#2451

ENERGY DATA SHEET #2451 AIVC 1935

SPORTS COUNCIL

AIVC

NUMBER 4

Ventilation

Airchange-on-demand cuts costs

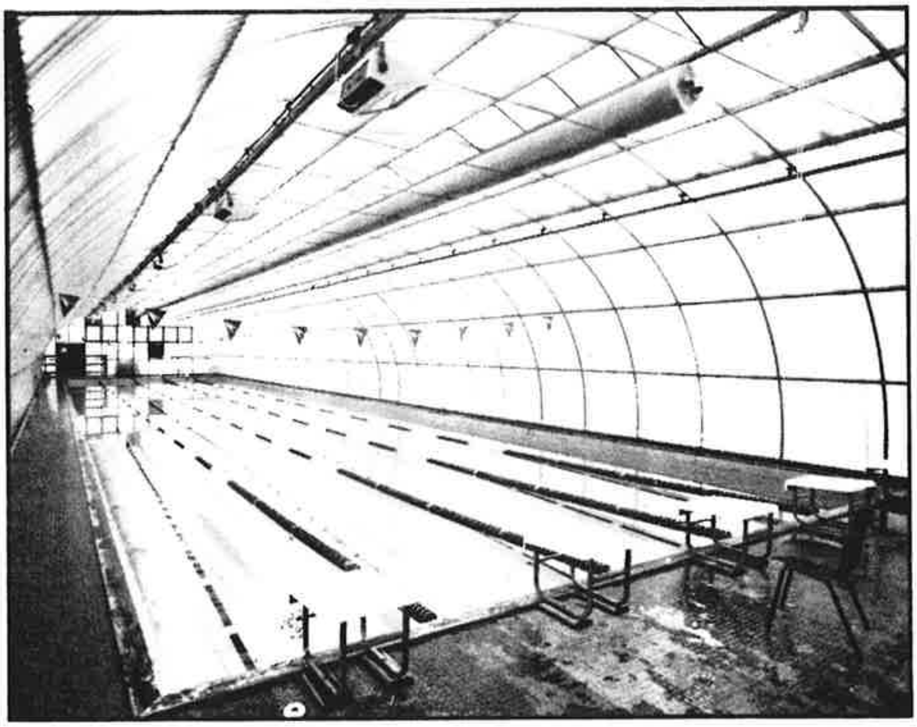
ALL SPORTS BUILDINGS need plenty of fresh air. Good air distribution and continuous ventilation is essential for the well-being of both buildings and people.

Fresh air clears smells, moisture **and** heat. An open window air vent may improve the well-being of people but not the economy of buildings. Constantly varying supply to match demand is the modern key to efficient ventilation.

In the same way that a person may increase breathing rate ten-fold to match increased activity, or to overcome stuffy air conditions, so a building needs to increase ventilation rate to cope with varying levels of contamination. Ventilation rates in buildings should adjust to improve fresh air supplies as required, whilst resisting unnecessary airchanges thus preventing too much heat being thrown out with the exhaust air. Variable controlled ventilation radically improves the performance of both building and people.

Dry air absorbs moisture. Ordinary dry sports buildings with dry air may get by naturally with 2 or 3 airchanges every hour. But, relentlessly, with increasing humidity and temperature, occupancy and contamination, problems also increase. Very moist air above active swimmers in busy pools is normally thrown away as ventilated air 5 or 6 times an hour. Some very high activity, high humidity, high temperature hydrotherapy pools manage 20 air changes an hour, or to look at it another way, throw away their whole poolhallful of air and heat once every three minutes!

In many heated buildings, three-quarters of total energy cost can go in ventilation.......one-quarter to power air distribution and two-quarters to heat air and building and to prevent condensation in cold weather. Maximum effort is needed to cope with moist air which holds more heat: dry sports facilities may need less ventilation, but are more susceptible to changing outdoor humidity.



Lightweight enclosures need practical and hygienic air distribution; **fabric tube** widely used in industry offers simple, low-cost installation in a day, and Terylene "duct" can be taken down for dry-cleaning. This 400mm diameter fabric tube and track for the 33m pool at Millfield School in Somerset, distributes warm air uniformly and without draughts to bathers. (Supervents of Tonbridge)

Clear-it Early logic led to heating and ventilation systems being switched off overnight when a building was unoccupied. As it cooled to match outside temperature, moist air trapped inside the building condensed in cold spaces staining and damaging the fabric. The solution next morning was to provide straight-through ventilation pulling in dry cool air one end and pushing out moist warm air the other, just to dry out the building. But that cool fresh air had then to be heated. Those cycles of cold and hot, moist and dry put a structure at severe risk.

WARNING In several insufficiently ventilated sports buildings over recent years, roofs deteriorated and caved in (see Energy Data Sheet 5). Correct ventilation is critical; insufficient ventilation or heating is dangerous let alone more costly in total repairs and running costs.

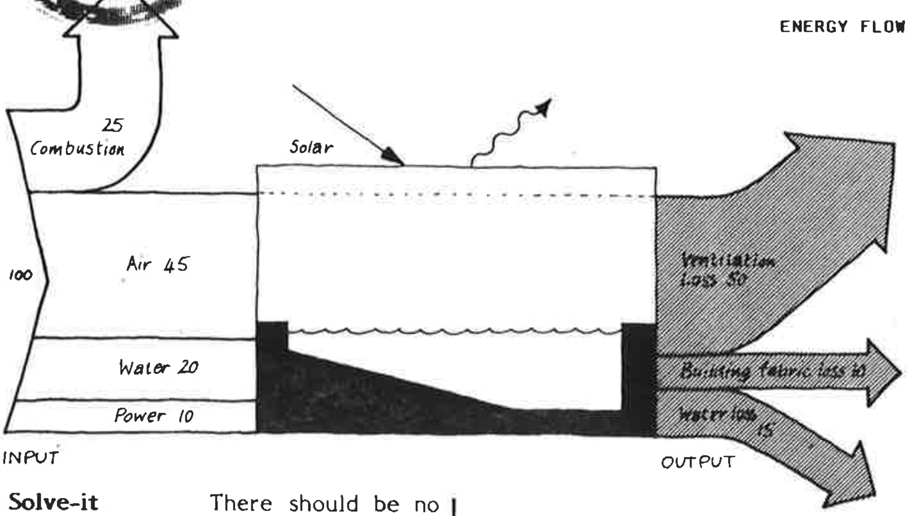
Limit-it Ventilation airflow causes continuous dilution, removes respiration products and distributes energy throughout the building. Reduced air volume in a building reduces heating requirement. By limiting unnecessary building air space and airchanges, it is reasonable to reduce basic energy use.

Control-it Lower outside and higher inside temperatures encourage condensation requiring more ventilation. Temperature of both air and fabric affects humidity; similarly occupancy affects condensation. Ventilation rate is closely tied to activity rate, particularly in pools where more bathers means more wet deck areas and more evaporation. The immediate solution: either limit a building's use or vary ventilation to suit conditions.

SAVE-IT in Sport ENERGY DATA SHEETS. Series provides outline guides to conservation topics: 1 Swimming Pool Covers; 2 Swimming Pool Disinfection; 3 Filtration & Water Circulation; 4 Ventilation; 5 Dehumidification; 6 Heat Recovery; 7 Heat Exchange; followed by Heat Pumps, Boilers, CHP, Alternative & Solar, Lighting, Enclosures, Management, Maintenance.

VENTILATION

ENERGY FLOW



Solve-it There should be no need to limit use and reduce revenue, as "it is possible to achieve a reduction in energy consumption for ventilation air and poolwater heating of up to 95%" reported by E R Mingo (Nov 1982) at South Western Region Sports Council seminar on energy conservation.

First, accurately regulate the building's temperature and humidity; second minimise ventilation to match activity and occupancy; third recycle and redistribute existing energy to save on new energy (see EDS 6 and 7).

Save-it Times When a sports building is unoccupied, airchange rates can be reduced by one-third. This achieves power saving approaching 80% and heat saving of 33%. Ice rinks can halve their rates. In poolhalls, with pool covers, airchange rates can be reduced by two-thirds and even stopped altogether along with close-down of boilers, in well insulated buildings (see EDS 1).

Environmental control Buildings are "climatic modifiers" whose design, systems and energy load need careful orchestration to tune finely the internal environment. High standard insulation and well insulated windows improve the performance. Less obviously in poolhalls, high quality water treatment (see EDS2 and 3) reduces the pollution that contaminates the air which necessitated high ventilation. With effective water/air conditioning, plus fitted pool or ice covers, it is possible to achieve 80% air recirculation during the day and 100% overnight in well protected buildings.

AIRTIGHT

Infiltration by outside air can be a significant energy deficiency. Air tightness in a building can be improved by caulking and sealing. This weatherproofing is probably the simplest and least expensive way of all to save energy.

Weathersealing lifespan starts with foam strips at 2 years in chlorinated atmospheres: backed felt or vinyl gives 5 years life; flat metal strips at least 10 years. Caulk oil-based sealing to doors and windows endures 2 years; latex or butyl rubber 5-10 years; silicone or acrylic compounds 10-20 years.

A 10% positive air pressure for the sports hall ensures airflow out to changing and service rooms so helping clear odours. Conversely, 10% negative air pressure for poolhalls prevents outflow of chlorinated, moist air which could damage other rooms and fabrics and even infiltrate building structure. Positive air pressure of the roof space above suspended ceilings also supports a vapour barrier membrane carefully installed to control condensation.

Interaction between humidity levels ventilation rates and conservation measures is a complex situation, but extremely important for building performance and user requirements.

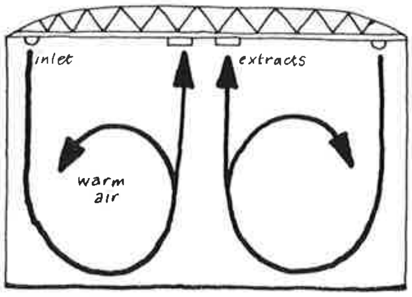
Guide to AIRCHANGE AND AIRFLOW (based on CIBS, DIN Standards, Swiss Code of Practice, TUS Information)

AIRCHANGES an hour	Buildings
1-2	Sportshalls large
2-3	Sportshalls small
4-5	Poolhalls
6-8	Teaching/leisure pools
8-10	Showers and changingrooms
10-15	Spa/flume/wave pools
15-20	Boiler rooms/canteens
20-40	Kitchens

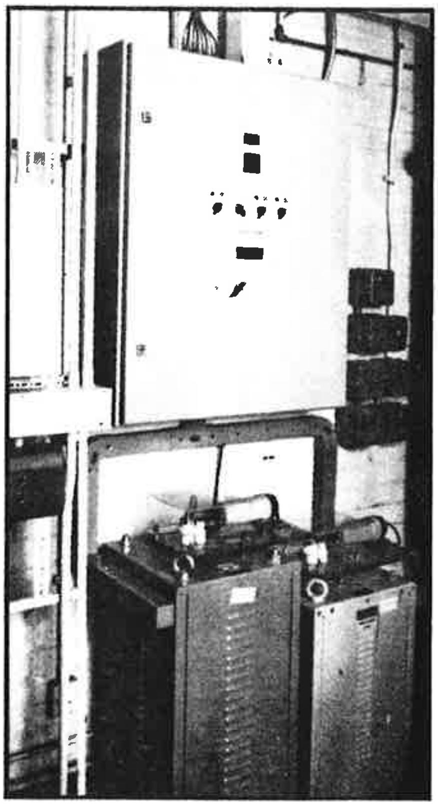
AIRFLOW $m^3/s/m^2$ of activity area	
0.005	dry areas
0.010	wet areas and pools
0.015	steamy areas
0.020	high activity/humid areas

AIRCHANGE

As buildings become more sealed and protected a safe environmental specification becomes more critical. Insufficient ventilation is debilitating and leads to long term health hazard. Spectators may be able to put up with stuffiness and too much heat for the short period they are watching a sport, but the active participant suffers reduced performance; and worse, the duty staff work there 8 hours a day, 5 or 6 days a week, year after year continually at risk. Where contamination exists and ventilation is

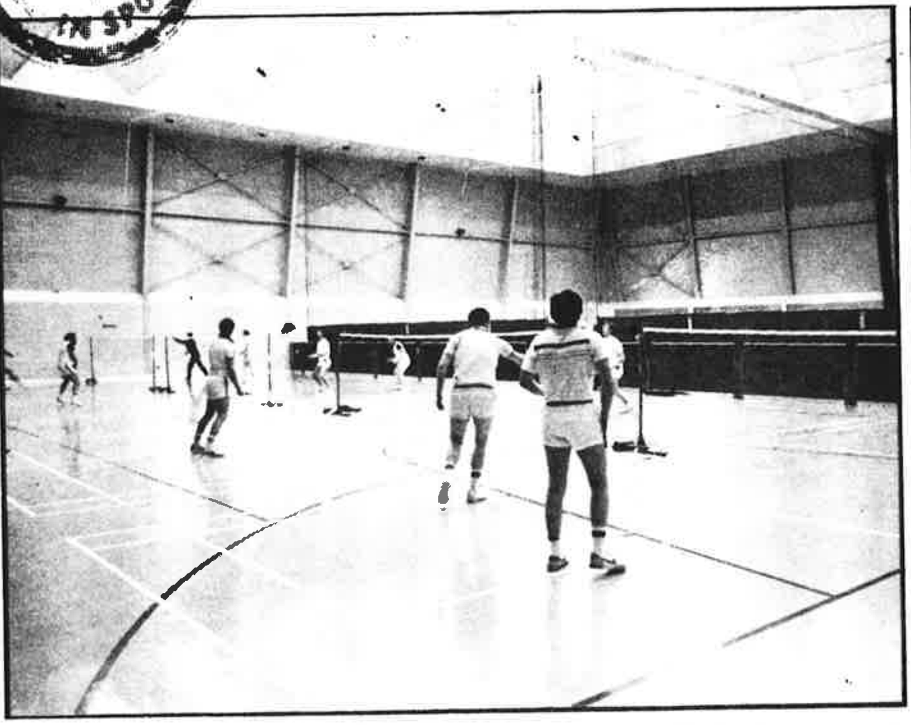


SPORTS HALL
H & V DISTRIBUTION



British Gas report MRS E401 shows fuel savings for variable flow ventilation at a 400m² pool operating under TUS conditions to be worth 22% of total energy consumed: photo shows panel and speed regulators at Stevenage (ESG Controls Cambridge).

VENTILATION



Margate Sports Hall perimeter air supply input and ceiling extract distribution, designed to suit varying ventilation rates: VAV payback expected within 2 years (ESG Controls, Cambridge).

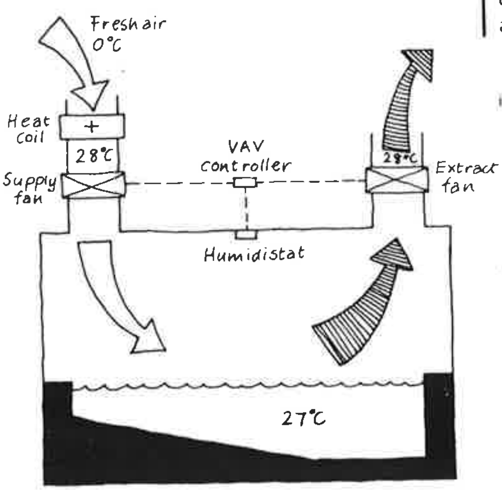
VARIABLE AIR VENTILATION (VAV)

The amount of moisture which can be held in air depends on the temperature. Moisture in air indoors will condense on colder surfaces losing heat and causing damage. The temperature at which condensation starts to form on a surface is the dewpoint temperature, an important factor in ventilation control.

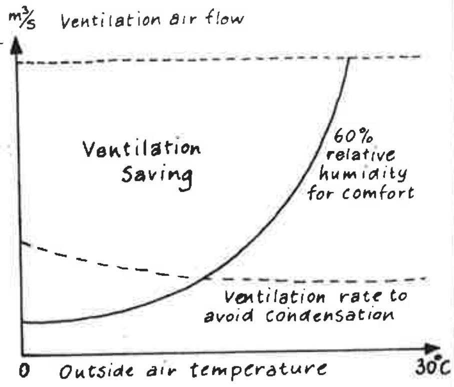
By sensing indoor and outdoor temperatures and humidity levels, and comparing them with the coolest indoor surface temperature when condensation forms, a variable ventilation controller adjusts fan speed/air rates to suit existing conditions. Adjusting fan speed to change the rate of air circulation is simpler though less effective than varying the fresh air brought in with damper control. Air dilution with varying fresh air supply allows more efficient distribution, since airchange rates can be held constant.

When combined with management appreciation of stuffiness and contamination plus anticipation for occupancy and activity, VAV systems sensibly match supply to demand. In cost saving terms, VAV can save at least one third of ventilation cost or one quarter of total energy cost for a sports building. Swansea Leisure Centre simply operates half-rate ventilation overnight to save 10% total heat and power cost. Fairfield Pool at Dartford with VAV daytime and low rate ventilation overnight, achieves nearer 20% overall cost saving.

VAV Schematic Controller senses both temperature and humidity to vary airflow rate. Source: ETSU



VENTILATION SAVING: Source British Gas



Control systems provide payback from energy savings within a year or two. Simple 2-speed fan control at high and low rates can save 25% ventilation energy; variable speed fan control can achieve 35-40% potential. · Fresh air dilution at constant airchange allows recycling of air from 10% daily proportion up to 100% overnight.

FUTURE

Better measurement - especially by humidistats - and continuous monitoring of heating and ventilation supply and demand offers significant savings. There is need for accurate evaporation data on busy pools relating activity, occupancy and wet areas to increasing potential energy regeneration. Careful water treatment control is critical for pools, and more information for water/air dilution rates is required.

Improvement to the understanding of air distribution patterns will lead to better energy use and upgrading of existing building stock.

Simple retrofit flexible tube heating and ventilation introduced to unventilated airspaces can extend usage and building life, while saving considerable energy costs. Such low-cost solutions build up to "Package deals" combining various technical mixes of covers/VAV/recovery coils/heat exchangers, etc.

Ventilation is by far the largest energy slice in many indoor sports building operating budgets; consequently it offers an equally large energy saving potential, well worth the investigation.

SOURCES AND ACKNOWLEDGEMENTS

Benson Controls, Normanton; Chartered Institution of Building Services (CIBS), London; Electric Fans & Controls, High Wycombe; ETSU, Harwell; C Jenkins, City of Swansea; N O Millbank, BRE Garston; E R Mingo, Plymouth Polytechnic (Energy conservation in a swimming pool hall); D N Morris, London Borough of Hackney (Plugging energy gaps in an indoor swimming pool, 1979 IB&RM Conference); Graham Newbert, UKAEA, Harwell; J Pearson, MRS British Gas, Solihull; Tony Robinson, ESG Controls, Cambridge; Stratotherm/Planad, Pinner; J L Holmes, Supervents, Tonbridge; Swiss Ventilation Codes of Practice; Tony Tanner, Cheshire County Council.

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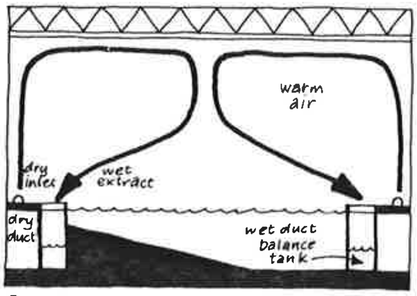
poor, the human problems start with listlessness, leading to recurrent allergies and eventually to increased ill-health.

AIR PATTERN

The best distribution patterns organise both high rate (for spectators) and low rate (for users) involving extra ductwork and more control to concentrate upon protecting the structure too. Air ventilation systems applying the high level, high flow ceiling input/extract diffuser need very careful sizing and directing. If ventilation rates are lowered for variable flow, short-circuiting can occur. To circumvent inadequate distribution instal grilles with good air-throw characteristics that suit flow rates.

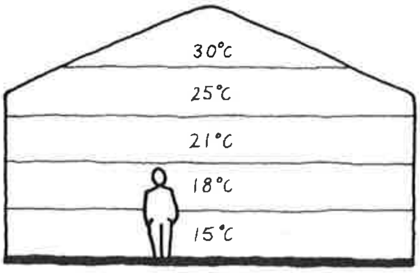


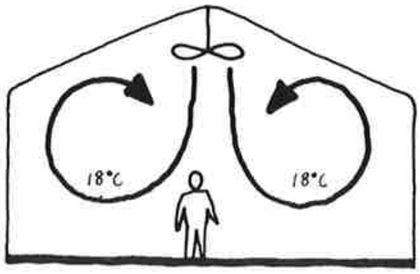
POOL HALL
H & V DISTRIBUTION

Full perimeter supply air at low level for pools is particularly effective and causes no difficulties with variable volume ventilation. Because there are different needs and standards, energy management is greatly improved with zoning large spaces or by separating wet from dry areas.

STRATIFICATION/CONVECTION

Source: Electric Fans and Controls





When systems are reduced or stopped overnight and air patterns changed or lost, a fresh air purge helps before starting up at normal rates each day. Intermittent ventilation poses possible corrosion problems in cold spaces and ducting systems. Regularly inspect airducts and dampers, ventilation fans, filters and controls, since failure and condensation still damage many sports buildings. Systems must employ good quality fittings and receive regular maintenance......... failures occur when inspection routines fail.

AIRFLOW

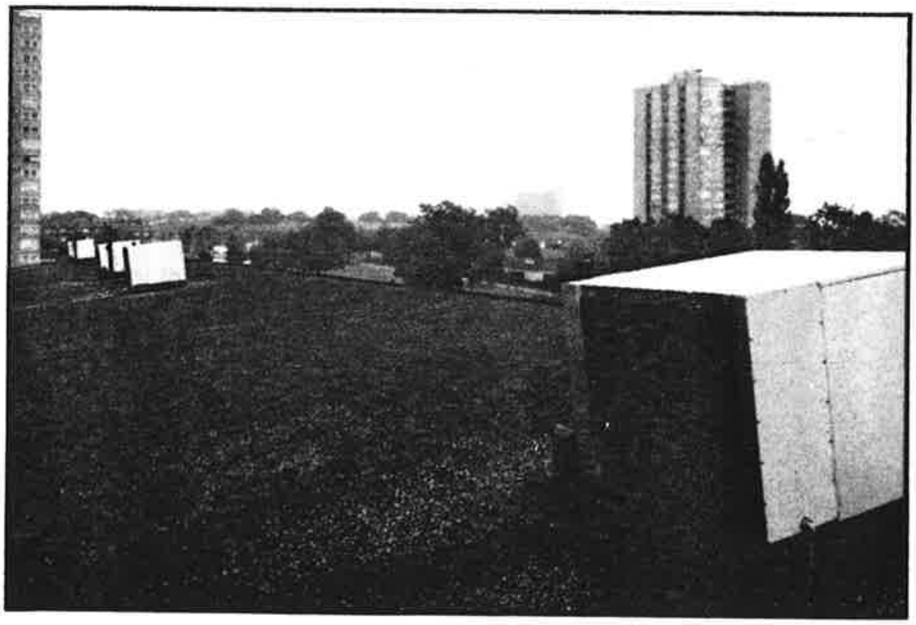
Slow airflow with large airducts using less fan power is more energy efficient. CIBS suggest checking frequently that ventilation equipment is performing correctly and achieving required temperatures and humidity; that dew-point controls for the indoor environment are located at windows; that condensation is eliminated by circulating warmer, drier air over walls and windows combatting cold air streams; that there is minimum air turbulence over wet areas and adequate air movement around the pool area overcoming closeness or high temperature; that swimming poolwater is covered overnight to stop evaporation losses.

Airflow volumes strive to match activity rates and the inevitable increase of wet areas when busy: maximum airflow at peak times is reduced to minimum airflow at quiet periods for energy efficient operation - see VAV below.

STRATIFICATION

In low ventilation buildings, warm air rises to stratify beneath the ceiling - floor temperature may be 15°C, while ceiling level tops 30°C. This layering acts like a humidity blanket over a pool where +1°C higher air temperature above water temperature helps suppress evaporation (see EDS 5 Dehumidification). The ventilation push of warm, dry air, mops-up moisture which can be turned to advantage later with heat recovery heat pump systems (see EDS 7 and 8).

Low cost prefabricated buildings can employ a punka fan to mix air layers. Alternatively, a flexible fabric central core tube working at low velocity, pushes warm air from ceiling to floor. These simple air-spreading methods offer moderate energy saving when there is little contamination.



3-in-1 Ventilation Savers......compact roof mounted units at Stevenage: each unit simply installed, saves space, cuts energy cost through **air handling, VAV and heat recovery** (ESG Controls, Cambridge)

H&V COMPARISON

High & low level input & extract
Low speed air currents reduce evaporation; provide increased ducting.
High level input/High level extract
High velocity inputs increase evaporation; must avoid shortcircuiting.
Low level input/High level extract
Counteract down draughts; special provisions for spectator gallery.
High level input/Low level extract
Use correct shape/size inlets; need to assist non-directional extracts.

Achieving 10% to 80% recirculation relies upon water/air qualities, total occupancy and the time of day.