Cell Services

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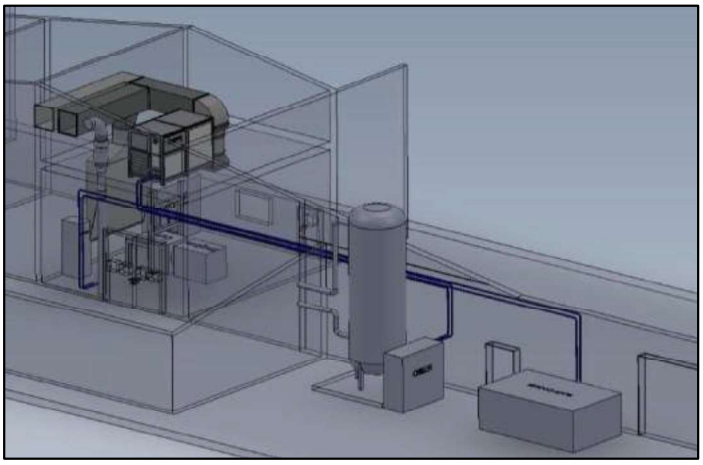
Driven by increasingly stringent legislation around the world, particularly in the area of emissions validation and development, there is a need to minimize test variability by reducing, controlling or eliminating all external influences that effect the accuracy and repeatability of test results. The control and repeatability of test cell ventilation and engine combustion air conditioning are recognized as key external influences that can have a significant impact on the test specimen and the results obtained.

Sierra-CP is unique in our ability to offer a suite of innovative modular solutions in this highly specialized field. This enables existing test cells to be upgraded, or new conditioning systems to be integrated into existing or new turnkey installations. Specific solutions include cell ventilation, exhaust extract systems, combustion air handling, intake air mass flow measurement, exhaust back pressure control, and engine fluid temperature (fuel, oil, coolant, intercooler).

As part of a turnkey package CP are able to provide the associated site services required for effective test cell operation, including chilled water circuits required for air and fuel conditioning units, bed water circuits required for engine and dynamometer cooling services, steam generation equipment, required for re-humidification of engine and test cell air. CP are able to provide these services in a wide range of capacities, ranging from the smallest of test cells to complete facility services. Sierra-CP are able to offer complete test cell design and build facilities as part of a turnkey package.



Combustion Air Handling Unit

CAHU

Transient Temperature, Pressure and Humidity Conditioning

1000, 1500, 2500, 3500 kg/hr

Introduction

The Combustion Air Handling Unit (CAHU) conditions the available ambient air supply and generates output air of controllable pressure, temperature and humidity levels to the specification of the user. This air provides a standard operating condition for the engine, and can be used for emissions work or for standardising the engine intake air conditions for mapping or optimisation work, and reduces test days lost due to adverse atmospheric conditions.

Benefits and Features

- Control of Pressure, Temperature and Humidity levels
  - Only conditions air for the engine
- Simulate alternative air conditions, such as:
  - Race Circuits
  - Foreign Countries Ambients
- Fast condition response for transient work
  - All potential air is conditioned ready for use
- Self contained unit
  - Send Set-points from an Existing Test Controller
- Two sided access for ease of installation, operation and servicing
- Three sizes as standard, 1000, 1500, 2500 and 3500 kg/Hour,
  - Passenger Vehicles, Race Engines and Heavy Duty Vehicles

Applications

- Standardise intake air for repeating experiments
- Power Pass Off Tests,
- Emissions certification work
- Conditions adverse ambient's to within the range of correction factors

System Description

The most accurate method of conditioning the air to the required level is to control the re-Heating and re-Humidification of the ambient air to achieve the necessary output. In order to do this, the ambient air is passed through the primary or condensing coil and is cooled to a base temperature and humidity level. This initial cooling of the air causes it to condense out a large proportion of its water content. The result is Cold relatively Dry air, this can then be conditioned by the CAHU.

Re-Humidification is achieved using a flow of high temperature steam either from an external steam supply which is assumed to be present the location of the CAHU, or an internal steam generator built into the CAHU. A dual control valve with three stages of turndown controls the flow rate of this steam. It is injected into the ductwork just before the Fan. The steam mixes with the process air while passing through the fan; this system gives efficient absorption of the steam into the process air, increasing the humidity level as required.

Air flow and pressure rise is created with a high-speed centrifugal fan. The fan is capable of raising the combustion air pressure by up to 120mBar (12kPa) above the air inlet pressure.

During pressure generation the fan generating the positive pressure ‘heats’ the air by several degrees C, due the adiabatic work done on the air. This heating effect during processing of the air is monitored and used to reduce the amount of re-Heating that is required.

Additional Heating is performed by electric heater coils mounted in the ductwork of the CAHU, these are switched ON in banks by the controller as necessary.

The airflow passes into a final delivery plenum. Two butterfly valves regulate the plenum pressure, one regulates inlet flow and one regulates the dump flow to atmosphere, and hence can adjust the pressure in the plenum. A third outlet port mounted on the roof of the CAHU as standard is connected to the engine air intake.

Under fault conditions the pressure plenum is protected by an under-pressure relief system. Following activation, the engine will draw air from the atmosphere, even though it may not be of the required conditions, it will eliminate potential harm to the engine and CAHU.

As negative pressure generation is required because the ambient air pressure may be higher than the required output air pressure, a second centrifugal fan in the CAHU is used to create a depression in the delivery plenum, seen at the CAHU outlet.

The CAHU controller includes I/O circuitry and wiring to accept the control of the exhaust back pressure valve which is used to provide a fixed exhaust back pressure. It is only possible to operate the exhaust at a pressure above atmospheric pressure as the dilution system has limited negative pressure capability.

It is intended that the excess CAHU flow will be passed into the exhaust after the silencer and before the EBPV so that the target exhaust pressure may be maintained under all engine flow conditions.

CAHU Specifications

The four CAHUs are designed to fit within the same envelope. This is the standard supply configuration. It is possible to design into a different space envelope by repackaging the component parts; this would be a special order.

CAHU Dimensions

The following are the dimensions of the CAHU units.

Physical Dimensions		
W x D x H	M	2.8 x 1.6 x 1.8
Weight – approximate models vary slightly	kg	2,200

Engine Delivery Conditions

Engine Conditions	**Units**	**Value**
Max Engine Flow Rate	**kg / hr**	**1000 1500, 2500 and 3500**
Min Engine Flow Rate (to keep duct conditioned to +/- 1C)	kg / hr	250 kg/hr
Min Pressure	mbar	1000
Max Pressure	mbar	1013
Absolute Humidity Min.	g/kg	6
Absolute Humidity Max.	g/kg	12
Relative Humidity	RH%	30% - 60% (at 25°C)
Output Temperature Range	°C	20 - 30

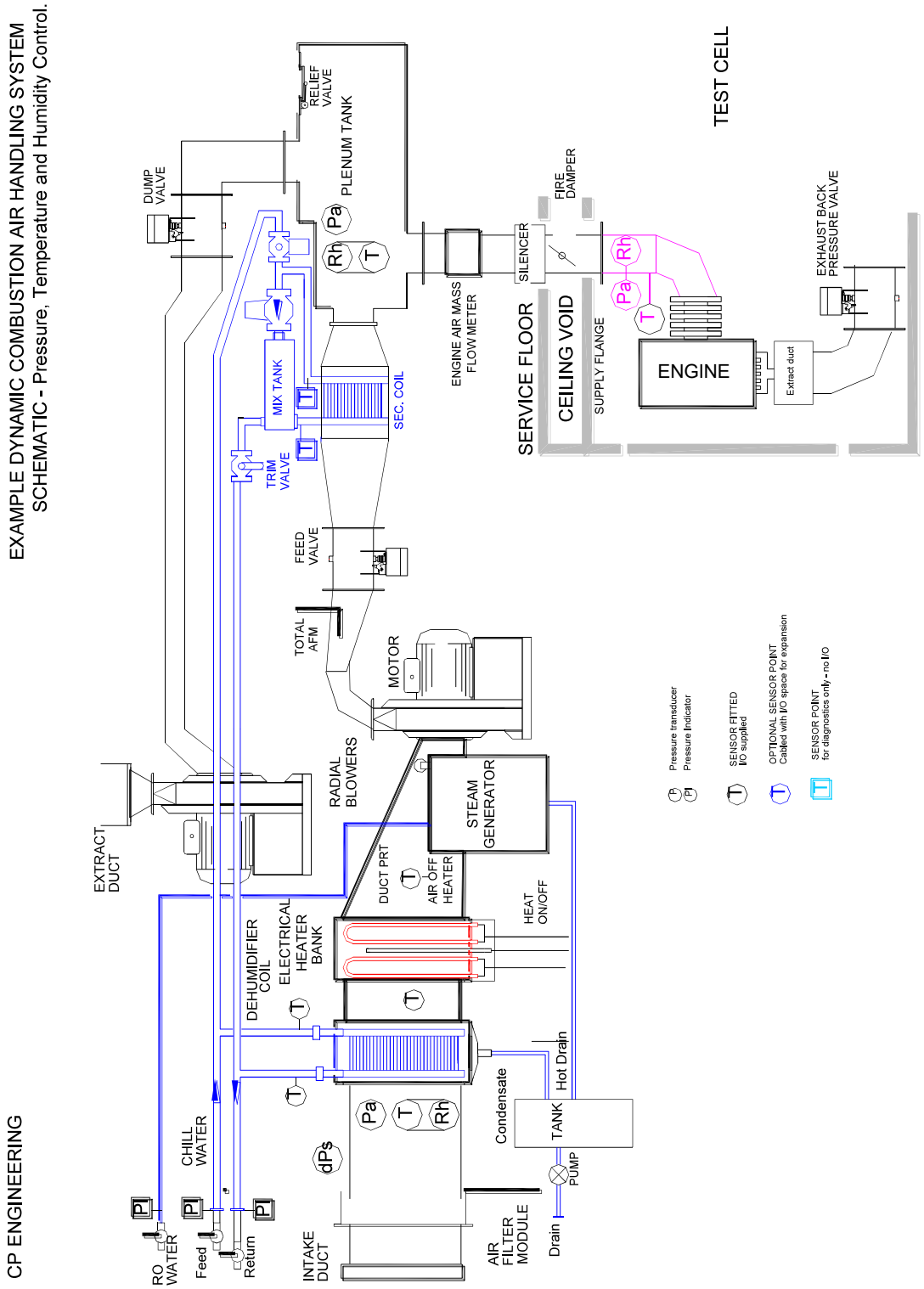
System Accuracy

The system accuracy is defined by the accuracy under operating conditions of the sensors used for stand-alone operation of the CAHU. It should be noted that under normal conditions the CAHU is actually trimmed by the test cell automation system so that the target engine conditions are achieved. Under these conditions the engine sensor accuracy applies rather than the CAHU sensor. For this reason fast response sensors are chosen in preference to very high precision sensors for the CAHU.

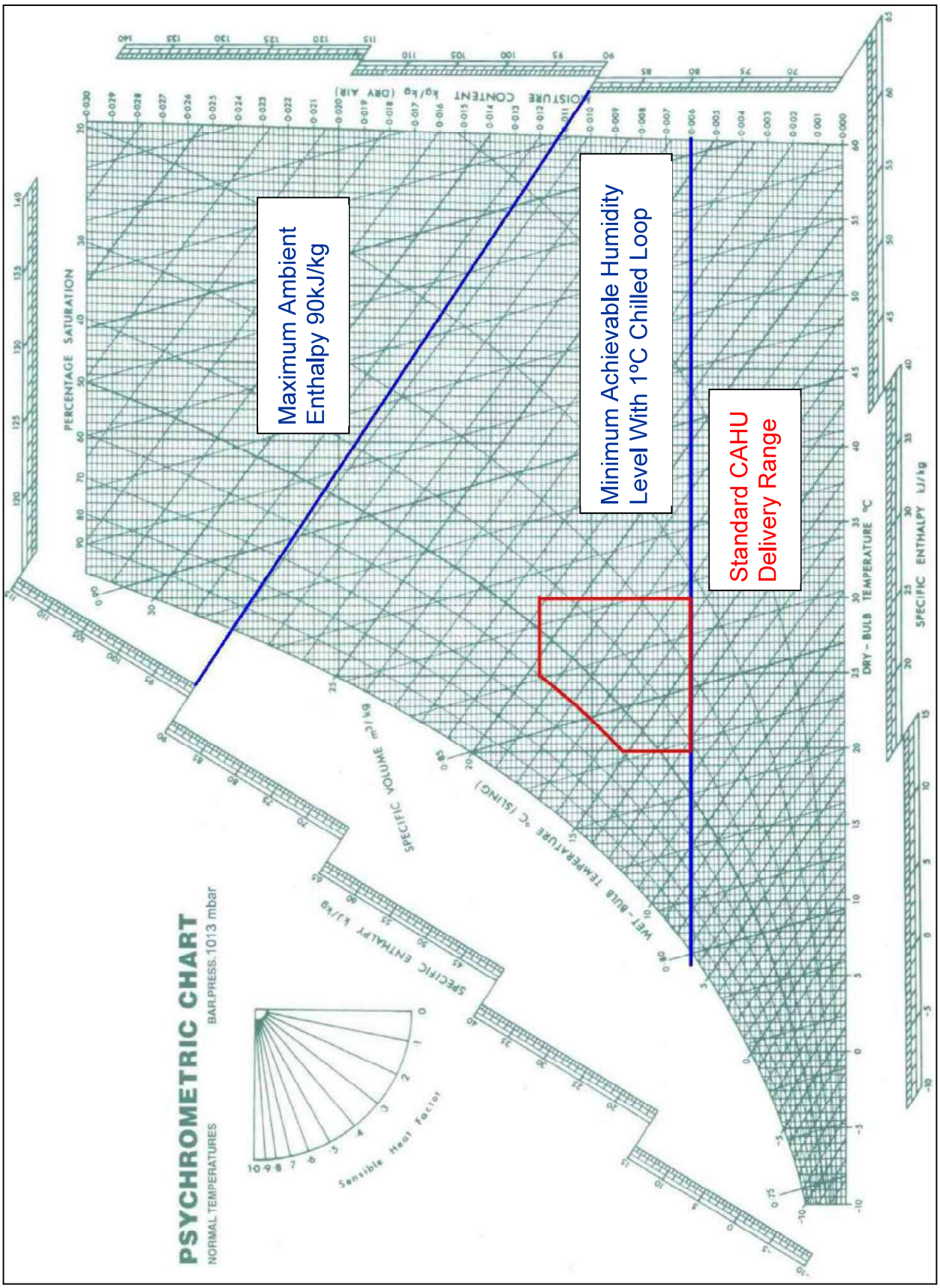
System Precision – Stand Alone Operation		
Temperature	°C	+/- 1.0
Pressure	mBar	+/- 1.0
Humidity	% RH	+/- 5% (3% typical) 95% of Duty for Humidifier Units

Schematic Diagram

The following schematic shows the process flow of the air to be conditioned by the CAHU.



Standard Temperature and Humidity Delivery Conditions



Customer Responsibilities

Generally the customer should make available or prepare the following services:

- Chilled Water Supply (1C Loop)
- Electrical Power Supply, 380-415V (3 phase + Neutral) 50Hz to CAHU electrical enclosure, current dependent upon size.
- Water to Humidifier Unit – either tap water or demineralised
- Condensate Drain

These will be confirmed and discussed during the project phase.

Customer Supply Requirements

CAHU		1000kg/hr	1500kg/hr	2500 kg/hr	3500 kg/hr
Chilled Water					
Fluid Supply Temp	°C	1	1	1	1
Fluid Flow Rate	Litre/s	2.0	3.0	5.2	7.8
Maximum Heat Rejection	kW	24	35	60	89
Water Supply Rate to Humidifier/Steam Supply Rate	Litres/hr	11	16	27	37
Tap Water or Demineralised water					
Electrical Requirements 380-415V 3ph 50Hz, Neutral wire required	Amps	100	120	170	230
Plastic Drain Required for Condensate Water					

Figures are based on a Maximum Ambient Enthalpy 90kJ/kg, Minimum enthalpy 0kJ/kg at sea level, and a supply voltage of 380V. CAHU and location specific customer requirements will be confirmed during the project phase.

Ductwork to engine

In its standard configuration the CAHU delivers conditioned air from the top of the unit. Other configurations are available on request.

In order to provide the best response and control it is best practice to have the CAHU as close to the point of final delivery as possible. The ductwork should be as short as possible and ideally be thermally insulated and smooth bore.

A flow meter is not included with CPs standard CAHU however is recommended for effective operation and should be integrated into the supply duct to minimise the duct overall length. CP can quote for a flow meter if required.

The ductwork should be thermally insulated – smooth bore and have an internal diameter of 200mm (3500kg/hr) and 150mm (2500kg/hr, 1500kg/hr and 1000kg/hr).

Additional Options

The final stage of the system is for the conditioned air to pass through an Air Mass measuring system of some description, such as a Venturi, Laminar Flow Element, Pitot Tube Array or Hot Film Mass Meter. The reading from this mass/ flow meter is fed back to the CAHU controller and logged.

CP do not supply flow measurement equipment with the CAHU's as standard, but can provide a Sierra AirTrak or other suitable air mass meters on request.

CP are able to supply CAHUs in temperature only, temperature and humidity only or temperature and pressure variations. As well as this CP are able to supply Boost rigs which allow high pressure combustion air simulation up to 6 bar, with temperature conditions. Please contact CP for further information on these products.

CAHU Arrangement

Ventilation Systems

Introduction

Sierra-CP offer bespoke cell ventilation solutions for engine test cells. Ventilation systems can be designed to fit around design constraints of existing test cells, or can be designed as part of our complete turnkey test cell installations.

System Description

All CP ventilation systems are supplied with intake, extract and recirculation ductwork. On a colder day this can reduce the amount of duty required from the heater elements, as ambient air can be mixed with re-circulated air (warmed by the engine) to allow a stable cell temperature to be maintained. The recirculation ductwork also enables test cell temperature soaking prior to testing, as air can be repeatedly heated or cooled (with the addition of cooling coils) during recirculation as required.

Sierra CP uses 2 inverter driven axial circulating fans with the standard ventilation system design, this allows flow rates to be controlled whilst maintaining test cell pressure.

Control of the ventilation system is by the CADET V14 control component. The vent system is controlled directly by a CADET Control, Automation and Datalogging system controller. This can be operate as a stand alone unit or receive setpoints from a CADET or 3rd party test cell host via an Ethernet AK protocol.

Key Components

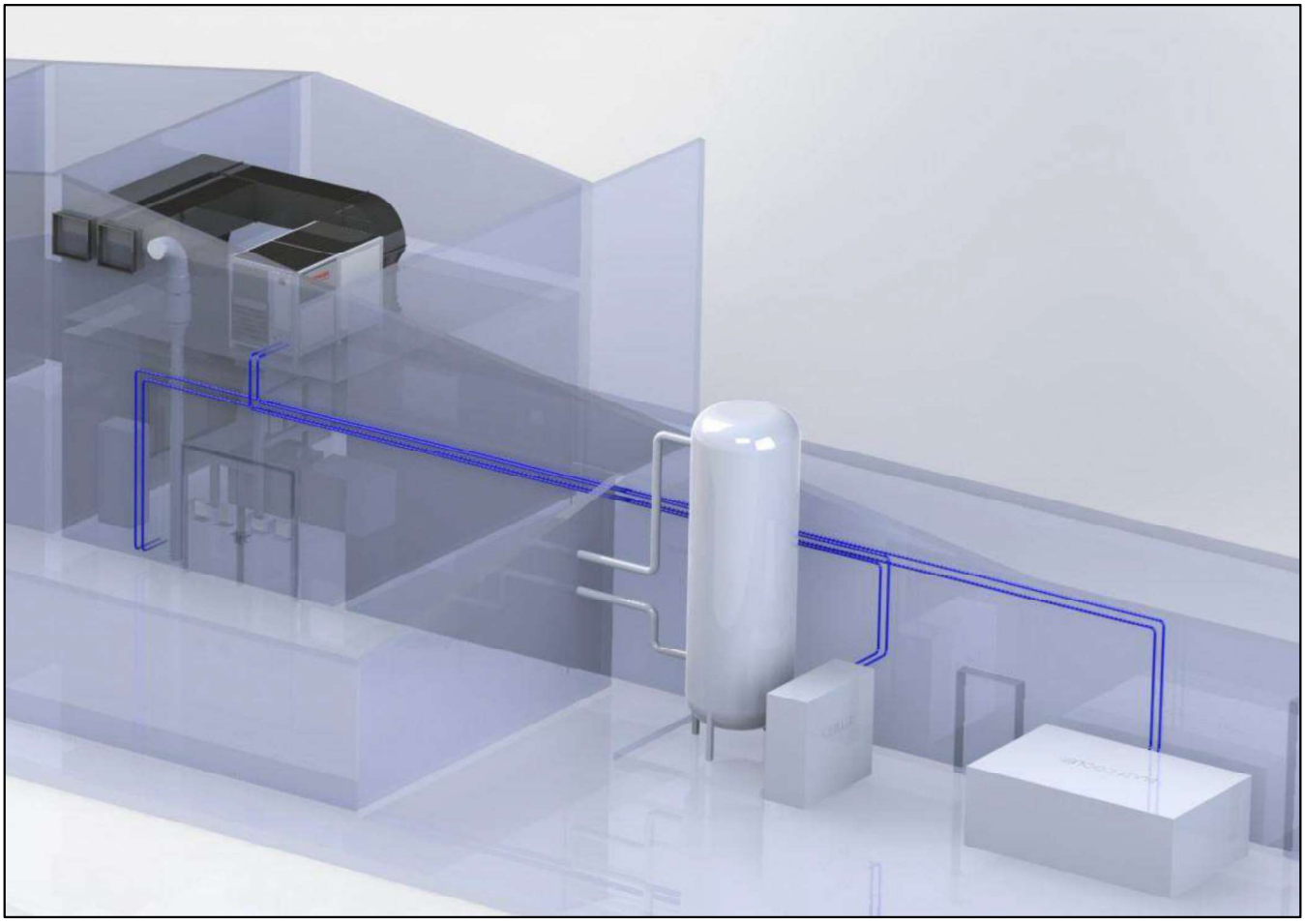
The key components of the ventilation systems are:

- Intake, extract and recirculation ductwork
- Inverter driven axial circulation fans on the intake and extract
- Diverter louvers and actuators
- Heater elements
- Removable ductwork section for the installation of cooling coils in the future
- Cover grills
- Acoustic elements
- Electrical power enclosure
- Control enclosure connected to CADET cell services system controller

Additional Options

Due to the bespoke nature of CP ventilation systems any requirements requested by a customer can be accommodated. Options such as humidity control (above ambient), fire dampers and custom filters can be accommodated.

On a number of occasions CP have integrated cooling coils into ventilation ductwork to allow cell temperatures below ambient to be achieved. This maybe required for test cell temperature pre-soaking, or to allow lower than ambient cell temperatures to be maintained during engine operation.



Cell Support Services