
APP
AIRCRAFT
PERFORMANCE
PROGRAM

APP - Aircraft Performance Program

Introduction

APP is an aircraft-performance calculation program, specifically designed to provide a fast and easy way to evaluate aircraft performance. Another major design requirement was to impose no restriction upon the type of aircraft that can be handled by APP. Due to the simple, self-explaining user interface, minimum training is required to get started using APP. The manual guides new users through their first steps. The program features powerful built-in post-processing and export functions to further process the data if needed. For the advanced user, APP will provide the necessary flexibility to solve even the most challenging and complex problems.

APP can accomplish a wide range of different tasks:

- Fast and easy evaluation of an aircraft design
- Comparison of different aircraft
- Competitor performance analysis
- Evaluation of design-changes
- Mission optimization
- Creating plots for flight manuals and marketing brochures
- Flight test and certification support
- Helping students to understand the impact of different parameters
- Feasibility Studies
- ...

APP - Capabilities

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Capabilities/Functionalities

The most important capabilities and functionalities of APP:

- Computation of aircraft **point performance**
- Computation of **mission performance**
- Optimization and variation of **mission-profiles**
- Detailed **Take-off and Landing calculations**
- Applicable to jet and propeller aircraft, both military & civil
- Easy data input and manipulation
- Built-in powerful **graphical post-processing**
- Over **60 output parameters**
- **4 unit systems** (SI, imperial, ...) for input and output
- **Export** of tables (Excel) and plots

APP - Theory

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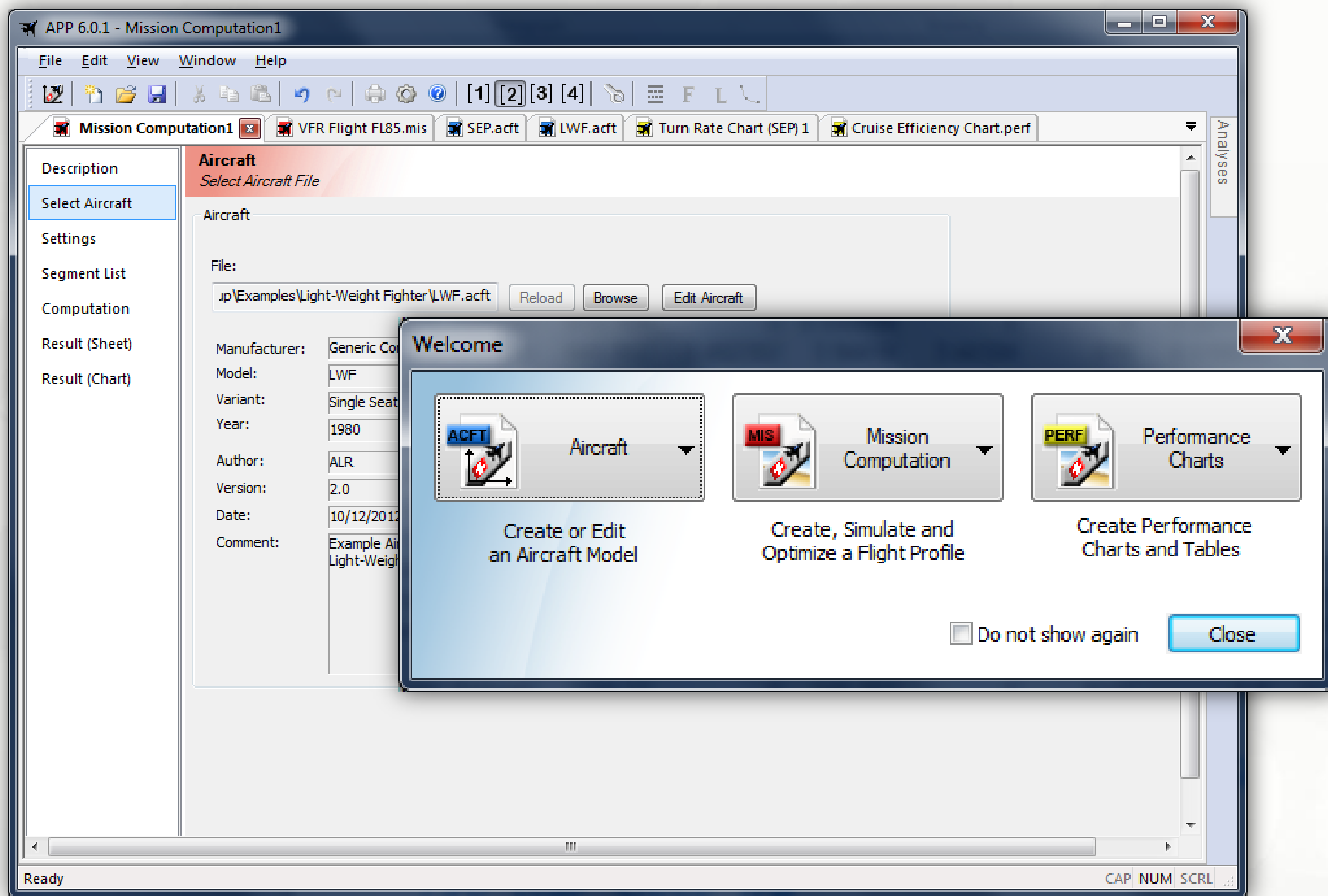
Flight Physics/Numerics

The physical and numerical principles behind APP were chosen to achieve accurate solutions while requiring only few computational resources:

- All calculations are based on 2 DOF point-mass equations
- No analytic simplifications or linearizations
- Mission integration and optimisation with Runge-Kutta (4th-order, fixed step)
- Using tabulated data depending on Altitude and Mach for thrust, C_L vs C_D, C_L vs AoA, fuel-flow, stores, ...

APP - Modern User Interface

APP has a modern and easy to use graphical interface. All computation modes are easily found and results can be generated quickly.



APP - Aircraft-Data

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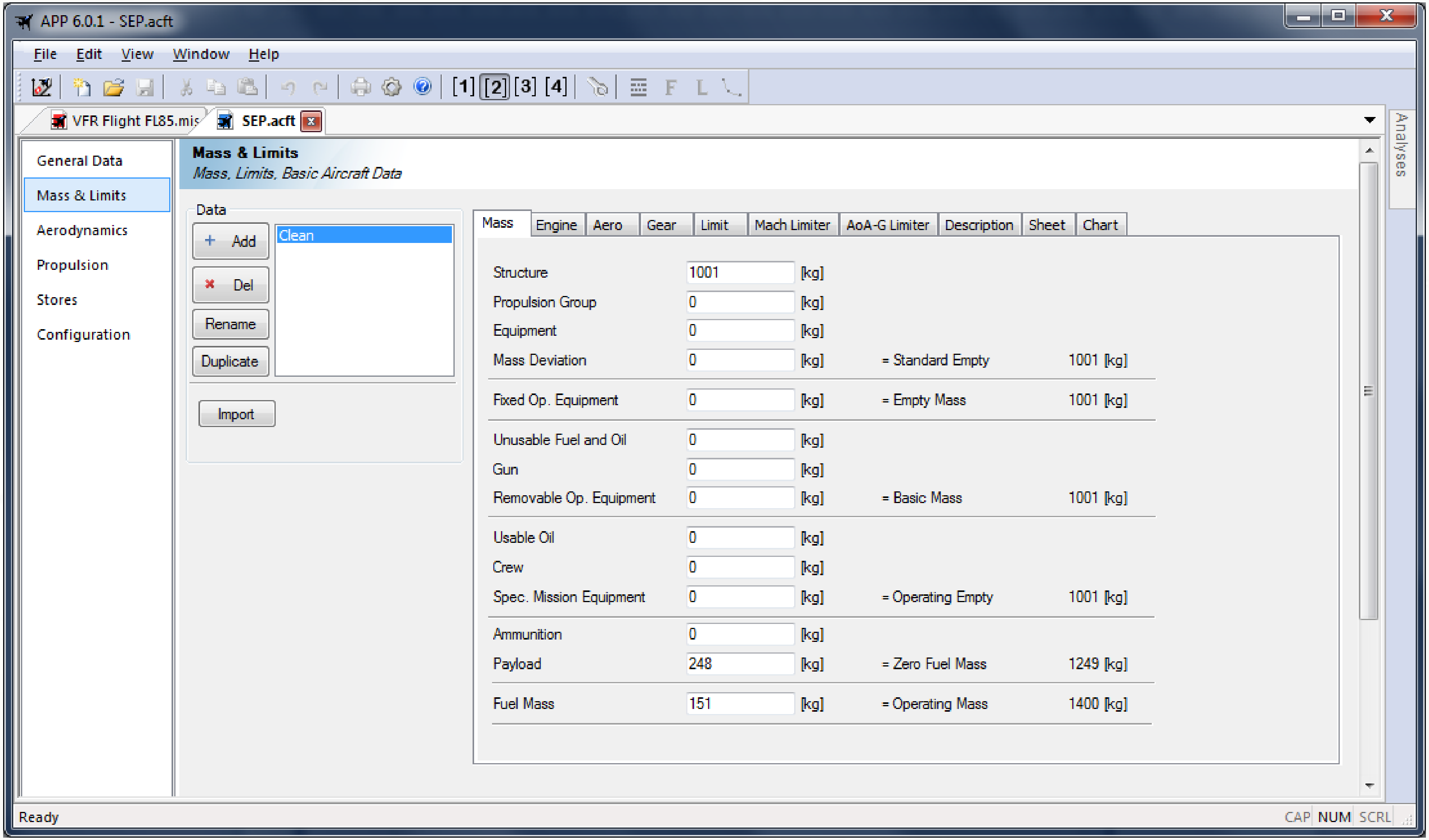
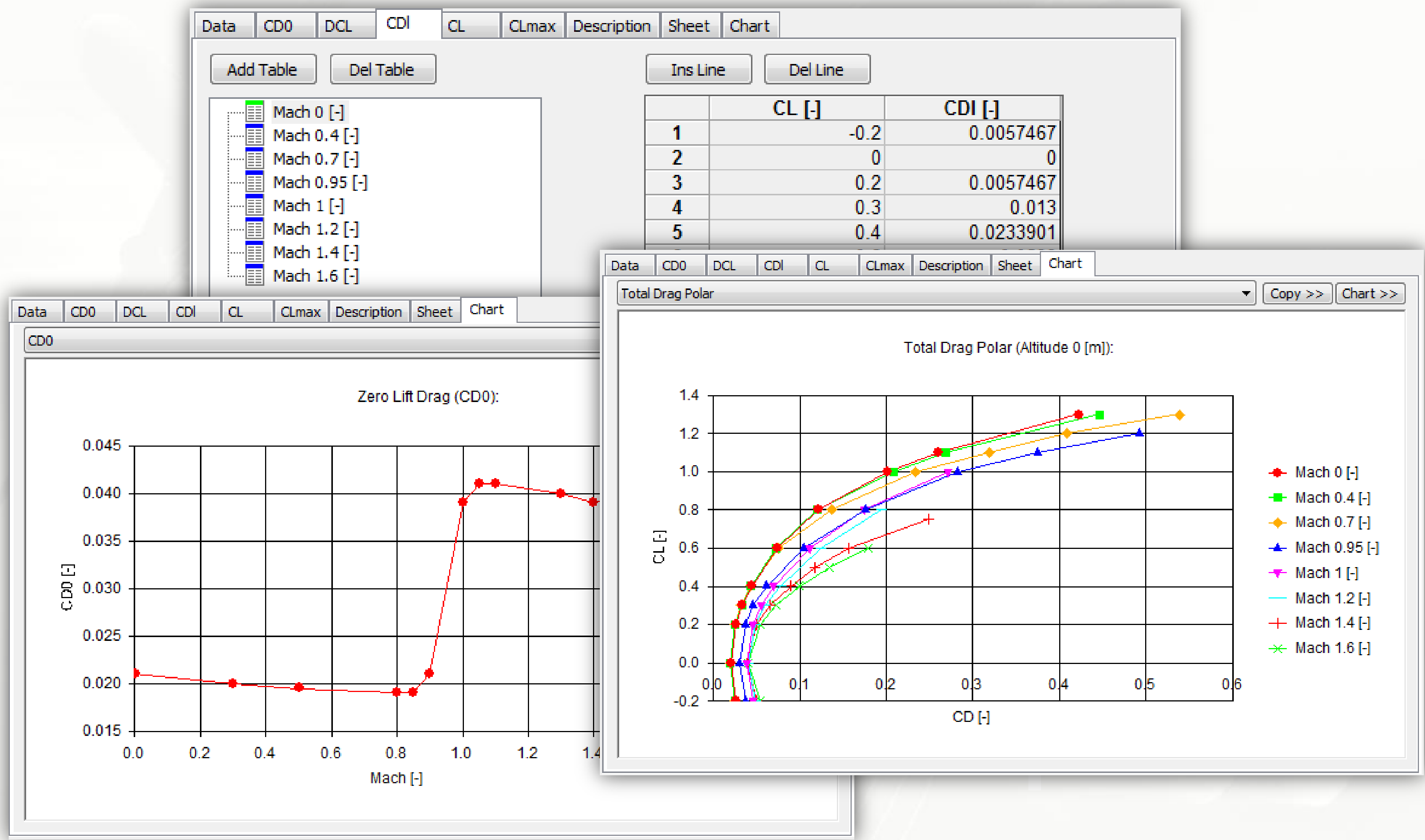
The following examples should give you an impression of the data-input interface and the level of detail possible to achieve. Shown here is the main-program window and a mass data table.



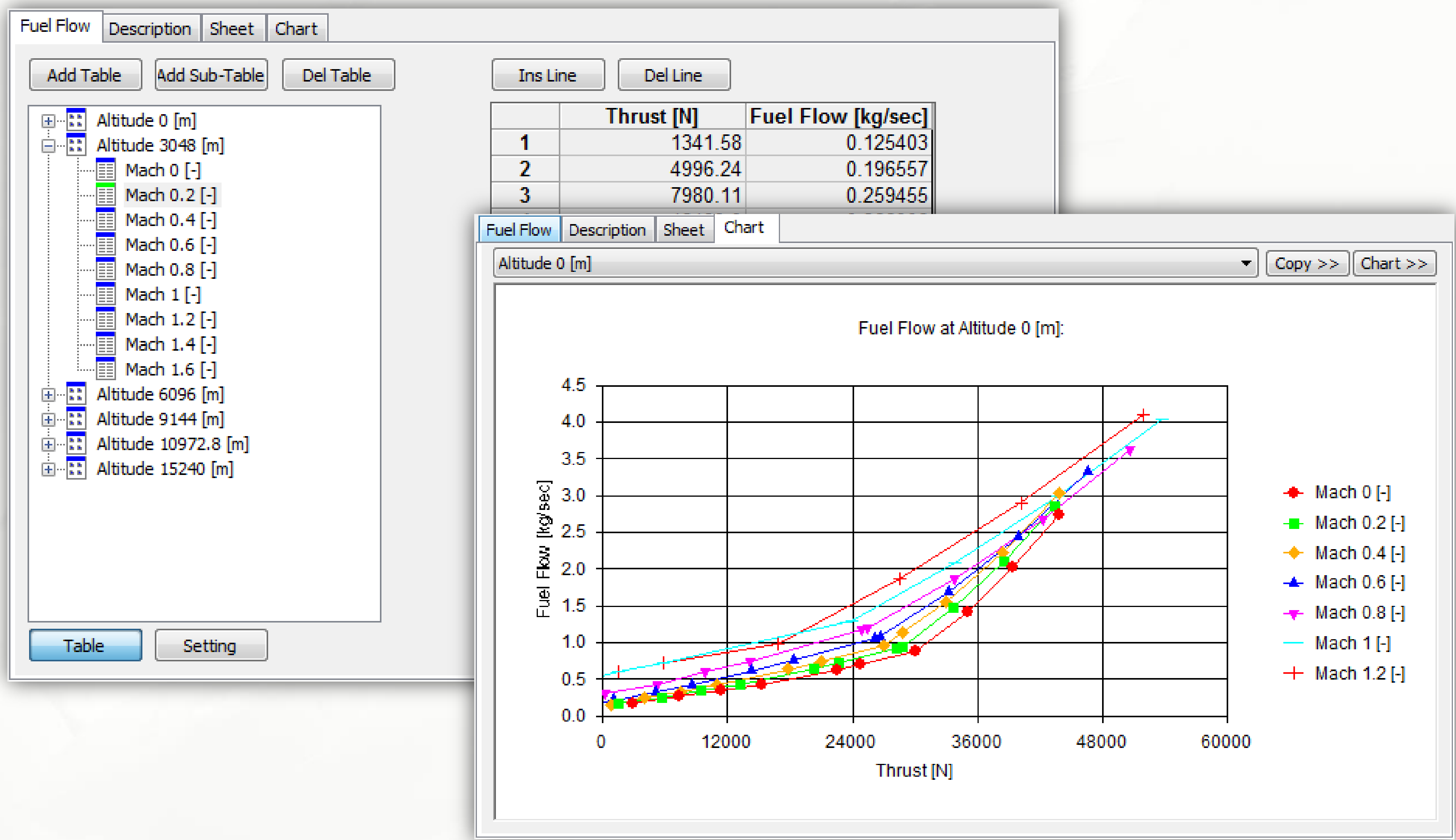
APP - Aircraft-Data

Aerodynamic data:



APP - Aircraft-Data

Fuel Flow data:



APP - Aircraft Data

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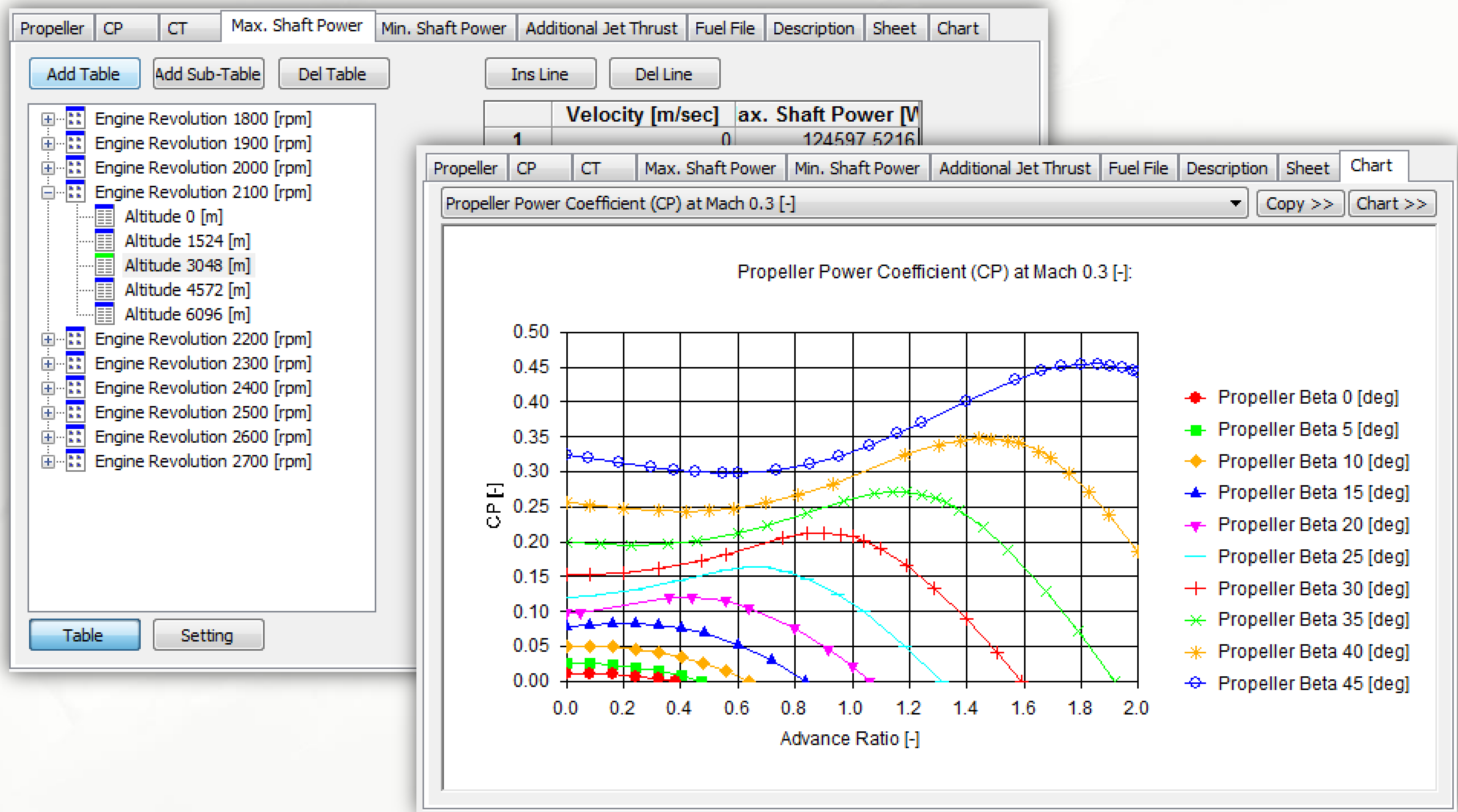
Propeller Propulsion Data:



APP - Point-Performance

The user can choose several pre-prepared standard-charts or calculate specific performance parameters:

Performance Parameters:

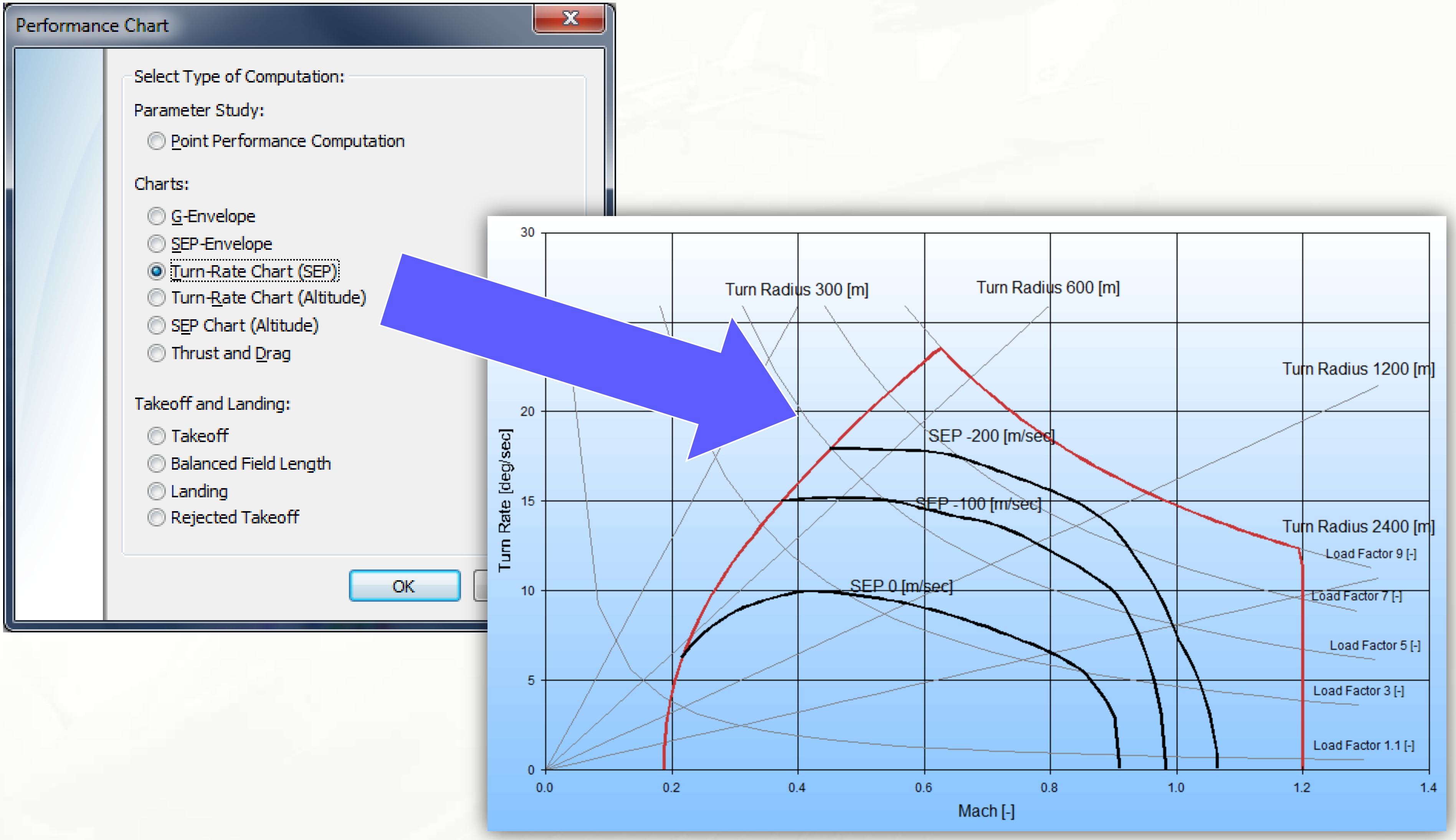
- Acceleration
- Climb (normal, best angle, best rate)
- Cruise (normal, best fuel flow, best specific range)
- Maneuver (maximum performance)
- Maximum Speed
- Stall Speed
- Specific Excess Power (SEP)
- Takeoff Acceleration

Standard Charts:

- G-Envelope
- SEP-Envelope
- Turn-Rate-Chart (const. Acc)
- Turn-Rate-Chart (const. Alt.)
- Turn-Rate-Chart (const. SEP)
- SEP-Chart (const Alt.)
- Thrust and Drag Chart

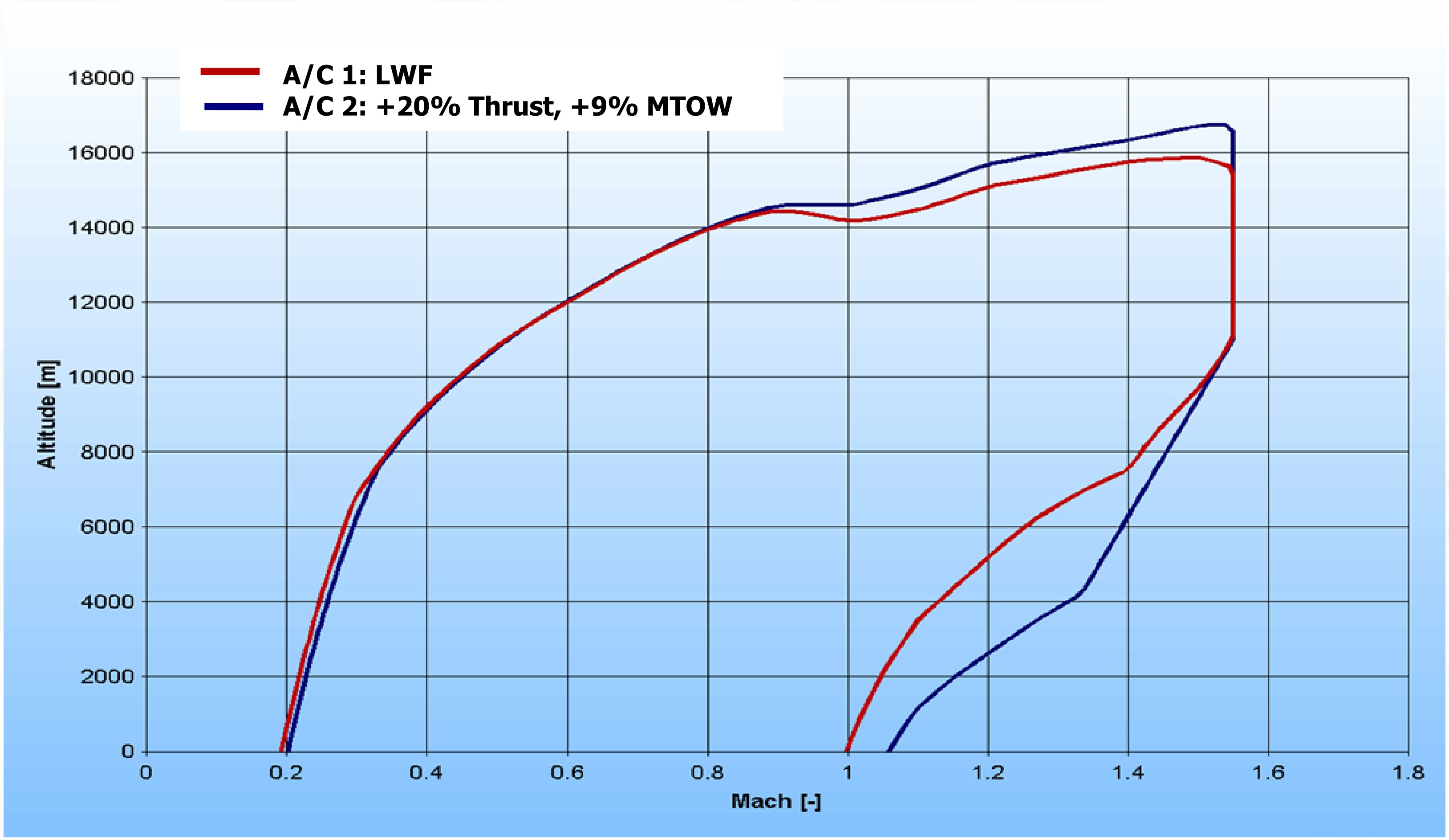
APP - Point-Performance Example

On the following pages point-performance-examples are presented, starting with a standard Turn-Rate-Chart:



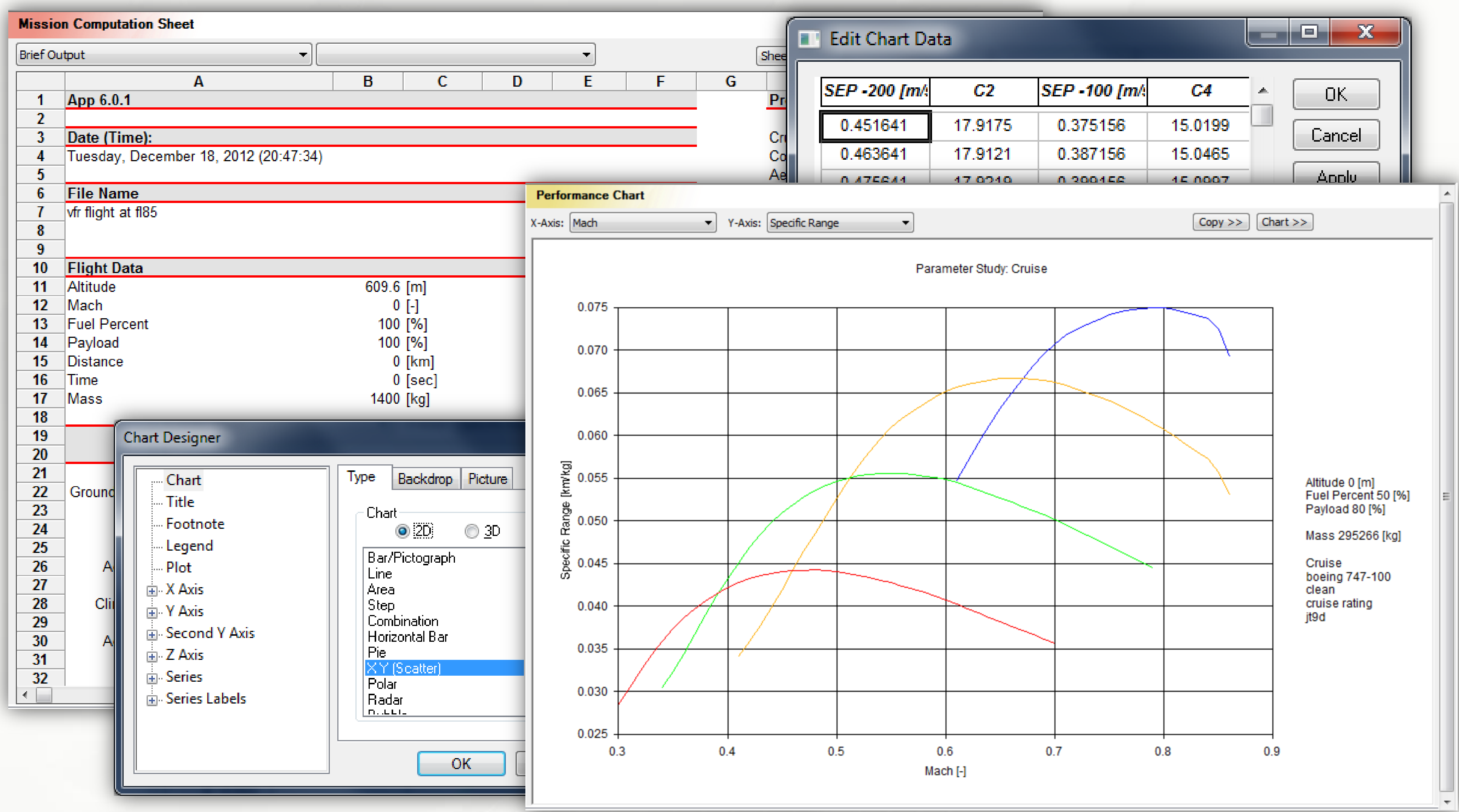
APP - Point-Performance Example

To evaluate the effects of an engine upgrade, the user just has to change the new engine-mass and specify a thrust-multiplier:



APP - Point-Performance Example

After the calculation, over 60 parameters are available to be plotted in XY-Plots or presented in tabulated form. It is possible to edit the data and to customize the plots.



APP - Mission-Computation

APP can calculate user specified missions and optimize them. Empty Fuel-Tanks can be dropped automatically. The following segments and optimizers are available:

Segments:

- Acceleration
- Climb (best angle, best rate)
- Climb (const Ma, EAS, CAS)
- Cruise (best SR, const Ma., opt. Alt)
- Descent
- Ground Operation
- Landing Roll
- Loiter (at best FF)
- Maneuver (const N_L, max N_L)
- Refuel
- Store Drop
- Take-off
- Tank Drop

Optimizers:

- Range Optimization
- Endurance Optimization
- Maximum Operating Range Optimization

APP - Mission-Computation

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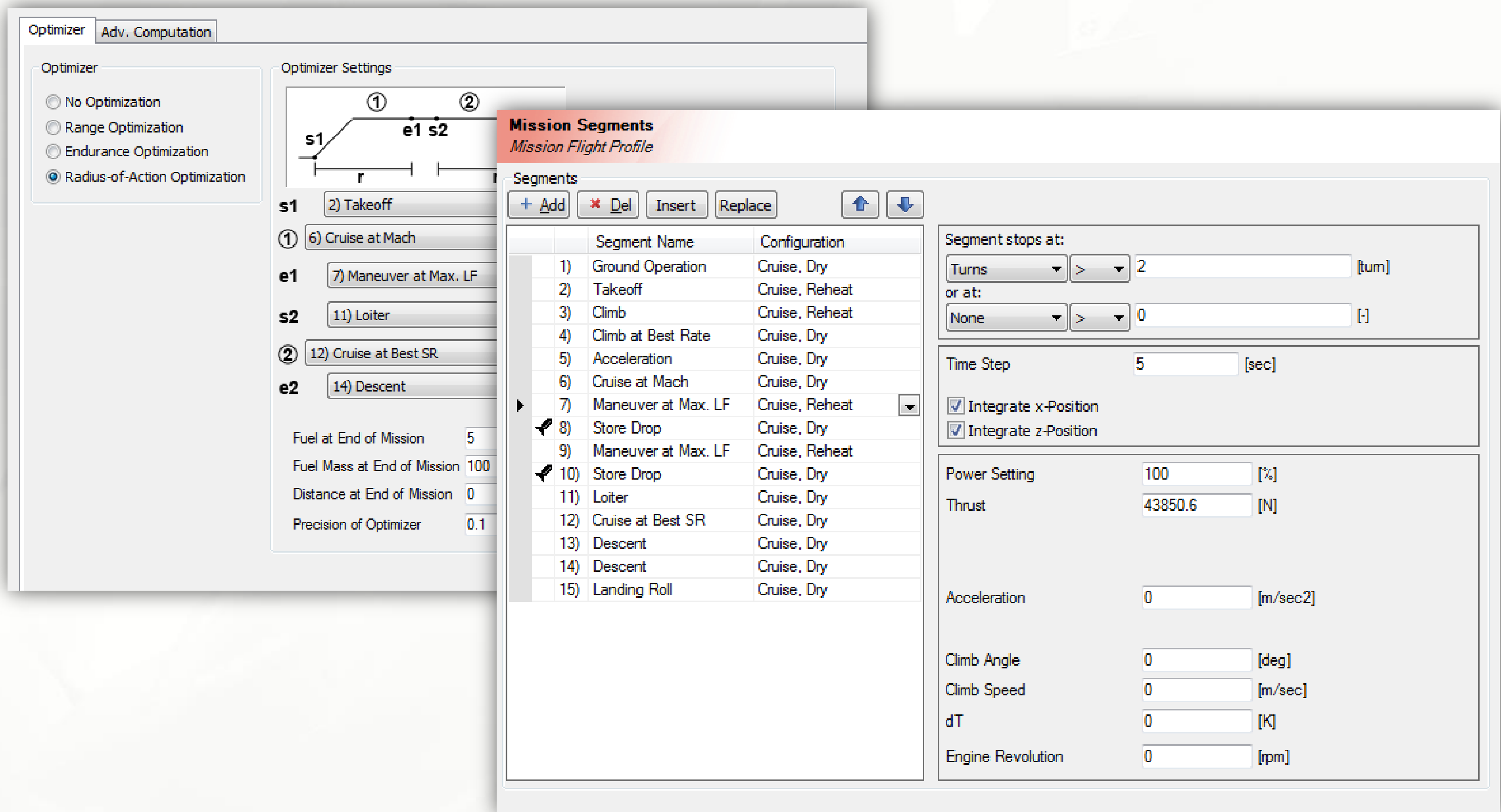
To build your mission, simply choose a segment and specify the condition at which it should end. You can also specify the segment on that should be optimized by APP if you wish to do so.



APP - Mission-Computation

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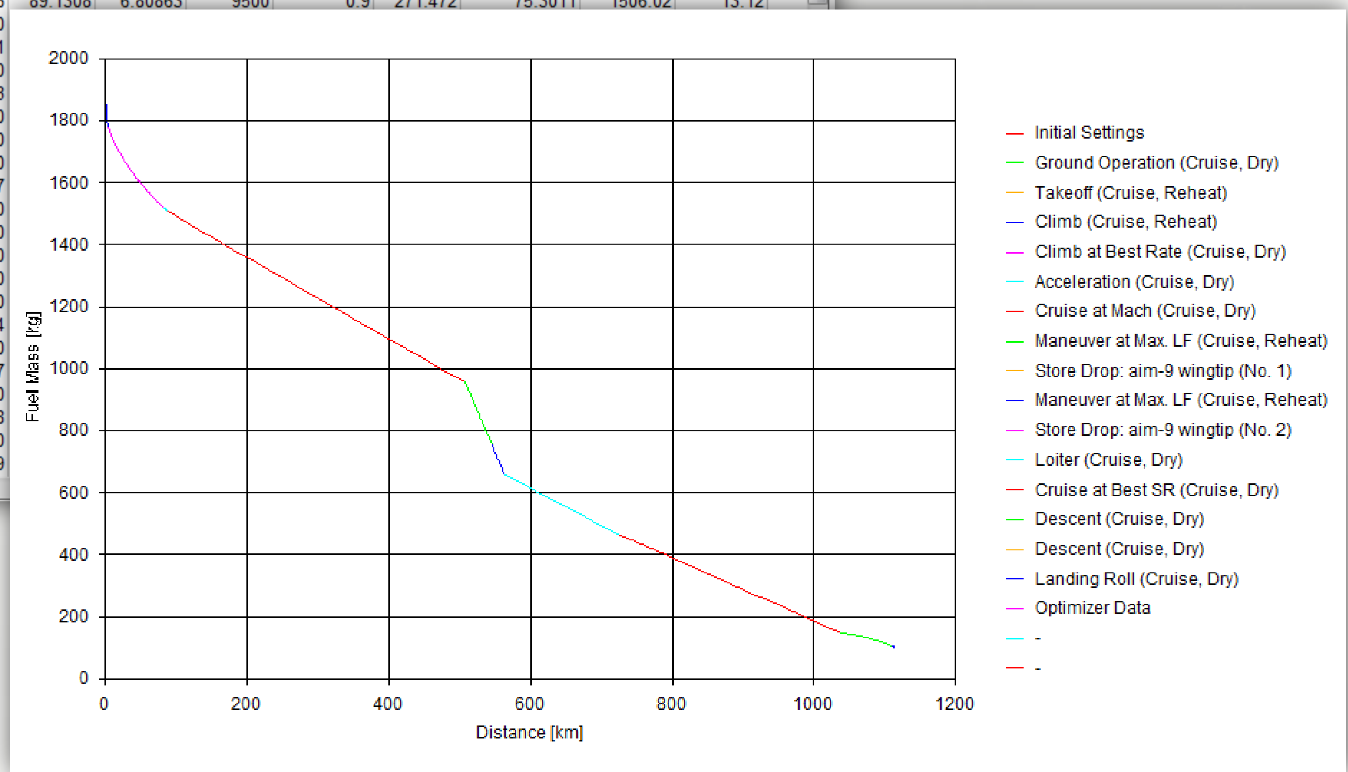
The results can reviewed in tabulated form or be plotted as XY-Plots, combining any of the over 60 parameters.

	A	B	C	D	E	F	G	H	I	J	K
31		[sec]	[min]	[km]	[km]	[m]	[-]	[m/sec]	[%]	[kg]	[kg]
32	Initial Settings	0	0	0	0	0	0	0	100	2000	0
33	Ground Operation (Cruise, Dry)	0	0	0	0	0	0	0	100	2000	0
34	Stop at Seg. Time: 10 [min]	600	10	0	0	0	0	0	94.8109	1896.22	103.782
35	Takeoff (Cruise, Reheat)	600	0	0	0	0	0	0	94.8109	1896.22	0
36	Stop at Velocity: 75.4456 [m/sec]	613.109	0.218489	0.500898	0.500898	0	0.221707	75.4456	92.9746	1859.49	36.7258
37	Climb (Cruise, Reheat)	613.109	0	0.500898	0	0	0.221707	75.4456	92.9746	1859.49	0
38	Stop at Altitude: 516 [m]	640.852	0.462382	3.94414	3.44324	516	0.516833	174.849	88.8685	1777.37	82.1216
39	Climb at Best Rate (Cruise, Dry)	640.852	0	3.94414	0	516	0.516833	174.849	88.8685	1777.37	0
40	Stop at Altitude: 9500 [m]	975.29	5.57396	82.3222	78.378	9500	0.851203	256.753	75.9571	1519.14	258.229
41	Acceleration (Cruise, Dry)	975.29	0	82.3222	0	9500	0.851203	256.753	75.9571	1519.14	0
42	Stop at Mach: 0.9 [-]	1001.04	0.429226	89.1308	6.80863	9500	0.9	271.472	75.3011	1506.02	13.12
43	Cruise at Mach (Cruise, Dry)	1001.04	0								
44	Stop at Seg. Dist.: 419.263 [km]	2545.45	25.7401								
45	Maneuver at Max. LF (Cruise, Reheat)	2545.45	0								
46	Stop at Turns: 2 [turn]	2684.72	2.32123								
47	Store Drop: aim-9 wingtip (No. 1)	2684.72	0								
48		2684.72	0								
49	Maneuver at Max. LF (Cruise, Reheat)	2684.72	0								
50	Stop at Turns: 1 [turn]	2750.67	1.09907								
51	Store Drop: aim-9 wingtip (No. 2)	2750.67	0								
52		2750.67	0								
53	Loiter (Cruise, Dry)	2750.67	0								
54	Stop at Seg. Time: 10 [min]	3350.67	10								
55	Cruise at Best SR (Cruise, Dry)	3350.67	0								
56	Stop at Seg. Dist.: 311.359 [km]	4742.33	23.1944								
57	Descent (Cruise, Dry)	4742.33	0								
58	Stop at Altitude: 516 [m]	5108.55	6.10367								
59	Descent (Cruise, Dry)	5108.55	0								
60	Stop at Altitude: 500 [m]	5109.56	0.0168358								
61	Landing Roll (Cruise, Dry)	5109.56	0								
62	Stop at Velocity: 1 [m/sec]	5151.99	0.707159								



APP - Mission Example

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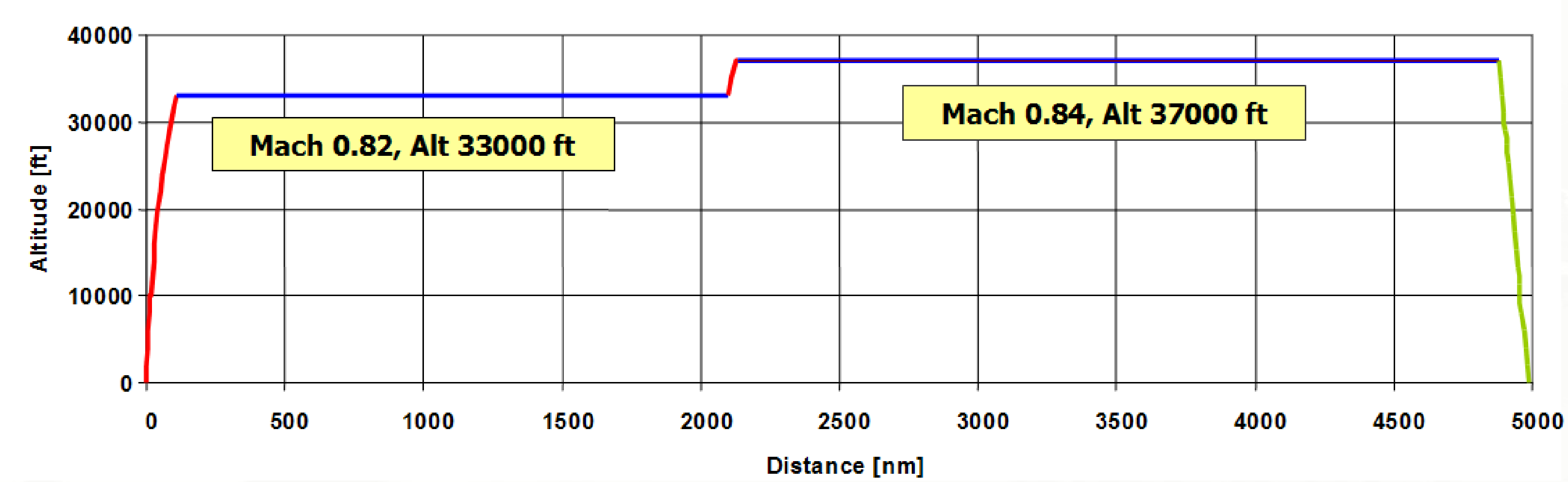
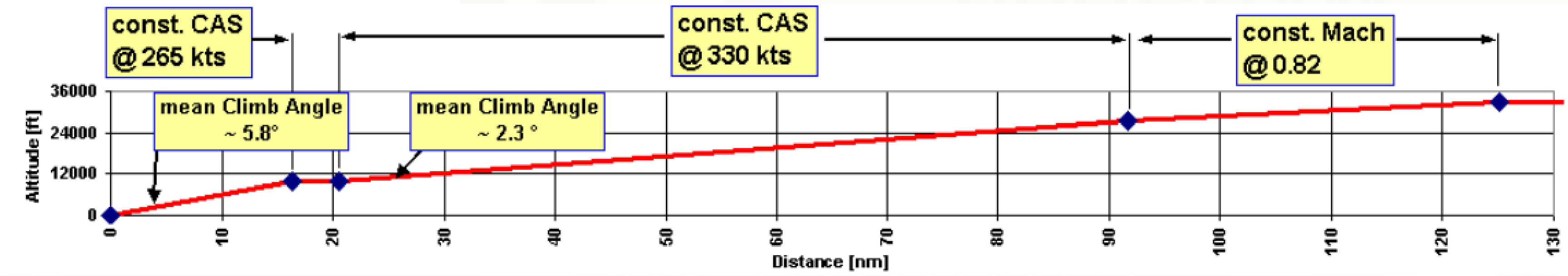
The modular approach to define a mission enables you to easily setup complex (realistic) climb schedules:



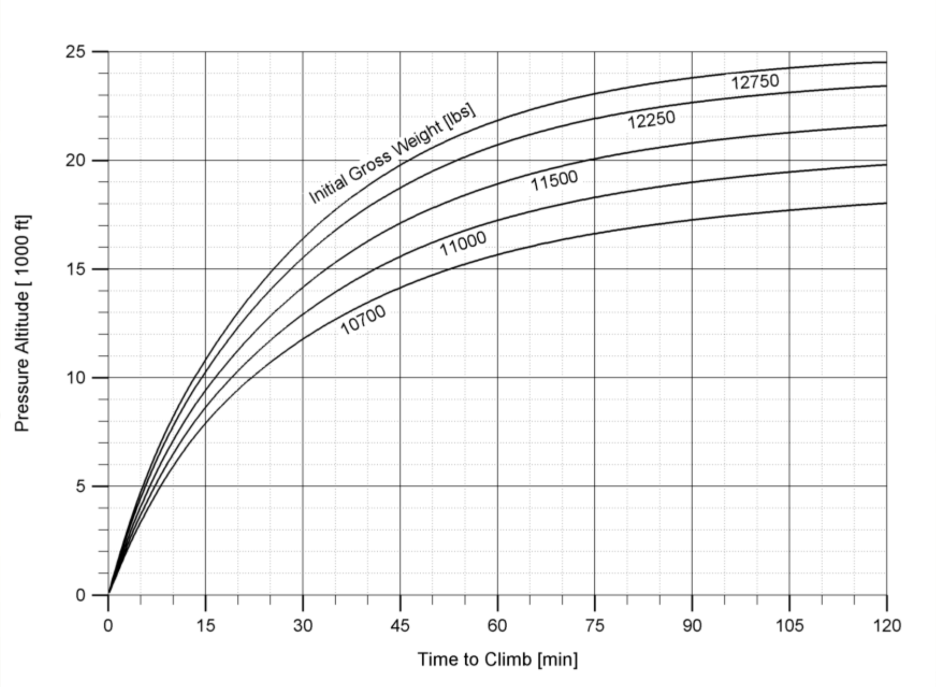
Detailed view of climb schedule**:**



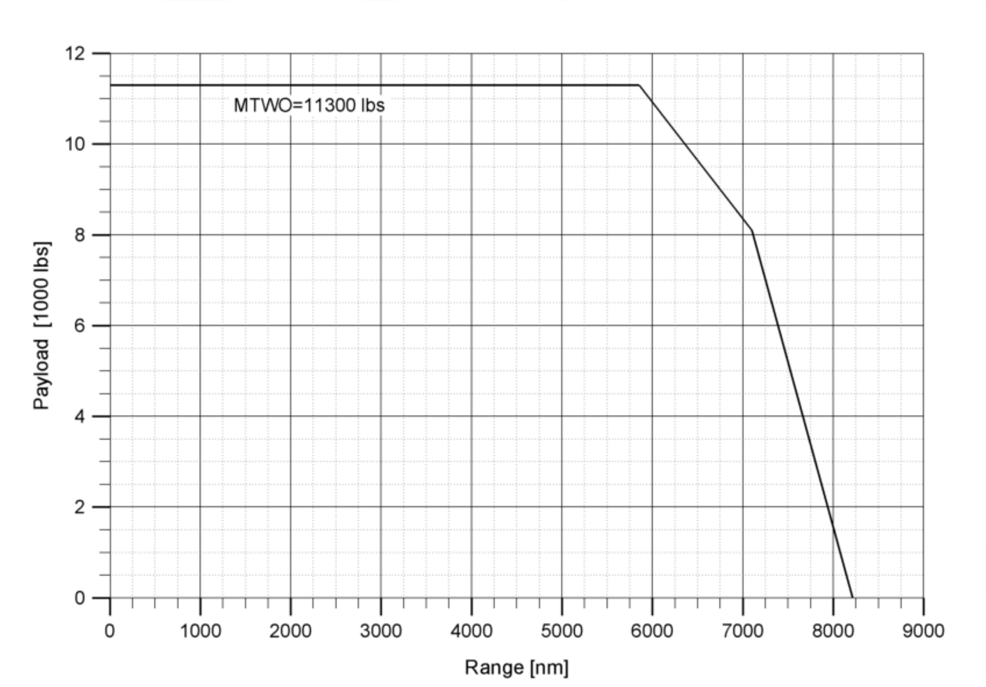
APP - Mission Example

Due to the wide variety of charts and plots used in manuals, handbooks and so on, its not possible to have a template for all of them in APP. However, APP can significantly reduce the time required to generate such charts. The following two charts were produced by defining a mission-segment once, calculate it several times varying one parameter (payload, target altitude) and combine the results in one chart:

Time-To-Climb-Chart



Range-Payload-Diagram



APP - Take off & Landing Computation

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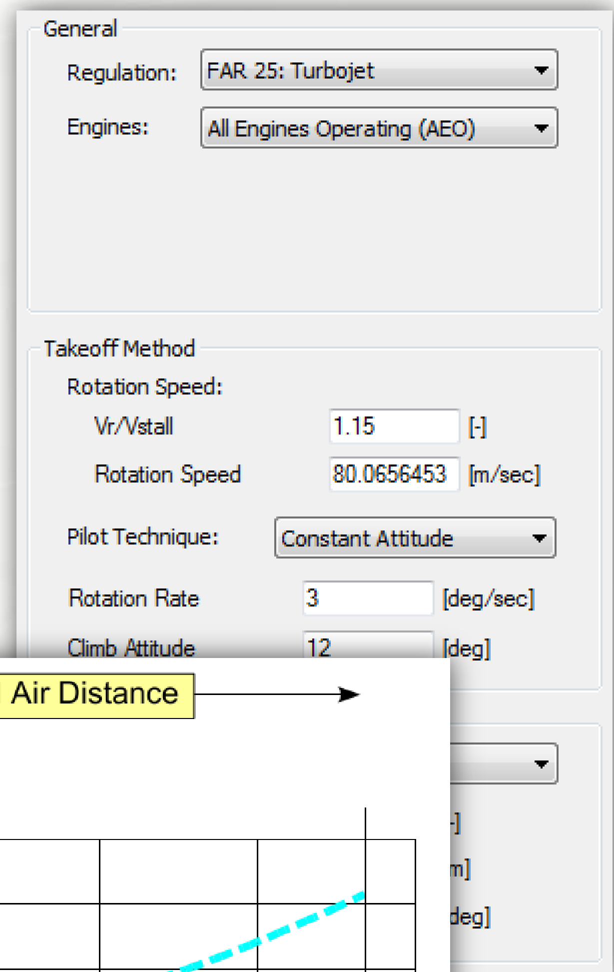
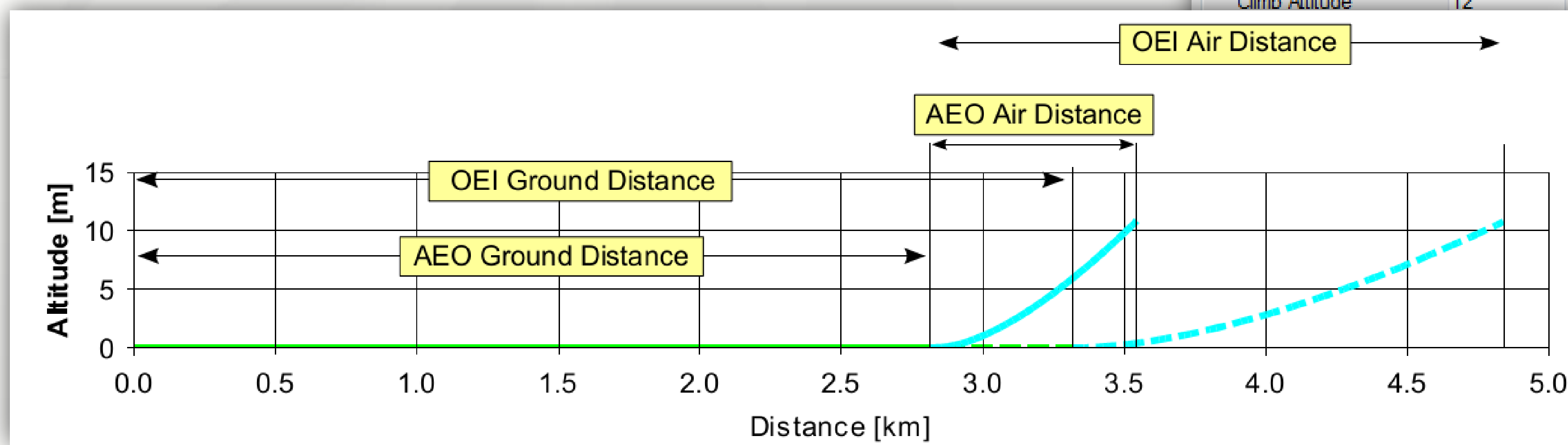
APP incorporates a unique 2.5-dimensional method to obtain takeoff- and landing- distances with respect to different certifications and environmental conditions.

- 4 Types of calculations:
  Takeoff, Rejected Takeoff, Balanced Field Length, Landing
- Regulation conform calculations respecting military and civil airworthiness:
  MIL-STD-3013, FAR Part 23 & 25, EASA CS 23 & 25
- All Engines Operative (AEO) and One Engine Inoperative (OEI) calculations
- Respecting runway dimensions as:
  Runway Length, Runway Altitude, Runway Slope
- Different runway conditions are available:
  Dry, Wet, Snow, Ice
- Calculations possible with or without afterburner

APP - Takeoff

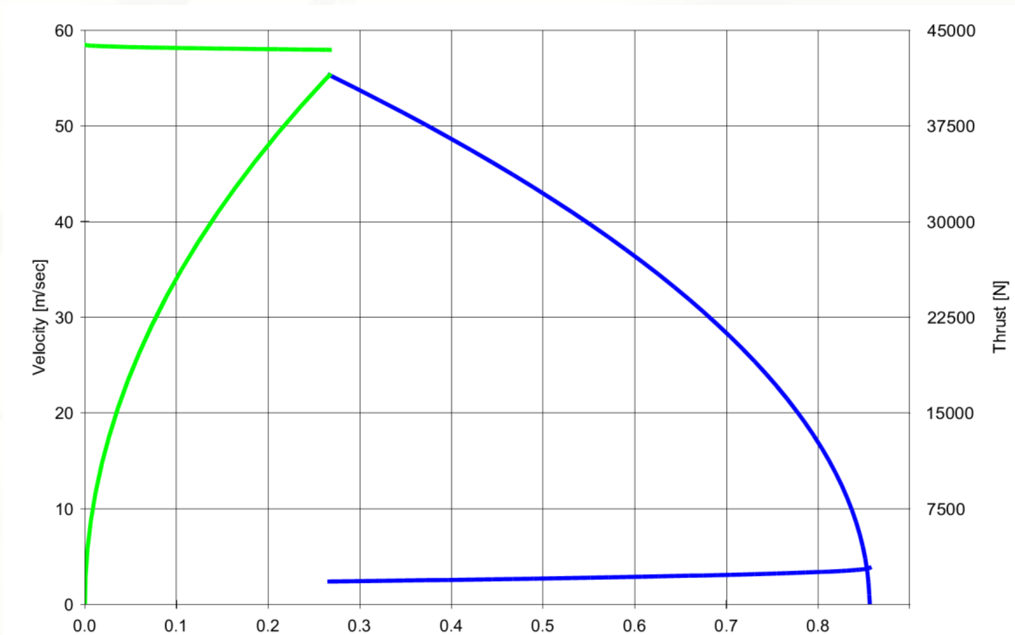
- 2 Pilot techniques are available
- Calculate the ground run distance and the air distance
- Calculate regulated takeoff distance
- Tailstrike angle will be respected
- Takeoff time determination

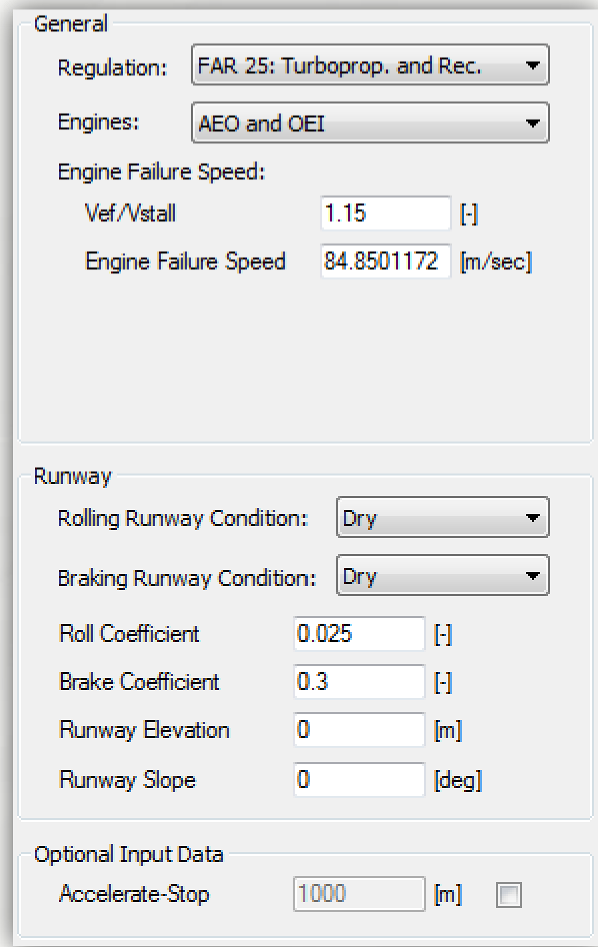




APP - Rejected Takeoff

- Pilot reaction time will be respected
- Time needed to apply brakes and retract throttles is respected
- Determine refusal speed from an engine failure speed





APP - Balanced Field Length

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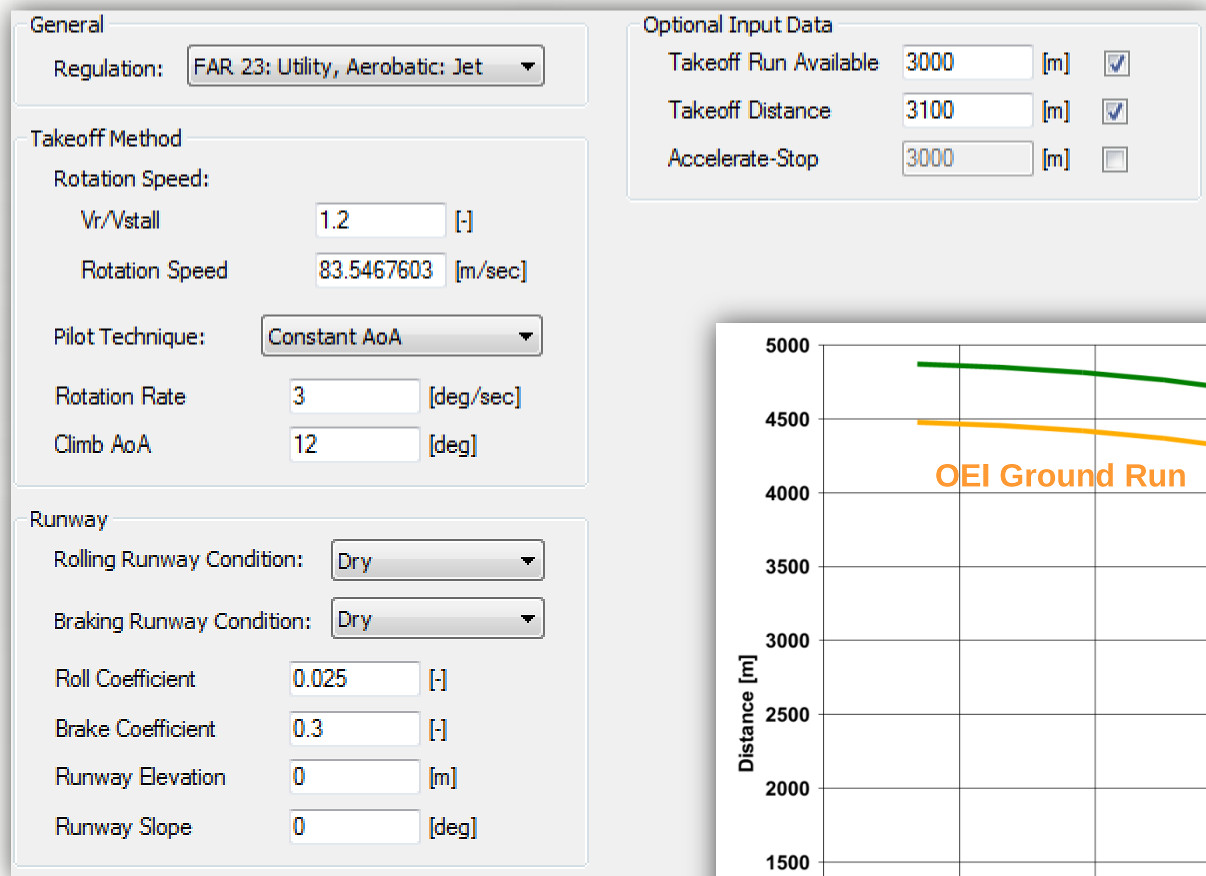
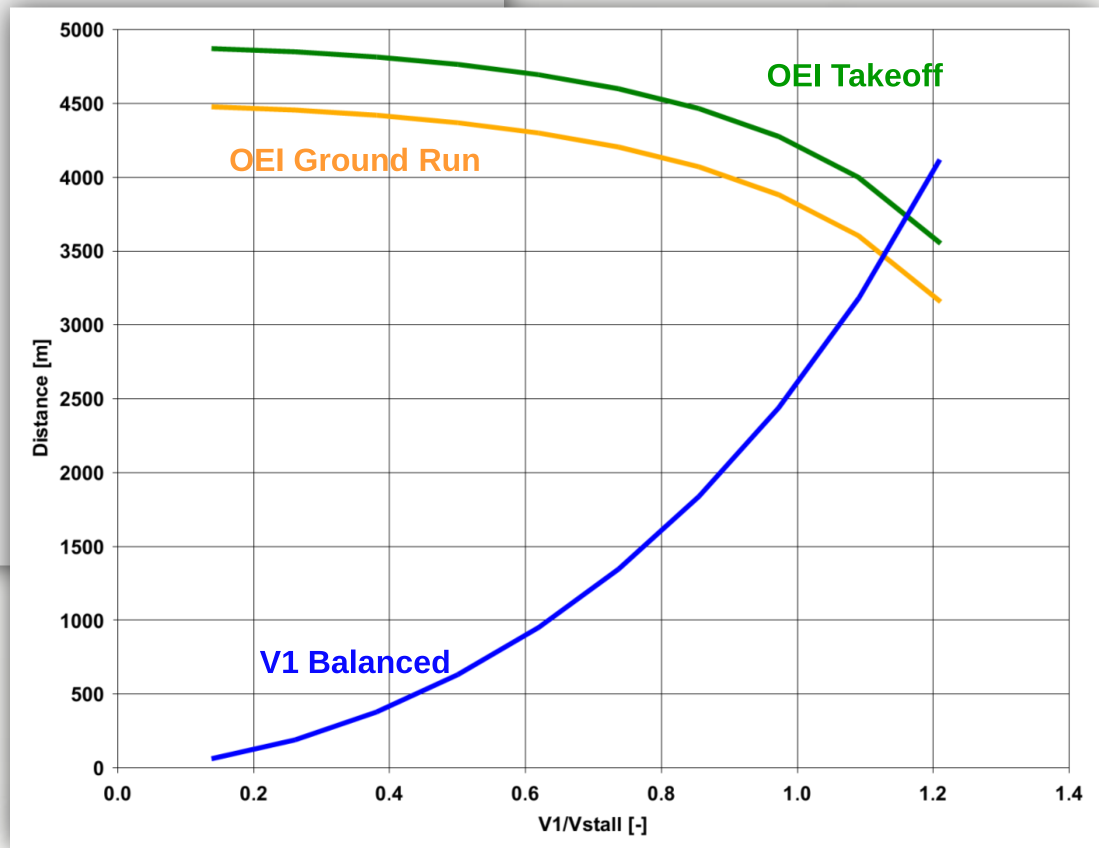
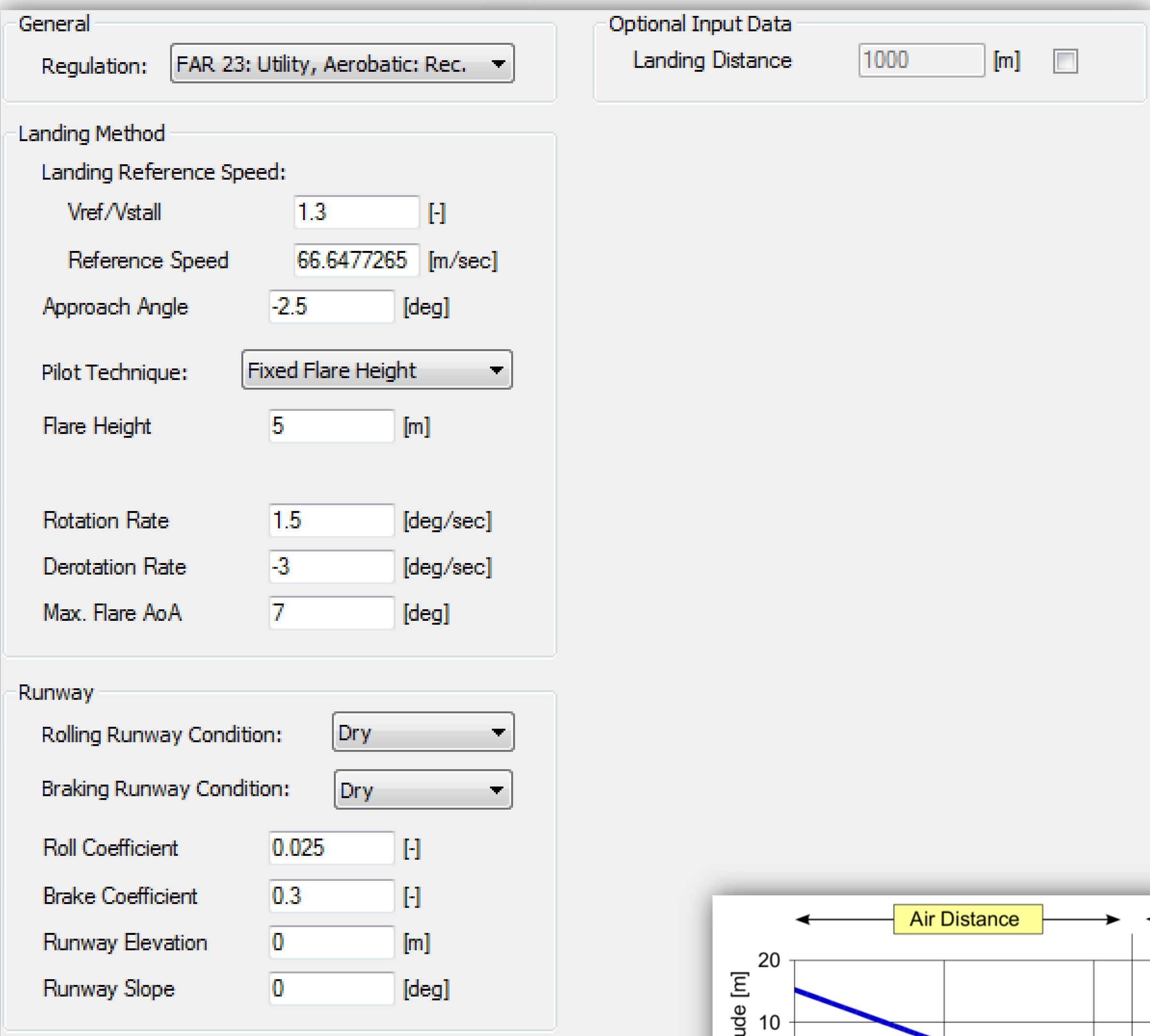




- Graphical V1 Balanced Calculation
- Determine Shortes Possible Runway length

APP - Landing



- Determine a landing path from a given sink rate at touchdown
- Determine the needed landing distance
- Define pilot technique and corresponding details
- Define environmental conditions
- Check for runway constraints