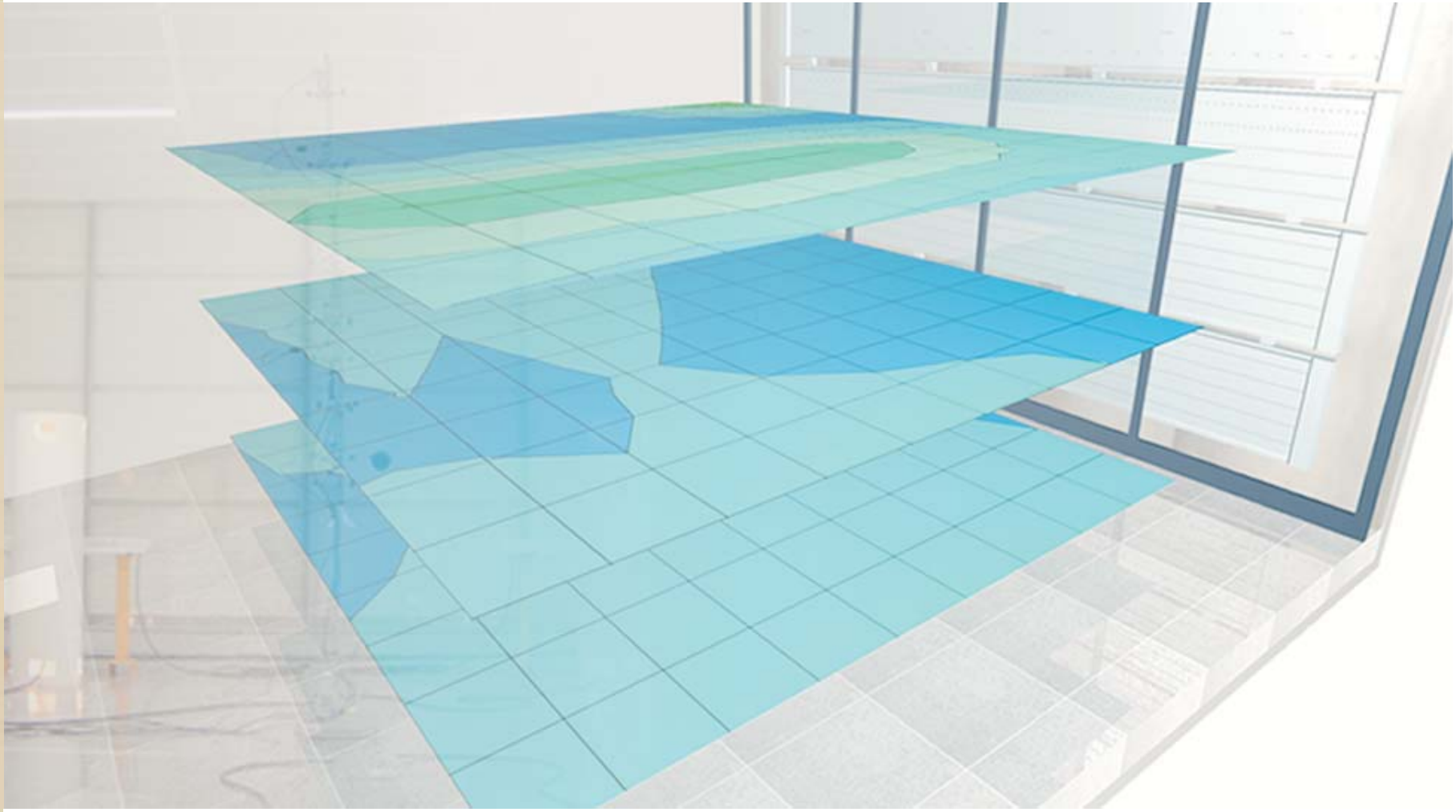
Radiant Heating Tests...Panel Position Scenario Analysis

0311rht issue 1

March 2006

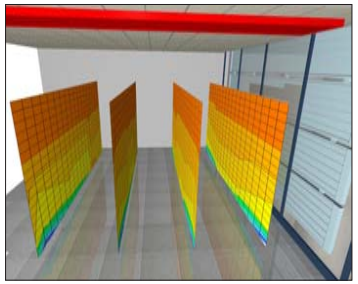


FRENGER systems

Test Paramenters


'DIN man' representing occupant heat load in Frenger testing facility.


Test laboratory viewing galery.


Client presentation showing heating panel in Frenger's test rig.

Introduction

This presentation describes tests undertaken by Frenger Systems Limited on a water driven radiant heating panel arrangement.

The arrangement particularly relates to those proposed for generic healthcare applications where a cooled thermal wall is used to represent the heat loss from a single cold façade.

The purpose of the testing programme, undertaken during November 2003, was to evaluate comfort conditions in a room where a radiant heating panel is positioned in two different orientations; parallel to the cold façade and perpendicular to the cold façade.

Assessment of the relative performance of the two scenario required quantification the following criteria:

- Air velocities
- Air temperatures
- Radiant temperatures

This was achieved by physical modelling techniques, which involved the actual measurements of air velocities, radiant temperatures and air temperatures in a full-scale laboratory based mock up.

Air velocity measurements were made at 3 heights above the finished floor level; 0.1m (ankle level), 1.0m (bed level) and 1.8m (standing head height).

Air temperature measurements were made at 3 heights above the finished floor level; 0.1m (ankle level), 1.0m (bed level) and 1.8m (standing head height).

Radiant temperature measurements were made using a shielded sensor (black bulb probe) at 2 heights above the finished floor level; 1.0m (bed level) and 1.8m (standing head height).

Test Room Construction

A test room with internal dimensions of 6.3 m by 4.9 m by 3.3 m (2.5m to the underside of the suspended ceiling) was constructed within the Frenger test laboratory. The room was constructed by Frenger Systems Limited and incorporated a semi acoustic ceiling and lights to represent a typical hospital ward.

The outer office space was controlled in terms of temperature and maintained uniformity at the level using Frengers Building Energy Management System (BEMS), by maintaining the surrounding areas at a similar temperature as the test room to ensure that heat transfer through the fabric of the test room is minimised.

The test room was constructed using plasterboard with 300mm of insulation above and below the test area to minimise heat loss or gain through the roof and floor. The walls were manufacture with plasterboard and 60mm thick insulation as standard and the thermal wall was insulated with Celotex and an air cavity to reduce energy losses further.

Product Identification

The climate system under test consisted of several individual components; the specification of each product can be seen below:

Atrium Radiant Heating Panel
Quantity: 1-Off
Model Type / Ref Atrium + Radiant Shield
Manufacturer: Frenger Systems Ltd
Physical Dimensions (LxWxD) : 900 x 600 x 100 mm.

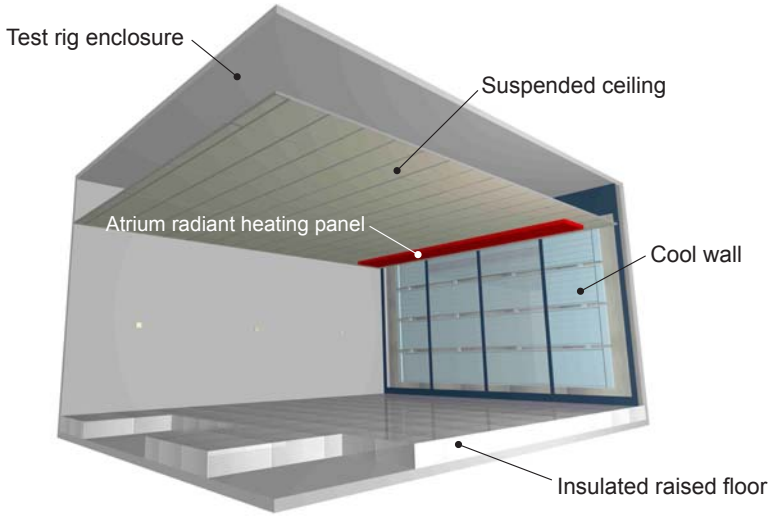
Ceiling Tiles
Model Type / Ref: Perforated Ceiling Tiles
Manufacturer: SAS
Physical Dimensions (LxWxD): 1200 x 400 x 25 mm.

The ceiling tiles were manufactured from 0.6mm (Nominal) Zintec, perforated with3mm holes on a triangular pitch. The perforation quantity equated to 33% free area over the ceiling zone. The ceiling tiles were finished powder coated white.

Light Fittings
Quantity: 6-Off
Model Type / Ref: Budget Troffer
Manufacturer: Thorn Lighting PTY Ltd
Rated Output: 28W
Physical Dimensions (LxWxD): 1200 x 200 x 60 mm.

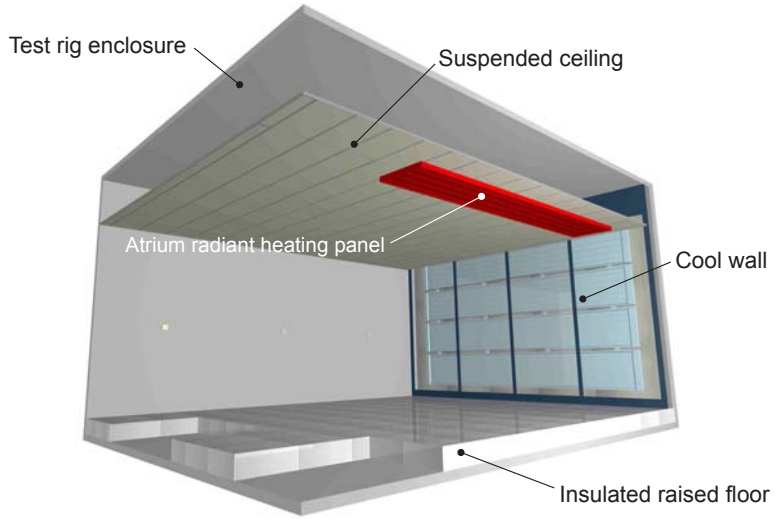
Test Arrangements

Arrangement 1



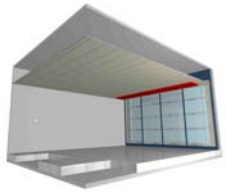
Radiant heating panel **parallel** to cool wall

Arrangement 2



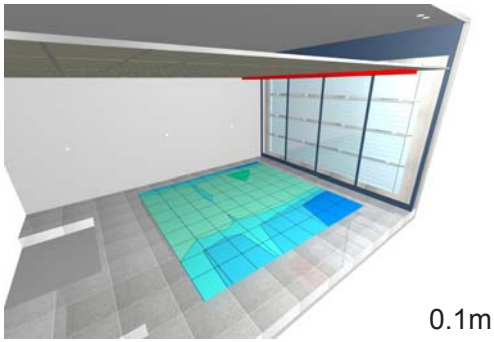
Radiant heating panel **perpendicular** to cool wall

Air termperature analysis

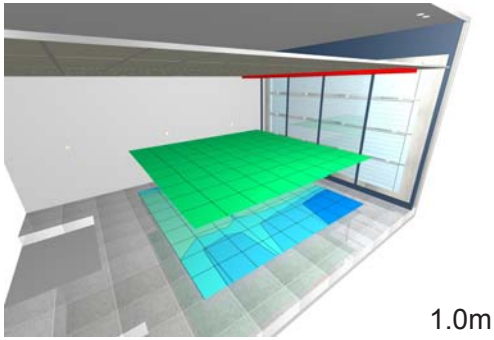


Arrangement 1

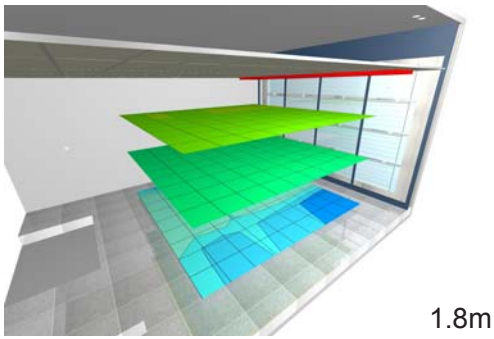
Cool wall capacity (W)	1040
Cool wall av. temp (C)	13.48
Heating panel capacity (W)	1201
Heating panel av. temp (C)	78.7
Energy loss (W)	161



0.1m above FFL



1.0m above FFL

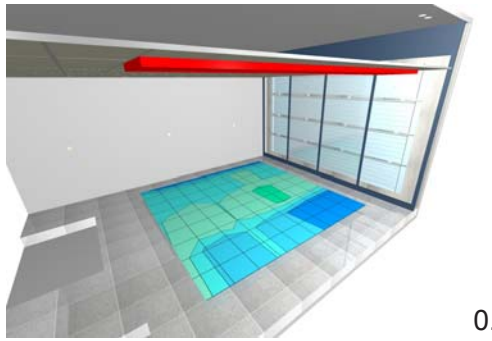


1.8m above FFL

+1.5K
+1.0K
+0.5K
average
-0.5K
-1.0K
-1.5K
-2.0K

Arrangement 2

Cool wall capacity (W)	1074
Cool wall av. temp (C)	13.53
Heating panel capacity (W)	1339
Heating panel av. temp (C)	77.6
Energy loss (W)	265



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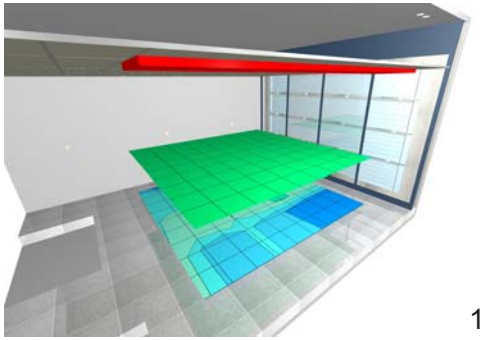
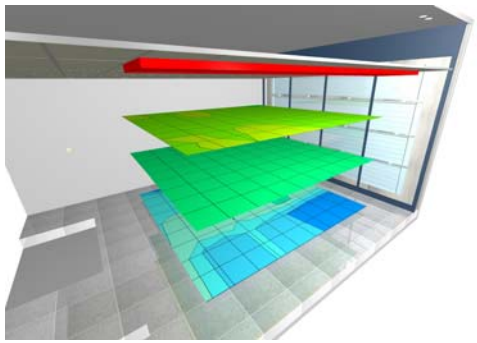


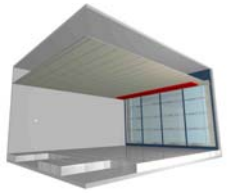
1.0m above FFL



1.8m above FFL

+1.5K
+1.0K
+0.5K
average
-0.5K
-1.0K
-1.5K
-2.0K

Radiant termperature analysis



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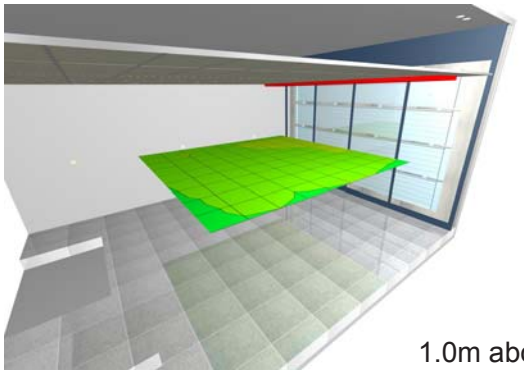

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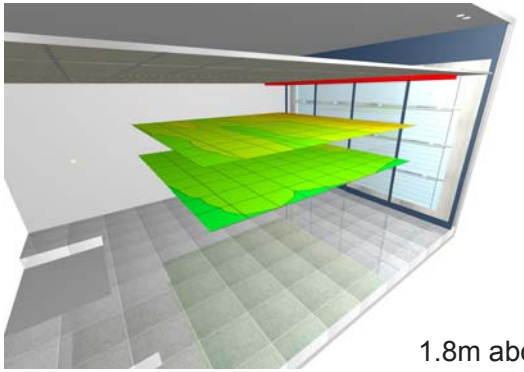
Energy loss (W)	161

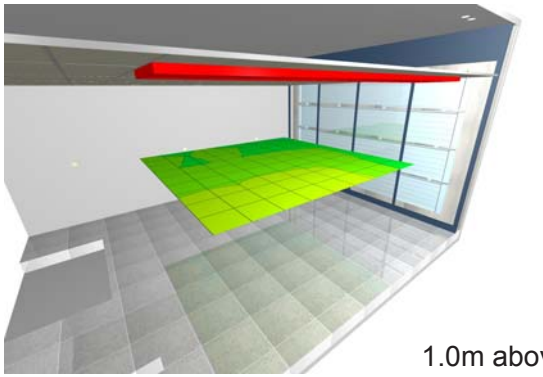
1.0m above FFL

+0.50K
+0.25K
average
-0.25K
-0.50K



1.8m above FFL

Arrangement 2



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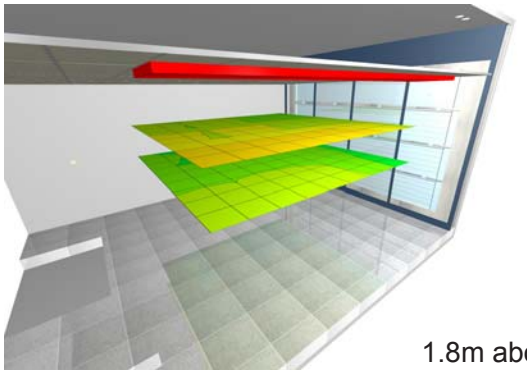
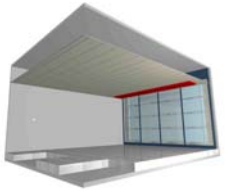


1.8m above FFL



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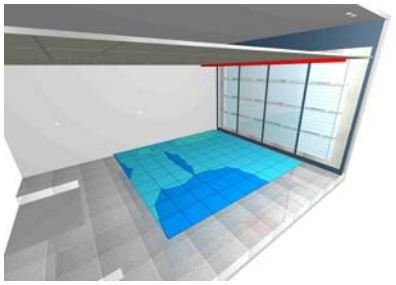
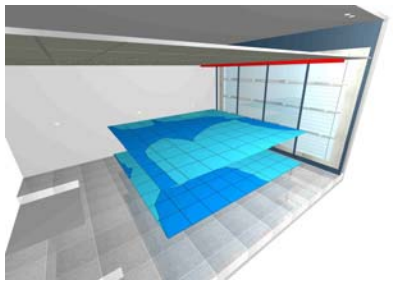
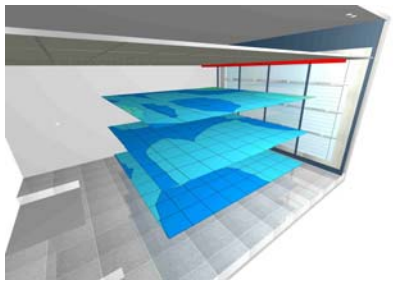
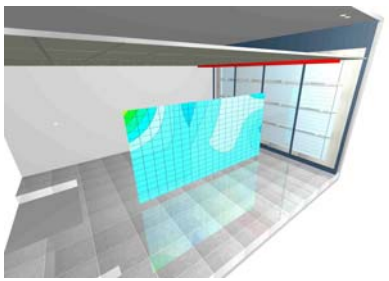


0.1m above FFL



1.0m above FFL





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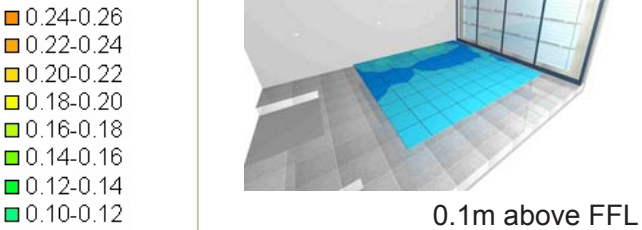

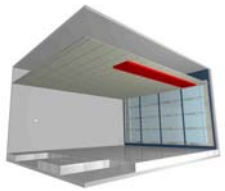

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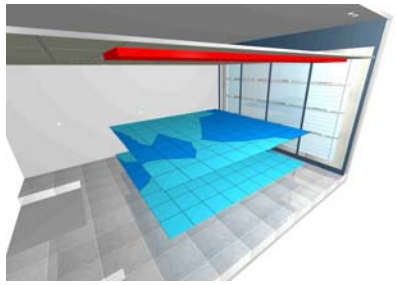
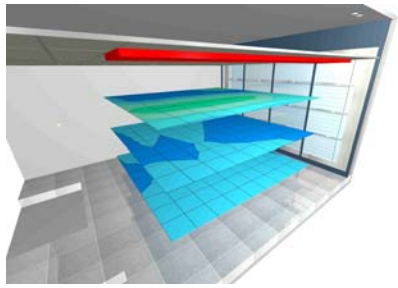
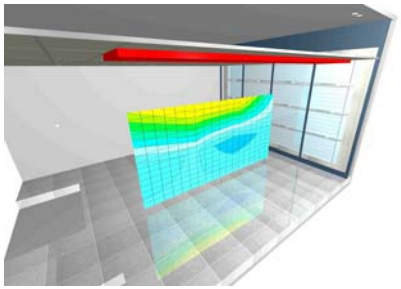
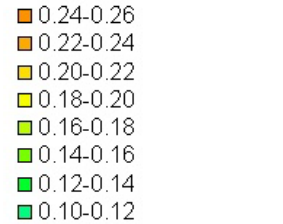


1.0m above FFL





1.8m above FFL



Air Velocity analysis

Summary & conclusion

Summary

Air Temperatures

Through the evaluation of air temerature measurements at 48 locations, the average room temperature for *arrangement 1* was determined as 20.6^{O}C.
An analysis was made of the deviation from this average at 3 different heights above finished floor level (FFL). The results of this analysis for *arrangement 1*can be seen below.

Height above FFL (m)	0.1	1.0	1.8
Deviation from room ave. temp. (K)	-1.32	+0.17	+1.22

The average room temperature for *arrangement* 2 was determined as 21.5^{O}C. An analysis was made of the deviation from this average at 3 different heights above (FFL). The results of this analysis for *arrangement* 2 can be seen below.

Height above FFL (m)	0.1	1.0	1.8
Deviation from room ave. temp. (K)	-1.45	+0.15	+1.30

It can be seen from these results that there was negligible difference in the distribution of heat within the test room when comparing the two heating panel arrangements.

Conclusion

It can be concluded that the orientation of the heating panel has very little effect on the distribution of heat within the space, determined from air temperature measurement. Considering the requirements of ISO 7730 that temperature stratification should not exceed 3K in the occupied zone (0.1m - 1.1m), it can also be concluded that thermal comfort is achieved with both arrangements.

Summary

Radiant Temperatures

Through the evaluation of radiant temerature measurements at 32 locations, the average room radiant temperature between 1.1m and 1.8m above FFL for *arrangement 1* was determined as 22.0^{O}C.
An analysis was made of the deviation from this average at 2 different heights above finished floor level (FFL). The results of this analysis for *arrangement 1*can be seen below.

Height above FFL (m)	1.1	1.8
Deviation from room ave. temp. (K)	-0.23	+0.31

The average room radiant temperature for *arrangement* 2 was determined as 23.1^{O}C. An analysis was made of the deviation from this average at 2 different heights above (FFL). The results of this analysis for *arrangement* 2 can be seen below.

Height above FFL (m)	1.1	1.8
Deviation from room ave. temp. (K)	-0.41	+0.36

It can be seen from these results that there was negligible difference in the distribution of radiant heat within the test room when comparing the two heating panel arrangements.

Conclusion

It can be concluded that the orientation of the heating panel has very little effect on the radiant heat distribution within the space. It can also be concluded that thermal comfort is achieved with both arrangements.

Summary

Air Velocities

Through the evaluation of air velocity measurements at 48 locations, the average room air velocity between 0.1m and 1.8m above FFL for *arrangement 1* was determined as 0.03m/s.

The average values at the differing measurement heights for *arrangement 1*can be seen below.

Height above FFL (m)	0.1	1.0	1.8
Average Air Velocity (m/s)	0.023	0.020	0.037

The average room air velocity for *arrangement* 2 was determined as 0.03m/s. The average values at the differing measurement heights for *arrangement 1*can be seen below.

Height above FFL (m)	0.1	1.0	1.8
Average Air Velocity (m/s)	0.022	0.020	0.046

It can be seen from these results that there was negligible difference in the distribution of air velocities within the test room when comparing the two heating panel arrangements.

Conclusion

It can be concluded that the orientation of the heating panel has very little effect on the air velocity distribution within the space. Considering the requirements of ISO 7730 that mean air velocities should not exceed 0.25 m/s in the occupied zone (0.1m - 1.1m), it can also be concluded that thermal comfort is achieved with both arrangements.

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