Airport Pre-Conditioned Air (PCA)

Airport Infrastructure Requirements

Introduction

There is an increasing drive for pre-conditioned air systems to be provided at airports. These are being installed in greenfield airports and retrofitted to existing airports. The reasoning is that this reduces the use of an aircraft's Auxiliary Power Unit (APU) and with that reduces emissions, noise and improves air quality on the ramp. Environmental legislation and airport operating procedures are also contributing to greater adoption of these systems. These systems should deliver benefits for airlines, airports, and the wider sustainability of aviation when planned and delivered correctly.

In conjunction with this there are trends in systems delivering insufficient cooling for aircraft. This impacts greatly on passenger comfort on the aircraft while waiting for departure. Changes in aircraft types and changing climate patterns are impacting this further.

The cost of installing PCA across an airport is a large capital expenditure undertaking. The cost of the system is only a part of the total cost. The wider enabling infrastructure requires a large investment, especially when retrofitting to an existing airport. The system chosen will also have ongoing costs in terms of energy consumption, maintenance, and stand operations. This will impact on the performance and reliability of the chosen system and the comfort of passengers.

The installation of the optimum system for an airport is a complex procurement exercise and requires clear requirements and selection criteria. This will lead to the optimum system being chosen, minimizing capital costs, operating and maintenance costs and optimizing performance and reliability throughout the asset lifecycle.

PCA Systems

There are three categories of PCA that are available on the market, the central system, the Point of Use (POU) system and the mobile system. These all have different strengths and weaknesses depending on the application.

A centralised PCA system uses a central plant within the airport to generate cool or hot air that is distributed using extensive pipe networks to the aircraft stands. These systems usually are highly efficient due to the economies of scale. Large-capacity chillers and compressors are more efficient than smaller, distributed units. Maintenance is centralized, reducing the need for multiple site visits. This system is best suited to an efficiently laid out airport design and a greenfield airport.

POU systems are the most common form of PCA systems at airports internationally. These systems can be provided as units that are mounted on passenger boarding bridges (where available) or on the apron. These systems benefit from flexible installation without the need for extensive piping or retrofitting of aprons and terminals. However, upgrading of the electrical infrastructure might be required and they do generally use more energy compared to centralized systems if the airport is busy and all the gates are being used. There is more maintenance required as there are multiple units distributed around the airport all with separate chillers etc.

Mobile systems are either trailer mounted or a vehicle that has an integrated PCA system to provide cool and hot air to remote stands. They are most suited to airports that require limited PCA provision and for remote stands. They are also ideal as back-up systems that can be deployed easily if there is a fault with a system. They do have drawbacks in that they add significant complexity on the stand during turnaround. They require staff to drive them around the airport increasing workload and personnel required.

when the capital costs will be reduced compared to retrofitting.

Table 1 Comparison of the different PCA systems

Feature / System Type	Centralized PCA System	Point-of-Use (POU) PCA System	Mobile PCA System
Installation Cost	High initial cost for infrastructure and piping	Moderate; individual units per gate	Lower upfront infrastructure cost
Operational Flexibility	Low; fixed location, aircraft must be at connected gates	Moderate; limited to gates with units	High; can serve any stand or remote location
Maintenance Complexity	Centralized maintenance, easier to manage overall	Maintenance per gate; spread out	Requires regular maintenance & logistics for moving units
Space Requirements	Requires plant room and piping infrastructure	Requires space at each gate for unit	Requires space for unit storage & manoeuvring
Environmental Impact	Efficient energy use; possible waste heat recovery and peak power use spreading	Depends on power source; usually electric and the energy sources for that electricity	Lower emissions than APU but diesel units emit pollutants
Reliability	High, due to centralized control and backup systems	Moderate; individual unit failures affect specific gates	Variable; risk of breakdown and limited backup units
Suitability for Remote Stands	Poor; only serves connected gates	Moderate; can be planned as part of remote stand design	Excellent; can serve any aircraft position

The system used is one part of the overall PCA operation at an airport. The ancillary infrastructure that conveys the air to the aircraft influences the thermal efficiency, ease of operations, reliability and maintainability. If there are passenger boarding bridges and the system is mounted on the bridge then flexible hoses are used. If the system is mounted on the stand or a central system, then pipes mounted to passenger boarding bridges can be used in combination with flexible hoses for the final connection to the aircraft. If there is no boarding bridge then normally flexible hosing from the head of stand is used directly to connect to the aircraft.

The most invasive delivery infrastructure used with a central or a stand mounted POU is underground stand distribution. This is the most thermally efficient method and should improve turnaround times and reduce complexity on the stand. It is best suited to large, busy greenfield airport development

PCA Performance

Performance and reliability can be greatly impacted by the specification of the unit that has been chosen to deliver the required cooling and heating for the weather conditions, aircraft type and variant. The use of undersized units leads to discomfort for passengers, greater energy usage and unreliability as the unit will be run at high output for longer which causes greater wear.

The specification of the range of weather conditions the system will operate in is crucial to performance. If the climate has greater extremes than specified, it will not be able to deliver the required heating or cooling. As climates are changing future conditions need to be considered too.

The specification of the aircraft to be serviced by the system need to include the mix of aircraft and the different variants, especially seating density. If there are larger and more densely seated aircraft this will cause performance issues.

The calibration of the system for the required heating or cooling is critical to deliver the required performance across different conditions. This could be aircraft type, temperature, humidity, boarding bridges or stairs.

The wider power infrastructure serving the systems can be critical especially for POUs and retrofitted airports. The ability of the electrical grid to provide the required power supply is critical for the performance of the system particularly at peaks when all the units will be operating at higher outputs. This can reduce the output from the units at these critical times. The power demand of airports is evolving as Ground Service Equipment (GSE), buses and terminal heating and cooling systems are being electrified. This places greater strain on the electrical grid.

The system ancillaries, especially how the air is conveyed from the unit to the aircraft can impact performance. If there are significant losses of heating or cooling through the hoses or piping used, this can reduce the system performance.

These considerations can lead to more unreliable systems that are running at maximum capacity for longer using more energy and being less reliable for the airport and their airline customers.

PCA Requirements

An airport that is proposing to install a PCA system for a greenfield airport or to retrofit to an existing airport should consider the following when selecting that system:

The airport should prepare an internal business case that accounts for the overall infrastructure costs, the operational costs, the energy availability, environmental impact, the ease, and flexibility of operation for airlines, ground handlers, and the airport. In the case of retrofitting the disruption and added infrastructure required should be included.

When choosing which system to adopt there is a need to fully understand the power demands of the system being chosen. This requires modelling for high demand scenarios of the airport using peak design hour demand for simultaneous usage of the system across stands and other energy infrastructure demand.

As part of the feasibility process for retrofitting POA PCA to an existing airport, an assessment must be made of the current electrical infrastructure and its capacity to deliver the required power demand to all stands. This must be considered as part of the overall cost and impact.

The airport should understand and collate the aircraft mix and variants, especially passenger density and the current and future weather conditions for the proposed asset life of the system. The aircraft handling conditions i.e. are all aircraft serviced by passenger boarding bridges or stairs is another important consideration. These are critical information for specifying the performance of the system being procured.

The system should be specified to conform with the IATA Air Handling Manual requirements for the performance of a PCA system at a minimum.

The system chosen should be assessed on cost, energy efficiency, long-term maintenance costs, reliability rate in similar conditions to the airport.

The vendors should provide maintenance and performance data to prove the ability of the system to provide the required cooling or heating and long-term reliability for the aircraft mix and weather conditions.

Factory acceptance testing and quality control should be included as part of the vendor evaluation and auditing by the airport.

Related Documents

IATA Airport Development Reference Manual (ADRM) 12th Edition

IATA Airport Handling Manual (AHM) 46th Edition

IATA Airport Infrastructure Business Cases position paper

IATA Airport Infrastructure Investment – User Consultation position paper