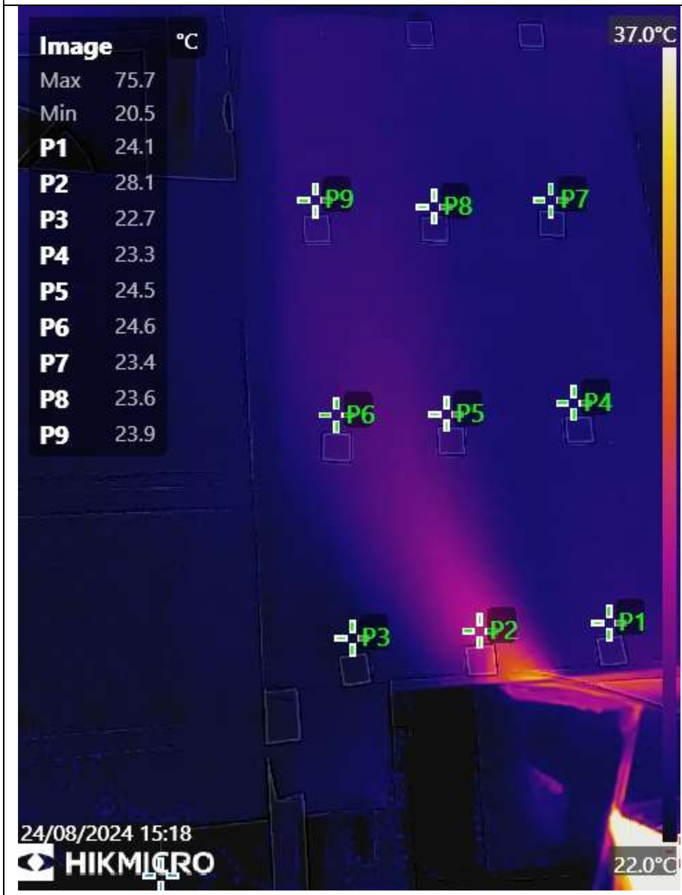
The following images are using an Electric Heating Solutions under pew heater. Again the image on the left is with the heater mounted on the floor with the front face of the heater 200mm behind the pew front. The right hand image has the heater mounted directly below the middle (vertical) line of markers. The heating patterns follow the same basic trends as those identified with the BN Thermic heater with a very narrow vertical plume when the heater is not mounted under a pew seat, and with a slightly wider plume when there is a seat above the heater.

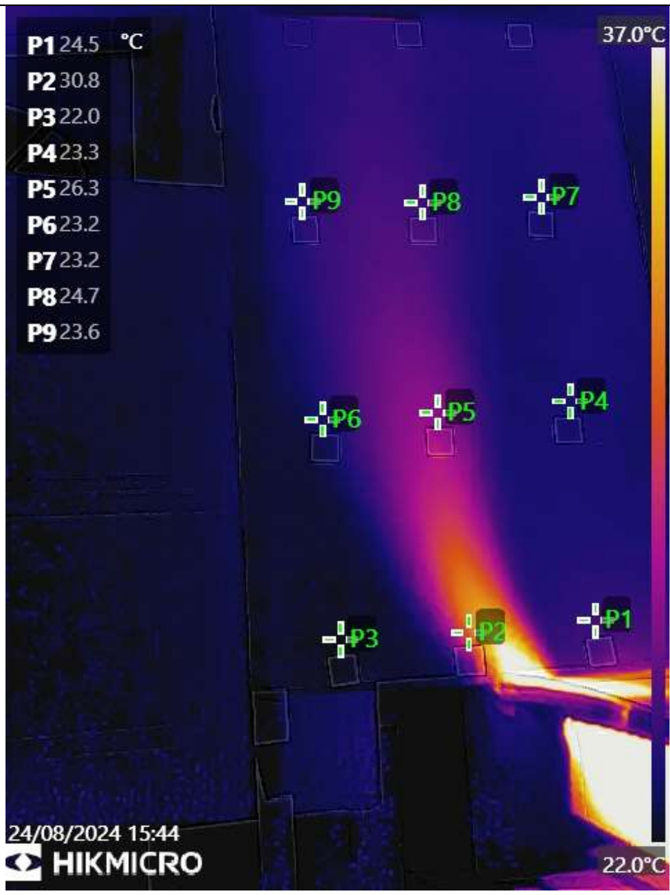




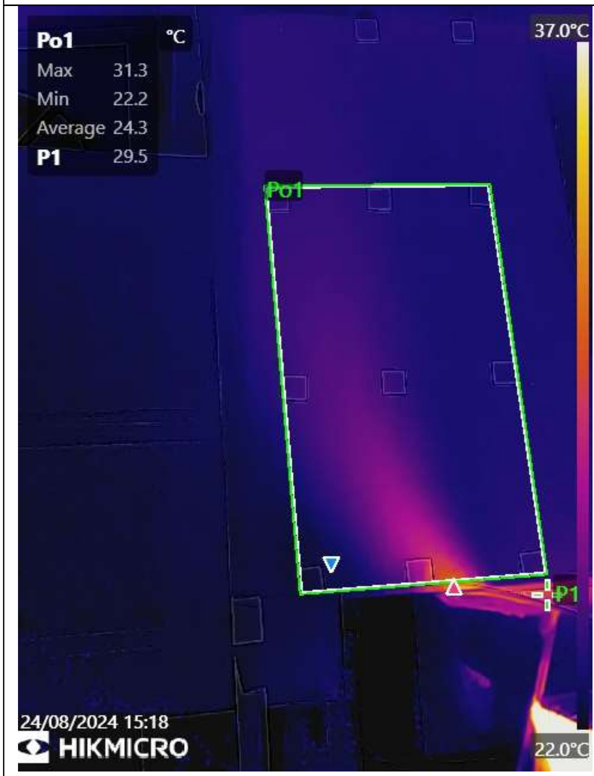
An additional test was undertaken to determine whether the positioning of the heater under a pew would impact on the warm air dispersion. These images were generated using the EHS pew heater. In the image on the left it is mounted on its floor mount. The top of the heater is 320mm (13") below the pew seat, and 200mm (8") from the front of the pew seat. In the right hand image the top of the heater is 80mm (3.5") below the pew seat, and 100mm (4") from the front of the pew seat.

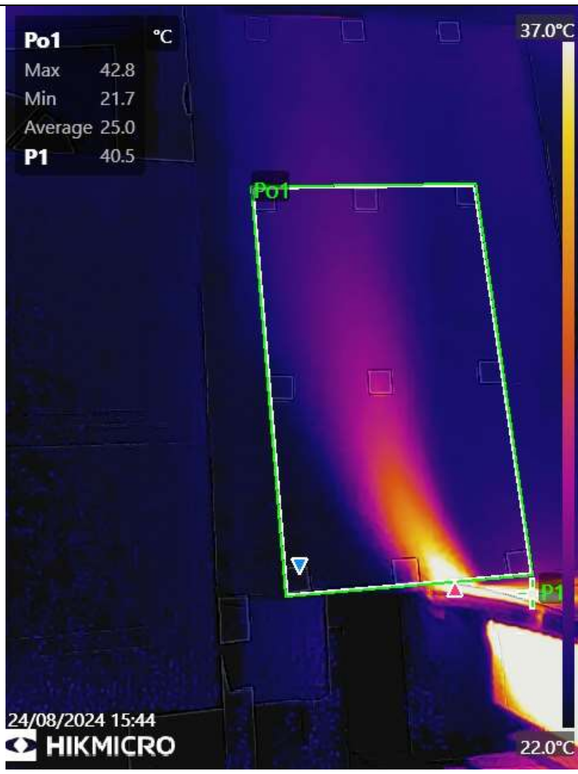
It can be seen that the placement of the pew heater in relation to the front edge of the pew seat impacted on the airflow. In the right hand image not only are the temperatures of the plume more intense, but the angle of the warm air flow is also closer to vertical, with the warm air also appearing to reach greater heights.





The images below are from the same test and provide peak and average temperatures in the same area. The right hand image has a peak temperature almost 12C higher than the left hand image, although the average temperatures are only 0.7C different. Of note is also the point (P1) temperatures on the 'pew' seat, with the higher mounted heater resulting in an 11C higher temperature. This would be lower with thicker wood, however it highlights the potential impact that different mounting heights can have on the pew surface temperatures.





There would likely be knock on consequences which should be explored. Two of these potential consequences are the risk of an uncomfortable level of heat just as the warm air escapes from under the pew, and if the heater is mounted higher, the radiant heat will be further away from the congregants feet, which may impact on overall thermal comfort.

The positioning of the pew heater will also impact on it's vulnerability to being kicked, and this could also be considered in the design process.

Opportunities for further exploration

1. Timelapse thermography to determine the rate of warming of a pew seat during winter conditions. It should be noted that this will vary with the wood and pew seat thickness. It is also likely to vary depending on the distance from the top of the pew heater to the base of the pew.
2. Explore the impact of different positioning of under pew heaters, both vertically and horizontally from the front of the pew. Ideally this would be undertaken by the manufacturers so they could recommend optimised mounting positions.

Recommendations:

1. Churches with existing convective pew heating which isn't located under the pew seat should consider trialling moving some of the heaters to be underneath the pew seats (with appropriate permissions) to confirm the impact on comfort and pre-heat times (the reduction of which will reduce energy use, cost, and carbon emissions) for their church.

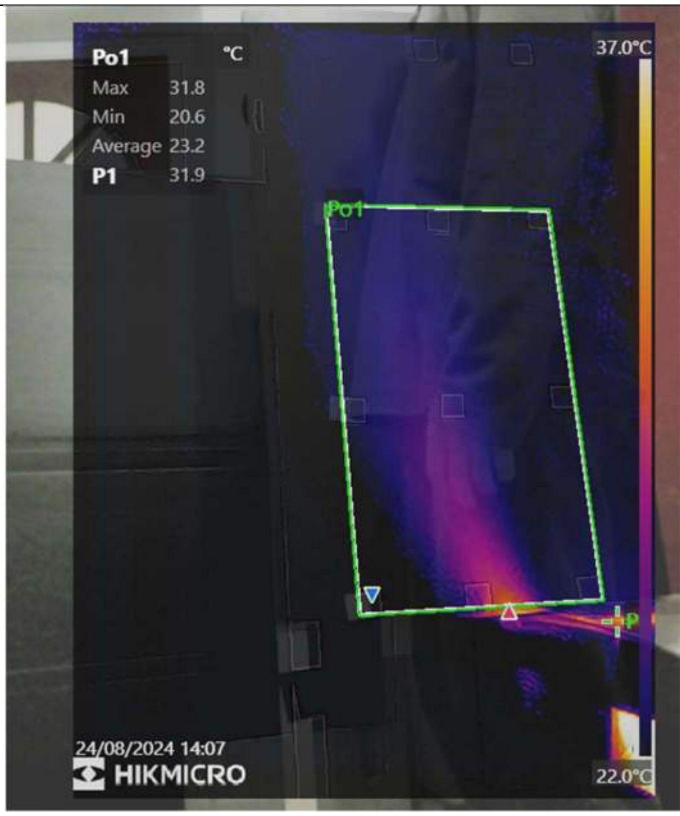
Note on the thermal image temperature measurements:

As a note the emissivity of wood is generally around 0.85, and this would effect the actual temperature readings given. The emissivity was not adjusted to take account of this, therefore the actual temperature readings will be slightly out, however they all should be incorrect by the same amount. The intent of the thermal images is to show the change in temperatures in an easy to understand manner, rather than to record the actual temperatures.

Appendix 1 – Thermal Image Overlay

The below images were merged to try and illustrate the difference in the warm air flows in relation to a person standing with the back of their leg an inch or two in front of the pew seat. The left hand image required the thermal image to be flipped to make sure the front of the heater was pointing in the right direction, and the heater was then positioned in line with the edge of the measurement material, 450mm (18”) from the front of the pew. This may be a little closer than actual installations. For the right hand image the thermal image was aligned directly with the base image. They are both of the BN Thermic heater.

As can be seen above, the warm air flow, at best, will skim the front of the person. If they’re lucky it will flow up the gap at the bottom of their jumper.



In this image the flow of the warm air will be broadly in line with the persons hands, and then up the front of the body. In reality the air would need to move around the person, so there would be some warm air flow up their back as well as around their front.