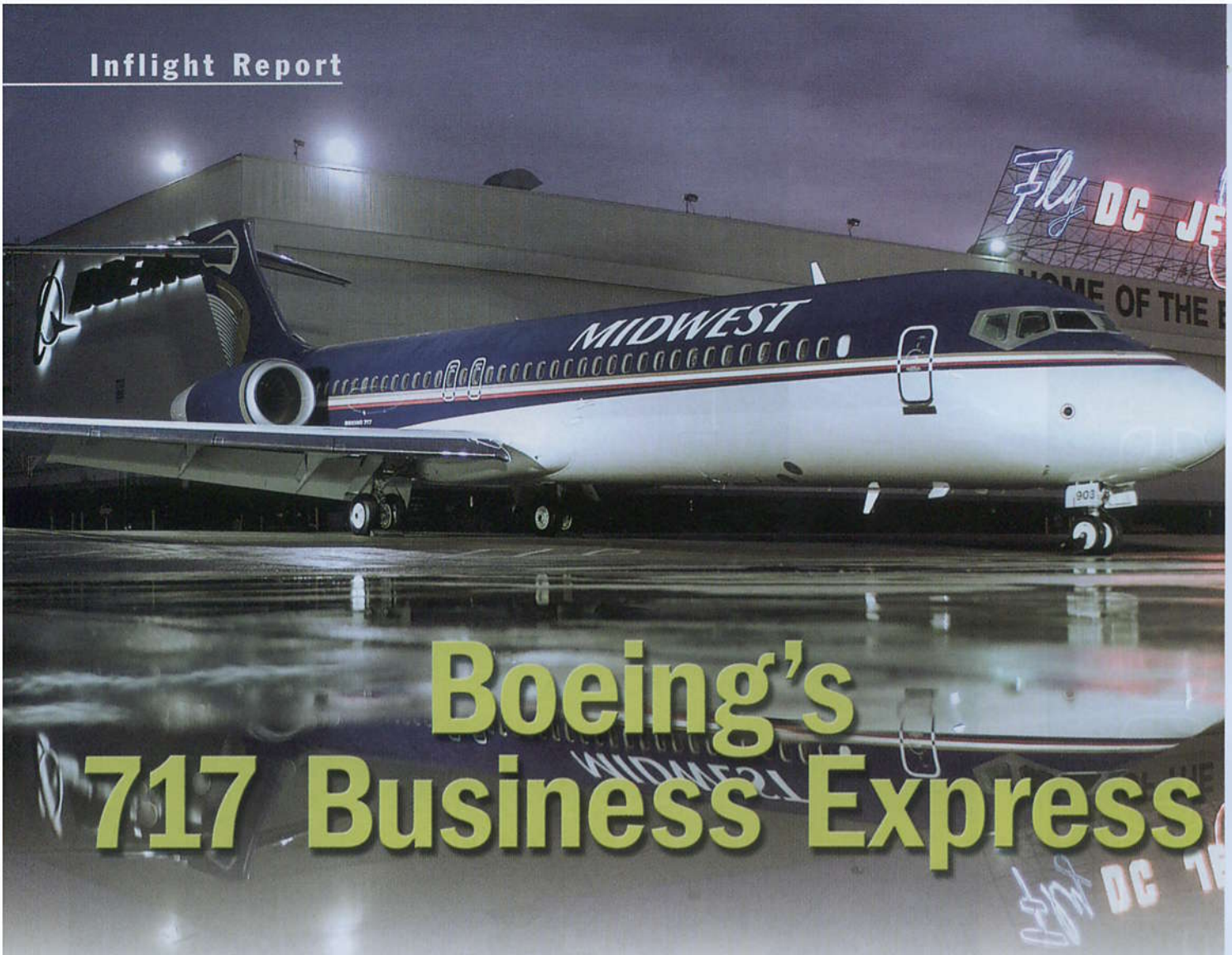


Boeing's 717 Business Express

Business jet travel efficiency for corporate troops

By Fred George

Forty-five years ago the first jetliners entered service, making possible 450-plus KTAS airport-to-airport travel speeds. In less than a decade, eight- to nine-hour transcontinental flights shrank to five hours or less. Nonstop jet service between hundreds of city pairs revolutionized the productivity of the world's business travelers.

Fast-forward to 2003. Commercial jet travel efficiency has become something of an oxymoron. Using the 21st century airline system, a multi-leg airline trip frequently takes more time (because of the air-freight inspired, hub-and-spoke route system) than it did when DC-7s and Super Connies provided nonstop service between the same city pairs. Today, don't bet on winning a point-to-point race with an LD3 container packed with caviar. The fish eggs just might beat you to your destination.

Business aircraft have been providing jet speed efficiencies to the travel schedules of many companies' key people for decades. And now many firms are looking at jet shuttles as a way of restoring jet travel efficiency for their troops.

"There's a terrific market out there for corporate shuttles, one that hardly has been scratched," explained George Saling, NBAA chairman. "The cost of operating these airplanes is competitive with commercial airline coach tickets, especially between smaller city pairs. Corporate shuttles are much more dependable than regional airlines in terms of on-time departures. Airline security also is becoming more onerous and the quality of airline service is deteriorating."

No business aircraft manufacturer is more acutely aware of these factors than Boeing, one of the pioneers of mass jetliner travel. This is the firm that has delivered more than 13,000 jetliners into service, including the 6,200-nm BBJ.

Boeing now intends to enter the corporate jet shuttle market, following the trend set by Bombardier, Fairchild Dornier and Embraer. It's introducing the Boeing 717 Business Express, a 60-seat, all-business-class shuttle with a maximum range of up to 3,041 nm, with NBAA IFR fuel reserves, when equipped with five optional aux fuel tanks. That's enough range to fly from New York to Los Angeles against 95 percent probability winter headwinds and land with NBAA reserves.

The Business Express thus will make possible longer-range business jet travel efficiency for larger groups of mid-level com-

pany employees than can be provided by the shorter range, smaller shuttle aircraft built by competitors. Moreover, Boeing asserts that it's usually less expensive to operate a Business Express than to buy airline tickets, even at volume discounts.

The Business Express Business Model

Any feasibility study of corporate travel patterns requires intensive research. "You have to partner with your corporate travel provider to determine your company's total travel volume. This can be difficult because you're kind of competing with the airlines," explained Lisa MacCartney, who chairs the NBAA's shuttle operations work group. "You really need valid data. You have to look beyond the scatter of the pattern, drilling down to analyze travel trends on a monthly, daily, perhaps even hourly basis.

"You have to ask, 'Do we have the volume to justify operating a shuttle?' and 'What does it cost to operate?'," MacCartney said.

Let's assume a company has a large volume of travel between city pairs that are 1,000 nm apart, roughly the distance between Seattle and Phoenix, New York and New Orleans, or Atlanta and Denver. Let's also assume that the company can buy blocks of advance-purchase, restricted coach tickets for $200 each way.

Each group of 50 people that travels between the city pairs costs the company $10,000, not including itinerary change fees, overnight lodging, car rentals, incidental meals or higher-priced last-minute ticket purchases.

To justify a shuttle aircraft, such as a B-717 Business Express, the aircraft must operate on a high utilization schedule to spread the fixed costs over a large number of annual flight hours. For example, in the case of a full-up $31 million B-717 Business Express with optional aux fuel tanks, it might cost a company 10 percent per year to lease the aircraft or to account for the cost of capital. If you fly 600 hours per year, that's more than $5,100 per flight hour. Ouch. Bump up utilization to 3,000 annual flight hours and the ownership cost drops to just over $1,000 per hour. Owner-ship costs shrink about 13 percent if the base line $27 million, 1,945-nm-range B-717, without aux tanks, is used in the model.

As illustrated in the accompanying Operating Cost table, it costs about $3,800 per hour to operate the B-717 Business Express, assuming it flies two roundtrips per day, Monday through Friday, between the 1,000-nm city pairs. Plan on 248 flying days per year to allow for a few holidays and maintenance.

Almost all aluminum, the B-717's "double bubble" fuselage combines two cylindrical cross-sections joined at the floor for increased external baggage volume in the belly.

Using this model, it costs roughly $10,000 to fly the aircraft on each 1,000-nm trip. So, if you fill 49 seats, you break even with basic airfare costs. Each additional passenger flies for free. Fill all 60 seats and you've saved more than $38 per person in airfare. Factor in some of the typical airline ticket price incidentals, such as itinerary change fees, and the cost savings may become considerably larger.

Worried about filling up the seats? "If you do it, they will come. Using the airlines, many folks travel only when they absolutely must. Using the corporate shuttle, they're more likely to fly when they need to travel on company business," assures MacCartney. Take the hassle out of air travel, and "You can change behaviors. Initially, you may not capture all your company's airline passenger travel [between those city pairs]. But when they start seeing the difference in schedule reliability, on-time service and just plain service that they're not getting on airlines, they'll come."

B-717 Business Express Range

Basic airplane, 110,000-lb MTOW, 60 Pax

MacCartney said it's essential to provide point-to-point travel efficiency, not just airport-to-airport jet speeds. She said 15-minute check-ins are possible because passengers are pre-screened by the company. It's essential to have plenty of on-site parking at the airport and productive work space at the terminal. And it's critical to ensure that ground transportation makes the connection with the shuttle. All this adds value to the shuttle operation. "We focus on exceeding expectations every day," MacCartney said, reflecting on her own company's shuttle operation.

Such ground support services can be challenging at some airports. Only a few FBOs and ground handlers can accommodate a 60-passenger surge twice a day in their parking lots, passenger lounges and ramp areas.

A corporate shuttle also has intangible benefits. "We're able to provide a level of intimacy between flight crews, flight attendants and passengers that adds peace of mind," MacCartney pointed out. En route work productivity and privacy also add value to a shuttle operation.

Then there's the matter of comfort. Coach seats on airlines typically are less than 18 inches wide with 32-inch seat pitch. The aisle in coach is a scant 19 inches wide. In contrast, business-class seats on a B-717 Business Express are 19.5 inches wide and spaced at a 46- to 52-inch pitch. The aisle is 24 inches wide, enabling pas-

sengers to get by a service cart. And the main cabin may be configured with laptop power outlets and a variety of airborne office equipment.

Long-Life Airframe and Updated Systems

The original DC-9 design study dates back to the late 1950s, when Douglas Aircraft needed a short-range jet to complement its transcontinental and transoceanic range DC-8. Douglas decided that its new aircraft would have to be economical to operate on routes between 100 nm and 1,500 nm in length, plus it would have to be capable of operating out of 5,000-foot-long runways.

The firm's top design priorities were safety, simplicity, reliability and operating economy. The final design was a twin jet with aft engines. This resulted in a clean wing and low stance on the ground, making for easy loading and servicing. The cabin floor, for instance, is only about 7 feet off the ground. Ease of maintenance also was a top design priority.

The wing shape, chord thickness and 24-degree sweep were chosen for runway performance, fuel storage volume and 425 to 435 KTAS cruise speed efficiency. The DC-9, though, would be able to cruise as fast as 0.80 Mach, equivalent to 461 KTAS at 35,000 feet in ISA conditions.

First certified in January 1966, the 80-passenger DC-9-10 had an 89.4-foot span, 8.55:1 aspect ratio wing with trailing edge flaps and no slats, a 104.4-foot overall length and a 27.5-foot height. It was powered by 14,000-pound-thrust Pratt & Whitney JT8D engines similar to the powerplants of the Boeing 727, providing almost too much thrust for the 85,700-pound aircraft. But fuel was cheap in those days and airports weren't particularly noise-sensitive.

A year later, the -30 was introduced with a 14.9-foot fuselage stretch and a 93.3-foot span, and an 8.7:1 aspect ratio wing featuring a recontoured leading edge equipped with slats. Shortly thereafter, the -20 made its debut, essentially a -10 with a -30 wing that reduced runway requirements by 10 percent. In later years, -20, -40, -50, -80 and -90 derivatives were developed, all of which are now out of production.

The Boeing 717, the 18th iteration of the DC-9, is essentially a high MTOW -34 version stretched three frames forward of the wing to compensate for extra weight of the 1,200-pound heavier, albeit considerably more fuel-efficient and quieter, 18,500-pound-thrust to 21,000-pound-thrust Rolls-Royce BR700-715 turbofans. The B-717's overall length is 124 feet, or

Boeing B-717 Business Express

	Basic Configuration	IGW Configuration with Five Aux Tanks
B/CA Equipped Price	$27,000,000	$31,000,000
Characteristics		
Seating	4+60/134	4+60/134
Wing Loading	109.9	120.9
Power Loading	2.97	2.88
Noise (EPNdB)	80.4/91.6/91.4	82.1/91.5/91.6
Dimensions (ft/m)		
External		
Length	124.0/37.8	124.0/37.8
Height	29.1/8.9	29.1/8.9
Width (Maximum)	93.3/28.4	93.3/28.4
Internal		
Length	76.9/23.4	76.9/23.4
Height	6.7/2.0	6.7/2.0
Width (Maximum)	10.9/3.3	10.9/3.3
Width (Floor)	10.3/3.1	10.3/3.1
Power		
Engines	2 RR BR700-715-A1	2 RR BR700-715-C1
Output (lb ea)	18,500	21,000
Flat Rating OAT°C	ISA+15°C	ISA+15°C
TBO	OC	OC
Weights (lb/kg)		
Max Ramp	111,000/50,349	122,000/55,339
Max Takeoff	110,000/49,895	121,000/54,885
Max Landing	100,000/45,359	110,000/49,895
Zero Fuel	94,000c/42,638c	100,500c/45,586c
BOW	68,500/31,071	70,870/32,146
Max Payload	25,500/11,567	29,630/13,440
Useful Load	42,500/19,278	51,130/23,192
Executive Payload	12,000/5,443	12,000/5,443
Max Fuel	24,609/11,162	37,540/17,028
Payload With Max Fuel	17,190/7,797	12,890/5,847
Fuel With Max Payload	12,650/5,738	20,800/9,435
Fuel With Executive Payload	24,609/11,162	37,540/17,028
Limits		
MMO	0.820	0.820
FL/VMO	FL 260/340	FL 260/340
PSI	8.3	8.3
Climb		
Time to/Alt.	27 min./FL 350	29 min./FL 310/350
FAR Part 25 OEI Rate (fpm)	453	487
FAR Part 25 OEI Gradient (ft/nm)	204	204
Ceilings (ft/m)		
Certificated	37,000/11,278	37,000/11,278
All-Engine Service	37,000/11,278	37,000/11,278
Engine-Out Service	17,600/5,364	14,300/4,359
Sea Level Cabin	19,500/5,944	19,500/5,944
Certification	FAR Part 25, Amend. 82/1999	FAR Part 25, Amend. 82/1999

Boeing B-717 Business Express

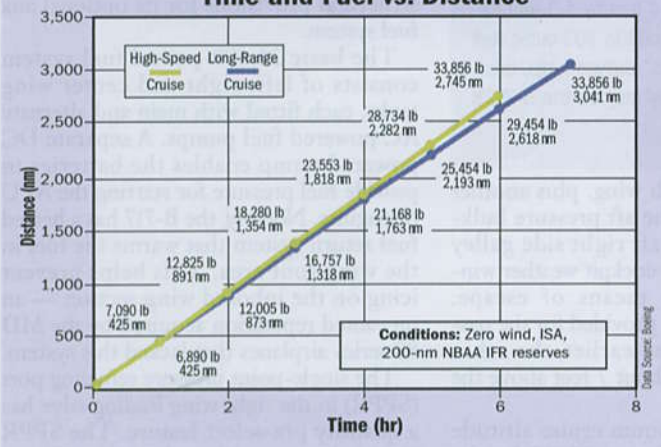
These three graphs are designed to provide a broad sketch of the B-717 Business Express' performance, based upon projections from Boeing's engineering team. Special thanks to Kevin Heise at Boeing for all his efforts. Do not use these data for flight planning.

Time and Fuel vs. Distance – This graph shows the performance of the B-717 Business Express at 0.76 Mach recommended long-range cruise and high-speed cruise, which varies from 0.77 to 0.80 Mach, depending upon cruise altitude. The average maximum-range cruise speed is slightly slower than long-range cruise. The numbers at the hour lines indicate the miles flown and the fuel burned for each of the two cruise profiles.

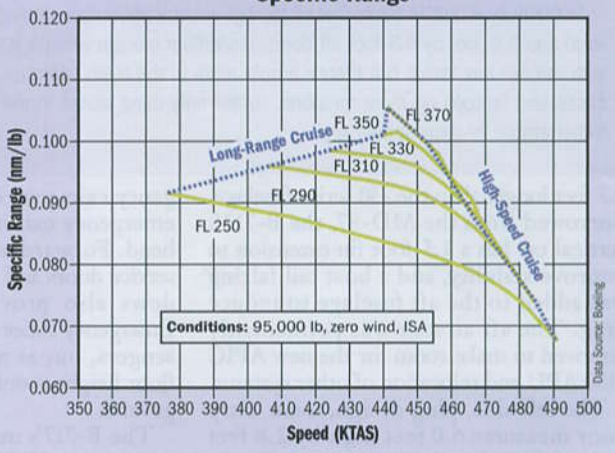
Specific Range – This graph shows the relationship between cruise speed and fuel consumption at representative cruise altitudes for a mid-weight B-717 Business Express. The graph indicates that specific range remains relatively constant from FL 330 to FL 370, so long as the aircraft is flown close to its 0.76 Mach long-range cruise speed. Above 0.77 Mach, fuel economy drops off rapidly.

Range/Payload Profile – The purpose of this graph is to provide simulations of various trips under a variety of payload and two airport density altitude conditions, with the goal of flying the longest distance at 0.76 Mach. Assume a 70,837-pound BOW, including the empty weight of five auxiliary fuel tanks and popular cabin options. Each of the five payload/range lines is plotted from multiple data points supplied by Boeing, ending at the maximum range for each payload condition. The time and fuel burn dashed lines are based upon the 0.76 Mach long-range cruise profile shown in the Time and Fuel vs. Distance chart. The runway distances assume the aircraft is fitted with the optional 21,000-pound-thrust BR700-715-C1 turbofans.

Time and Fuel vs. Distance

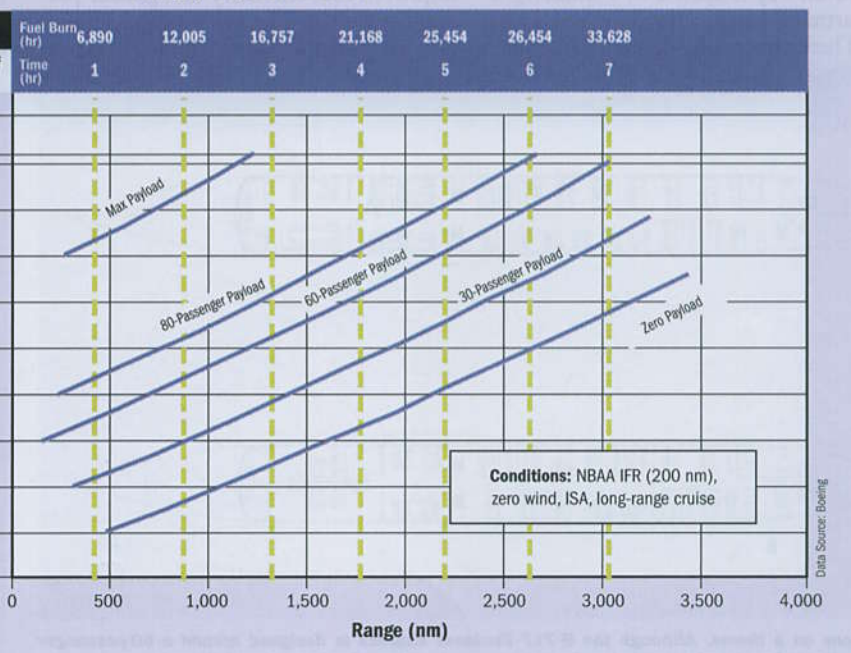


Specific Range



Range/Payload Profile

FAR Part 25 Takeoff Field Length (ft)		
SL ISA	5,000 ft ISA+20°C	Gross Takeoff Weight (lb)
		125,000
5,454	9,109	121,000
5,367	8,791	120,000
4,948	7,496	115,000
4,554	6,548	110,000
4,183	5,957	105,000
4,101	5,411	100,000
4,026	4,909	95,000
3,953	4,442	90,000
3,884	4,211	85,000
3,819	4,122	80,000
		75,000



Passenger Accommodations

There are just 15 rows of seats on the Business Express, so passenger loading and unloading is quick. Each business-class seat is 19.5 inches wide and each row can be spaced as far apart as 52 inches, depending upon the amount of space allotted to interior closets. Seats may be equipped with laptop power outlets, 500-plus mbaud Internet access and a variety of inflight audio-visual options.

Overhead, business travelers will find redesigned passenger service units and larger overhead storage bins with integral lighted handrails. Acoustical insulation has been improved to reduce cabin noise levels.

The cabin may be configured with fore and/or aft galleys and vacuum lavatories. Single-point fresh water and waste water connections are used to service both the galleys and lavs. The vacuum lavs eliminate the need for a separate blue water system.

In the belly is 1,204 cubic feet of storage volume accessible through 4.4-foot by 4.3-foot forward and 3.0-foot by 4.3-foot aft doors. Underfloor storage volume is reduced to 703 cubic feet with the five aux tanks. But there's ample room in the main cabin for folks' carryon bags, briefcases and laptops on most missions, so the only thing stored in the belly may be the B-717's rather ample fly-away spares kit.

4.7 feet longer than the -30 series fuselage. Borrowed from the MD-87, the B-717's vertical tail has a 1.5-foot fin extension to improve stability, and a boat tail fairing was added to the aft fuselage to reduce drag. The aft airstair was permanently removed to make room for the new APIC 2100 APU and relocation of other systems.

The left side, plug design, main entry door measures 6.0 feet high by 2.8 feet wide. A DC electrically operated, illuminated stairway is stored in a watertight compartment beneath the floor and doorway. There are two 1.7-by-3.0-foot emergency exits over each wing, plus another emergency exit in the aft pressure bulkhead. Forward and aft right side galley service doors and the cockpit weather windows also provide means of escape. Emergency slides are provided for the passengers, but as noted earlier, the cabin floor height is only about 7 feet above the ground.

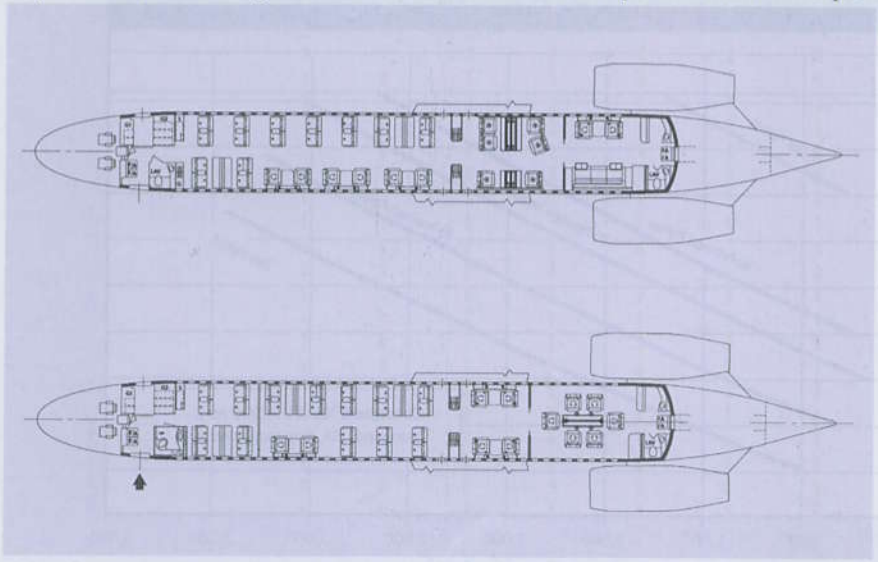
The B-717's maximum cruise altitude was increased 2,000 feet, to 37,000 feet for improved fuel efficiency and greater passenger comfort. The avionics and systems also have been updated. The B-717 is produced at the former Douglas facility in Long Beach, Calif.

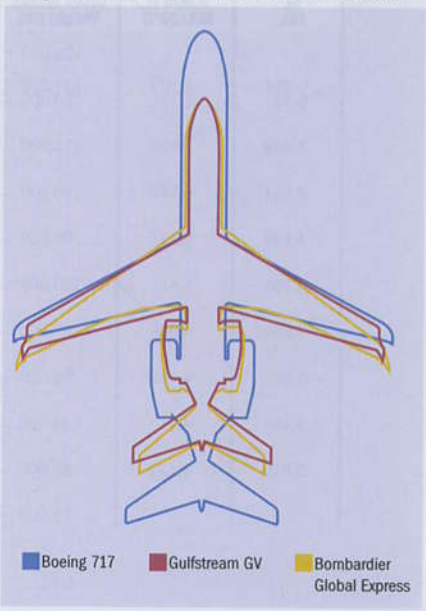
Almost all aluminum, the "double bubble" fuselage combines two cylindrical cross-sections joined at the floor for increased external baggage volume in the belly. The original airframe design life was 60,000 cycles/60,000 flight hours. However, based on an industry review of the airframe's widespread fatigue damage tolerance, the B-717 should easily last 100,000 cycles or more. There's nothing magic to creating the longest service life of any airliner of which we know. It's a matter of using heavier gauge aluminum in high-stress areas.

Notably, DC-9 series aircraft have been available with a variety of optional belly fuel tanks from the manufacturer for decades, so the B-717 has well-proven structural provisions for its optional aux fuel system.

The basic 24,609-pound fuel system consists of left, right and center wing tanks, each fitted with main and alternate AC powered fuel pumps. A separate DC powered pump enables the batteries to provide fuel pressure for starting the APU or engines. Notably, the B-717 has a heated fuel return system that warms the fuel in the wing root area. This helps prevent icing on the inboard wing section — an unwanted reputation acquired by the MD 80 series airplanes that lacked this system.

The single-point pressure refueling port (SPPR) in the right wing leading edge has a quantity pre-select feature. The SPPR port is low enough to be accessible to most ground service personnel without them needing a ladder. Approximate refueling time is 10 minutes with the standard





Variations on a theme. Although the B-717 Business Express is designed around a 60-passenger interior, the airliner interior can be configured in more traditional business aircraft layouts.

tank configuration and 15 to 20 minutes with five aux tanks. Overwing refueling ports alternatively may be used to refill the main wing tanks, but not the aux tanks.

Boeing Long Beach has flight tested, but not certified, a four aux belly tank system for the B-717. Similar to the BBJ's, the aux fuel system will use cabin pressure to transfer fuel to the wing center tank.

The aux tank testing program included full structural, systems and FMS integration. Each gallon of additional aux fuel capacity adds about 1 pound to aircraft BOW, so a 1,930-gallon five aux tank system will add about 1,930 pounds to the aircraft's BOW.

The basic airplane, with a 110,000-pound MTOW, can fly 60 passengers 1,945 nm and land with 200 nm NBAA IFR fuel reserves. A five-tank system would hold an extra 12,931 pounds of fuel, extending range by 1,079 miles with 60 passengers. Notably, the B-717's optional 121,000-pound MTOW allows plenty of margin for the increased BOW, the extra fuel weight of the five tanks and calculating the passengers at 200 pounds each.

But the five-tank system has yet to be flight tested, let alone certified. The five-tank development program, though, will include full systems and FMS integration. Any aux tank system will require new modifications to the fuel system because systems and avionics provisions for aux fuel weren't included in production aircraft to save cost and weight.

The aircraft's primary electrical system is AC, with split left and right busses. The B-717 has 85 percent fewer components than legacy DC-9 products, plus fewer relays and contactors for increased reliability. This results in less heat and no AC hum from electrical equipment adjacent to the cockpit. Each engine has a 40 KVA integrated drive generator and the APU has a 60 KVA generator. An AC external power source also may be used. AC power is used for "heavy lifting" tasks, such as fuel pumps, anti-ice heaters and most avionics boxes. Three transformer/rectifier units provide DC power for external lights, critical control functions and other systems.

A new "no break power transfer" system ensures there are no surges when transferring from one AC power source to another, such as from the APU to the engine-driven generators after start.

Three nickel cadmium batteries provide DC power for APU start. They also provide one hour of emergency electrical power, including emergency AC by means of an inverter. The left-side avionics and flight instruments, for example, are available on emergency power, but not the transponder, autopilot and automatic pressurization system.

The B-717 retains the DC-9's manually operated flight controls. The ailerons and rudder are aerodynamically positioned by control tabs connected to the flight controls. The rudder, though, is normally hydraulically actuated with a manual reversion mode. The elevator, too, has a hydraulically powered downward deflection function that's used only for stall recovery.

Digital S/O

The B-717's Advanced Common Flightdeck (ACF) system is part of a family of Honeywell integrated avionics products originally developed for the DC-10 and MD-11 wide bodies, with the intention of migrating the technology to Douglas' narrow body airliners. The ACF's workload reduction features were designed to eliminate the need for a third flight crewmember. Aboard the two-crew B-717, the ACF essentially adds a second officer to the cockpit team.

The ACF uses Honeywell's hub-and-spoke architecture Versatile Integrated Avionics (VIA) system that combines (1) FMS, (2) display drivers, (3) caution and aural warning, and (4) digital flight data acquisition functions into the hub boxes. This four-to-one integration reduces weight, volume and power consumption by almost 75 percent compared to Honeywell's Boeing 777 and Next Generation 737 AIMS computers. VIA also increases reliability.

Look closely at the B-717 cockpit and you'll find it's much less cluttered with dials, switches, controls and indicators than the MD-80 and DC-9 airliners. The ACF enabled Douglas and Honeywell to integrate a half dozen systems indications into the EICAS.

The instrument panel has six 8-by-8-inch, second-generation LCD screens that boast a 40,000-hour MTBF. The designers used color, symbol changes and graphics to convey information clearly and concisely. If you don't need to know about it, the data vanish.

Few, if any, airliners have more advanced avionics than the B-717. For example, the EICAS has a systems "status" page that enables the crew to gain a quick overview of each system. It also features a "consequences" page that summarizes critical action items system by system if a malfunction or abnormality occurs.

The ACF's FMS is an advanced member of Honeywell's Pegasus family, featuring required/actual navigation performance computations, a required time of arrival 4-D navigation mode and full radio tuning. Indeed, the B-717 has no radio tuning heads except for the comm radios and transponder. All other radio tuning functions are performed through the FMS MCDUs, not unlike Honeywell's PlaneView system on the G500/G550.

Almost all avionics are seller furnished, including multi-mode radios, Mode S diversity transponders, TCAS II, EGPWS, reactive wind-shear warning and a 100-watt, solid-state A708B radar with both Doppler turbulence detection and predictive wind-shear warning functions. RVSM and CAT IIIA certification come standard, and CAT IIIB capability is available as an option.

The B-717's two-by-two business-class arrangement provides passengers with plenty of work space, as opposed to . . .

Multifunction spoilers, with a roll augmentation function, now are fly-by-wire controlled, rather than cable controlled, and hydraulically actuated. Both the leading edge slats and trailing edge flaps are hydraulically powered. The three-axis trim system also is electronically controlled and electrically actuated.

Bleed air is used for engine start, pressurization and anti-ice protection. The source for engine start can be the APU, an engine or an external source while on the ground. Two three-wheel ACMs provide air conditioning. An improved temperature controller and high flow mode cool the cabin considerably faster on warm days. A gaspar fan is an option.

An automatic pressurization controller, tied to the Air Data Inertial Reference Units and FMS for destination field elevation, handles most of the pressurization workload, except for closing the cabin door and starting the engines. The cabin features a 8.3 psi differential and 100-percent fresh air flow.

The B-717 is one of the few aircraft to use bleed air to heat both the wing and horizontal tail leading edges. Unlike the MD-80, the B-717 automatically schedules bleed air to the tail and wings, even in the event of one engine becoming inoperative. A ground-use ice detector is optional, but there is no inflight ice detector available. Bleed air also is used for engine inlet ice protection. Probes, windshield and static source plates are electrically heated for ice protection.

The 3,000-psi hydraulic system is divided into left- and right-side functions, most of which are redundant for critical systems. Left and right engine-driven pumps, redesigned for longer life, normally supply hydraulic power for the nosewheel steering, the above-mentioned primary and secondary flight control functions, thrust reversers and wheel brakes. The right side, though, is more critical than the left because it also actuates the landing gear, so it has an electrically powered aux pump. A two-way power transfer unit also enables one hydraulic system to power the cross-side system. Hydraulic lines now use swedge fittings, rather than flared ends, for longer life and fewer leaks.

DC-9 operators griped about high brake wear rates, resulting in brake overhauls every 500 to 700 landings. Boeing fitted the B-717 with 1-inch larger brake packs and wheels plus low-profile tires. The result? Brakes that last 1,400 landings or more.

Fourteen degrees of nosewheel steering is available through the rudder pedals. A left-side steering tiller provides up to 82 degrees of steering authority.

Being an airliner, the B-717 has extensive fire warning and extinguishing systems. The engines and APU have two loop detection systems and twin fire bottles, plus there is a multi-zone cargo hold fire detection and extinguishing system.

The 375-hp APIC 2100 APU is considerably more powerful and quieter than the Honeywell GTCP 85-129 fitted to earlier DC-9 series aircraft, so it provides better airflow for cabin cooling and heating, and it's a more welcome visitor at noise-sensitive airports. Intake and exhaust ducts, fitted with extensive acoustic insulation, now are on the top side of the fuselage to reduce outside noise levels below the 85 dBA limit for European operations.

APIC 2100 has a full-function DEEC that automatically controls all aspects of operation, plus it logs exceedances and charts wear patterns. In the event of a fire or overheat, the APU shuts down automatically. In addition, there is a manual APU shutdown and fire extinguisher switch panel located below a door in the tail cone, enabling a flight crewmember or ground service person to shut down the unit and suppress an APU fire in an emergency while the aircraft is parked.

. . . the DC-9/MD-80s traditional three-by-two coach airline layout.

Flying the Boeing 717

This summary of our flying impressions of the B-717 is based upon two simulator sessions at Alteon Long Beach and one demo flight in mid-May in B-717 serial number 5119 in Midwest Airlines livery and configured with 88 business-class passenger

seats. The simulator sessions were flown with Ralph Luczak, B-717 chief production pilot, and Tom Melody, director of flight operations. Randy Wyatt, experimental test and project pilot, flew with us on the demo flight. Don Bidlack, B-717 fleet manager for flight crew training, accompanied us as safety pilot.

Wyatt and Tom Croslin, chief B-717 design engineer, walked around the airplane with us, pointing out its design features. Almost all preflight check items are easily accessible or have remote indication functions in the cockpit.

Ease of access is the B-717's strong suit. The belly of the aircraft is 3.1 feet to 3.9 feet off the ground, depending on loading, providing quick access to the forward and aft luggage bays, electrical equipment compartment and aft equipment bay, plus refueling panel.

Boeing's (and Douglas' before it) focus on B-717 dispatch reliability was quite apparent during preflight. The B-717 has dual nav lights, dual fuel quantity indication systems, dual fire detection systems and manual backup functions for almost all powered and automated systems.

As we entered the cockpit, external AC power already was connected to the aircraft, automatically energizing the Honeywell avionics suite with its six, large-format LCDs. The B-717 has one of the most advanced avionics systems of any airliner in the world, having borrowed

As with its airliner sibling, the Business Express is configured so passengers can control their environment. Laptop power outlets are an option.

On our evaluation flight, the B-717 had a better thrust-to-weight ratio than a fully loaded Gulfstream 550.

most of the technology from the MD-11 cockpit. (See "Digital S/O" sidebar.) The normal position for switches is aft for off and 12 o'clock for knobs. The aircraft has a very short paper checklist for normal procedures because of its easy system flow patterns and fully interactive system synoptics on the center EICAS screens, divided into engine and alert display and system display functions. On the overhead, aft is off for switches and 12 o'clock is normal for knobs.

Using external AC power, we completed the cockpit checks, switched on the triple Air Data IRUs and programmed the FMSes. The box recommended 114 KIAS for V1, 120 for rotation, 128 KIAS for V2 takeoff safety speed and 158 KIAS for V3 flap retraction, which we confirmed for the 18-degree flap configuration and 95,000-pound takeoff weight, 79 percent of MTOW. The FMSes don't compute takeoff field length, so Boeing plans to supply Business Express operators with its laptop-based preflight planning software, similar to the program that comes with the BBJ. The laptop kit also enables the crew to complete full mission planning and transfer the result to the FMSes.

After checking the APU fire warning system and switching on the DC fuel pump, starting and operations tasks are handled by a digital electronic control unit. The no break power transfer (NBPT) system provided a seamless transition between external AC and APU AC power. The cabin cooled quickly once APU bleed air was directed to the twin ACM packs.

FADECs handle most of the start chores associated with the BR700-715 engines. They're even programmed to windmill the engines for 30 seconds prior to start to comply with Rolls-Royce's warm engine start procedures. At idle, each engine's AC generator comes on line, but the only indication is a symbology change on the EICAS because of the NBPT.

Even at light ramp weights, a healthy push on the thrust levers is needed to start the aircraft rolling with cold tires. We started the turn out of the chocks at too slow a speed and the aircraft stopped. Six to 8 knots is needed before sharp turns. Below 35 knots, the PFD's airspeed indicator reads IRS groundspeed. Above, it reads indicated airspeed.

Taxiing to Runway 30 at Long Beach, we noted that it's necessary to avoid speeds close to 17 knots. That velocity can excite a mild MLG wheel shimmy that's annoying to passengers. In addition, we were challenged to apply the wheel brakes smoothly, partly because they were not yet broken in. The aircraft had been flown only once before in production flight test.

Once cleared for takeoff, we advanced the throttles and switched on the auto flight system, thereby arming the autothrottle (A/T) system. A little additional push and the A/Ts engaged. Aircraft acceleration was sprightly, considering the aircraft had a better thrust-to-weight ratio than a fully loaded G550.

Using the tiller wasn't necessary, considering the 17 degrees of NWS authority available through the rudder pedals. Initial pitch force at rotation was moderate, as we followed the flight director command bars up to 20 degrees pitch attitude. In the event of an engine failure, the pitch com-

Rolls-Royce Deutschland BR700-715

The B-717's BR715 engines use the same 10-stage, axial flow compressor, low-emissions combustor and two-stage high-pressure turbine as the BR710 that powers the Bombardier Global 5000/Global Express and Gulfstream G500/G550. But the BR715 has a 10-inch larger 58-inch fan, a two-stage N1 supercharger and a three-stage low-pressure turbine. Its larger fan and higher bypass ratio are better suited to the B-717's relatively low cruise altitudes.

The basic BR715-A1 engine is rated at 18,500 pounds of thrust for takeoff. The optional -C1 version produces 21,000 pounds of thrust for takeoff. The thrust difference between the two engine versions is especially apparent at hot-and-high airports. A B-717 departing at a weight of 110,000 pounds from *B/CA*'s 5,000-foot, ISA+20°C airport has a 9,818-foot TOFL when equipped with -A1 engines. If fitted with -C1 engines, the TOFL drops to 6,548 feet because the aircraft can meet FAR Part 25 one-engine-inoperative (OEI) climb requirements with more flap extended.

The -C1 engine, however, costs more to buy than the -A1, and its hourly operating costs are somewhat higher.

mand automatically is reduced to maintain V2 and the A/T system advances the operative engine's thrust to maximum, if not previously selected. Notably, a flight path vector cue may be displayed to help the pilot flying monitor actual climb angle performance.

Passing through 3,000 feet agl, the FMS commanded a slight nose-down pitch for acceleration and we retracted the flaps at 158 KIAS, then the slats at 210 KIAS. Flap retraction results in a considerable loss of lift that must be countered with a 3- to 4-degree nose-up pitch increase.

SOCAL approach vectored us over LAX and then we intercepted J5 toward Bakersfield. Wyatt programmed the FMS MCDUs for an ILS approach upon arrival. Lateral and vertical navigation guidance precision using FMS and GPS, however, is so accurate that it's difficult to tell when you've switched over to ILS, except for the annunciations at the top of the PFD.

We hand-flew the first two approaches, one ILS and one GPS/RNAV, to gain experience in the airplane. Again we noted the need to decrease pitch by 3 to 4 degrees with flap extension. The B-717 could benefit from a flap/stab interconnect, in our opinion.

VREF speeds at 93,000-pound and 92,000-pound approaches were 128 and 127 KIAS for the flaps 40 degree landing configuration. Landing reference speeds in the B-717 are based upon 1.23 VSO. Our next approach was a coupled, simulated one-engine-inoperative ILS, using 25-degrees flaps for the 91,000-pound landing weight. VREF was 130 KIAS, 3 knots faster than the flaps 40 degree landing speed. This was followed by a low approach and a one-engine-inoperative (OEI) go-around — all coupled to the autopilot.

Previous work in the simulator indicated that rudder forces during an OEI takeoff or go-around are moderate. The FMS automatically commands a reduced nose-up pitch attitude during the OEI go-around and initiates acceleration to flap retraction speed at 800 feet agl. Notably, the flight crew can cram the throttles past a soft stop if power in excess of rated thrust is required to save the airplane. While this requires extra engine maintenance, in these critical situations the FADECs command the engines to produce as much thrust as possible without over stress or over temp.

The single-point pressure refueling port is low enough to be accessible to most ground service personnel without them needing a ladder.

We landed at Bakersfield, again having some difficulty modulating the brakes smoothly. Wyatt pointed out that, had it been necessary, the thrust reversers also have an emergency override that enables the crew to command extra reverser performance if needed to stop the aircraft on a wet or icy runway. If employed, this, too, requires extra maintenance.

While taxiing back to Runway 30R, we received a new IFR clearance to W-291 for airwork and completion of production flight test tasks.

At 37,000 feet, we probed the aircraft's high-speed buffet characteristics in turns. At the aircraft's relatively light 85,000-pound cruise weight, we could sustain up to a 37-degree bank angle at 0.76 Mach before encountering buffet. But as shown on the accompanying charts, high-altitude cruise performance is not the B-717's strong suit. Fuel economy remains relatively constant from FL 330 to FL 370 at mid-cruise weights. When departing at 121,000 pounds, the most efficient initial cruise altitude is FL 350 to FL 360, depending upon OAT.

Clean and dirty stalls were performed in the simulator. Heeding the B-717's stall warning stick shaker and hydraulically powered elevator pusher while advancing the thrust to max results in prompt stall recovery and little altitude loss. Steep turns were performed both in the simulator and in the aircraft. They're easier in the aircraft because of g-force feedback and abundant visual cues.

Changes in thrust cause very little pitch trim change. Deploying the fully adjustable speed brakes also results in little pitch change. Full deployment does result

While both the leading edge slats and trailing flaps are hydraulic, the spoilers are fly-by-wire.

in some buffet and pronounced loss of lift, thereby enhancing maximum descent capabilities.

Our final approach into Long Beach was a CAT IIIA coupled approach to touchdown. Wyatt started the APU, providing a third AC power source as a back-up, required for such procedures. We also engaged both autopilot channels, another prerequisite for CAT III approaches.

VREF was 119 KIAS for the flaps 40 degree, 81,000-pound landing weight. The digital flight control system (DFCS) flew the approach more precisely and smoother than most experienced B-717 pilots (and substantially better than we could).

At 50 feet, the DFCS began the landing flare, retarding the throttles shortly before touchdown. We had to use manual braking because s/n 5119 wasn't fitted with the optional auto-brake package.

Total time for the flight was 2+45.

The Right Product in Today's Market?

Boeing officials foresee several applications for the B-717 Business Express. One company, with 50 to 60 people who frequently travel between specific city pairs, might operate the aircraft. Certainly, firms such as Airbus Industrie, Daimler-Chrysler and even Lufthansa have validated the utility of all-business-class shuttles on such routes. Smaller shuttle aircraft operating over shorter stage lengths long have been an air travel staple for some U.S. corporations.

In another scenario, two or three non-competing companies each with 15 to 20 passengers who frequently travel between the same city pairs might share use of a Business Express. Nonstop service, say between non-hub cities on Atlantic and Pacific coasts, would save considerable travel time, if not cost. In this case, the aircraft could be operated by a management firm such as Avjet, Jet Aviation, NetJets, PrivatAir or TAG.

Combined management and charter firms also would be prime candidates for the Business Express, helping them to expand their FAR Part 121 on-demand air carrier services when their Part 91 or 125 clients didn't need the aircraft. Likely charter clients would include sports teams and other affinity groups.

The B-717 has a reliability advance over most other airliners. Few can top its 99.4- to 99.6-percent dispatch reliability. That's only a pipe dream among some smaller regional airliner manufacturers.

In current lean times, it may be tough for a company to justify adding a corporate shuttle to its flight department. A joint-venture even may be a hard sell. But the B-717 Business Express is no royal barge with wood inlays, marble veneers and gold shower fixtures. It's basic Boeing business transportation for mid-level employees, so it may be easier for the board of directors to endorse. And person-to-person contact has become more essential, not less, in the age of e-mail and video conferencing.

The success of the B-717 may be more dependent on market timing than on its pure pragmatic appeal. As folks await an economic turnaround, airline service continues to deteriorate, with more frequent delays, longer check-in lines and more crowded coach cabins. Security concerns, loss of en route productivity and rising ticket costs help tip the balance in favor of corporate shuttles. Add in an occasional epidemic like SARS, disruptive strangers and filthy tray tables, and commercial airline travel becomes even less appealing.

At present, the B-717 Business Express has the 1,000-nm to 3,000-nm heavy lift corporate shuttle market all to itself. Virtually no other shuttle aircraft can tote a 12,000-pound payload over such distances at such low operating costs and with such comfort for passengers. The direct operating costs of most used airliners far exceeds that of the B-717.

Moreover, a new Airbus or Boeing 737 next-generation airliner costs $10 million to $12 million more than a B-717, which has a considerably higher profile ramp presence.

The shortcomings of commercial airline travel will become more acute as the economy recovers and air travel increases. When that happens, the B-717 Business Express may become a regular visitor at outlying airports so favored by business jet users and so needed by everyday business travelers. **B/CA**

B-717 Business Express Operating Costs

	Assumptions		Per Trip	Annual
Passengers/Trip	60			
Block Time	2.8			
Flight Time	2.55			
Trips per Day	4			
Trips per Year	992			
Block Hours/Year	2,778			
Flight Hours/Year	2,530			
Trip Distance	1,000 nm			
Airplane Price	$31,000,000			
Ownership	$3,100,000 per Year		$3,125	$3,100,000
Insurance	$217,000 per Year		$219	$217,000
Flight Crew	$135,000 per Pilot	*8 on Staff*	$1,089	$1,080,000
Cabin Crew	$81,000 per Flt. Attendant	*12 on Staff*	$980	$972,000
Fuel	1,600 Gallons per Trip	*$2.00*	$3,200	$3,174,400
Maintenance	$295 per Flight Hour		$751	$745,347
Landing Fees	$170 per Trip		$170	$168,640
Administration, Pubs & Training	$0.166 per nm		$166	$164,672
Catering	$6 per Pax per Trip		$360	$357,120
Parking/Hangar	N/A			
Crew Overnight	$125 per Crewmember	*5 per Trip*	$625	$155,000
Total Cost per Trip			**$9,700**	**$10,134,179**
Total Cost per Hour			**$3,804**	
B-717 Business Express Trip Cost Per Passenger			**$161.66**	
Airline Ticket Cost Per Passenger			**200.00**	
Savings Per Passenger			**($38.34)**	