

ADVANCED FLIGHT SIMULATOR DATA (AFSD)

Version 1.23 – October 2002

1. FILES

AFSD.EXE	Program (version 1.23)
AFSD.PDF	This file

2. PROGRAM HISTORY

AFSD was initially designed as a test program (at this time, its name was FSTP for Flight simulator Test Program) in order to:

- 1) understand how FS2000 and FS2002 were calculating some aerodynamical data such as lift, drag and their components
- 2) investigate the effects of several air file variables and tables and changes we introduce in them..
- 3) help making more realistic aircraft models under FS2000 and FS2002

With time, I added several more general display categories and options and I feel this program can now also be useful for flight planning and following purposes and not only for FDE designing

3. PROGRAM FUNCTIONING

The originality of the program is that it simultaneously accesses key aerodynamical data via Pete Dowson's FSUIPC interface AND necessary aircraft data via a direct access to the .air file variables and tables and/or to the aircraft.cfg information, as appropriate.

Pete Dowson has regularly updated and improved the FSUIPC interface and recently gave us access to key aerodynamical variables such as accelerations, dynamic pressure, thrust data, instantaneous gross weight and much more.

For some calculations AFSD also access air file variables and tables as well as some aircraft.cfg data. The program logic was designed according to what we currently know as regard air file parameters (and aircraft.cfg for FS2002). Future releases will of course take into account any new knowledge in the field.

4. INSTALLATION AND REQUIREMENTS

AFSD is a single EXE program which doesn't require any installation procedure. It will not change the registry. It is a **Visual Basic 5.0** program which requires that the appropriate VB5 runtime files are installed.

If you are using an English or French Windows version, the only necessary system VB5 files are:

MSVBVM50.DLL

STDOLE2.TLB

OLEAUT32.DLL

OLEPRO32.DLL

ASYCFILT.DLL

COMCAT.DLL

If you are using a non-English non-French version of Windows, you will also probably need the VB5FR.DLL in the Windows\System (or system32 under XP) directory.

AFSD is a Windows 32-bit program and has been tested on Windows 98SE and Windows XP

It is only designed to work with **FS2000 and FS2002** ; FSUIPC will detect the FS version and the program will act accordingly

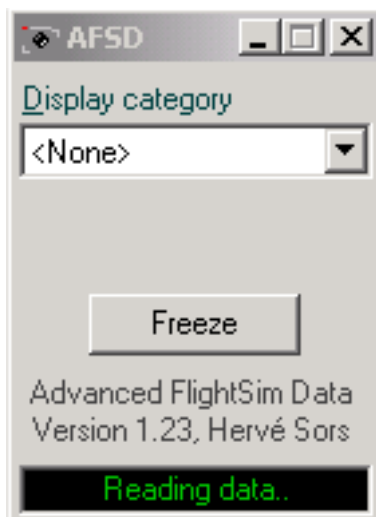
It requires that the **FSUIPC.DLL module version 2.87 or greater** is properly installed in the FS modules directory.

5. FIRST SCREEN AND DISPLAY CATEGORIES

Launching the program will move its main window at the top left corner of the screen .and you will need to resize the FS screen so as to be able to view the program data flow. The AFSD window's width has been reduced to a minimum so as to preserve the FS display width

If, at a particular time, you do not need to look at AFSD data anymore you can:

- 1) Maximizes FS window (AFSD will go on working in the background)
- 2) Minimizes AFSD to the task bar
- 3) Or closes it!

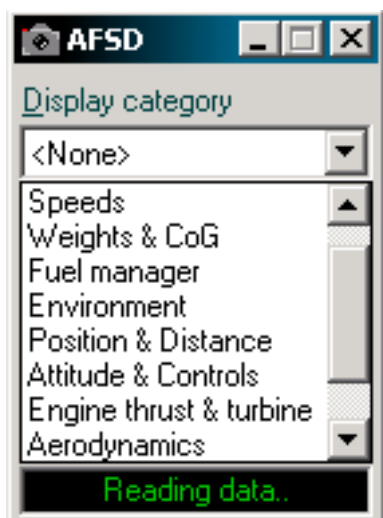


After it has been launched, AFSD will try to establish a FSUIPC based communication with FS2000/FS2002 and will warn you in case of any error or problem

The green “**Reading data**” label indicates everything is OK

The **Freeze** button will stop all program activity (it disables the timer loop) in the case you think your system needs it for optimal performance (although I didn't notice any decrease of frame rate during my tests)

Note that AFSD will detect any aircraft change within the simulator and will automatically update all parameters. Displayed data are recalculated each second (except during some phases of the autoland module process where they are recalculated every 250 ms)



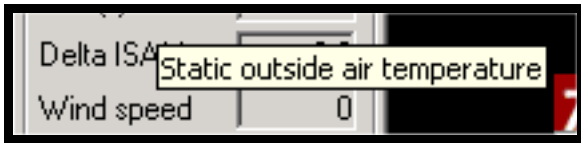
The **Display category** combo box will propose several data categories as shown here

Each data set is displayed in a separate form (you can move it where you want to)

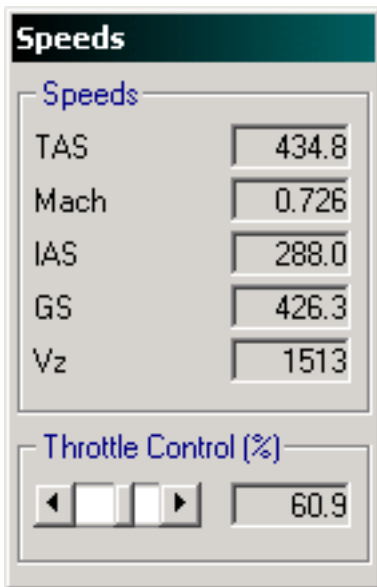
Changing the data set (through the main form combo box) will automatically close the previous data sheet

6. DATA REFERENCE

Signification and units of displayed values are always indicated in **yellow tool tips** that will appear if the program has the focus and mouse pointer is above a display label as shown below



6.1 Speeds



This screen displays accurate values (0.001 mach unit / 0.1 kts) of:

True air speed (TAS, kts)

Mach value

Indicated air speed (IAS, kts)

Ground speed (GS, kts)

Vertical speed (Vz, fpm)

Note that speed data are not available (NA) in slew mode

The **Throttle control (%)** cursor can be used to finely set the engine power for some aerodynamical tests. It is disabled if the AP Autothrottle function is engaged

6.2 Weights & CoG



All weights are displayed in Lb or Kg according to the **Weight unit** choice. Available data are:

Empty weight which is the empty weight of the aircraft as defined in the aircraft.cfg file or in the aircraft air file (if it is not defined in the aircraft.cfg)

Fuel weight

Payload weight (calculated as GW-fuel weight-empty weight)

Gross weight (GW) which is the gross actual weight of the aircraft as loaded

CoG (%) is the position of the center of gravity by reference to the mean aerodynamical chord center of lift position (positive if afterwards, negative if backwards)

6.3 Fuel manager

The Fuel Manager form displays the following data and settings:

Fuel data	
FOB(*)	22492
Fuel burn(*)	8496
TSFC	0.882
NAM	8.19
Range	1191

(*) Relative to fuel unit

Fuel unit:
☒ USG ☐ Lb ☐ Kg

Fuel tank selector:
Left

The Fuel Manager form will display:

Fuel on board (FOB) (US gallons, Lb or Kg according to the **Fuel unit** choice)

Fuel burn which is the total fuel consumption per hour (again USG/h, PPH or Kg/h according to the chosen unit)

Thrust specific fuel consumption (TSFC) which is the ratio of fuel consumption (PPH) / total engine thrust (lb) (Note that fuel unit is irrelevant here)

NAM which is the covered distance (NM) per 1,000 lb fuel consumption relative to true air speed (TAS)

Range is the instantaneous aircraft range (NM) taking into account actual FOB, fuel burn and ground speed

The **Fuel tank selector** combo box will give you the opportunity to select any available fuel tank without using the Aircraft/Fuel settings menu of the simulator (which doesn't always select the desired tank and generates fuel rounding errors by resetting the %)

6.4 Environment

The Environment form displays the following data and settings:

Environment data	
PA	465
Height AGL	551
OAT(*)	63.4
Delta ISA(*)	6.0
Wind speed	1
Wind dir	142
H/T Wind	NA
WCA	NA
QNH(*)	30.15

(*) Relative to T/P unit

Temperature unit:
☒ °F ☐ °C

QNH unit:
☒ inHg ☐ hPa

This form displays the following environmental data:

Pressure altitude (PA, ft)

Height above ground level (ft) relative to the aircraft CoG position

Outside static air temperature (OAT, °C or °F) according to the **Temperature unit** choice)

Difference between OAT and standard temperature (ISA) (°C or °F)

Wind speed (kts) at aircraft position

Wind direction (degrees magnetic) at aircraft position

Head or tail wind component (H/T Wind, kts)

Wind correction angle (WCA, which depends on wind direction, current aircraft heading and true air speed)

QNH (inches of mercury or hectopascals according to the **QNH unit** choice)

H/T wind and WCA will not be available in some conditions (no wind, TAS < 10 kts, slew mode and some other extreme conditions)

Note that standard temperature (ISA) is calculated from pressure altitude and the USA 1976 standard atmosphere model (used in FS2000/2002). Also note that changes in magnetic vs true wind headings for surface winds as introduced by the latest version of FSUIPC (2.91) are taken into account.

6.5 Position & Distance

Position & Distance

Position data

Latitude
N48 44 01.0

Longitude
E002 21 19.8

Ground Alt 292

Mag Var W03.5

True HDG 241.8

Mag HDG 245.3

Distance calculator

Locked Latitude
N48 44 06.8

Locked Longitude
E002 21 36.2

Distance 1247

☐ NM ☒ Ft

Unlock current

The **Position data** frame displays the following data:

Latitude (current aircraft latitude, format is N/S dd mm ss.s)

Longitude (current aircraft longitude, format is E/W dds mm ss.s)

Ground altitude (ft) at current aircraft position

Magnetic variation (degrees E/W dd.d) at aircraft position

True heading (degrees)

Magnetic heading (degrees)

The **Distance calculator** frame module gives you the opportunity to calculate a distance (either in NM or feet) from any previously locked position. Pressing the **Lock current** button will memorize the current position and will continuously display the distance between locked and current position. Locked latitude and longitude will appear as **red labels** in the Locked Latitude and Locked Longitude fields. Changing the display category will not reset the locked position so as you can navigate in the available display screens without losing the memorized “locked” position

Typical uses of this module are:

- calculation of runway takeoff or landing distances (use Ft)
- climb and descent distances (use NM)

Pressing the **Unlock current** button will reset the distance calculator

6.6 Attitude & Controls

Attitude & Controls

Aircraft attitude

Body AoA	7.27
Wing AoA	9.27
Pitch	1.09
Bank	0.41
Side Slip	0.04
Slope	-6.18

Controls

Elevator	0.00
Aileron	-0.09
Rudder	0.00
Trim	2.11

NA for helo and rocket

This part displays basic and advanced aircraft attitude and aircraft controls positions:

Body angle of attack (AoA) is the angle between the aircraft fuselage and the true air speed (TAS) vector

Wing AoA is the angle between the wing profile and the TAS vector ; it depends on Body AoA, wing incidence and wing twist ; this parameter will determine the wing lift (see Aerodynamics)

Pitch is the angle between the aircraft fuselage and the horizontal reference world axis (up is positive)

Bank is the fuselage angle on the longitudinal axe

Side Slip is the fuselage angle on the vertical axe

Slope is the air relative flight path angle

All aircraft attitude angles are in *degrees*

Aircraft Controls data (Elevator, aileron, rudder and elevator trim) deflections (degrees) are displayed in the Controls frame

Note that for evident reasons these some of these data are not available for helicopters and rocket models

6.7 Engine thrust & Turbine

Engine thrust-Turbine

Total engine thrust

Thrust (lb)	19591
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Turbine data

N1	46.9
CN1	47.3
N2	71.6
CN2	72.1
EPR	1.059
EGT	511
ITT	576

Turbine selector

☒ 1 ☐ 2 ☐ 3 ☐ 4

The engine thrust and turbine form displays:

Thrust ; this is the true instantaneous value of total engine thrust (lb-force) for all piston and/or turbine aircrafts and helicopters (excluding gliders) ; for turboprops, it is the addition of turbine and prop thrusts

Turbine data are only available for turbine powered aircrafts (e.g. jet, rocket and turboprop aircrafts) with the following displays:

N1, CN1 : raw and corrected N1 values (%)

N2, CN2 : raw and corrected N2 values (%)

EPR : engine pressure ratio (no unit)

EGT : exhaust gas temperature (°C)

ITT : inlet turbine temperature (°C)

You can use the **Turbine selector** option buttons to display any engine data set

6.8 Aerodynamics

Aerodynamics	
Basic data	
TAS	543.4
Mach	0.504
GW	94034
Thrust	9348
Q	259.26
Lift and Drag	
CL	0.318
CD	0.0318
Lift components (*)	
CL Wing	0.318
CL Elevator	0.000
CL HS	0.000
CL Flaps (+)	0.000
CL Spoilers	0.000
Mach factor	1.038
Drag components (*)	
CD0	0.0200
CDi (est)	0.0100
CD Mach	0.0018
CD Gear	0.0000
CD Flaps (+)	0.0000
CD Spoilers	0.0000
NA for helo and rocket (*) NA if cfg scalars<>1 (+) estimated for FS2002	

This is one of the most sophisticated data display that could be of some help for aircraft designers

Here **Basic data** are in English or engineering units

TAS: True air speed (ft/s)

Mach value

GW: aircraft gross weight (lb)

Thrust: total engine thrust (lbf)

Q: dynamic pressure (lb/ft²)

Total **Lift and Drag** coefficients values are calculated according to the classical motion equations (forces along the relative wind direction for CD and perpendicular to the relative wind direction for CL) taking into account gross actual weight (GW), thrust, dynamic pressure (Q), slope, accelerations if any and reference wing area (from aircraft.cfg or air file)

Lift components are calculated for main wing, elevator, horizontal stabilizer, flaps and spoilers from total CL, wing CL vs AoA table (Table #401), deflection angles and max lift coefficients of control surfaces ; *Note that due to the complexity of flaps data in FS2002, CL due to flaps (CL Flaps) is not directly calculated but is only estimated by difference*

The **Mach factor** (which is used to correct the CL wing value) is calculated from air file table #404 and Mach number

Drag components include parasite drag (CD0), Mach drag, drag due to gear and spoilers extensions ; again, Flaps drag is estimated from other drag values. At this time, induced drag (CDi) is also estimated by difference (by now, this is only possible when flaps are fully retracted)

Aerodynamical data are not available for helicopters and rocket models ; also *some values will not be calculated if drag and/or lift scalars in the aircraft.cfg file are changed* (ie are not = 1.000)

AFSD will always remain conservative and will check conditions in which data can be reliably calculated ; otherwise a “NA” label will be displayed

6.9 VOR1 & ADF Info

VOR1 & ADF Info

VOR1

Identifier: CLM

From/To: 078.8

Distance: 26.7

☒ To ☐ From ☐ Auto

Lock AP Course

Needs AP HDG mode

ADF

Identifier:

To HDG:

The **VOR1** frame displays

VOR1 Identifier

From/to magnetic heading (according to selected option button)

The *Auto* check box will display To or From VOR heading automatically depending on current aircraft heading and VOR position

Distance to VOR station (note it is an horizontal distance calculated from current aircraft and VOR coordinates)

The **Lock AP course** button will enable an automatic following of **AP course**. This function needs that the **main AP command and heading mode are engaged**. Lock will be automatically disengaged at or below 5NM horizontal distance from the VOR

The **ADF** frame displays the identifier and QDM (magnetic heading) of any valid tuned ADF frequency

6.10 ILS & Autoland

This module will give you all necessary information about ILS data and tracking and also incorporates an autoland function.

Correct autoland functioning requires that:

1) You enabled the panel **NAV display** (and disabled the GPS display) and that a **valid ILS frequency** has been selected on VOR1. Otherwise you will see the following message

ILS Autoland status

No NAV1 ILS data

Disengage

Autoland is engaged

2) You engaged the **main autopilot command** as well as **heading mode** and **altitude hold**. Note that the autoland module **doesn't use the autopilot approach mode**. Autoland will not be available if the aircraft do not have heading or altitude hold functions. Manual or auto speed adjustments will be your job since AFSD do not control that. The following screen indicates an invalid AP mode

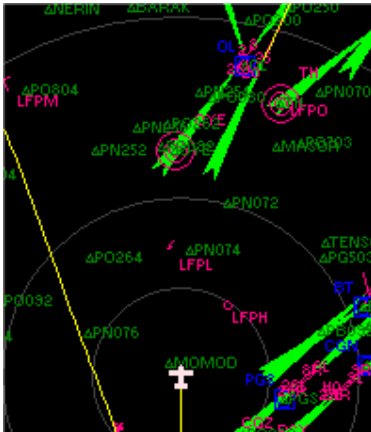
ILS Autoland status

Invalid autopilot mode

Disengage

Autoland is engaged

3) Your flight path will intercept the ILS localizer on a, let say, **30-45° angle or less** (although this is not mandatory) and **at least at 10-20 NM from the touch-down zone** (you must intercept the glide slope from below)



Intercepting the OLW ILS (LOC course 257.6°)

Current distance from TDZ: 17.7 NM

Current heading: 230°

AP altitude locked at 3,000 ft AMSL

Autoland engaged

ILS & autoland	
ILS data	
Identifier	OLW
DME	17.7
LOC course	257.6
GS gradient	5.2
TDZ height	292
ILS tracking	
LOC correct	-126
GS correct	118
Target Vz	-912
Radar ALT	2709
TDZ Distance	17.7
ILS Autoland status	
Localizer acquiring	
Disengage	
Autoland is engaged	
Autoland options	
DA	200
Flare Alt	100
TDZ Vz	-300

ILS data will display available ILS data if a valid ILS frequency is received on VOR1

Identifier

DME (horizontal distance to TDZ, NM)

LOC course (localizer course, degrees magnetic)

GS gradient (glide slope gradient, degrees)

TDZ height (Touch-down zone elevation, ft AMSL)

The **ILS tracking** frame indicates actual deviations from localizer and glide slope paths (**LOC correct** and **GS correct** displays) ; these are integer values from -128 to +128.

Target Vz is the required vertical speed for GS following taking into account the GS gradient and actual ground speed.

Radar ALT is the aircraft height above TDZ elevation

TDZ distance is the horizontal distance (NM) to TDZ

ILS Autoland status panel

(see above for necessary conditions)

Autoland options

DA: decision altitude (ft AGL) ; altitude below which autoland will be locked

Flare Alt: Flare altitude (ft AGL)

TDZ Vz: Final vertical speed for touchdown

Note that the autoland function will automatically apply reverse thrust (if available) and brakes (if autobrake has been set) after the aircraft has landed

7. RELEASE HISTORY AND CHANGES

Version 1.23

First public version

8. AIRCRAFT DESIGNERS INFORMATION

This program is continuously evolving. However, I cannot make it available to the FS community (who do not necessarily needs all program functions) as frequently as I change it. If, as an aircraft designer, you wish to have the latest version, please email me

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2) include program file (AFSD.EXE) and documentation (AFSD.PDF)

After reading this file (AFSD.PDF), you are aware that whatever the way this program is used, I won't be liable for any damage that may be caused by it and any consequence of using it (see Disclaimer section)

11. ACKNOWLEDGMENTS

Many thanks to Pete Dowson for providing us and always improving the awesome FSUIPC interface, Ron Freimuth, Ian Kerr and many others for their help in "understanding" FS data and suggestions for improvement , Pierre Dousset, Pascal Génotal and other pilots for testing the program

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Feel free to e-mail me any question, criticism or suggestion