The SOCCARENA Stadium Durham.

The Soccarena stadium is an indoor arena covering eight “astro-turf” 6 a-side football pitches and internal buildings containing offices, changing rooms, and leisure facilities.

It is a large structure with 6 metre walls and a domed fabric roof. It is 138m long, 50m wide and 14.5m high at its apex and contains approximately **2.8 million cubic feet** (80,000 cubic metres) of space.

The stadium has some in built air movement, there are four air inlet vents high up at each end of the building, combined, these have a combined area of approximately 9m²

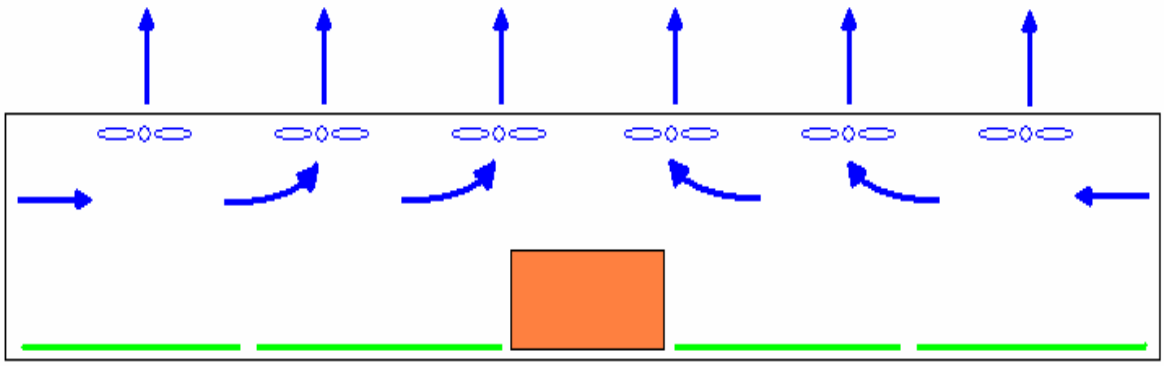
Additionally, there are six air-extraction fans mounted in the roof. The effect is to drag air along the underside of the roof and expel it.

PROBLEM

The building has a single skin fabric roof and responds quickly to atmospheric changes. Water droplets condense on the cold surfaces on the underside of the roof skin. These are dislodged off by the wind or through impact by football and fall on players and internal buildings.The water has built up on the roof of the internal buildings and caused damage to both building and contents.

The existing air circulating system does not create any down draught and has no method of scrubbing humid air from the lower areas of the stadium. The only turbulence at pitch level is produced by eighty football players running around however they are responsible for a large percentage of the humidity and they do not push air up towards the extracting fans.

EXISTING AIR CIRCULATION.



A site visit carried out 10th January 2006 at 11.00.

(The stadium was empty and did not show the true extent of the problem, which would be amplified when 90 people start exerting themselves.)

During the site inspections, various readings and notes were taken both inside and outside the building.

Outside.
Air temperature was 9.2 °C and the relative humidity (RH) was 88.5%.

Inside
Air temperature varied from 8.1 °C (courts 1 – 4) to 7.3 ºC (courts 5 – 8)
Mean average = 7.7 °C

R/H varied from 87% (courts 1 – 4) to 92.3% (courts 5 – 8)
Mean average = 89.6%.

By using the psychrometric chart, we can highlight Soccarena's problem quite easily….

By checking 90% RH against 8 ºC we find the dewpoint temperature (the temperature at which condensation will occur) is approximately 6.5 ºC

This means that any surfaces or materials that have a temperature of 6.5 º C or below will have an active condensation problem.

We found that most surfaces in the arena had a temperature of below 4 ºC.

A second site visit was carried out on the 12th of January 2006 at 19.00
The stadium contained 96 people who had been playing football for an hour.

Outside.
Air temperature was 5.4 °C and the relative humidity (RH) was 80.6%.

Inside
Air temperature varied from 7.3 °C (courts 1 – 4) to 6.9 ºC (courts 5 – 8)
Mean average = 7.1 °C

R/H varied from 73% (courts 1 – 4) to 79.1% (courts 5 – 8)
Mean average = 76%.

The dewpoint was 3.1°

The building structure and skin temperature varied from 5 – 7°C, which was above the dewpoint so condensation did not present and problems on this occasion.

SOLUTION

To raise the air temperature to 8 - 10°C above ambient will raise the dewpoint and prevent water droplets from condensing on colder surfaces.

By installing two DRYAIR EU 240 systems and eight PHE 60 fan coils, the air temperature can be raised by as much as 20 - 25° above ambient which will reduce RH dramatically.
Example: -
If we raised the temperature inside the arena from 8 ºC to 18 ºC, the relative humidity would fall to around 45%.
If we raised the temp by 12 ºC to 20 ºC, the RH would fall to around 38%.

Eight PHE 60's move 25,600 m³ / h.
It would therefore take three hours to re-circulate all the air.

Based upon an incoming air temperature of 8 °C the hot air leaving the fan coil would 55°C. This is far too hot for football.

A more logical solution would be to utilise some of the stadiums existing air-moving equipment.

By reversing the stadiums roof fans, warm air gathering at roof level could be brought down and re-circulated before being expelled from the side vents. This principle is called "moisture flush" and would remove the need to heat 100% of the air.

33% of the stadiums air can be heated in 1 hour.

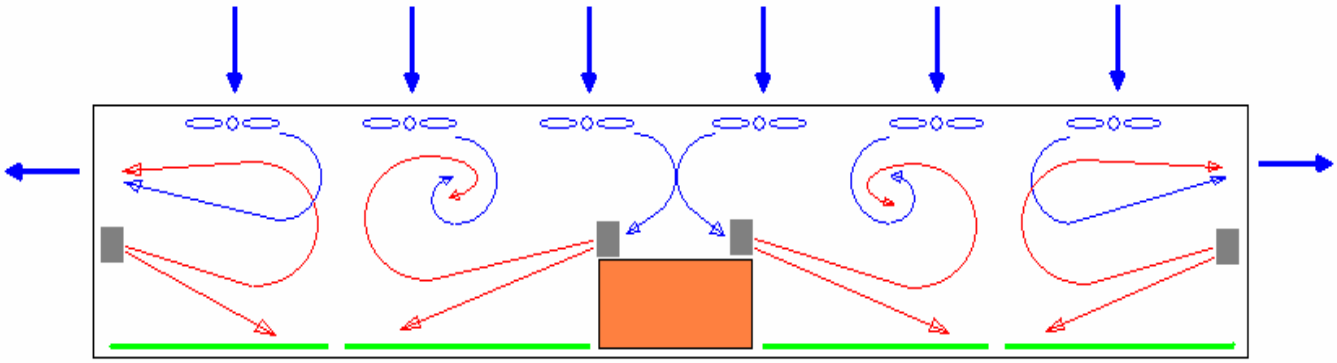
This would give an overall temperature of 25.6°C minus the heat loss from cooler air and from the lack if insulation within the building could give us an average temp of **18°C.**

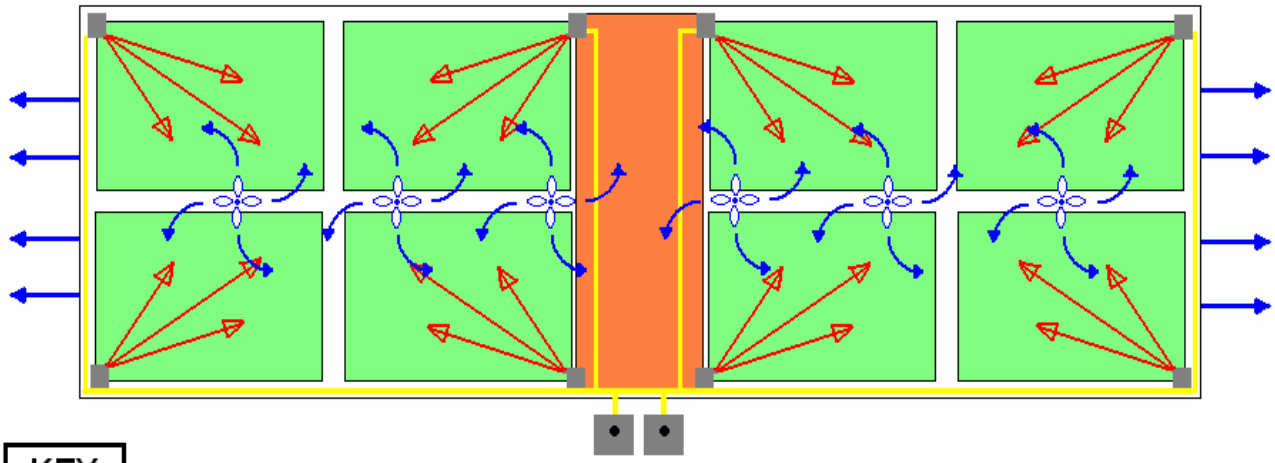
The DRYAIR equipment operates on a "Moisture Flush" system.
This is created by positive pressure.
In the Soccarena stadium, Dryair's intention is to utilise the existing ceiling fans to create the positive pressure thereby allowing the Dryair system to devote 100% energy into developing heat.

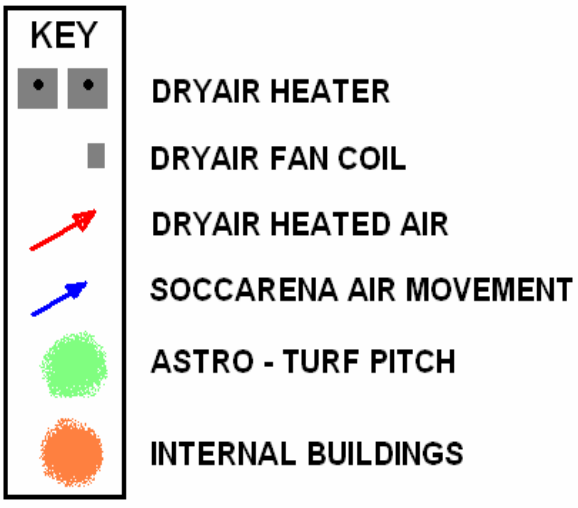
The Dryair system should run for at least an hour to build up a heat "chamber", then the ceiling fans should be switched on to circulate the moisture laden air before pressurising it out of the side vents.

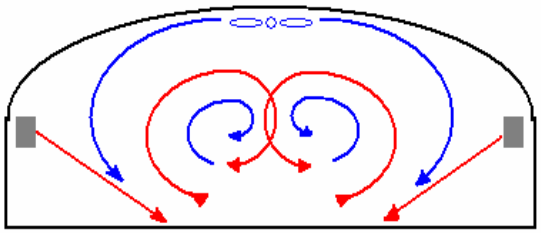
Utilising this air movement allows for occasions when humidity inside is high but outside is low. In this instance, all the fans can be switched on, drawing in fresh air, circulating it around and pushing out the moisture. This saves the fuel costs of the heating module.
The movement of air can be exploited during the summer months when the stadium can become uncomfortably hot. The addition of fresh air and positive pressure provides a cooling effect to participants.

‘Moisture Flush Process’









THE TECHNICAL SPECIFICATION

The two Dryair EU 240 heating modules will be coupled together to create one 480-kilowatt (1,800,000Btu) unit.

This is diesel fired and can consume 9.6 gallons per hour in a maximum heat (worst case scenario)
However in economy mode (maintaining heat) only 4.8 gallons per hour will be burnt.

The unit is powered by mains (240v single phase) electricity.

Its electrical energy consumption is: -
8 x PHE 60 consume 11.2 kilowatts of electricity per hour
2 x EU 240 consume 6.6 kilowatts of electricity per hour

Combined, this is 17.8 kilowatts (74 amps) at maximum or 8.9 kilowatts (37 amps) on economy.

The eight PHE 60, heat exchangers are independently thermostatically controlled. This allows an exchanger to switch on and off if a hot or cold spot is sensed whilst the remaining exchangers continue producing heat.

As the exchangers reach their temperatures and shut down, the heat demand decreases, the heating module senses the temperature change and shuts down to conserve fuel. When the heat demand increases, the heating module will fire back up.

HEAT MODE

The two EU 240 heating units operate as one large module. In this mode maximum heat is produced from all eight heat exchangers and the stadiums ceiling fans are switched on. This continues until the stadium air temperature has been raised enough to alter the dewpoint and the moisture-laden air has been pressured out of the side vents. When this is achieved, the heating module can be switched into economy mode

ECONOMY MODE

After the stadiums air has been heated and ejected or when a cold dewpoint is forecast, economy mode may be used. In this mode, only one of the two EU 240 heaters is fired and the four inner heat exchangers are used. This will half the electric and diesel consumption.

COOL MODE

Turning on the stadiums ceiling fans and all eight Dryair exchangers will create sufficient cold air circulation to reduce the skin temperature of the audience and participants.

This requires only electrical input; no diesel is needed.

ADDITIONAL FEATURES

WATER HEATING

The Dryair hot fluid circulating loop could be used to heat water for showers / hand washing, etc. subject to the compatibility of the existing hot water system.

SITE SECURITY

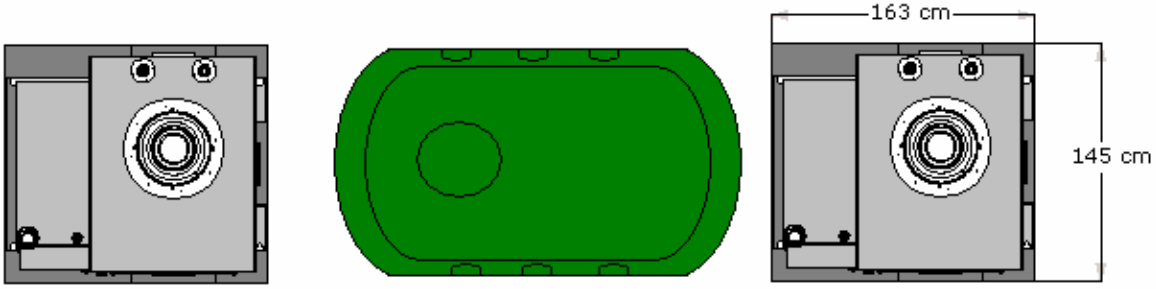
Dryair recommends enclosing the two heating modules and bunded fuel tank in a site secure compound.

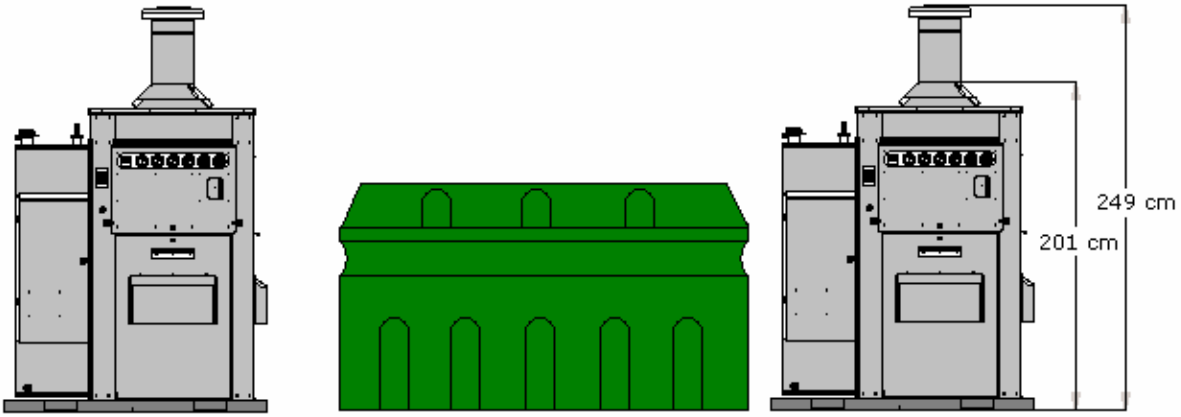
Fuel Oil Storage:

Oil Tank Capacity

550 gallons (2500 litres)

Length 253 cm
Width 143 cm
Height 143 cm





COMPARABLE HEATING METHODS

Radiators

A double radiator 1.5m long and 0.5m high gives out approximately 10,000btu, (this is a large domestic radiator). This gives a surface area of 0.75m^2.

Two EU 240's give out 1,800,000btu combined. This is the equivalent to 180 large double radiators and would fill an area of 135m^2.

If installed in line, it would stretch for 270m or 886 ft.

The Soccarena Stadium is 453 feet long as a result both walls each side along the length of the building would be lined with radiators.

Propane space heaters

A 200,000btu space heater can heat an area of 50,000ft^3 .

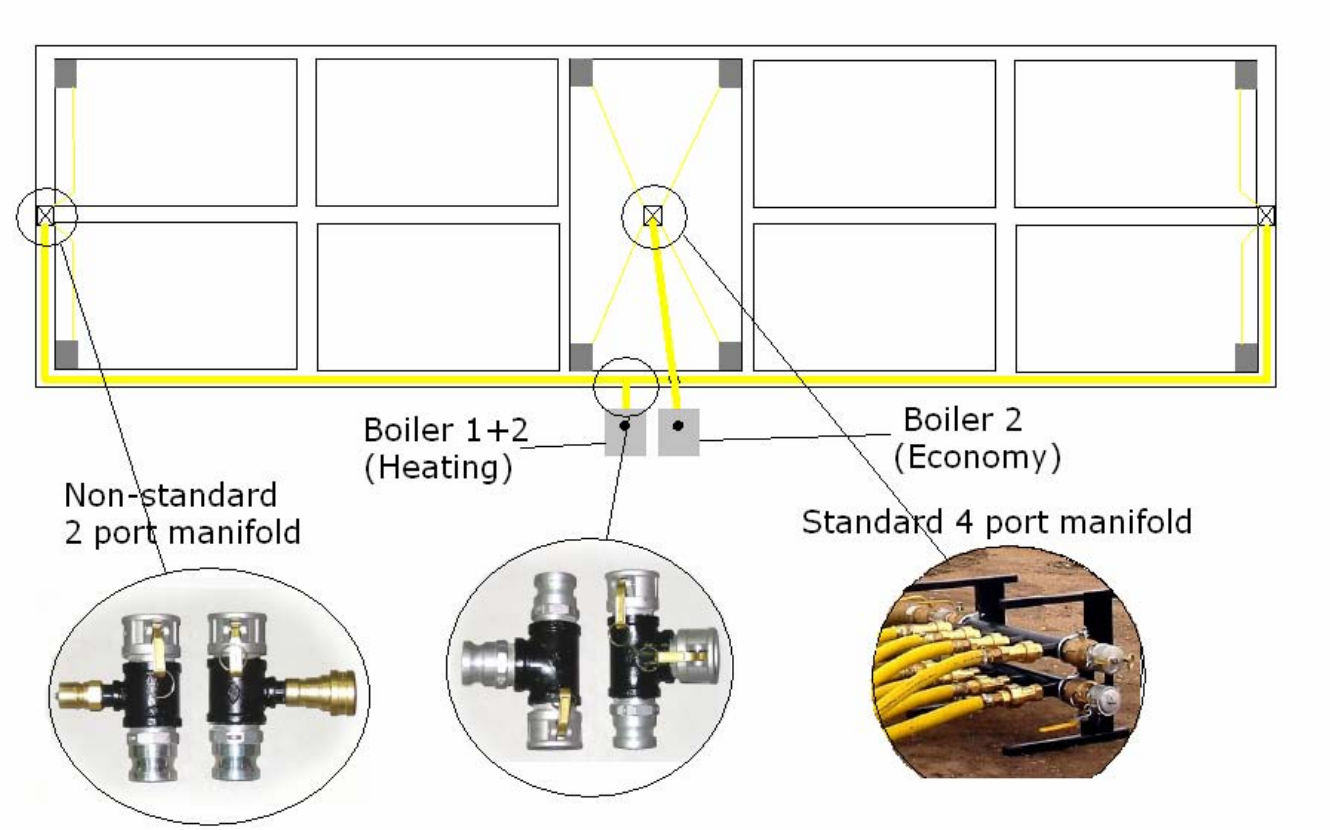
56 space heaters would be needed to heat Soccarena.

Each space heater consumes 4.61 kg per hour, therefore, 56 space heaters would consume 258.16 kg per hour or approximately 57 gallons per hour

Propane heaters produce one gallon of water per gallon of propane burnt, net result being 57 gallons or 259.58 ltrs per hour introduced into the building.

Propane heaters generate carbon monoxide which is poisonous in large quantities and would require additional air input.

Pipe Run Connections



Remote Management & Information System

The Dryair “moisture flush system” comes with the added benefit of the unique PTC remote management system, giving all concerned effective, accurate management data on the systems operation.

Key Features

Central Web-based Management	Remote Telemetry Hardware
* Communication (monitoring & control)	* GSM/GPRS network modem
* Database storage	* Communications
* Alarm processing	TCP/IP, PPP application level
* Notification (E-mail SMS)	* Data logging
* Reporting	* Alarm processing
* Configuration	* Simple AT Command line
* Administration	* Real time clock scheduling
* Optimisation	Specialised M2M services
* Security	* Application hosting
(admin, customer, site level	* Customisation

Operational staff wherever they are based or located, can receive if required up to the minute data and operational information on the system and its current status, along with data enabling the most cost effective operational strategy to be adopted, thereby maximising operational savings.