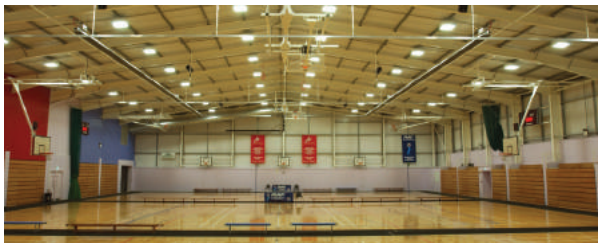





NORTEK™
GLOBAL HVAC

Application Guide

Sports & Leisure Heating & Ventilation

AMBIRAD AIRBLOC NORDAIRNICHE BENSON REZNOR

Application Guide

Sports and Leisure

This guide aims to help all those responsible for sports and leisure facilities to reduce operating costs, and improve comfort and safety, by introducing cost-effective heating and ventilation into their premises.

Sport England estimates that facilities spend 25 to 30% of the total operational cost within any one establishment on energy; quite often the largest single overhead. Indeed swimming pool halls typically use 75% of their total energy bill on heating and ventilation.

This guide advises on he selection, design and operation of the most appropriate heating and ventilation systems for multi-use sports halls, indoor sports arenas, swimming pools and other leisure facilities.

AmbiRad has extensive experience in saving energy within these environments all around the world.

Table 1 CO_2 emissions per unit of delivery.

Fuel	CO^2 (Kg/kWh)
Natual gas	0.19
Oil	0.27
Coal	0.30
Electric	0.52

*Rate as of 01/04/14

Factors to be considered

The Climate Change Levy

> The Climate Change Levy (CCL) became effective from 1 April 2001. After wide consultation an energy tax was considered the best way of 'promoting' reductions in energy use and achieve the Government's commitments in reducing greenhouse emissions.

> The CCL levies 0.541 pence per kWh on electricity; and 0.188 pence per kWh on gas consumption; which equates to a 20% increase on the average gas bill. This means that sports and leisure businesses now need to consider how best to reduce the burden of the energy tax. Investment in energy efficient heating can substantially contribute to minimising the impact of the levy.

> A correctly designed and installed energy efficient heating system, can reduce gas consumption by up to 65% depending on the application and provide many other benefits.

Energy and Fuel Considerations

> Natural gas is, on balance, the most efficient environmentally friendly practicable form of energy, although slightly less efficient at the point of use than electricity, natural gas produces nearly 2¾ times less 'greenhouse' emission in its overall production (see table 1), and is on average only one quarter of the cost . Therefore natural gas clearly is the most cost effective, clean fuel, for sports and leisure facilities.

Requirements of the building

The ways in which sports halls are often utilised, often intermittently and irregular at time intervals, make the efficient use of energy extremely difficult. Therefore consideration must be given to selecting a heating system that offers flexibility of operation at optimum efficiency.

> The aim is to create an environment without stuffiness, where occupants can exercise vigorously in complete comfort. In larger premises this also may include spectator or other ancillary areas with different operating requirements.

> An overall minimum air temperature of 12°C to 16°C is adequate for active sports, where as 20°C may be more appropriate for social use or more sedentary activity.

> Condensation on walls or floors should always be eliminated, as this can be dangerous and poses a threat to player safety.

> In some cases presence of air movement is inadvisable as this may detrimentally affect flight of shuttlecocks, or table tennis balls, but also may create a feeling of discomfort for active occupants, as well as being noisy.

> Sports arenas may well need to maintain statutory ventilation requirements especially where the public are present in large numbers

> Sports Halls usually have high ceilings and often, it is only the lowest two metres of the building which require heating. Therefore it becomes very wasteful and costly to heat the entire volume of the building, especially when the facility requires flexible use.

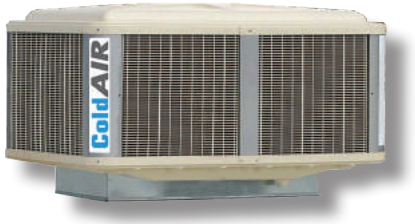
> Small gymnasium areas and exercise rooms require adequate ventilation to maintain subtle air quality.

> For safety reasons it is advisable not to have heating systems occupying activity floor space.

> Ideally any overhead heating system should incorporate protection to minimise the risk of balls or other objects becoming trapped, or damaging the appliance.

> Heating systems should prove easy to operate and straight forward to maintain.

> Sports halls can suffer from summertime overheating due to internal heat loads. ColdAIR evaporative cooling is a low cost, environmentally friendly solution.



> ColdAIR evaporative cooling systems cool the air using a natural principle and are on average 75% cheaper to install than air conditioning. As the air passes through wet filters, it loses part of its heat due to the evaporation of the water and thus the air temperature is reduced. The absence of refrigerants, associated with an air conditioning plant, produces a system with minimal energy requirements and many air changes for a very low cost.

AMBIRAD

Sports and Leisure Heating and Ventilation

Heating Systems

Comparison of heating systems for Sports Halls

System	Capital Cost	Running Cost	Plant Space	Control & Operations	Maintenance	Flexibility & Response	Efficiency (Local)	Environmental effect[3]	Ventilation / air quality	Noise	Vulnerability	Appearance
Ducted warm air (+ low pressure hot water (LPHW))[1]	Poor	Average	Poor[2]	Average	Poor[2]	Good	Average	Average	Good	Average	Average	Good
Built-in wall fan convectors LPHW[1]	Average	Average	Poor[2]	Average	Poor[2]	Average	Average	Average	Average	Average	Average	Average
Ceiling hung convectors LPHW[1]	Average	Average	Poor[2]	Average	Poor[2]	Average	Average	Average	Average	Average	Average	Poor
Gas-fired unit heaters	Good	Good	Good	Average	Average	Average	Average	Good	Average	Poor	Average	Poor
High level radiant LPHW[1]	Average	Average	Poor[2]	Average	Poor[2]	Poor	Good	Average	Poor	Good	Average	Average
Underfloor LPHW[1&4]	Average	Average	Poor[2]	Average	Poor[2]	Average	Good	Average	Poor	Good	Good	Good
Underfloor off-peak electric[4]	Average	Poor	Good	Poor	Good	Poor	Average	Poor	Poor	Good	Good	Good
'Black tube' gas radiant	Good	Good	Good	Average	Good	Average	Good	Good	Poor	Average	Average	Average

[1] Assumes gas or oil-fired.
[2] Assumed LPHW boiler, etc dedicated to hall.
[3] Includes for generation and distribution of 'primary' fuel.
[4] Special requirements for hall construction etc.

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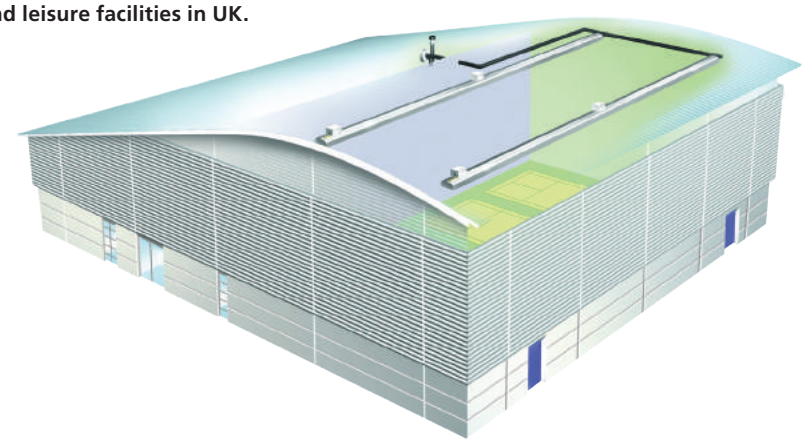
Good Average Poor

Electric storage heaters and electric or individual gas radiant heaters have not been included as they are not considered to be appropriate systems for the size of hall and usage.

***Sport England identifies continuous black tube gas-fired radiant heating , such as the Nor-Ray-Vac 'LR' system as a cost effective east to operate and maintain option for multi-use sports halls.**

***As a result Sport England included continuous radiant tube heating in the standard specification for the** Optimum Sports Hall**. A government financed initiative to bring the very high standards of sporting facility to schools, colleges and communities throughout the country. Sport England have since produced new guidance documents for the 'Affordable Sports Hall' (successor to the Optimum Sports Hall). Again continuous gas fired radiant heating, such as Nor-Ray-Vac, has been specified as factory tests show it can be designed to be BB93 compliant. The Nor-Ray-Vac continuous gas fired radiant heating system has been installed in excess of 950* sports and leisure facilities in UK.**

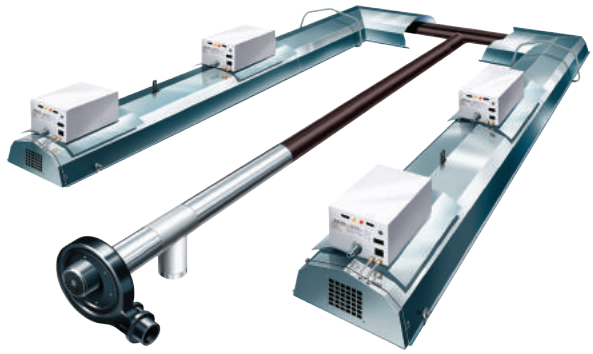
***figures up to June 2015**



Radiant Heating

The primary source of radiant energy in the natural environment is the sun. By standing in the sun's rays a feeling of warmth is experienced, whist in the shade it feels considerably cooler. Radiant heat warms all solid objects and surfaces in its path.

Nor-Ray Vac



Radiant heat is transmitted in the form of electromagnetic vibrations or waves , which are emitted by a hot surface, travel in straight lines, just like light, and are absorbed by cooler solid objects on which they fall.

AmbiRad has exploited this concept in its energy efficient radiant heating systems. Radiant tube heaters, mounted overhead, produce infra-red radiant heat that is directed downward by a reflector. The infra-red heat passes through the air without heating it and falls on people , floors and equipment below by creating a comfortable all round radiant warmth at low level, without wastefully heating the whole volume of the building or the roof space. Because radiant heat can be controlled directionally, only the occupied areas of the building need to be heated, which enables considerable energy savings to be realised.

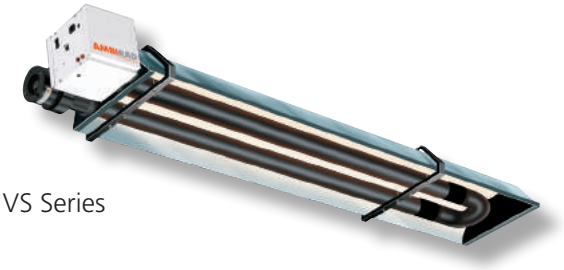
The objective of a radiant heating system is to ensure that the people in he building are comfortably warm. After all, without people that need for heating any building becomes largely superfluous. The human body experiences a sensation of comfortable warmth when it is giving heat to its surroundings. If the body emits too much heat it feels cold. Conversely, if the body cannot emit sufficient heat it feels too hot. By the correct application of radiant heating system comfort levels can be optimised. Radiant heat warms objects and surfaces, increasing the mean radiant temperature and reducing the body's loss of heat to its surroundings. In addition by eliminating air movement, convective loss of heat from the body will also be reduced.

The benefits of radiant heat

> Savings between 25% - 70% of fuel costs can be achieved.

> Achieves a comfortable environmental temperature with approx. 5°C lower air temperature - ideal for active sports.

> Eliminates condensation and moisture by directly heating walls and other surfaces.



VS Series

> Heats without air movement, increases player comfort. Essential for badminton

> Provides rapid heating up times.

> Systems can be controlled easily to provide varying zoned temperature and operating times.

> Heaters mounted at high level eliminates the need for a plant room.

> Minimise roof heat loss.

> Protective ball-guards available.

> Easy to install and service.

> Warms muscles prior to strenuous activity.

Application Guide

- Sports Halls
- Indoor Arenas
- School /multi-use halls
- Tennis Centres
- Squash Courts
- Bowls halls
- Gold driving ranges
- Climbing centres
- Indoor go-karts centres

Limitations of radiant heating

Not Suited for:

- Swimming pools
- Low ceiling applications

Requires additional plant where:

- Ventilation/summer fresh air is required
- Smoke evacuation required

Where these conditions exist or where there is a specific requirement for air movement or ventilation a warm air heating system should be considered.

Warm air heating

Warm air heating is the transfer of energy by means of convection. Air is heated either directly or indirectly and mechanically circulated around the environment.

Warm air is delivered through direct fired or indirect fired equipment which can be suspended within the building, roof mounted external or sited within a plant room.

Warm air can provide heating only, heating and ventilation, summer ventilation, full fresh air or recirculation.

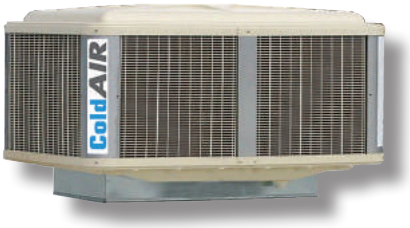
Indirect gas fired warm air heating systems

Ideally suited to applications such as small gymnasiums and exercise rooms in hotels, gym and sports complexes which have specific ventilation requirements or have low ceilings. They can either be free blowing or ducted applications. Heaters can be remotely sited in a plant room for ease of maintenance and management.

ColdAIR Systems

Improve the air quality in sports halls on a hot summer day by introducing a large number of air changes, with filtered cooled air

By design sports halls have a large volume, thus installation and running costs prohibit the option of air conditioning systems



Application Guide

Direct fired combined heating & ventilation systems (CHV)

The Nordair Direct fired CVH system provides both fresh and warm air into the building. It has a patented 80/20 variable ventilation and recirculation facility which supplies the amount of fresh air, required to meet the changing requirements of the building.

In heating mode 100% fresh air is heated and distributed through air induction nozzles, evenly pressurising the building and minimising stratification. Once optimum conditions have been reached the system modulates the fresh air input and utilises up to 80% re circulated air for maximum economy.

When building occupancy demands or where statutory ventilation requirements need to be met, the system automatically varies the volume of fresh air input to provide total environmental control.

CHV can also provide specialist air movement functions such as smoke evacuation. Integrated to the fire warning facility, in the event of a fire the CHV systems can be reversed to extract fumes and smoke from the building.

The Benefits of CHV

Benefits:

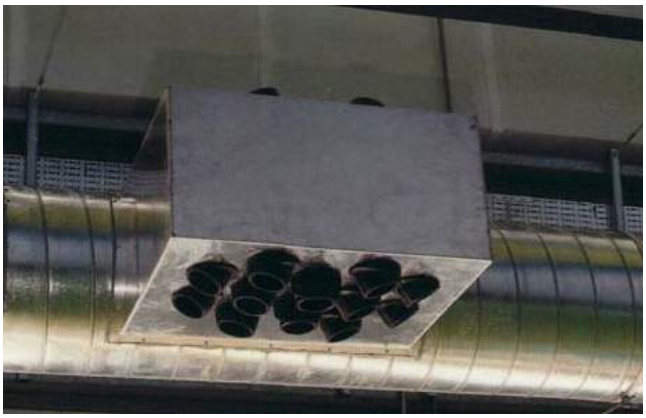
- Effective air distribution throughout the building.
- Modulation of fresh or recirculation air.
- Environmental control.
- Temperature uniformity.
- Humidity control.
- Air quality.
- Optional smoke evacuation.
- Minimal stratification.
- Recirculation and economy mode - for less active sessions.
- Low noise.

Features & Benefits of Direct Fired Units

> High efficiency for reduced operating costs
> Fully modulating burner with high turn down
> ratio (up to 20:1)
> Close control with rapid response to temperature changes
> Low maintenance costs
> Improved indoor air quality
> Summer fresh air for "free cooling"
> Alternative model options allows systems to be tailored to suit a wide range of applications
> Horizontal or vertical units
> Indoor or fully weatherproofed outdoor units
> Optional evaporative cooling can be added
> Servicing and maintenance in one point outside the space.

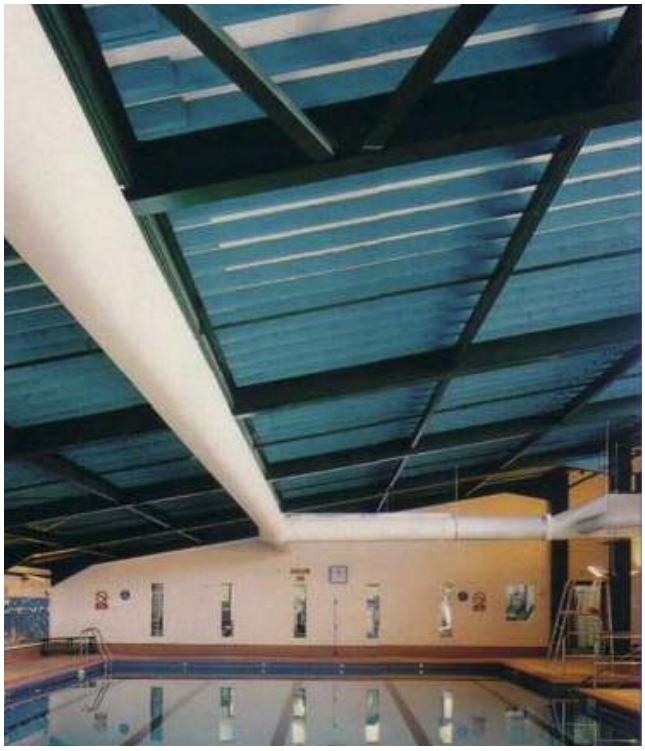
Application Guide

> Large public arenas
> Indoor sports stadiums
> Swimming pools
> Auxiliary areas in leisure complex



Limitations of CHV

> Not suited to smaller areas
> Harder to zone



Environmental control for swimming pools

Environmental control for swimming pool halls can account for up to 80%of the energy used in swimming pool applications. To protect the building fabric and maintain a comfortable environment for the occupants it is essential that the relative humidity and the temperature of the air within the pool hall is closely controlled. To minimise running costs it is desirable to recover the heat which is normally wasted in the exhaust ventilation and return it to the incoming fresh air input ventilation.

Nordair Enviropak™ units provide an ideal solution for swimming pool halls offering close control and optimum energy efficiency, and incorporate the following features:

> May be fitted with heat recovery to extract up to 75% of the heat in the exhaust air and return it to the incoming fresh air supply ventilation.

> A two-speed fan or variable volume control so that ventilation rates can be precisely matched to the building's requirements.

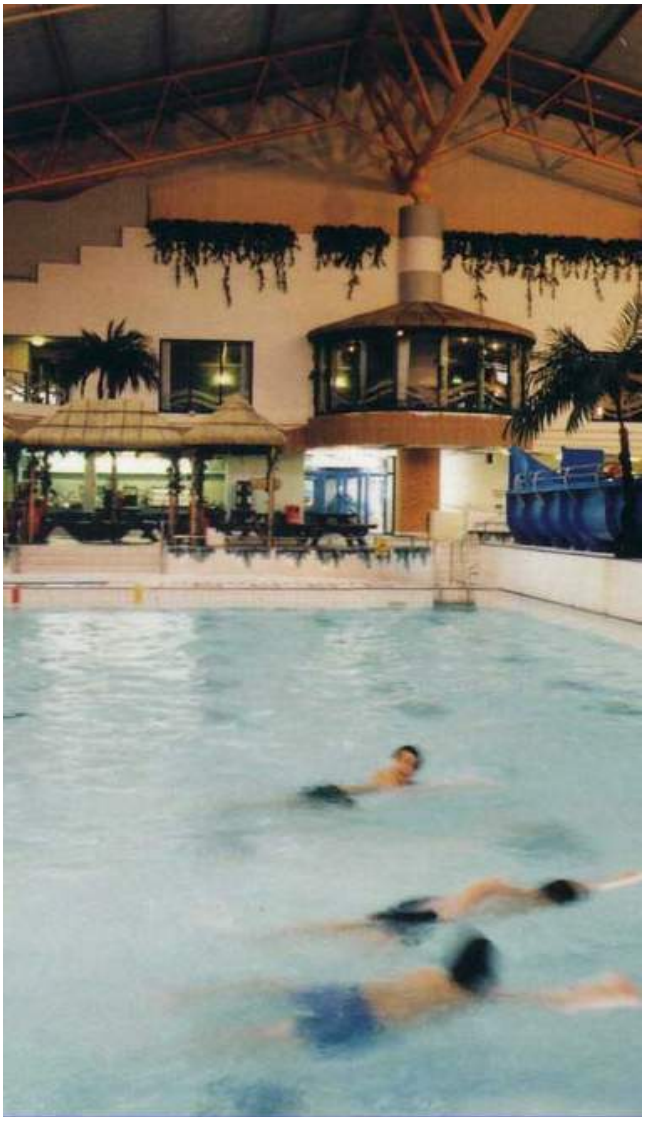
During the unoccupied mode there is little or no requirement to introduce fresh air. In periods of low occupancy and/or during winter periods when the moisture content of the ambient air is low, it is possible to maintain indoor air quality with reduced ventilation rates. During maximum occupancy periods when there is a high ambient moisture content the ventilation rate can be increased up to the maximum, replacing moisture laden pool air with drier fresh air.

> Heat recovery from the exhaust air keeps operating costs to a minimum.

> Direct gas firing provides the most efficient means of heating the incoming air as this achieves 100% thermal efficiency (based on CV)

> Provides fully modulating control with turn down ratios of 20:1 without any reduction.

Nordair Enviropak™ is a fully packaged unit complete with integral microprocessor controls which can be interfaced with the building management control system.



Distribution of the air within the pool hall is also critical to ensure that ventilation air is adequately distributed whilst at the same time avoiding excess air movement, eliminating cold draughts which may detrimentally affect comfort of bathers and spectators.

Nordair Novo-Jet™ air distribution nozzles provide a very aesthetic solution to air distribution within the pool hall as they are easily incorporated into the building fabric or architectural features and avoid the need to install ductwork across the pool. The nozzles allow large volumes of air to be evenly distributed across the space without draughts, outlet velocities can be carried in conjunction with the supply air temperature so that terminal air velocities can be controlled for optimum comfort conditions.

Environmental separation

Air curtains offer a cost effective , energy efficient solution to the problem of sustaining comfort and economic heating or cooling in areas where doors are in frequent use.

In many sports environments there is the need to separate two areas operating at different temperature or comfort conditions, this may be outside to inside or even areas within the building. Environmental separation can be achieved through the use of ambient or heated air curtains. Doors between swimming pools and the remaining complex for instance can be 'protected' by an energy saving air curtain to stop the cooler air spilling into the heated environment.

Application Guide

> Reception areas outside and internal doors
> Swimming pools entrances/exits

Summary application guide

	Radiant	Direct fired CHV	Indirect fired warm air	Over door protection	ColdAIR
Sports halls	✓	0	0	0	✓
Schools/multi-use halls	✓	x	0	0	✓
Indoor arenas	0	✓	0	0	✓
Public arenas	x	✓	0	0	✓
Tennis centres	✓	✓	✓	0	✓
Swimming pools	x	✓	0	✓	x
Small gym/exercise rooms	x	x	✓	0	✓
Bowls halls	✓	0	✓	0	✓
Squash courts	✓	x	x	x	0
Golf driving ranges	✓	x	x	x	x
Reception areas	x	x	✓	✓	0
Changing rooms	x	x	✓	0	0

Note: Represents a guide only

✓ - Recommended 0 - Optional solution x - Not applicable

AmbiRad sports & leisure installations include:

> Manchester United Training Centre

> Burnley AFC Gymnasium

> JJB Soccer Dome, Trafford

> Aldersley Leisure Village, Wolverhampton

> Leeds University

> Newcastle Telewest Arena

> Latymer Upper School , Hammersmith

> West Point Exhibition Arena

> Edgbaston Priory Tennis Club

> Redbridge Olympic Training Venue

> University of East London Sports Halls

> Ravenscroft Sports Facility

> Northumbria University Sports Hall

> Surrey University Sport Hall

> ACS Egham International School Sports Hall

> And numerous schools, local authority and private school halls throughout the country.

Case Study

Newport Sports Village

Background

The Newport International Sports Village is a state-of-the-art indoor sports complex, built and managed by Newport City Council, South Wales.

Facilities include a football and athletics stadium, tennis centre, squash courts, astroturf pitches and an Olympic-standard velodrome designed to host international cycling competitions.

The 7,500m² cycling arena is surrounded by tiered spectator seating. Within the confines of the steeply-banked cycle track there are 12 badminton courts for public use.

Newport City Council required a heating system that would maintain different comfort temperatures for participants on the cycle track/badminton area and spectators in the seating area. It also had to be capable of preventing the formation of condensation on the underside of the roof, and be very quiet in operation.

Application

To heat the race track and badminton courts area, a Nor-ray-Vac continuous radiant tube system comprising 16 burners, each with an output of 46kW was installed. The system is roof-suspended at 10m from floor level.

Above the seating areas, three 35kW AmbiRad linear tube heaters were installed. Both heating systems were flued through the side walls to avoid roof penetrations.

A single control system allows the Nor-Ray-vac and linear radiant tube heaters to be controlled in five separate zones.

Technical Specification

Area	7,500m²
Height	10m
Volume	75,000m³
Heaters	16 x 46kW Nor Ray Vac
	3 x 35kW Radiant

Benefits

Radiant tube heating offers many benefits in sports hall environments. It warms up rapidly yet does not waste energy heating the volume of air in the building. Players and spectators feel warm, comfort temperatures are maintained and warmth is evenly distributed, but relatively little fuel is consumed - ensuring the system remains economical.

Flexibility is also built into the system. Five separately controlled zones ensure that the heating needs of 'active' parts of the building can be met without wasting fuel by unnecessarily heating areas that are not being used. For example, a single badminton court can be heated if it's the only section of the arena in use.

Radiant heating works by emitting infra-red rays that warm only people and objects. By taking the chill off objects, radiant heating effectively prevents the formation of condensation within a building. It operates without air movement and is very quiet. However, to ensure near-complete silence, the fans were housed in acoustic enclosures.

Case Study

St Johns Beaumont School

Background

Building a state of the art sports centre, the St. Johns Beaumont School, a Jesuit preparatory school near Egham, looked for a heating system that offered flexibility alongside superb efficiency. The solution was found in leading supplier of heating systems AmbiRad's Nor-Ray-Vac - a radiant heating system that is so popular it has been installed in over 700 sports halls in the UK.

St Johns Beaumont School's new build sports centre is packed with a host of features, including a 30ft climbing wall, indoor cricket facilities, performing arts centre, rowing room and a gymnasium alongside the main athletics hall. Intended to double up as a venue for the school, the hall has a cutting edge draping system that can instantly turn into a marquee environment for plays, prize giving's and more.

Application

Owing to the multipurpose nature of the centre, heating choice was particularly important. To ensure energy efficiency, the system had to stand alone from the school's boilers, which function 24/7, and warm up quickly when needed. It also had to have superb temperature control, able to be cool enough for athletic activities and hot enough to keep people warm during school events. The Nor-Ray-Vac system is so advanced that as well as heating halls precisely, it can warm different areas according to need, for example keeping spectators warm and sports teams cool during athletic fixtures.

It is the SmartCom³ controller that allows heating provision to be controlled so accurately. A specialised microprocessor, it lets users control heating provision precisely, ensuring that the sports hall can be flexibly heated to meet any need, from sporting events to concerts and school proms.

The selected heating system was based around two radiant branches of the Nor-Ray-Vac system. Each was connected to a 32LR and 24LR burner. These energy efficient units are capable of delivering excellent fuel savings of up to 60 % on alternative methods. Such energy efficiency is due to the ingenious design of the system. By burning fuel at point of use, wasteful heat distribution is eliminated, along with the need for a separate plant area.

Benefits

Nor-Ray-Vac radiant heating systems provide an excellent solution for sports halls. Mounted at ceiling height, they provide no obstruction for sporting activities and can be covered with grilles for added protection. Their height provides no obstruction to their functioning, as they work by emitting infrared rays, like the sun. These rays heat only the objects and people in their path, meaning that no energy is wasted warming the massive volume of air within the hall.

The system works by drawing fresh air from ducts into the burners and heating system with a vacuum fan. To comply with the acoustic requirements of BB93, a Department for Education and Skills mandate that specifies the acoustic performance of educational buildings, the fan was enclosed in an acoustic shell. This ensured that the sports hall met the regulations stating that schools are quiet environments where staff and students are not undermined by disturbance.

Completed, the sports centre is a prominent feature of St. Johns Beaumont School. Opened for the start of the new academic year by Her Majesty the Queen, it has proved extremely popular with the students. Meeting the challenge of heating its large sports hall, the AmbiRad Nor-Ray-Vac system provides the school with an energy efficient, cost effective and highly usable climate control system that is a top choice with specifiers across the UK.

Technical Specification

Area	594m²
Height	8.7m
Volume	5,168m³
Heaters	2 x 32LR & 2 x 24LR

Case Study

Brunel University

Background

Potential Olympic stars, together with university students and local school children, are already taking advantage of the flagship £7m indoor sports facility at Brunel University. And their training is made more comfortable thanks to the Nor-Ray-Vac continuous radiant tube heating from AmbiRad that has been installed to provide state-of the-art energy efficient heating.

The Indoor Athletics Centre (IAC) and adjacent Netball Hall, at Brunel's Uxbridge campus, are the product of a joint funding project between the University, UK Athletics, Sport England and the Lottery. The structure, designed by David Morley Associates, has an eye-catching curved roof.

The 3,168m² athletics hall incorporates a 6-lane sprint and hurdles straight, long and triple jump pits, areas for pole vault and high jump and throws practice nets. The Netball Hall offers full-court netball together with four badminton and basketball courts. It is now the training base of the England netball team.

Application

The Nor-Ray-Vac heaters were positioned at approximately 6m from floor level. Controlled centrally from the University's building management system, they maintain a constant temperature of around 14-16°C.

John O'Keeffe, Estates Manager of Brunel University, comments: "This is an excellent system for this application. The athletes can train in a comfortable temperature, irrespective of the weather outside."

Benefits

Continuous radiant tube heating is ideal in the sports hall environment. It works like the sun, emitting infra red rays that heat only people and objects in their path. No energy is wasted needlessly heating the volume of air in the building, making this heating solution the economic alternative in large space sports halls.

Radiant heating can take account of the different comfort needs of active sports participants and spectators, ensuring both are pleasantly warm without overheating. The heating system can also operate at 2-3 degrees lower than convection heaters without compromising comfort of the building's users. The result is long-term reductions in energy usage and carbon emissions.

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