What's Your NLA?

How Will New Large Aircraft Affect Your Airport Facilities?

A Report for the Aviation Industry
Prepared by Burns & McDonnell

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NLA Revisited . . .

In 1994, Burns & McDonnell recognized that the advent of new large aircraft could have a significant impact on the airport facilities we design and build for clients around the world. To address that impact and to inform our colleagues in the industry, we studied the issue in that year's special report, "Make Way! New Large Aircraft Are Coming!"

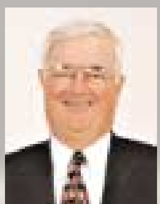
Since then, several developments have again made the new large aircraft a top aviation issue. Airbus has firmed up its plans to build the A380, which will be the largest passenger aircraft in the world. With orders from several carriers, this "super-jumbo" jet is slated to move from the drawing board to the skies within the next three years – and into the world's airports by early 2006. By 2019, Airbus predicts, the demand for aircraft of this size will grow to more than 1,500.

Although Airbus is betting on the industry's desire to reduce congestion by flying bigger planes, rival aircraft manufacturer Boeing is placing its bets on the flying public's desire to bypass crowded hubs by flying farther and faster. Boeing has shelved its plan for a stretched version of the 747 to focus on the development of longer-range and higher-speed aircraft.

But the super jumbo is not the only new aircraft impacting the aviation industry. Recent years have brought the advent of other planes that can rightly be termed "new large aircraft." For the regional airline market, the larger aircraft is the regional jet, which is quickly replacing the turboprop as the aircraft of choice for commuters. By 2005, the Regional Airline Association predicts, regional jets will account for more than 50 percent of the regional fleet and will carry 70 percent of regional passengers.

At the same time, the growth of international commerce has spawned significantly larger business jets that are flying executives farther and faster than ever before.

While all of these new aircraft promise to bring a higher level of service to passengers, they are also creating new requirements for your facilities. At Burns & McDonnell, we specialize in meeting the needs of the ever-changing aviation industry. As a leader in aviation facility design for more than 60 years, we've helped hundreds of airline, airport and corporate clients accommodate bigger and better aircraft and respond to the increasing demand for air travel. So whatever new large aircraft is heading for your facility, we have the experience and expertise you need to be ready.



David M. Griffith
President
Aviation Group

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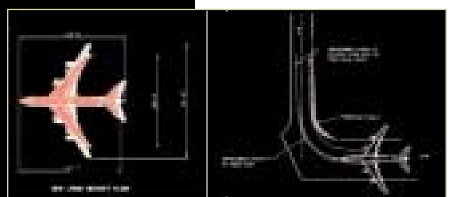

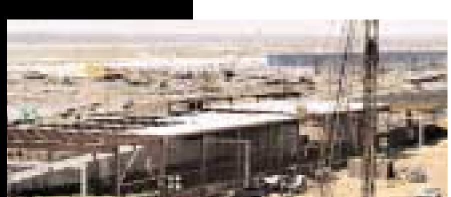

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Terminal Capacity

By David Yeamans

With an anticipated growth rate of 5 percent per year, air passenger traffic is predicted to double in 15 years and triple in 20 years. To meet this demand, aircraft manufacturers have developed the "super-jumbo" jet, an aircraft that will be capable of carrying from 555 up to 800 passengers.

The first of these aircraft is expected to be Airbus Industrie's A380, which is scheduled to enter into service early in 2006. Since its commercial launch late in 2000, the European aircraft manufacturer has announced firm commitments from an increasing number of the world's major airlines for what will be the world's largest aircraft. Singapore Airlines, Air France, Virgin Atlantic, Emirates, Qantas Airways and Qatar Airways have all placed orders for the A380.

It is anticipated that the A380 will serve airports that currently serve the B747-400, the largest commercial aircraft now in operation. However, Airbus Industrie's super jumbo will be 11 feet longer, 41 feet wider, 15 feet taller and 400,000 pounds heavier than Boeing's jumbo jet. So while these aircraft promise to relieve airport congestion by carrying more passengers with fewer flights, they will put a significant operational burden on the current airport infrastructure that can only be relieved with expansion and renovations.

Introducing larger wing span aircraft will add to the already complicated task of scheduling and parking aircraft at the gates, as maintaining the required wingtip/operational separation between planes may prevent the use of adjacent gates while loading and unloading the A380. One solution is to park the aircraft remotely on hardstands and transport passengers via buses or vans to the concourses and terminals. However, such operations — already being used at many airports to avoid the expense of terminal and apron expansions — have proven to be quite expensive. This arrangement is also inconvenient for passengers and service crews.

Most airlines have aircraft scheduling and capacity planning/yield management programs to enhance gate efficiency and bottom line profits. Hypothetically, airlines could schedule super-jumbo jet aircraft during off-peak times to lessen passenger volume during peak times. However, this is contrary to the traditional "hub and spoke operation," which tries to maximize aircraft use by converging to a control point (hub) during certain times of the day. Scheduling these aircraft during off-peak times might also be contrary to overseas time slots. Dramatic rescheduling of aircraft, unless proven profitable for the airlines, will never happen.

The double-decker design of the A380 may also present problems at some airports. To maintain competitive airline schedules and restrictive takeoff/landing slots, these super large aircraft will need to be turned around in the same amount of time as the smaller jumbo aircraft. To facilitate the 90-minute turnaround demanded by the airlines and airports, the A380 has been designed to utilize three passenger bridges simultaneously. While some recent terminal construction projects have been designed to accommodate this type of configuration, the use of upper-level bridges would require significant structural modifications to many existing terminals.

At airports with annual passenger volumes of 8 million or more, the super-jumbo jet may bring a welcome relief from airside operation congestion. However, the aircraft's high passenger volume may contribute to increased terminal and landside congestion. To accommodate 555 to 800 passengers per flight, gate holdrooms may have to double in size, concourses may need to be widened, and capacity of ticket processing, baggage handling and customs areas may need to be expanded. Curb frontage, arrival and departure roadways and automobile parking — already constrained at many airports — may not be able to handle the peak surges of arriving and departing passengers that will be created by the large aircraft.

Capacity limitations at many major airports may force the use of these new large aircraft. While cities are moving rapidly to provide the most direct and lowest-cost service with smaller aircraft, these tendencies are causing operational and capacity problems at the busier airports. Delays continue to rise. The new large aircraft could be the solution to some of these delays — as long as the airport infrastructures can be built in an affordable and timely manner.


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A380


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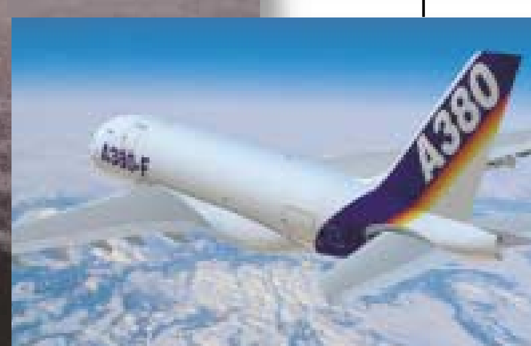
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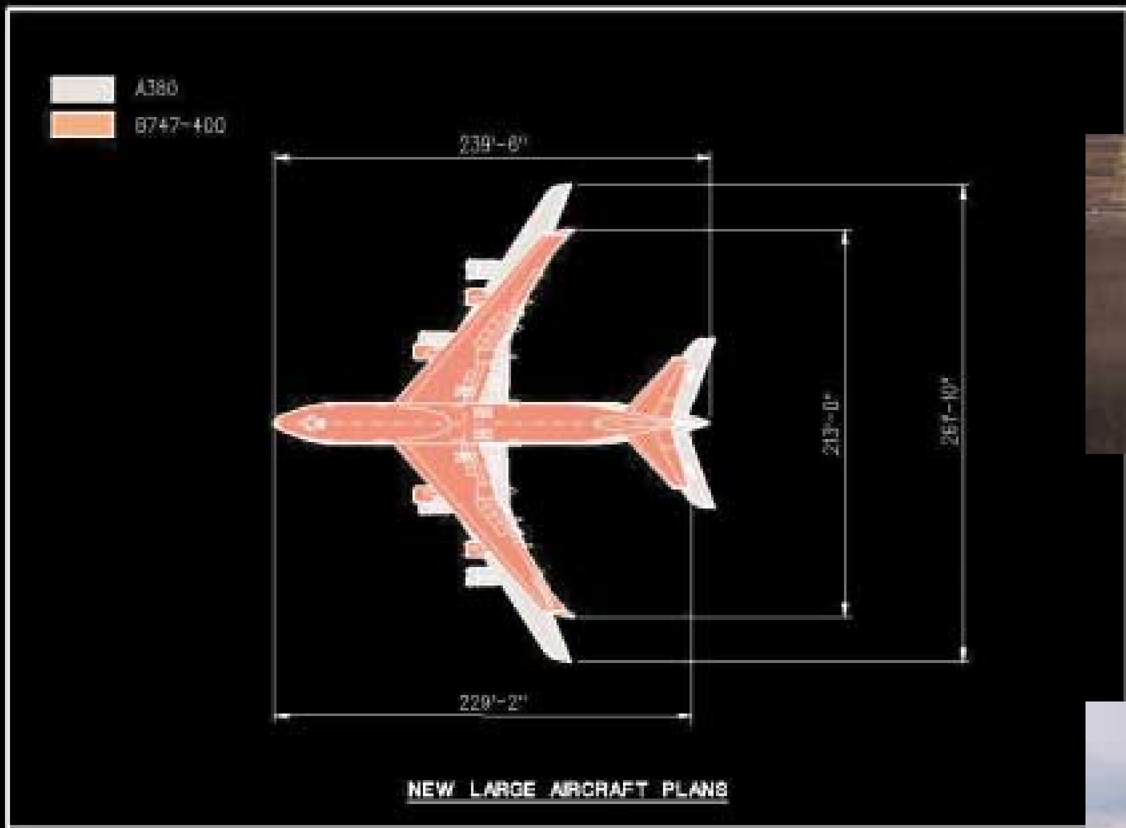
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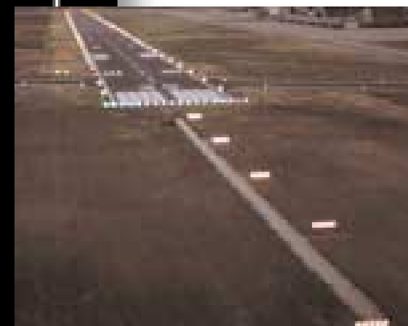

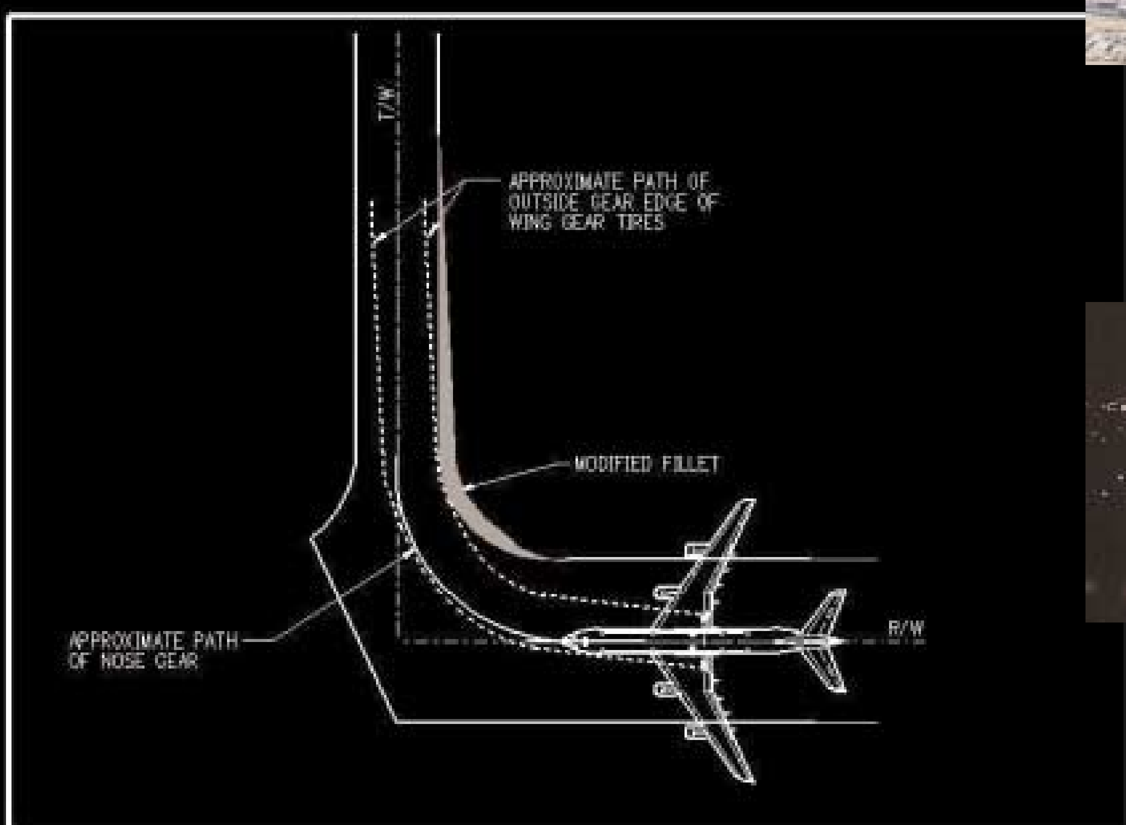
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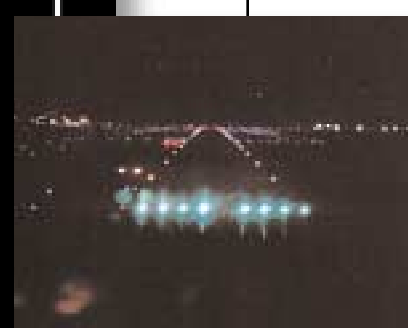

Airfield Accommodations

By Renita Mollman, P.E.

Although the maximum takeoff weight of the A380 will be over 1.2 million pounds, new and better wing technology and higher performance engines will allow the aircraft to operate from the same runway lengths as existing B747-400s. In addition, more wheels have been incorporated into the design of the landing gear to maintain wheel loading similar to the heaviest aircraft now in operation. However, accommodating the aircraft's wingspan of close to 262 feet may require significant modifications to airfields at airports intending to serve the new large aircraft. The A380's wingspan makes it the first aircraft in Federal Aviation Administration (FAA) Design Group VI. To meet the requirements established for this category, runway and taxiway widths, as well as runway-to-taxiway and taxiway-to-taxiway separations, will need to be increased.

Airfields that are designed to meet the criteria for FAA Design Group V, which includes the B747-400, have 150-foot-wide runways and 75-foot-wide taxiways. Although waivers may be granted to allow the A380 to operate on Group V runways, Design Group VI establishes 200-foot-wide runways as the standard for an aircraft with the A380's wingspan. Additionally, the FAA mandates taxiways of 100 feet wide for aircraft in Design Group VI. However, some airports may avoid the complete renovation of taxiways by increasing the fillet radius at intersections or by widening the taxiway just enough to maintain the required taxiway edge margin. This might allow taxiways to be widened to 80 rather than 100 feet. The use of judgmental oversteering — already a common practice at many airports — may also reduce the need for fillet modifications.

Because many of the world's airports have a limited amount of space available for expansion, achieving the separations between runways and taxiways required for the new large aircraft may present the greatest challenge to airports. Separation criteria for FAA Group V aircraft is 400 feet for runway-to-taxiway and 267 feet for taxiway-to-taxiway. Runway-to-taxiway and taxiway-to-taxiway separation requirements for Group VI aircraft are 600 feet and 324 feet, respectively. When speculation about the super-jumbo jet began in the early 1990s, many predicted that folding wing technology might allow new large aircraft to operate at existing Group V-compliant airfields. However, folding wings, which are available on Boeing's 777, have not proven to be popular with airlines. At this point, it does not appear that folding wings will be a feature of Airbus' A380.

Planning for new airports and expansions at existing airports are already taking the proposed new large aircraft into consideration. However, these aircraft may be able to operate at some facilities with modifications to taxiway fillets and operations.


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Room on the Ramp

By Mel Sehrt, P.E., and John Park, P.E.

With the arrival of Airbus Industrie’s A380 slated for 2006, some airports will need to evaluate their ability to provide ramp services for the new large aircraft. Although these airports will most likely be equipped to service the largest commercial aircraft now in operation — Boeing’s 747-400 — the "super-jumbo" jet will put new demands on systems that provide aircraft with fuel, ground power and preconditioned air.

Fuel

Even though the fuel capacity of the A380 is 28,000 gallons greater than the 747-400, the super-jumbo jet should not create a significantly higher demand for fuel, since it promises to reduce the total number of flights and will be more fuel-efficient. However, pumping 85,900 gallons into the A380 in the time necessary for the desired 90-minute turnaround may require some modifications to fueling systems. It will require more than two simultaneous connections, which means three to four hydrant carts and a similar number of hydrant pits will be needed at gates serving the A380. In addition, carts serving the large aircraft will need higher lift gates. And while there may not be a need for more storage capacity, airports that anticipate servicing more than one super-jumbo jet at the same time may need to examine the pumping capacity of their fueling systems.

Preconditioned Air and Ground Power

The A380 will also put new demands on the systems that provide preconditioned air (PCA) and ground power. Because the aircraft will have more volume and more passengers, heating and cooling requirements will be significantly higher. And, as for fuel, accommodating a 90-minute turnaround will create periods of high demand. This may make central PCA systems more desirable, since ice storage can be built up during non-peak times and used during periods of high demand. The A380’s use of three 90-KVA plugs may also make central systems for providing 400-hertz ground power more attractive, since such a system would eliminate the problems with synchronization that might arise when attempting to provide power through separate point-of-use units.

A Handle on Hangars

By Mike Fenske, P.E.

Although there are currently fewer than 70 orders for the A380, Airbus Industrie predicts that the demand for very large aircraft will grow to more than 1,500 by the end of the decade. If these predictions prove to be true, there will be a corresponding demand for significantly larger maintenance facilities at many of the world's airports. Hangars built to service the B747-400 are simply not large enough to accommodate the A380's tail height of 79 feet, wing span of 262 feet and length of 239½ feet. Moreover, the cost of construction may not be proportionate to the additional floor space required. The increased size and weight of the aircraft may mean an exponential increase in the cost of these facilities.

Accommodating aircraft the size of the A380 will drive up the structural unit costs of maintenance facilities. The tail height of the new large aircraft significantly increases the height requirement of the hangar doors and the interior clear height, resulting in a corresponding increase in the overall height of the structure. In turn, an increase in height increases structural load factors that building codes require to be designed into the structure. These increased factors increase the size requirements of the primary structure, as well as all components and cladding at all heights.

To allow space for the jacking of the A380, the interior clear height will need to be a minimum of 92 feet. This will need to be achieved without violating the height restrictions placed on airport structures. In some cases, this may mean that owners will not be able to build hangars on desired sites. However, with innovative designs that minimize structural depth in the tail area, achieving the required interior height may be possible within the defined height parameter. Other solutions to limit jacking height may also be desirable and cost-effective.

The greater wingspan of the new large aircraft will mean a greater clear span, or column-free area. Increased steel sizes to span these longer distances will drive up the unit cost of steel for the entire facility as much as 20 percent. In addition, hangar floors will need to be stronger to accommodate the jacking weight of the aircraft, which is 300,000 pounds greater than the 747-400.

The increased size of the very large aircraft will also create greater distances for the delivery of utilities such as start air, shop air, and electricity. However, in terms of increased costs, the modifications to fire protection systems may be the most significant. Increased overhead and

Big Business

By Brian Tompkins and Bill McCully, P.E.

In meeting the needs of global leaders flying farther to satisfy business requirements, the Boeing Business Jet (BBJ) is the new larger aircraft for corporate executives. Although only 10 percent longer than other jets typically used for corporate travel, the BBJ is 65 percent taller and 25 percent wider than the Global Express or the Gulfstream V. Recently, Boeing introduced an even larger version of its new business airplane. The BBJ II has 25 percent more interior space, twice the luggage space, and is 19 feet longer than the BBJ. Just as the super jumbo will require larger hangars for commercial aircraft, these

underwing system coverage areas will demand increased pipe sizes, larger pumping capacities and larger storage requirements for water and AFFF concentrate. Depending on the final layout, the increased cost of the fire protection system may approach 30 percent.

Regardless of the size of the aircraft, maintenance facilities represent a significant investment for owners. However, the increased costs associated with constructing hangars to accommodate very large aircraft will make careful planning even more crucial. To meet operational needs while maintaining cost-effectiveness, it will be more important than ever to fully analyze the available options, as well as look for opportunities to value engineer these projects.

larger business aircraft are generating new requirements for corporate hangars.

Hangars for the BBJ will need significantly more expensive fire protection systems. Under the National Fire Protection Association's 1995 regulation for aircraft hangars, airplanes the size of the Global Express and the Gulfstream V require Group II hangars. With a tail height of 41 feet, the BBJ will require a Group I hangar. This will result in larger piping and larger storage areas for foam and water. Although regulations introduced in 2001 may relax the requirements for Group I hangars somewhat, it may take several years for these to be adopted in all regions.

Another feature that distinguishes the BBJ from other corporate jets is its range. Capable of flying more than 6,000 nautical miles, the aircraft can make trips of up to 14 hours in length. Because of its size, it can also carry more passengers. Providing flight support for international travel or many passengers will create a need for expanding the flight support areas in hangars designed for the BBJ.

The BBJ is also significantly heavier than other corporate jets. With a maximum taxi weight of 171,500 pounds, almost twice that of the Gulfstream V, Boeing's larger business aircraft will require thicker concrete in the hangar floor and apron area.

The new larger business airplane has proven to be a popular option for many of the world's leading companies. Since the first BBJ rolled off the assembly line in 1998, Boeing has delivered close to 60 of the large business jets. And while it is not nearly as large as the new super jumbo, this new larger aircraft will present similar challenges in the design and construction of the hangars that will be needed to service them.

Regionals Rising

By Dave Hadel, P.E.

Despite the widespread attention given to the super-jumbo jet, it is not the only new aircraft affecting commercial aviation. The other new large aircraft — the regional jet — is rapidly changing the face of commuter air travel.

As the FAA defines it, a regional jet (RJ) is a turbofan-powered airplane seating 100 or fewer passengers. According to a report by the United States General Accounting Office, 86 percent of the RJs in operation at the end of 2000 were 50-seat Bombardier or Embraer aircraft, with the remainder consisting mostly of 32- and 37-seat Fairchild or Embraer RJs. Currently, manufacturers are reporting high sales of regional jets with more than 70 seats.

Since its introduction in the early 1990s, the regional jet has become an increasing presence in the fast-growing regional airline market. While only 78 RJs were in operation in the United States in 1995, the FAA reports that the number had grown to 569 by 2000. With the growth of commuter airline enplanements outpacing that of larger domestic carriers, the number of RJs in operation is expected to top 2,190 within the next 10 years.

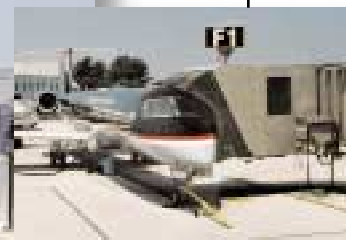
According to the FAA's 2000 Aviation Capacity Enhancement Plan, regional jets are being used in a variety of ways. In certain markets, they are replacing turboprop aircraft to provide the higher level of service desired by commuters. In addition, regional jets allow airlines to provide additional seating capacity on flights previously served by turboprops, eliminate the excess capacity of larger jets or take advantage of the RJ's greater fuel efficiency. RJs are also being used to provide new service in existing hub-and-spoke operations, as well as to bypass hubs and provide direct flights between smaller markets.

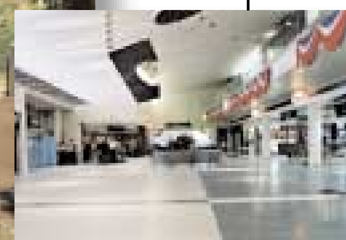
To be equipped for regional jet service, many small commercial airports may need modifications to their pavement systems. Moving from serving a turboprop such as the 19-seat Beechcraft 1900D to serving a 50-seat Embraer 145 regional jet, for example, would require an evaluation of the strength of runways, taxiways and apron areas. With a maximum take-off weight of 48,500 pounds, the Embraer is more than 30,000 pounds heavier than the Beechcraft. The greater weight of the Embraer also means that it requires a longer runway. As specified by the manufacturer, the take-off field length for the Beechcraft is 3,740 feet. For the Embraer, it is 6,465 feet. Thus runways at airports designed for turboprops like the Beechcraft may not be long enough for regional jets.

The requirement for longer runways for regional jets is not just an issue for small airports. Many larger airports that serve as hubs for commuter travel also have runways dedicated to commuter aircraft that were originally designed for small turboprops. Of course, these airports have longer runways that can accommodate RJs, but mixing regional and larger jet traffic on the same runway can complicate aircraft landing schedules, since minimum aircraft separations vary by mix.

According to the FAA, the main reason for the rapid increase in the use of regional jets is their popularity among passengers. With operational characteristics much like narrow body jets, RJs are quieter, more comfortable and faster than turboprops. Along with the increase in the use of RJs is an expectation of a level of service similar to that provided on larger jets. Passengers want to board regional aircraft directly from the terminal rather than from the tarmac. At both small airports and commuter hubs, this means providing passenger boarding bridges, preconditioned air and ground power at the gate — something that typically has not been done for regional flights. For some airports, meeting passengers' expectations may require terminal modifications or perhaps construction of new terminals for commuter operations.

The GAO reports that while the number of mainline jet departures increased nine percent between 1997 and 2000, the number of RJ departures increased 735 percent during the same period. As this trend continues, both small and large airports will be faced with choices about the level of service they will provide for regional passengers.





Commuters Take Flight

By David Yeamans and Chris Green

The growth of regional air travel — and the higher level of service being provided to commuters — is perhaps nowhere more evident than at Philadelphia International Airport, where US Airways and the city of Philadelphia recently opened a new terminal specifically designed for regional flight operations. Terminal F, a 190,000-square-foot, 38-gate facility, comprises $100 million of a $700 million airport improvement program being managed by Burns & McDonnell.

With the new commuter terminal, US Airways Express passengers are no longer bused to aircraft parked on the tarmac, but board most flights directly from individual departure lounges through boarding bridges that protect them from inclement weather. The bridges are designed specifically for regional aircraft, including the 50-seat Canadair and Embraer regional jets that make up an increasing percentage of the regional carrier's aircraft fleet. The new terminal also features a dedicated commuter ticket lobby, passenger support facilities, a US Airways Club and baggage claim systems designed to accommodate terminating and connecting passengers. An enclosed, second-level pedestrian bridge connects Terminal F to the existing Terminal E, while a shuttle bus link facilitates passenger connections to US Airways' mainline flights.

The largest carrier in the growing regional air travel market, US Airways Express operates more than 150 daily departures and serves 43 destinations nonstop from Philadelphia. During its first year of operation, the new commuter terminal is expected to serve more than 2 million passengers.

Eco-friendly Fueling

By Grant Smith, P.G.

To meet increasing demand for air travel, airlines are purchasing many mid- to small-size aircraft and new larger aircraft. Although purchases are of newer, more fuel-efficient aircraft, the increased volume of air travel still requires airports to add fueling capacity.

Fueling systems across the country are quickly reaching their maximum operating capacity. Many systems are also nearing the end of their designed life (approximately 30 years). Due to these conditions as well as maintenance and fuel pit location changes, construction activity involving fueling systems at airports is increasing, with more to come as the new larger aircraft are delivered and put into service.

Like all major airport projects, demolition and construction of fueling systems pose challenges, including security clearance for working on the Airport Operations Area (AOA) and night work in order to minimize impact on aircraft gate operations. Fueling system projects also present unique challenges in management of environmental aspects.

The following is an overview of the key steps recommended in planning and implementing an environmental program for a fuel hydrant system construction project.

- **Establish Risk-Based Standards for Soil and Groundwater Cleanup**
  Well in advance of construction, establish risk-based, site-specific cleanup standards for soil and groundwater through negotiation and coordination with the airport authority and regulatory agency. Risk-based standards will minimize the amount of contaminated material that has to be taken off site for disposal. The regulatory status of the fueling system should also be clarified with the appropriate agency. In some instances, airport hydrant systems are exempt from federal underground storage tank regulations; therefore, written clarification of the system's regulatory status is recommended before construction starts.

- **Conduct Environmental Baseline Assessment**
  Conduct a subsurface sampling program along the proposed alignment of the new fuel system to establish existing conditions prior to fuel system construction. This data set will serve as the baseline condition for which the fuel system owner is taking responsibility. In addition, a study of the existing fuel system may be necessary for regulatory closure, as permits may be required for abandonment of fueling components and treatment and disposal of contaminated soil or water.

- **Implement Contracting Methods to Control Environmental Costs**
  Develop special construction specifications for use in the bidding process that provide advance notice to bidders regarding the environmental conditions likely to be encountered, and the procedures to be followed for handling impacted soil and groundwater. This step serves to control project costs and reduces the possibility of change orders for unknown environmental conditions.

- **Prepare Contaminated Soil and Contaminated Water Management Plan**
  Plan and describe detailed procedures to be followed in removing, handling, storing, and disposing of contaminated soil and water encountered during construction.

- **Develop Environmental Cost Tracking System**
  Develop a system to track environmental costs during individual phases of the project. Identifying potentially responsible parties and involving or keeping them informed from the beginning of the project may help in deferring cost during the project and aid in cost recovery efforts after fuel system construction.

- **Establish Communication With All Affected Parties**
  Establish a system to ensure that proper communication is maintained throughout the project with all parties, including the fuel consortiums or fuel system owners, contractors, the airport authority, environmental regulators, and other affected tenants.

Environmental considerations present unique challenges for airport fuel system construction projects. Careful planning, proper cost tracking and effective communication can make the entire process run more efficiently and cost effectively.

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