DELTA VIRTUAL AIRLINES

McDONNELL-DOUGLAS MD-11
OPERATING MANUAL

THIRD EDITION

FEBRUARY 10th, 2005

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AIRCRAFT HISTORY

The MD-11's history began in 1968, the year the Apollo space program was getting under way towards the moon, the Vietnam war was raging and hippies were doing anything they could to scandalize the country. The DC-10, a large three engine turbofan wide body aircraft, intended for medium- to long-range flights, entered production at the Douglas plant in Long Beach, California. First deliveries began in 1971 and continued until 1989. Capable of carrying from 250 to 380 passengers and a flight crew of three, (two pilots and a flight engineer) a total of 386 commercial DC-10 aircraft were delivered to 71 airline and carrier companies along with 60 KC-10 tanker /cargo models built for the United States Air Force.

> *About the Douglas Aircraft Company* - Founded in 1920 by Donald W. Douglas, the Douglas Aircraft Company built more than 45,000 aircraft including the classic DC-3 twin-engine piston transport (which served as the C-47 during World War II) and the larger DC-6 and DC-7 four engine piston transports. In the years following the war, Douglas was the leading American maker of commercial aircraft. Responding to the arrival of the Boeing 707 in the 1950s, Douglas developed the DC-8 - a successful four-engine transport capable of carrying up to 220 people, which is still in use today.
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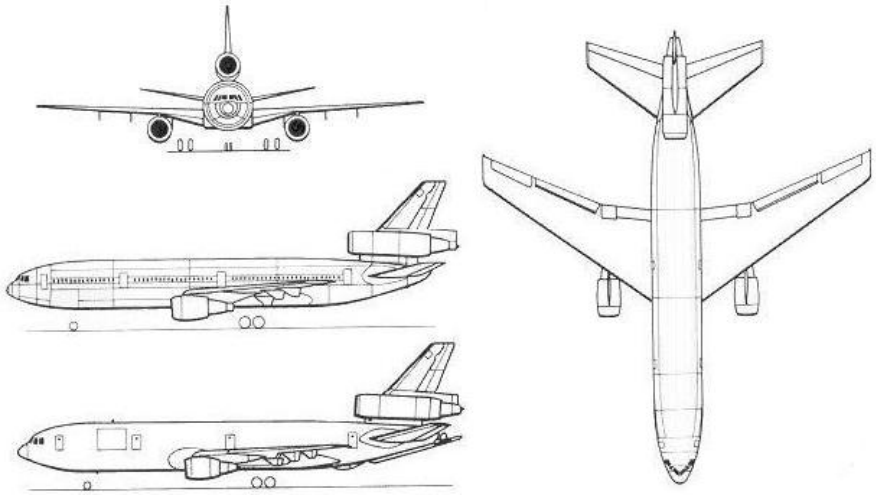
> During the mid-1960s, Douglas encountered financial challenges that led to its merger with the McDonnell Aircraft Corporation of St. Louis in 1967 while the DC-10 was still in the design stage. Douglas was the commercial component of that venture, while McDonnell focused more on military aircraft and helicopters (most famously the F-4 Phantom fighter). Merged, the two companies became known as McDonnell-Douglas Aircraft Corporation. This entity survived for over thirty years, until its merger with Boeing in 1997.

The DC-10 went through six models – the initial version, the Series 10, was designed for high-capacity domestic routes of up to 3,330 nm. The Series 15 was designed for "hot and high" operations, while the Series 20 (which only flew in prototype form) was designed for long-range operations. The Series 30 and 40 aircraft were the true long-range workhorses, with lengthened wings, an additional centre landing gear and range of up to 5,000 nm in the Series 40.



(From Jane's Civil Aircraft)

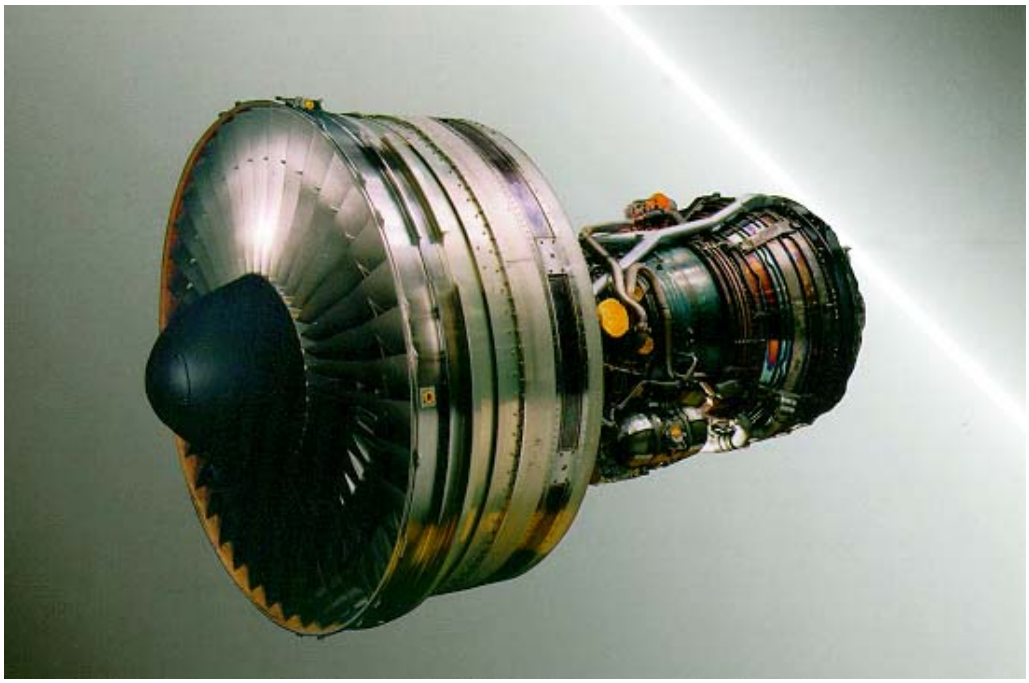
TURBOFAN ENGINES ARRIVE

The 11,000 lbs of thrust produced by each of the four Pratt & Whitney JT3C water-injected turbojet engines on the early DC-8s and 707s helped launch the passenger jet age. However, these engines had some significant drawbacks – low thrust, excessive noise and large quantities of smoke (especially with water injection!)

Turbofan engines solved these problems by adding an additional "fan" in front of the engine core to blow cooler air around the core. This added thrust, and greatly decreased the amount of noise generated at high power levels. Initial turbofan jet engines included the P&W JT3D, at 18,000 lbs thrust, which powered the 707-320 and DC-8 Series 50/60 and the Rolls-Royce Conway, installed on the DC-8 Series 40 and 707-436. However, the huge wide-bodied aircraft of the late 1960s needed something with even more thrust.

For the DC-10 Series 10, the General Electric CF6-6 was developed, with a single engine generating 40,000 lbs (or the equivalent of all four JT3Cs on a 707-120!), or 120,000 lbs total. The Series 20 was designed around the Pratt & Whitney JT9D 45,000 lb turbofan, the same engine that powered the 747 and early 767 models. As with most other airlines, later versions had more powerful engines. The Series 30 used the 51,000 lb GE CF6-50, and the Series 40 was powered by the JT9D, rated at 53,000 lbs.

In closing, the descendants of the CF6 deserve mention. GE and SNECMA moteurs of France later jointly developed the CFM56, a high bypass turbofan engine. These 18,500 to 34,000 lbs thrust engines were initially designed for the United States Air Force's KC-135 tanker re-engine program, replacing JT3C and JT3D engines. They were used in a similar fashion in the "Series 70" of the DC-8, and as original equipment on modern aircraft such as the Boeing 737 (300 series onwards), Airbus A319/A320/A321, as well as the original A340-200.



THE MD-11 TAKES OFF

As McDonnell-Douglas went into the design study of Series 50 and then the Series 60 DC-10, they eventually decided to launch a much more advanced aircraft based on the DC-10. The DC-10-60 eventually became known as the MD-100, the MD-XXX and finally the MD-11.

The MD-11 program was launched on December 30th, 1986, with the first delivery to Finnair taking place on December 7th, 1990. It brought a lot of improvements over the DC-10, including the following:

- A stretched fuselage (6.68 meters longer, approximately 20 feet)
- Longer wing
- Winglets for better stability
- Refined airfoils on wing and tail plane
- More powerful engines
- Strong composite parts on flaps, etc.
- First all digital glass cockpit in a commercial aircraft
- Two member flight crew, instead of three
- Larger fuel capacity, 2,000 gal more
- Longer range, up to 8,225 nm in ER version
- First complete 'fly-by-wire' flight capabilities
- Option of Propulsion Controlled Aircraft PCA

The new MD-11 was large enough to fly up to 410 passengers, making it a serious competitor to the Boeing 747/777, and the Airbus A330/A340, the world's largest commercial aircraft. The MD-11 is the largest wide body tri-jet ever built, and quite possibly the last one, since subsequent large aircraft designs have used either two or four engines.

The advanced, fully computerized, six-cathode ray tube display digital flight deck, also called the "glass cockpit", was now used to take over most of the flight engineers job. Monitoring engine performance, it has wind shear detection & guidance devices, dual flight management systems to conserve fuel and dual autopilots with fail operational capability. With these improvements, the flight crew is now reduced to the Captain and First Officer. The MD-11 was the first commercial aircraft to truly "fly – by – wire" from takeoff to landing (United States to Germany) without a pilot's hands on the controls.

Another notable improvement was the concept of a Propulsion Controlled Aircraft, or PCA. Developed by NASA and tested on an MD-11 in 1995, this revolutionary system allowed the safe landing of the aircraft with the hydraulics switched off. PCA uses the aircraft's autopilot together with programming in the flight control computers, and operates the aircraft solely by increasing or decreasing engine thrust. Increasing thrust in all engines allows the plane to climb, decreasing allows descent, and alternating thrust in left or right engines independently, allows for turns. If a plane has a major mishap, losing its hydraulics for flaps, ailerons, rudder, or elevators, it can still potentially make a safe landing. This is not as far-fetched as it may seem, as one two separate occasions disabled DC-10 aircraft were landed based on manual control of engine thrust alone, most famously in Sioux City, Iowa in 1989. Unfortunately, it is expensive, and no MD-11 customer asked for its planes to be retrofitted with the PCA system.

PERFORMANCE IMPROVEMENTS

Pilots who love a career flying challenge are in love with the MD-11. Carriers think a lot of the MD-11, too. Lufthansa Cargo said the MD-11F (freighter version) is the most economical and environmentally friendly airplane on the market. It requires 25% less fuel per ton/kilometer than the Boeing 747-200F, and has much lower emission rates. It is a quiet jet, with noise levels well below the strictest sound emission regulations. The enlarged hatch and semi-automatic loading system get high marks, making it possible to load and unload cargo faster. The plane soon became popular with freight carriers.

The MD-11 temporarily suffered a setback when discovered it did not meet advertised payload/range specifications. These problems were solved when McDonnell-Douglas enacted a performance improvement program (PIP) in order to reduce drag, weight, and fuel consumption. PIP was very successful, with performance improved by 8%, and fuel burn improvements were up, by up to 3%. However by the time the program was completed, the MD-11 was facing competition from comparable long-range airliners, such as the Boeing 777. Because of the additional cost of maintaining and operating a third engine, customers started to lean towards the 777.

BOEING BUYS MCDONNELL-DOUGLAS IN 1997

After Boeing purchased McDonnell-Douglas in 1997, production on the MD-11 was halted three years later. It was predicted by McDonnell-Douglas that well over 300 units would be built, when 195 total units actually were. Subsequently, it sold to 22 carriers. Federal Express purchased the most with 31 freighter versions, Delta Air Lines tied for second place with Varig, each having 15, and Swissair bought 14. Japan Airlines and KLM also bought 10. Many serve on long trans-oceanic routes.

DELTA SAYS GOODBYE TO THE MD-11

Wednesday, January the 1st 2004 was a sad day for many of us. This was the last day an MD-11 would wear the Delta colors on a scheduled flight. N807DE wearing the OC scheme landed at Atlanta from Narita, it was received with honor by the Atlanta Hartsfield Fire Fighters unit, spraying gallons of water over his shinny fuselage.

After that many Delta MD-11´s where translated to the dessert awaiting a new exploiter. Luckily some of them where recently bought by FedEx (Federal Express). Although these planes wont wear the Delta scheme again we are happy to know they are going to continue flying. We will see them with a different scheme but we will know they once flew for Delta.

AIRCRAFT SPECIFICATIONS

TYPE	MD-11P	MD-11F	MD-11CF	MD-11 Combi
LENGTH	202”			
WINGSPAN	169’ 10”			
WING AREA	3,648 ft^2			
HEIGHT	57’ 11”			
EMPTY WEIGHT	291,600 lb			
MAX. WEIGHT	602,500 - 630,500 lbs	630,500 lbs		602,500 - 630,500 lbs
STD. SEATING	285 - 410	None	350 - 410	181 - 214
MAX. RANGE	7,630 - 8,225 nm	4,450 nm	4,450 7,620 nm	6,495 nm
ENGINE TYPE	PW4460, PW4462 or GE CF6-80C2			
TOTAL THRUST	180,000, 186,000, 184,000 lbs			
FUEL CAPACITY	38,615 gal			
LOWER CARGO	6,850 ft^3			935 ft^3
MAIN CARGO	None	15,530 ft^3	14,508 ft^3	3,590 ft^3
CEILING	45,000 feet MSL (FL450)			
CRUISE SPEED	**Typical** FL310: Mach .74 (280 KIAS), FL360: Mach .87 (286 KIAS) **MAX RANGE** FL310: Mach .72, FL360: Mach .86			
TAKEOFF SPEED	(460,000 lbs gross weight) V_1=134 KIAS, V_r=150 KIAS, V_2=163 KIAS			

MD-11P=Passenger

MD-11F=Freighter

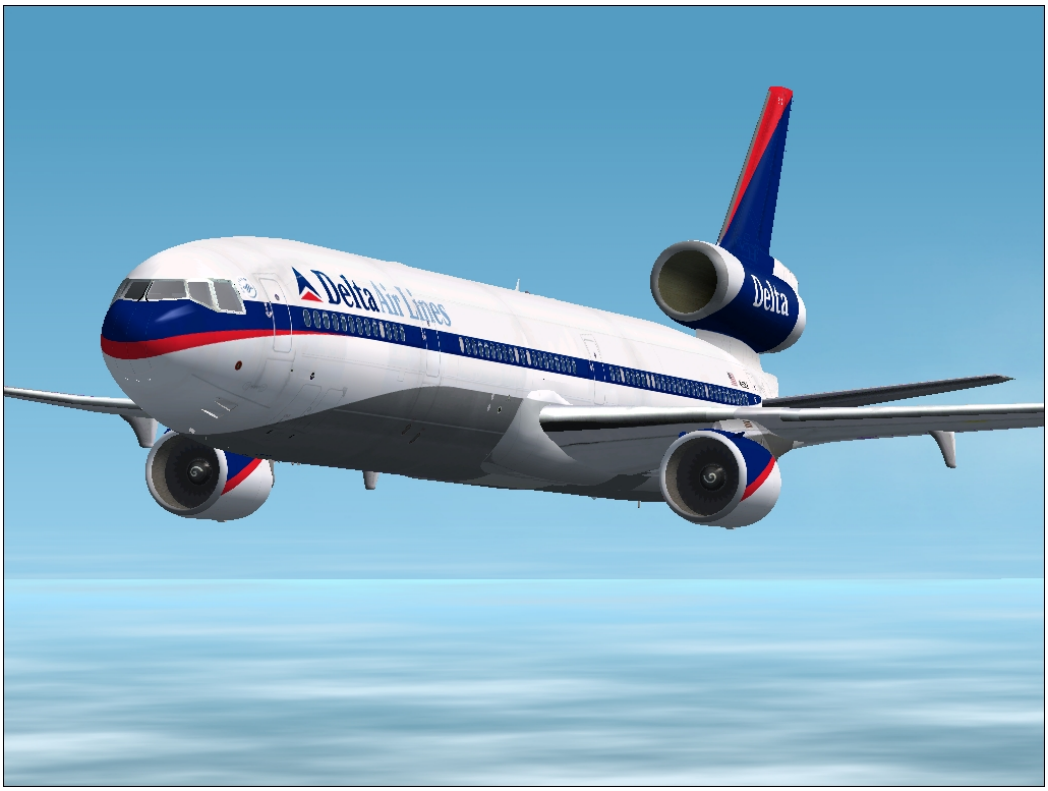
MD-11CF=Convertible Freighter=P or F

MD-11 Combi=P+F

RECOMMENDED EQUIPMENT

Delta Virtual Airlines provides 32-bit Windows aircraft fleet installer utilities for its aircraft, as part of its Fleet Library. The MD-11 Fleet Installer contains the International Flightsim Design Group (IFDG) MD-11 in a variety of Delta, Alitalia and Korean Air Lines liveries, along with an MD-11 created by Alain Capt.

These aircraft models and panels are available from the Delta Virtual Airlines Fleet Library, as well as the popular flight simulation web sites http://www.flightsim.com and http://www.avsim.com/.



FUEL LOADING

Delta Virtual Airlines' MD-11 has five fuel tanks, left aux, left, center, right, and right aux. Both the left and right aux tanks have a capacity of 49,574 lbs of fuel. Both left and right tanks have a capacity of 40,853 Lbs. The center tank holds 77,041 Lbs, for a total of 257,895 Lbs of fuel. With a full load of fuel the MD-11 is capable of flying over 8,000 nautical miles. One gallon of Jet A fuel weighs approximately 6.70 lbs.

- Range: 7,200 NM
- Fuel Burn Rate Factor: 31.6 lbs/NM
- Fuel Base Amount: 40,000 lbs
- Fuel Loading Formula: **(Fuel Base Amount + (Distance * Fuel Burn Factor))** Calculation of this formula gives you the correct amount of fuel for your trip.
- As an example, for a 2000 nautical mile flight leg the Fuel Loading Formula would be **(40,000 lbs + (2000NM x 31.6)) = 103,200 lbs**. Please note that this does not take into account the 45 minute reserve required; approximately 15,000 lbs.
- To load fuel into your aircraft, select ***Aircraft***, then ***Fuel*** and place the correct fuel amounts in the correct tanks.

Look at three typical flight examples:

- KMCO (Orlando, Florida) to KATL (Atlanta, Georgia) 450 nm would require approximately 54,000 lbs of fuel.
- KATL to EGLW (London-Gatwick, United Kingdom) (NAT route) 4,000 nm would require approximately 166,000 lbs of fuel.
- KLAX (Los Angeles, California) to NRT (Tokyo-Narita, Japan) (PACOT route) 5,200 nm would require approximately 204,000 lbs of fuel.

Captains ordering fuel for Delta Virtual Airlines flights should remember that more fuel equates into more drag, requiring more power. An unnecessary overabundance of fuel will only cost the company money. Fuel should be kept as close to the trip fuel required as possible. With that said, **it is always the pilot's responsibility to ensure that there is enough legal fuel for the flight**. Any incident that was the result of mis-calculating the fuel load will always be the fault and sole responsibility of that flights captain and crew. When in doubt, take more.

Delta Virtual Airlines aircraft shall always carry a minimum fuel load for the trip to the destination, and at least 60 min reserve in cruise at low altitude (Fuel Base amount) plus a 45 min reserve for diversion to the designated alternate landing site.

Any trip estimations that you see in this manual are for calm winds and standard outside air temperatures. Deviation from standard winds or temperatures will result in different actual performance for your aircraft. When flying over long bodies of water, remember that in the event of pressurization problem or an engine failure that requires descent to 14,000 feet MSL for passenger comfort, the fuel burn for the aircraft will increase significantly and may leave you short of your initial destination. Plan accordingly!

TIP: This equation doesn't consider wind. This is of special importance when crossing the ocean. If you fly Atlanta-Gatwick with the fuel indicated by the equation you will reach destination with enough fuel to fly to your alternate. By contrast, flying Gatwick – Atlanta, you will be having strong head winds, and this equation will surely leave you short on fuel. This is a quick way to crosscheck the fuel quantity. At cruise, the average fuel consumption of the iFDG MD-11 is 2,800 Kg/h per engine. This is approximately 6,200lbs. The total average is 18,600 Lbs/h. Now you should go to the timetable and check the estimated flying time and multiply the hours by 18,600. That leaves you with a rough estimate for you flight. The following procedure should only be done when flying long flights with strong head winds.

Example:

Frankfurt to Atlanta. Approximately 10 hours. 4053 miles.

The equation: (40,000 + (4053 * 31.6)) = 168,075 lbs.

Now, we multiply our average fuel consumption by the timetable flight length.

18,600 * 10 = 186,000 lbs

In this situation you can see that there is a big difference between the values, if you would have loaded the fuel given by the first equation, you may have been short. Other than this situation the equation works fine, the problem is when you have a long flight with strong head winds. These winds will make your fuel consumption increase greatly.

Alain Capt's McDonnell-Douglas MD-11 Panel

Overhead Panel

1. Pushback Selector
2. Engine Ignition A
3. Engine Ignition B
4. External Power
5. Battery Switch
6. APU Switch
7. Air Cond selector
8. Air Cond on/off switch
9. Engine 1 Anti-Ice
10. Engine 2 Anti-Ice
11. Engine 3 Anti-Ice
12. Wing Anti-Ice
13. Tail Anti-Ice
14. Pitot Heat
15. Seat Belts Selector
16. Strobe Lights
17. Landing Lights
18. Taxi Lights
19. No Smoking Selector
20. Yaw-Damper
21. Left Runway Turnoff Light
22. Right Runway Turnoff Light
23. Navigation Lights
24. Logo Lights
25. Beacon Lights
26. Hi Intensity Lights

Mode Control Panel

1. Panel Flood Light Switch
2. Altimeter Setting Knob (Push for Standard 29.92)
3. Decision Height Setting Knob
4. GPS Toggle
5. Kneeboard Toggle
6. Flight Director
7. EHSI Mode Selector (NAV1, NAV2)
8. ADF EHSI Selector
9. Decrease NAV1 Course
10. Decrease NAV2 Course
11. Increase NAV1 Course
12. Increase NAV2 Course
13. Speed Selector Knob*
14. Auto-Throttle Switch
15. IAS Mode Select
16. Mach Mode Select
17. Heading Selector Knob*
18. Heading Mode Select
19. NAV Mode Select
20. Approach Mode Select
21. Autopilot Master Switch
22. Altitude Selector Knob*
23. Altitude Mode Select
24. Wing Leveler Mode Select
25. Back Course Mode Select
26. Vertical Speed Selector Wheel
27. Overhead Toggle Switch
28. CRT 3 Toggle Switch
29. CRT 4 Toggle Switch
30. Throttle Quadrant Toggle Switch
31. Start/Stop Crew Function
32. Increase Simulation Rate
33. Decrease Simulation Rate
34. Skip/Reset Crew Function

Items With (*): These Knobs operate a different mode depending on left/right mouse click.

Airspeed Selector Knob: Left click will engage the Hold Current IAS mode (will hold your current Airspeed, doesn't matter if you have got any speed selected in the window), right click will engage the Maintain Selected IAS mode.

Heading Selector Knob: Left click will engage the Hold Current Heading mode, right click will engage the Maintain Selected Heading mode.

Altitude Selector Knob: Left click will engage the Hold Current Altitude mode, right click will engage the Maintai3n Selected Altitude mode.

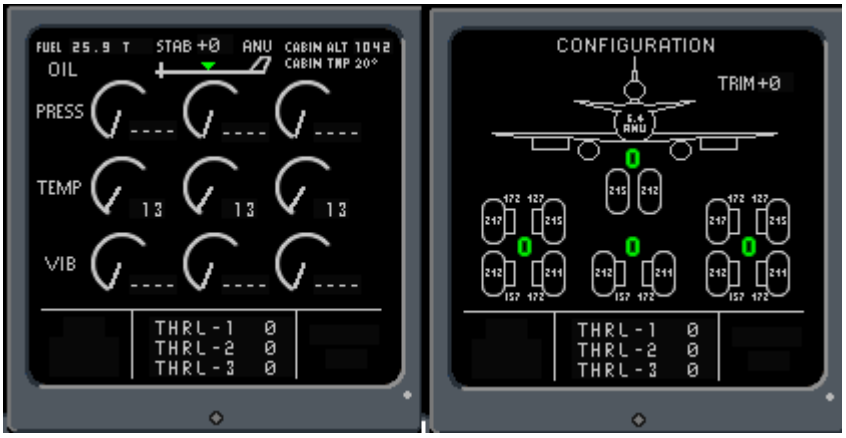
FORWARD PANEL

CRT 1: EADI (Electronic Attitude Direction Indicator)

CRT 2: EHSI (Electronic Horizontal Situation Indicator)

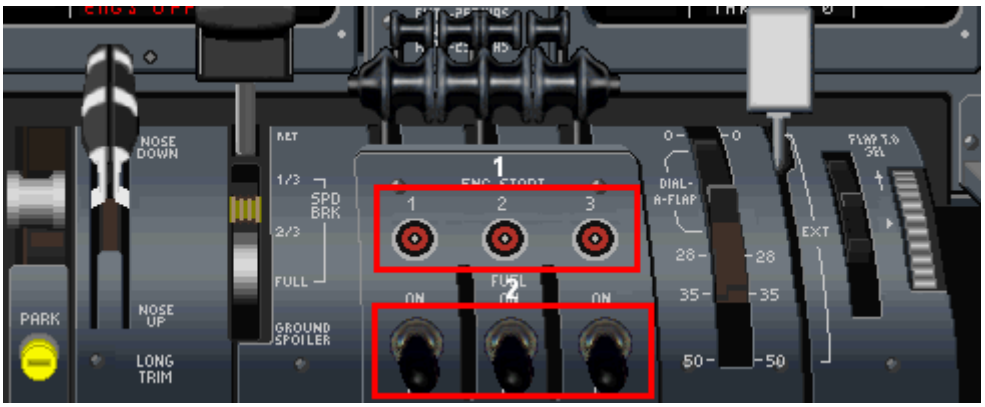
CRT 3: Primary Engine Display. Toggles with Fuel Status Page

CRT 4: Secondary Engine Display. Toggles with Configuration Page



Radios And Throttle Quadrant

1. Weight Page
2. On/Off Switch
3. NAV1 Ident. Switch
4. COM2, COM1 Toggle
5. NAV2 Ident. Switch
6. On/Off Switch
7. NDB Ident. Switch



1. Engine Start Switches
2. Engine Fuel Cutoff Switches

DELTA VIRTUAL AIRLINES STANDARD OPERATING PROCEDURES

These procedures are designed so that today's crews can work together effectively and safely as well as allowing some standardization of procedures for the company. By standardizing procedures the company can budget flights better financially as flights will always be the same or at least somewhat similar.

For the crews, this means that the company can schedule pilots together that have never flown together before and still maintain a safe operation. For Delta Virtual Airlines, these procedures are for the benefit of the pilots using this manual. By flying using these procedures pilots will be able to make better use of the manual and also operate the aircraft in a similar fashion company wide.

NOTE: In any circumstance where company procedure conflicts with manufacturer's recommended operation, company procedure will take precedence unless a safety factor is involved. Discretion is the responsibility of the Captain.

The following procedures are intended for use with the Alain Capt panel found in the Delta Virtual Airlines McDonnell-Douglas MD-11 fleet installer.

BEFORE START

- Battery – ON
- EICAS, EHSI, EADI, radios Power Switches – ON
- Auxiliary Power Unit – ON
- Air Cond (APU ON) – ON
- Seat Belt & No Smoking Signs – ON
- Yaw Damper – ON
- Navigation & Logo Lights – ON
- Set Frequencies and Courses as required for Departure
- Flight Director – ON
- Autopilot – Set & Disengaged (*)
- Instruments – Sync & Cross Checked

CLEARED FOR START

- Air Cond – OFF
- Beacon & Hi Int Lights – ON
- Engine Ignition A or B
- Engine Start Switch – ON
- Start Levers – ON

AFTER START

- Engine Ignition – OFF
- APU – OFF
- Air Conditioning – ON
- Anti-Ice – As Required
- Pitot Heat – ON
- Taxi Lights – ON

Before Takeoff

- Flight Controls – Checked
- Auto Throttle – ON
- Flaps – Set
- Stabilizer Trim – _____Units Set
- Take Off Briefing – Reviewed

Cleared for Takeoff

- Engine Ignition A & B – ON
- Strobe & Take Off Lights – ON
- Runway Turnoff – ON

After Takeoff

- Engine Ignition – OFF
- Flaps – UP
- Gear – UP
- Taxi Lights – OFF

--10,000 Ft—

- Landing & Logo Lights – OFF
- Seat Belt Sign – OFF

--CRUISE—

- Runway Turnoff Light – OFF

Descent Approach

- Seat Belt Sign – ON
- Runway Turnoff – ON
- Approach Briefing – Reviewed

--10,000 Ft--

- Landing & Logo Lights – ON
- Altimeters – Set

LANDING

- Engine Ignition A & B – ON
- Flaps – ___, Set
- Gear – Down, 4 Green
- Speedbrake – Armed

VACATING

- Engine Ignition A & B – OFF
- APU – ON
- Landing & Strobe Lights – ON
- Taxi Light – ON
- Flaps – UP
- Speedbrake – Down Detent

SHUTDOWN

- Parking Brake – Set
- APU – ON
- Start Levers – Cut Off
- Seat Belt Sign – OFF
- Anti-Ice – OFF
- Pitot Heat – OFF
- Beacon & Hi Int Lights – OFF
- Runway Turnoff – OFF
- Flight Director – OFF
- Flaps – UP, no Lights
- Speedbrake – Down Detent

SECURED

- Logo & Navigation Lights – OFF
- Air Conditioning – OFF
- EICAS, EHSI, EADI, Radios – OFF
- APU – OFF
- Battery – OFF

When taxiing with the MD-11 keep in mind that the nose wheel is way behind your eye's position, this means that if you want to make a 90º turn and turn so as to keep the yellow line below your head, it's possible that your main gear wheels end up in the grass. To prevent this, wait until the yellow line is behind your head reference point to start the turn. For steep turns in the ground don't exceed 10 knots.

NOTES FROM THE CHIEF PILOT

If you have flown a few large planes on flight simulator, you have probably flown some of the Boeing jets. If you want to step up the challenge to your piloting skills, then the MD-11 will do. Real world pilots who fly the MD-11 say it is a big satisfaction to fly it and land it properly. It is said to be an unforgiving plane compared to some other commercial aircraft, and there is little time to recover on a bad landing. Do the same maneuvers you did with the other aircraft, like turn too hard an angle, too much flap on approach, or forget you have speed brakes on full as you enter a turn, and the MD-11 will start to fall. It does not quite "float" like the 747 or 777. It takes off fast, lands fast and stalls more easily.

Weight onboard, mainly how much fuel you have loaded, makes a *big* difference in the way the plane climbs, turns, and handles on takeoff (and landing too – if you are carrying a lot of weight on landing). The difference between empty weight and maximum weight can be more than 300,000 lbs – more than the aircraft's own weight. Simulator aircraft designers tend also to increase the weight already in the Flight Simulator aircraft.cfg file, in order to simulate a big load of passengers and luggage. Use your judgment, the flap and speed specs for takeoff and landing are guides, not rules. Runway length for takeoffs and landings can differ greatly depending on aircraft weight. Suggested runway length for takeoff with a full fuel load is 12,000 feet, but near empty weight you can use an 8,000-foot runway. Takeoff and landing speeds can vary as much as 25 knots or more, depending on weight and weather / wind conditions.

ACKNOWLEDGEMENTS AND LEGAL STUFF

- Delta Virtual Airlines is not in anyway affiliated with Delta Air Lines or any of its subsidiaries. We are a non-profit, non-commercial organization catering to the Flight Simulation community. The real Delta Air Lines web site is located at http://www.delta.com/.
- Revisions of this manual may have been made since its publishing. Please check Delta Virtual Airlines' web site at http://www.deltava.org/ for the most up to date version.
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- This manual is designed for use by Delta Virtual Airlines as reference material for flight simulator pilots operating the McDonnell-Douglas MD-11 aircraft. There is no guarantee of the accuracy of this information. This is a reference for the virtual flying world and is not to be used for real world aviation.
- The information in this manual has been gathered from Internet resources and from test flying the aircraft in Microsoft Flight Simulator 2002 Professional and Microsoft Flight Simulator 2004 on Microsoft Windows XP Professional. This manual makes no claim to represent Boeing, McDonnell-Douglas, Pratt & Whitney, General Electric, Microsoft, Delta Air Lines, Lufthansa, or any other party involved.
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