Theatre Units

System Philosophy.

In operating theatres, fitted with modern laminar flow air supply systems, the operating staff and, indeed, the patient are literally in the supply air stream and are virtually in the supply air duct. It becomes obvious, therefore, that the velocity and temperature of the supply air now becomes critical. The surgeon, according to the procedure, selects the temperature of the supply air and the temperature should not fluctuate more than 0.25°C DB in either direction.

The air velocity is also critical, especially when operating at low temperatures. BS5726, which relates to aero microbiological safety zones, states that the downward speed of air flow should not be less than 0.25 m/s and not more than 0.5 m/s. At velocities below 0.25 m/s, the air pattern is susceptible to disturbance by physical obstacles and, from the heat of the operating light as well as movement of the operating staff. On the other hand, air velocities in excess of 0.40 m/s will cause excessive drying of the wound as well as cooling of the patient, who may become hypothermic. (Morris, Wilkey, Anesthesiology (1970) 173 New York).

The Heat Pump Laminar Flow A/C units for operating theatres, satisfy all of the above and provide a constant amount of clean air (EU8) at a constant temperature to the Hepa filters and thence through the laminar flow canopy and screens, into the theatre.

AHU Section.

The unit casing is manufactured from non-toxic flame retarding, steam expanded polystyrene insulating material 45mm thick which meets with the requirements of ZERO ODP, with an inner and outer covering of 0.6mm Chromadek steel.
Stainless-steel inners/outers can be fitted on request. The casing is assembled using anodised aluminium sections. Access doors are provided for easy access to all serviceable components of the AHU. Nylon square key cam-locks are also fitted standard on fan access doors for safety & security reasons. Where requested locks can be fitted keyed-alike.

Fan.

The supply fan is a Direct Driven BCC Plug fan which, together with the fan motor is mounted on a common frame/base. The direct drive prevents belt debris contaminating the filters as well as ensuring less vibration and a longer bearing life.

To prevent air noise, draughts, water carry-over from coil and to provide stable psychometrics, the supply air controlling the static pressure in the supply air duct controls volume. A variable frequency/voltage speed-controller then ensures the correct fan speed to provide a constant airflow regardless of filter condition.

Cooling Coil and Bypass damper

A twin circuit DX evaporator coil, matching the compressors, cools the supply air. The coil is circuited in such a way that even when only one circuit is operational; the entire coil face is cooling. This type of circuiting is described as "row-split"

The supply air volume is determined by the minimum air velocity below the laminar flow screen multiplied by the area of the screen. To achieve proper supply air conditions, approximately 50 % of the supply air bypasses the coil and is mixed with the off-coil air. The ratio of off-coil air and bypass air is regulated by motorised face and bypass dampers to maintain a constant supply air temperature without heating and cooling at the same time. A limitation is set on the bypass damper to prevent it closing to more than 50% and thereby forcing too much air over the cooling coil which would spoil the psychometric balance as well as cause moisture carry-over.

Heater Bank

An electrical heater bank is installed to supply heating when required. The elements are manufactured from 3.2 Watt/cm² Incaloy and are fitted onto a sheet metal terminal box. The elements are removable as a single assembly. This removable assembly incorporates the element mounting plate and terminal cover. A manual overheat protection is also fitted onto this assembly.

Filters

A washable primary filter bank is installed upstream of the DX coil and the fan and motor.

The high efficiency (EU8) secondary filter bank is installed downstream of the fan and motor and protects the Tertiary filters.

The Tertiary filters usually form part of the Laminar Flow Canopy.

Attenuators (supplied by others) should be covered with a non shedding material like Melenex.

Condensing Section.

The Condensing Section forms an integral part of the package unit except in split systems where the condensing and supply air sections are separate units.

Compressors.

Two hermetic compressors of equal capacity are fitted. Each compressor is fitted with service valves and a crankcase heater.

Condenser Coil.

A twin circuit condenser coil is installed to match the heat rejection of the compressors at the specified ambient. The circuits are split over the face of the condensing coil.

Condenser Fan.

A belt-driven FCC DIDW condenser fan with a two-speed motor is fitted to units that are installed indoors. This fan is run at high or low speed to control the head pressure of the compressors. Whichever circuit requires the most cooling will govern the condenser fan speed. Propeller fans, cycled to control head pressure, are fitted to units mounted out of doors.

Refrigeration Components and Control.

Filter/driers with sight glasses, thermal expansion valve (TEV), hand shut-off valves and electrically operated solenoid valves are provided. HP/LP safety cut-outs and head-pressure controls are also included. To prevent low suction conditions at low loads, a hot-gas bypass system bypasses hot gas into the system after the expansion valve but before the evaporator coil to provide de-superheating.

The compressors are protected by HP and LP cut-outs as well as anti-single phasing thermal current overload cut-out devices. An internal thermistor protects the compressors from high temperatures

Temperature and Humidity Control.

A Siemens programmable control system is installed enabling all units in the same complex to be linked and to be accessible from a remote location via a modem. No special programs are required in the remote stations to achieve this communication process which is protected by a multi-tier password protocol. On site access is possible by connecting into one of the controllers with a notebook computer.

A PERMANENT TELEPHONE LINE IS REQUIRED AT THE SITE MODEM WHICH CANNOT BE MORE THAN 10m FROM THE NEAREST CONTROLLER

Cooling is controlled from supply air temperature in 2 stages with fine control provided by regulating the face and bypass dampers.

Heating is controlled in sequence with cooling from supply air. A "step less" current valve controls the re-heater bank to provide stable supply air temperature.

Should a humidifier be installed, proportional humidity control is provided and [Hum %] will be displayed when the humidifier is operating. The humidity set point is adjustable. De-humidifying is offered as an option

The unit control includes the following features:

- Separate Essential and Non-essential power connections
- The BCC supply fan is speed controlled to provide a constant airflow.
- Condenser fan low ambient control.
- HP and LP safety cut-outs.
- All electrical starters, contactors, isolators, fuses etc. to ensure the safe, reliable and efficient operation of the A/C system.
- A microprocessor-based control system providing the following features:-
    i. Communication from a remote location providing monitoring as well as program updating and setting via a telephone line modem
    ii. Two stage cooling. (+ 0.5°)
    iii. Proportional, step less control of electrical reheaters
    iv. Humidity control providing proportional humidifying control, when an electrode steam humidifier has been installed and de-humidifying if required.
    v. Full compressor management, including, pump-down, anti-short cycling control, running hours and more.
    vi. Comprehensive, alpha-numerical status indication of all settings, conditions, inputs, outputs and alarms
    vii. Remote supply temperature adjustment.
    viii. Remote On/Standby facility.
    ix. Diagnostic help.
    x. Running hrs of all major motors.

Installation

The TPAC must be handled with care. Rough handling and dirty site conditions may damage coil fins and internal components as well as cause external damage to the casings.

The TPAC unit should be mounted on a firm, level surface, preferably on a 50-100mm high concrete plinth. The plinth, apart from raising the unit and base above standing water and ensuring a positive fall on the condensate drain, will also absorb all minor vibrations. A 150mm deep P-trap on the condensate drain is to be installed by the A/C contractor. These units are virtually vibration-free but, if desired, TECO pads can also be fitted under the feet of the unit.

Allow sufficient room around the unit for access as well as space to open access doors and to remove filters and other equipment.

Duct and pipe connections should be "self-supporting" and not place stress on the unit.

Connections to the Essential and Non-essential electrical supply and to the supply and return air ducting and external wiring are not included. Others supply the remote set point adjusting control separately for installation and connection. The remote

on/off switch, if required must be installed by the contractor. The supply air temperature sensor is to be installed in the supply duct, the sensor will be supplied loose for onsite fitting and wiring by the contractor. The pressure sensor is supplied to the contractor for remote mounting. The pressure sensor is to transmit the pressure drop across the laminar flow screens. To achieve this, 6mm tubes are to be run from port "P1" of this sensor into the CALP and "P2" is to be piped into the Theatre space in order to measure the pressure difference without interference from external pressure sources.

Testing

The units will be supplied pre-tested before splitting for delivery. On-site re-commissioning and handing over to the resident Engineer can also be provided at extra cost.

Performance and Specifications		
Model		**TPAC 20 LF**
Reference		
Supply Air Volume	**l/s**	**2300**
Ext. Static	**Pa**	**450**
Fan Static	**Pa**	**1350**
Fan Type		**BCC 450 PFN**
Fan Motor	**kW**	**7.5**
Ambient	**℃**	**38℃ DB**
On coil ℃ DB / ℃ WB	**℃**	**22℃ DB/15.4℃ WB**
Supply air ℃ DB / ℃ WB	**℃**	**17℃DB/ 65% RH – 25℃ DB/45% RH**
Compressor Capacity	**KW**	**2 x 9 8 kW**
Coil air volume	**L/s**	**932**
Total Cooling	**kW**	**19.61**
Altitude	**masl**	**Sea level**
Stages		**2**
Refrigerant		**R 22**
Electric heating	**kW**	**12**
Humidifier	**Kg/hr**	**5**
Essential Power supply	**A**	**12 A 380vac**
Non-Essential Power supply	**A**	**40 A 380 vac**
Filter Media		**EU 9 2-stage**
Filter quan / size		**1 600x600**
Length / Depth	**mm**	**2900**
Width	**mm**	**1390**
Height	**mm**	**1780**
Essential FLA	**A**	**11 A 380/50/3**
Non Essential FLA	**A**	**36 A 380/50/3**
Condenser Air	**l/s**	**3000 l/s (Propeller fans)**