



Runway Exit Design Tool (version 3.0.0): Quick User Guide

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Acknowledgments

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 - Charlotte-Douglas International Airport (Jack Christine)
 - Metropolitan Washington Airports Authority (Jennifer Dermody)



Runway Exit Design Model Installation Instructions





Installation Instructions (1)

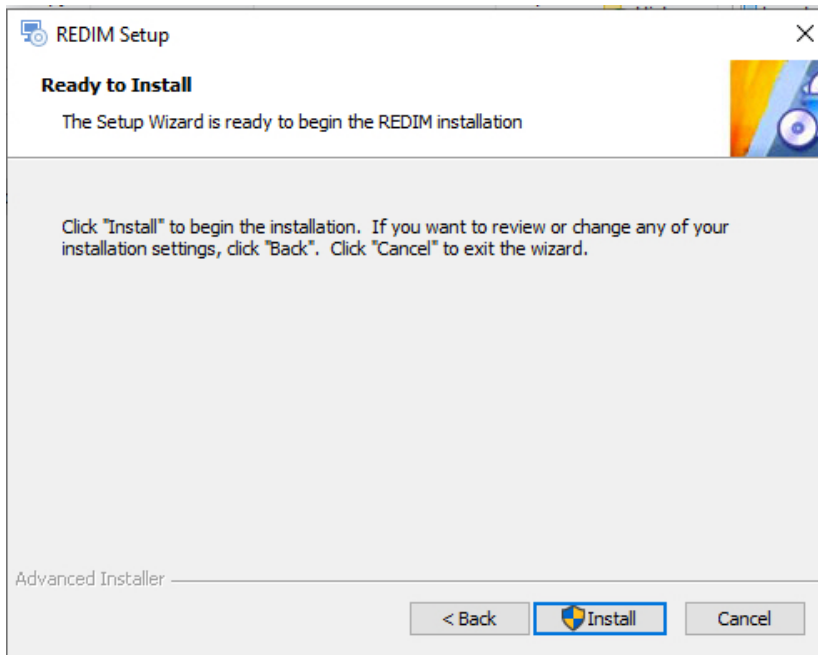
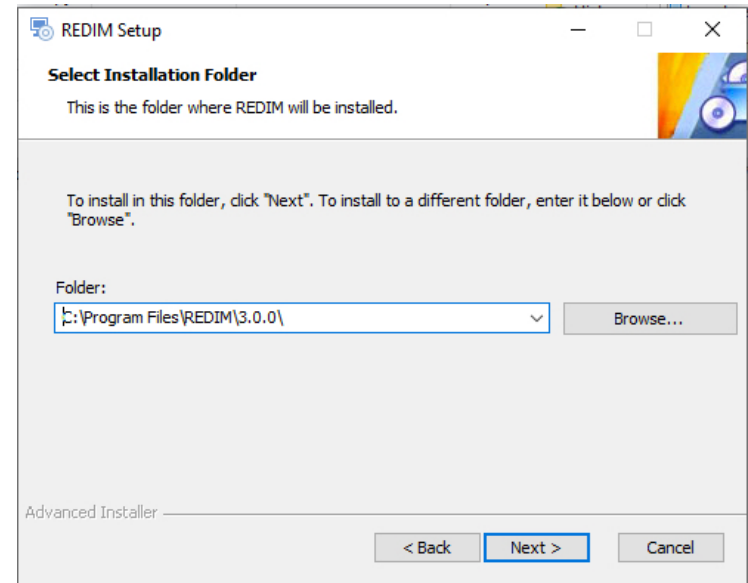
- Step 1: Download the Runway Exit Design setup file from:
<https://atsl-software-downloads.s3.amazonaws.com/redim/V3.0.0/redim.exe>
- Step 2: Run the program setup





Installation Instructions (2)

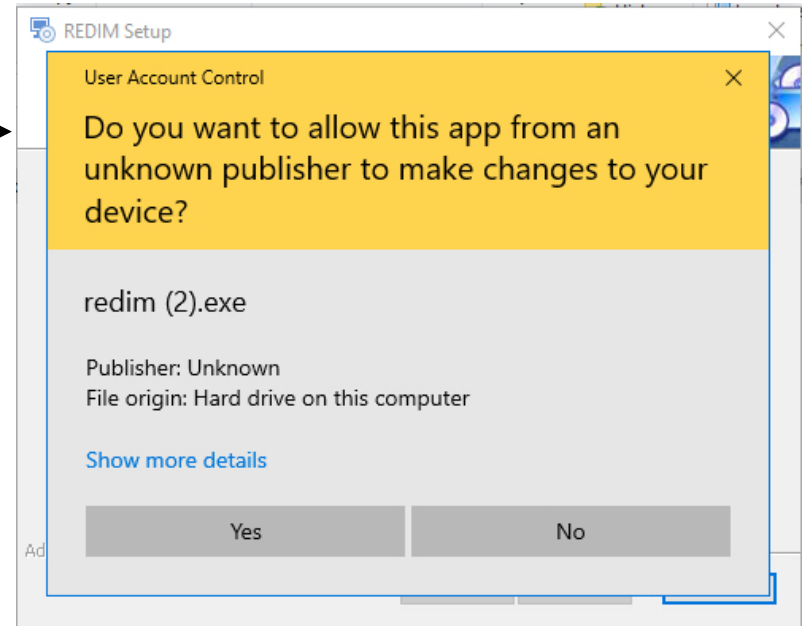
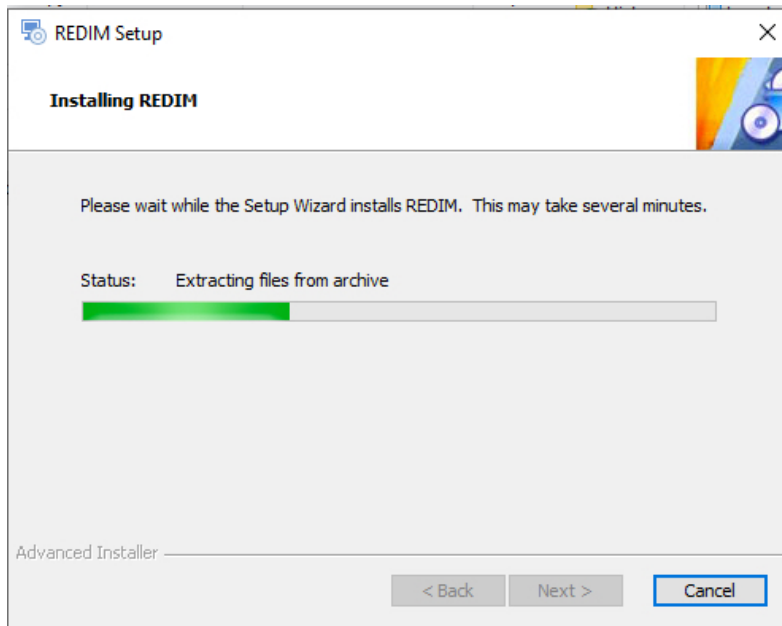
- Step 3: Select installation folder:
- Step 4: Proceed with the installation





Installation Instructions (3)

- Warning message
- Installation bar

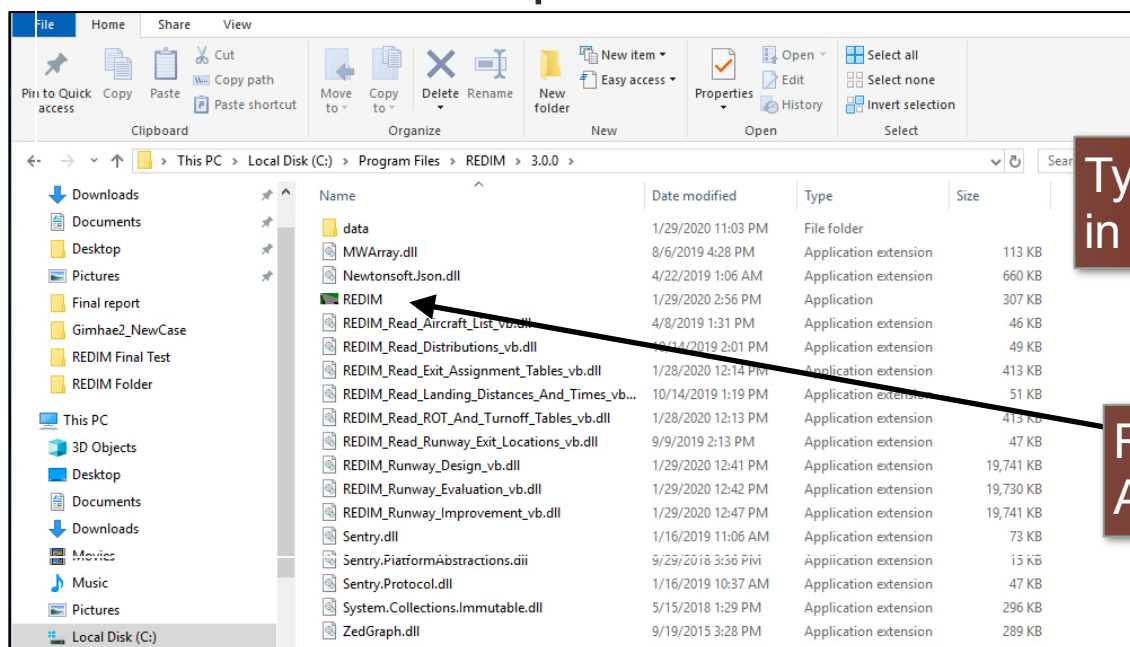


Installation Instructions (4)

Completing installation message



Installation completed



Typical files installed
in your computer

Runway Exit Design Model
Application



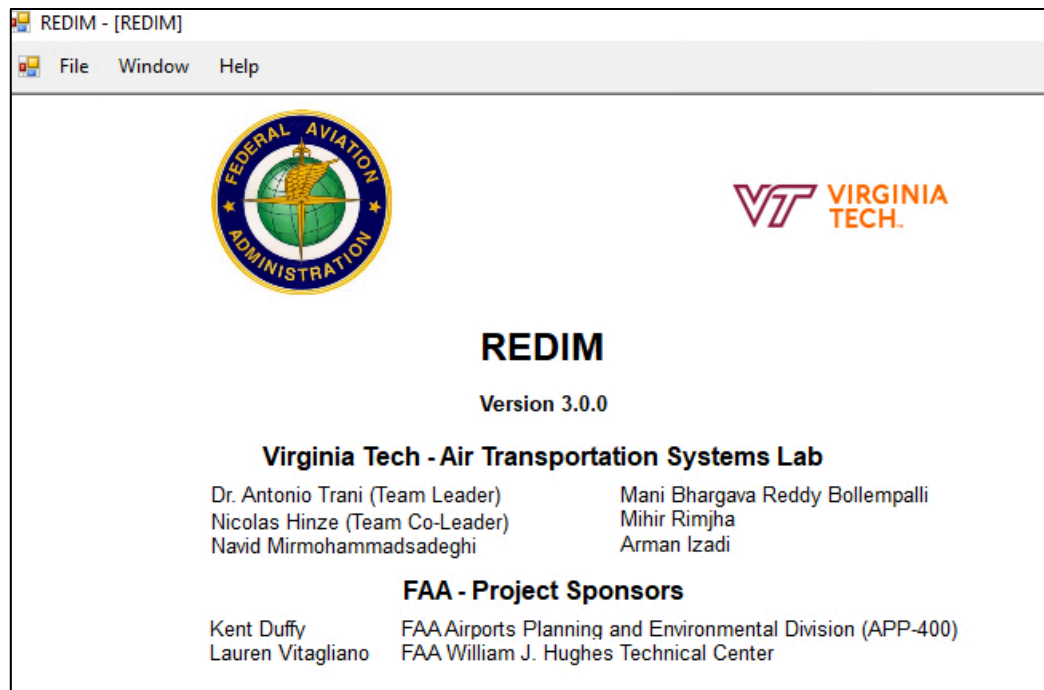
Using the Runway Exit Design Model





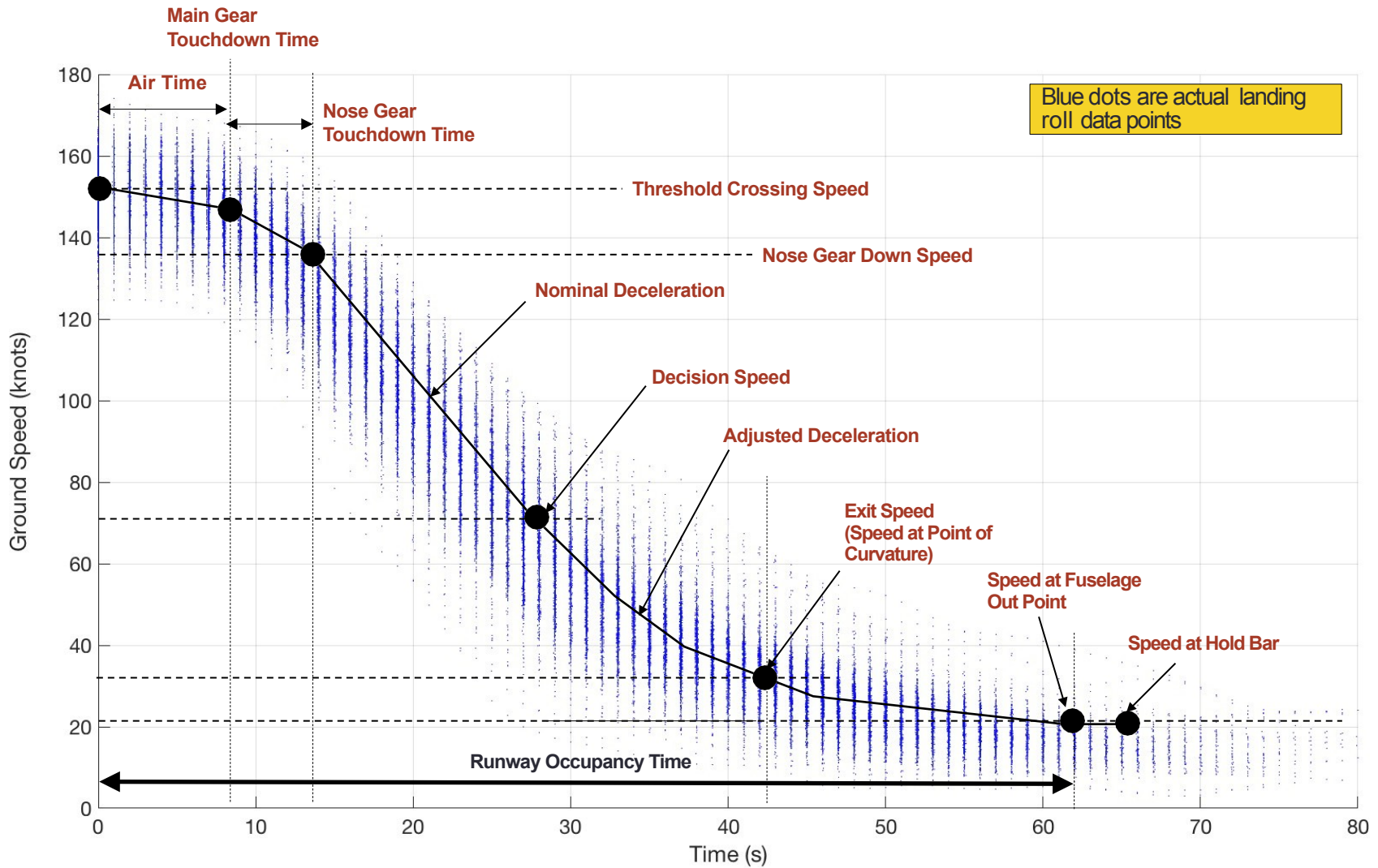
General Information About the Model

- Exit Design Model has three analysis modules:
 - a) Evaluation of an existing runway**
 - b) Improvements to an existing runway**
 - c) Design optimal locations for a new runway**





Runway Exit Model Landing Roll Profile Phases Modeled





REDIM 3 Menu Structure

REDIM - REDIM Final Test - [Aircraft Data]

File Aircraft Database Window

- Restore
- Move
- Size
- Minimize
- Maximize
- Close Ctrl+F4
- Next Ctrl+F6

REDIM - REDIM Final Test - [Aircraft Data]

File Aircraft Database Window

- New Project...
- Open Project...
- Close Project
- Exit

REDIM - REDIM Final Test - [Aircraft Data]

File Aircraft Database Window

- Show Database
- Edit Database

REDIM - REDIM Final Test - [Evaluate an Existing Runway - Total Distance for MD80 (7200FTRun) - Table]

File Aircraft Database Window Help

- Design a New Runway
- Improve an Existing Runway
- Evaluate an Existing Runway
 - Create New Folder...
 - Evaluate_test1
 - TestMD80_7200ft
 - Delete Folder
 - 7200FTRun
 - Runway Settings
 - Runway Exit Locations
 - Runway Occupancy Times

1 Aircraft Database

2 Evaluate an Existing Runway - Runway Occupancy Times (39.4 s - Std Dev: 8.4)

3 Evaluate an Existing Runway - Runway Exit Aircraft Assignment (7200FTRun) - Table

4 Evaluate an Existing Runway - Total Distance for MD80 (7200FTRun) - Table

(ft)	PDF Alt (%)	PDF Dry (%)	(%)
3,234	10.2	10.7	5.4
3,259	0.0	0.0	0.0
3,284	0.0	0.0	0.0
3,309	0.0	0.0	0.0
3,334	0.0	0.0	0.0

REDIM - FAA AC Runs - [Evaluate an Existing Runway - Runway Occupancy Times (34.7 s - Std Dev: 6.6 s) (4000ftRunway_AAC_A_RA_exits) - Table]

File Aircraft Database Window Help

- Design a New Runway
- Improve an Existing Runway
- Evaluate an Existing Runway
 - Create New Folder...
 - AAC A Runs
 - Start Evaluation...
 - Delete Folder
 - 4000ftRunway_AAC_A_30deg
 - 4000ftRunway_AAC_A_RA_exits
 - Runway Settings
 - Runway Exit Locations
 - Runway Occupancy Times
 - Tables
 - Plots
 - Runway Exit Aircraft Assignment
 - Landing Components Distributions
 - Landing Distances and Times
 - Edit Runway
 - Delete Runway
 - 4000ft_Runway_AAC_A_USMix_RA
 - 4000ft_Run_AAC_A_USMix_30deg
 - 3000ftRunway_AAC_A_RA_exits
 - 3000ft_Run_AAC_A_USMix_30deg
 - AAC C Runs

Show: Times To PC Turnoff Times Runway Occupancy Times

Runway Occupancy Times

(4000ftRunway_AAC_A_RA_exits)

Aircraft Name	e1	e2	e3	e4	e5	e6	e7	e8	e9	e10
BE33	15.1s	17.2s	20.1s	23.0s	25.6s	28.0s	30.5s	33.1s	35.6s	
BE35		17.3s	20.5s	23.0s	25.7s	28.1s	30.5s	33.3s	35.8s	
BE36	16.7s	18.6s	21.4s	24.0s	26.4s	28.9s	31.5s	33.9s	36.4s	
BE55				18.4s	22.8s	24.0s	26.4s	28.2s	30.0s	
C152			21.3s	25.2s	28.5s	31.8s	35.0s	38.5s	42.0s	
C172			21.6s	25.2s	28.6s	31.8s	35.1s	38.5s	42.1s	
C177		19.9s	22.2s	24.9s	27.6s	30.2s	32.7s	35.3s	37.9s	
C182		19.2s	22.2s	24.7s	27.5s	30.1s	32.7s	35.3s	38.0s	
C206		18.3s	21.9s	24.7s	27.4s	30.0s	32.5s	35.1s	37.7s	
C208	16.3s	19.9s	22.2s	25.1s	27.7s	30.2s	32.8s	35.3s	38.2s	
C210		19.4s	21.9s	24.7s	27.5s	29.9s	32.5s	35.1s	37.8s	
COL4		18.2s	20.9s	23.8s	26.1s	28.7s	31.2s	33.6s	35.9s	
DA40		19.5s	21.9s	24.6s	27.2s	29.8s	32.3s	34.9s	37.7s	
M20P		18.7s	21.8s	24.3s	26.9s	29.5s	31.9s	34.5s	37.3s	
P28A		18.3s	21.2s	24.0s	26.6s	29.1s	31.6s	34.2s	36.9s	
P32R		19.6s	22.2s	24.8s	27.4s	30.0s	32.3s	35.1s	37.7s	
TBM7		20.7s	22.1s	24.3s	26.2s	28.5s	30.4s	32.6s	35.1s	



REDIM 3 Aircraft Database

- The model contains data for 298 aircraft
 - 134 turbofan aircraft
 - 105 piston aircraft
 - 59 turboprop aircraft

REDIM - FAA AC Runs - [Aircraft Database]

File Aircraft Database Window Help

Design a New Runway
Improve an Existing Runway
Evaluate an Existing Runway
Create New Folder...
AAC A Runs
AAC C Runs
AAC D Runs 9000ft
AAC_B_Runs
Individual_Acft_Runs

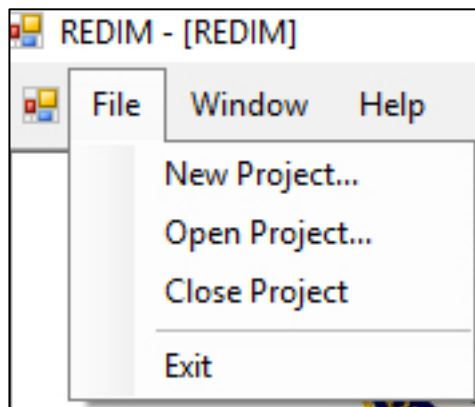
Aircraft Design Group (ADG): I

ADG I Aircraft

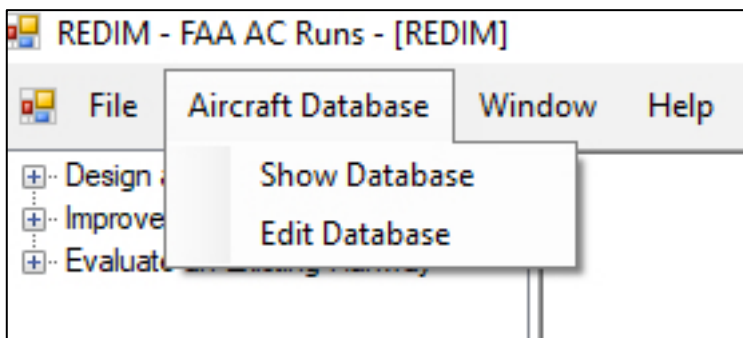
Aircraft ID	Aircraft Name	Engine Type	Aircraft Design Group	Aircraft Approach Category	Nose Gear to Main Gear (m)	Nose Gear to Tail (m)	Wing Tip Radius (m)	Full Length (m)
AA1	Grumman American AA1	Piston	I	A	1.48	5.14	3.78	5.87
AA5	Grumman American AA5	Piston	I	A	1.66	5.65	4.92	6.71
AC11	Rockwell Commander 112	Piston	I	A	2.15	6.65	5	7.63
AC50	Aero Commander 500	Piston	I	A	4.27	10.95	7.49	11.2
AC90	Turbo Commander 690	Turboprop	I	B	5.1	12.89	7.16	13.5
AEST	Piper Aerostar	Piston	I	B	3.43	8.91	5.2	10.6
B36T	Beechcraft Bonanza 36	Piston	I	A	3.19	6.99	5.89	8.5
BE10	Beechcraft B100 King Air	Turboprop	I	B	4.43	11.67	7.02	12.2
BE23	Beechcraft 23 Musketeer	Piston	I	A	1.89	7.12	5.02	8.2
BE24	Beechcraft 24 Sierra	Piston	I	A	1.96	6.85	5.04	7.9
BE33	Beechcraft F33 Bonanza	Piston	I	A	2.24	7.19	5.17	7.7
BE35	Beechcraft V35 Bonanza	Piston	I	A	2.2	7.87	5.76	8.6
BE36	Beechcraft 36 Bonanza	Piston	I	A	2.47	7.63	5.18	8.1
BE40	Beechcraft 400 Hawker	Jet	I	B	5.88	13.39	6.86	14.8
BE50	Beechcraft 50 Twin Bonanza	Piston	I	A	1.14	8.18	7.1	9.6
BE55	Beechcraft 55 Baron	Piston	I	B	2.2	7.87	5.76	8.6



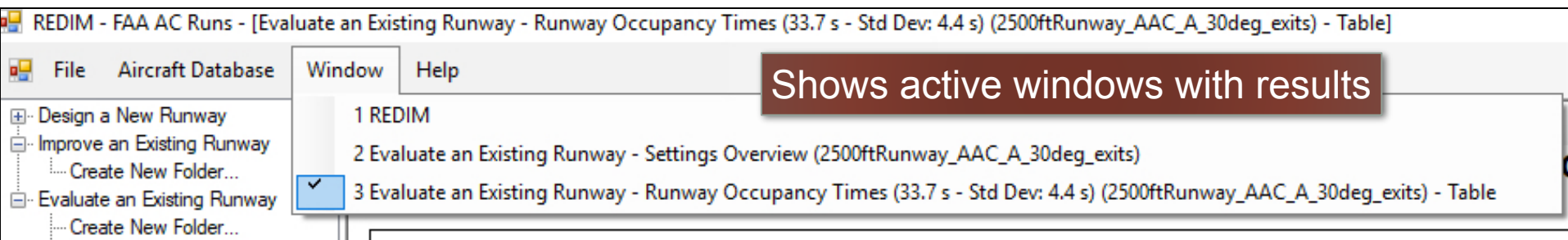
Pull-down Menus in the Runway Exit Design Model



Creates new projects
Opens existing projects
Closes a project



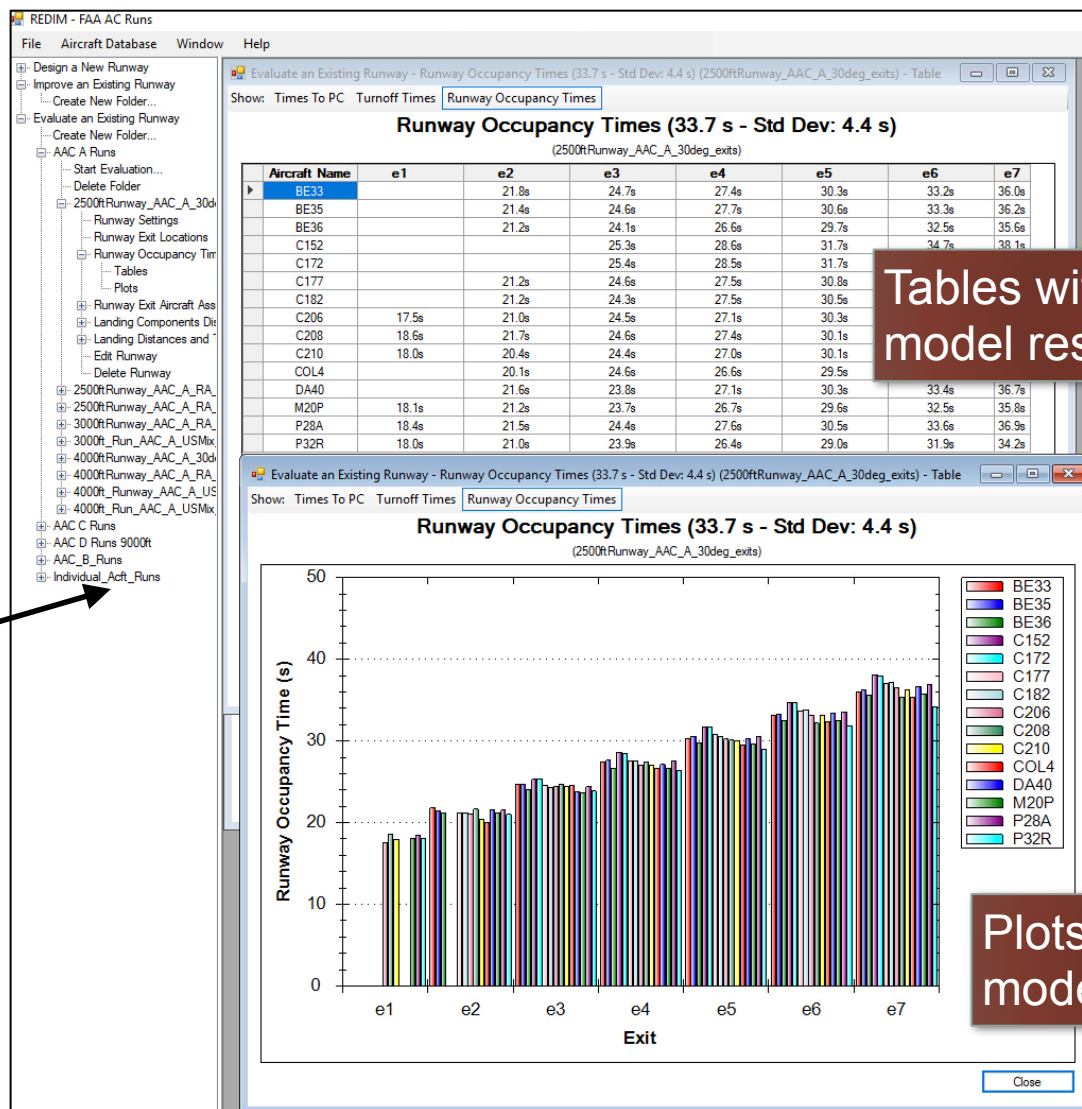
Shows the aircraft database of the model
Allows adding or editing aircraft into the database



Shows active windows with results



Interface and Panels in the Runway Exit Design Model



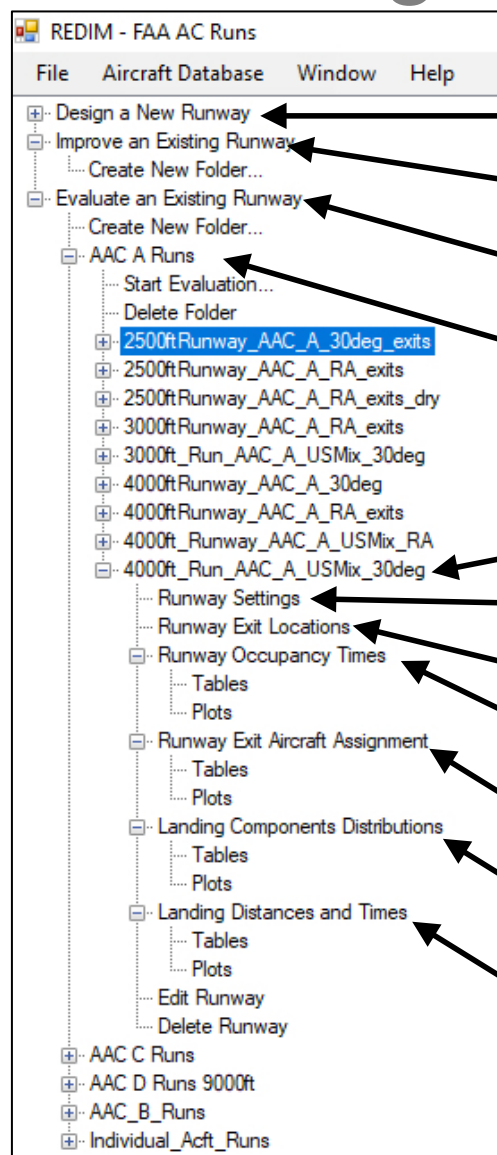
Tables with relevant model results

Navigation and project panel with information and results

Plots of relevant model results



Navigation/Project Panel Hierarchy



Design a new runway

Improve an existing runway

Evaluate an existing runway

Project folder

Scenarios inside project folder

Scenario settings

Runway exit locations

Runway occupancy times (tables and plots)

Runway exit assignment (tables and plots)

Aircraft landing distributions (tables and plots)

Aircraft landing distances and times (tables and plots)



Runway Optimization Case Study



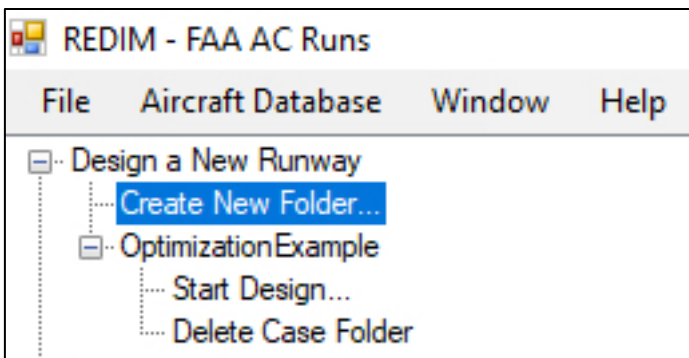
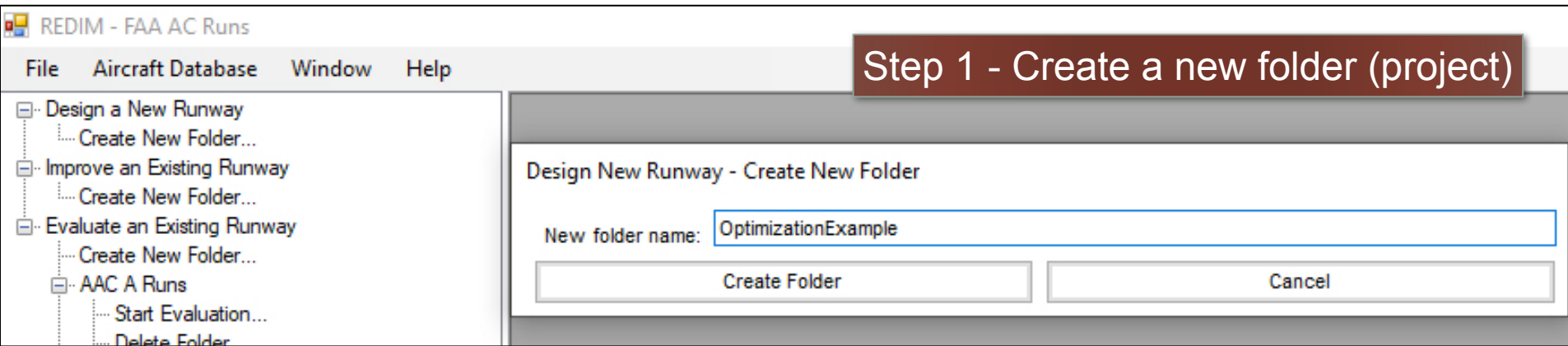
Summary of Optimization Case Study

- Design a new runway with 5 optimally located right angle exits
- Eight aircraft in fleet mix
- Sea level ISA conditions
- 10% wet and 90% dry pavement conditions
- 800 feet minimum distance between runway exits

[-] Analysis Info	
Date:	2/23/2020
Time:	7:03:44 PM
Model Version:	Version 3.0 - BETA Release - Date : 02/14/2020
Unit System:	Imperial
Debug Mode:	0
Runway Fallback Mode:	AAC
Exit Fallback Mode:	AAC
[-] Selected Aircraft	
BE33 - Beechcraft F33 Bonanza -	10%
BE55 - Beechcraft 55 Baron -	10%
C421 - Cessna 421 Golde Eagle -	10%
TBM9 - Daher-Socata TBM 940 -	10%
B350 - Beechcraft King Air 350 -	20%
CL60 - Bombardier Challenger 600 -	20%
A320 - Airbus A320 -	10%
B738 - Boeing 737-800 -	10%
[-] Analysis Constraints	
Number Of New Exits:	5
New Exit Type:	90°
[-] Environmental Data	
Airport Elevation:	0 feet
Airport Temperature:	59°F
Runway Length:	10000 feet
Runway Width:	148 feet
Minimum Exit Separation:	801 feet
Wet Conditions:	10%



Optimization Case Study





Optimization Case Study (2)

REDIM - FAA AC Runs

File Aircraft Database Window Help

Design a New Runway
 Create New Folder...
 OptimizationExample
 Start Design...
 Delete Case Folder
 Improve an Existing Runway
 Create New Folder...
 Evaluate an Existing Runway
 Create New Folder...
 AAC A Runs
 Start Evaluation...
 Delete Folder
 2500ftRunway_AAC_A_30deg_exits
 2500ftRunway_AAC_A_RA_exits
 2500ftRunway_AAC_A_RA_exits_dry
 3000ftRunway_AAC_A_RA_exits
 3000ft_Run_AAC_A_USMix_30deg
 4000ftRunway_AAC_A_30deg
 4000ftRunway_AAC_A_RA_exits
 4000ft_Runway_AAC_A_USMix_RA
 4000ft_Run_AAC_A_USMix_30deg
 Runway Settings
 Runway Exit Locations
 Runway Occupancy Times
 Tables
 Plots
 Runway Exit Aircraft Assignment
 Tables
 Plots
 Landing Components Distributions
 Tables

Design a New Runway - Step 1 - General Information

Step 1: General Information

Units
☐ Metric ☒ Imperial

Runway Information

Name: NewRunway_22

Length: 3048 meters. 10000 feet

Width: 45 meters. 148 feet

Minimum Exit Separation: 244 meters. 800 feet

Airport Information

Elevation: 0 meters. 0 feet

Temperature: 15 degrees Celsius. 59 degrees Fahrenheit

Wet Conditions: 0% 100%
 10%

Cancel <- Previous Next ->

Step 3 - Enter the runway general information

We suggest using 10% wet and 90% dry for design purposes for most airports



Optimization Case Study (3)

REDIM - FAA AC Runs

File Aircraft Database Window Help

- [-] Design a New Runway
 - [-] Create New Folder...
 - [-] OptimizationExample
 - Start Design...
 - Delete Case Folder
- [-] Improve an Existing Runway
 - [-] Create New Folder...
- [-] Evaluate an Existing Runway
 - [-] Create New Folder...
 - [-] AAC A Runs
 - Start Evaluation...
 - Delete Folder
 - [+] 2500ftRunway_AAC_A_30deg_exits
 - [+] 2500ftRunway_AAC_A_RA_exits
 - [+] 2500ftRunway_AAC_A_RA_exits_dry
 - [+] 3000ftRunway_AAC_A_RA_exits
 - [+] 3000ft_Run_AAC_A_USMix_30deg
 - [+] 4000ftRunway_AAC_A_30deg
 - [+] 4000ftRunway_AAC_A_RA_exits
 - [+] 4000ft_Runway_AAC_A_USMix_RA
 - [-] 4000ft_Run_AAC_A_USMix_30deg
 - Runway Settings
 - Runway Exit Locations
 - [-] Runway Occupancy Times
 - Tables
 - Plots
 - [-] Runway Exit Aircraft Assignment
 - Tables
 - Plots
 - [-] Landing Components Distributions
 - Tables

Design a New Runway - Step 2 - Define Aircraft Mix for New Runway

Step 2: Define Aircraft Mix for New Runway

Aircraft ID	Aircraft Name	Aircraft Design Group	Aircraft Approach Category	Aircraft Mix (%)
AA1	Grumman American AA1	I	A	
AA5	Grumman American AA5	I	A	
AC11	Rockwell Commander 112	I	A	
AC50	Aero Commander 500	I	A	
AC90	Turbo Commander 690	I	B	
AEST	Piper Aerostar	I	B	
BE10	Beechcraft B100 King Air	I	B	
BE33	Beechcraft F33 Bonanza	I	A	10
BE35	Beechcraft V35 Bonanza	I	A	
BE36	Beechcraft 36 Bonanza	I	A	
BE40	Beechcraft 400 Hawker	I	B	
BE55	Beechcraft 55 Baron	I	B	10
BE58	Beechcraft 58 Baron	I	B	
BE60	Beechcraft 60 Duke	I	B	
BE99	Beechcraft 99 Airliner	I	B	
BL17	Bellanca Viking	I	A	

Total aircraft mix allocated: 100%

Cancel

<- Previous

Next ->

Step 4 - Define the aircraft fleet mix that will use the runway



Optimization Case Study (4)

REDIM - FAA AC Runs

File Aircraft Database Window Help

Design a New Runway
 Create New Folder...
 OptimizationExample
 Start Design...
 Delete Case Folder

Improve an Existing Runway
 Create New Folder...

Evaluate an Existing Runway
 Create New Folder...

AAC A Runs
 Start Evaluation...
 Delete Folder
 2500ftRunway_AAC_A_30deg_exits
 2500ftRunway_AAC_A_RA_exits
 2500ftRunway_AAC_A_RA_exits_dry
 3000ftRunway_AAC_A_RA_exits
 3000ft_Run_AAC_A_USMix_30deg
 4000ftRunway_AAC_A_30deg
 4000ftRunway_AAC_A_RA_exits
 4000ft_Runway_AAC_A_USMix_RA

Design a New Runway - Step 3 - Runway Constraints

Step 3: Runway Constraints

Runway Constraints

Number of New Exits:

Exit Type:

Custom Exit Definition

Angle: degrees.

Radius of Central Curve: meters. feet.

Path Length from Point of Curvature to Holdbar: meters. feet.

Cancel <- Previous Next ->

Step 5 - Define the runway constraints and the number of new runway exits

REDIM

? All the required inputs are collected. Are you ready to run the analysis now ?

Yes No



Optimization Case Study (5): Review the Results

- [-] Design a New Runway
 - ... Create New Folder...
 - [-] OptimizationExample
 - ... Start Design...
 - ... Delete Case Folder
 - [-] NewRunway_22
 - ... Runway Settings
 - ... Runway Exit Locations →
 - [+] Runway Occupancy Times
 - [+] Runway Exit Aircraft Assignment
 - [+] Landing Components Distributions
 - [+] Landing Distances and Times
 - ... Edit Runway
 - ... Delete Runway

Exit	Exit Status	Exit Type	Location (ft)
Exit 1	Open	90°	3,773
Exit 2	Open	90°	4,593
Exit 3	Open	90°	5,413
Exit 4	Open	90°	6,398
Exit 5	Open	90°	7,546
Exit 6	Open	90°	10,000

- Model suggested runway exit locations
- Runway exit locations are the distance from the runway threshold to the point of curvature of the runway exit



Optimization Case Study (6): Runway Occupancy Times Table

Design a New Runway

- Create New Folder...
- OptimizationExample
 - Start Design...
 - Delete Case Folder
- NewRunway_22
 - Runway Settings
 - Runway Exit Locations
 - Runway Occupancy Times
 - Tables →
 - Plots
 - Runway Exit Aircraft Assignment
 - Landing Components Distributions
 - Landing Distances and Times
 - Edit Runway
 - Delete Runway
- Improve an Existing Runway
 - Create New Folder...
- Evaluate an Existing Runway
 - Create New Folder...
- AAC A Runs
 - Start Evaluation...
 - Delete Folder

Design a New Runway - Runway Occupancy Times (49.7 s - Std Dev: 9.6 s) (NewRunway_22) - Table

Show: Times To PC Turnoff Times **Runway Occupancy Times**

Runway Occupancy Times (49.7 s - Std Dev: 9.6 s)
(NewRunway_22)

Aircraft Name	Exit 1	Exit 2	Exit 3	Exit 4	Exit 5	Exit 6
A320			44.4s	50.9s	59.7s	83.4s
B350	40.0s	46.1s	52.6s	61.1s	71.5s	
B738			41.6s	48.8s	56.3s	79.3s
BE33	40.7s	46.2s	53.4s	64.2s	79.2s	102.3s
BE55	37.6s	43.3s	49.7s	56.5s	67.0s	94.7s
C421	43.5s	48.8s	55.5s	63.9s	75.4s	102.8s
CL60	36.0s	42.0s	47.6s	55.3s	64.4s	89.9s
TBM9	42.6s	48.3s	56.1s	66.9s	75.9s	110.2s

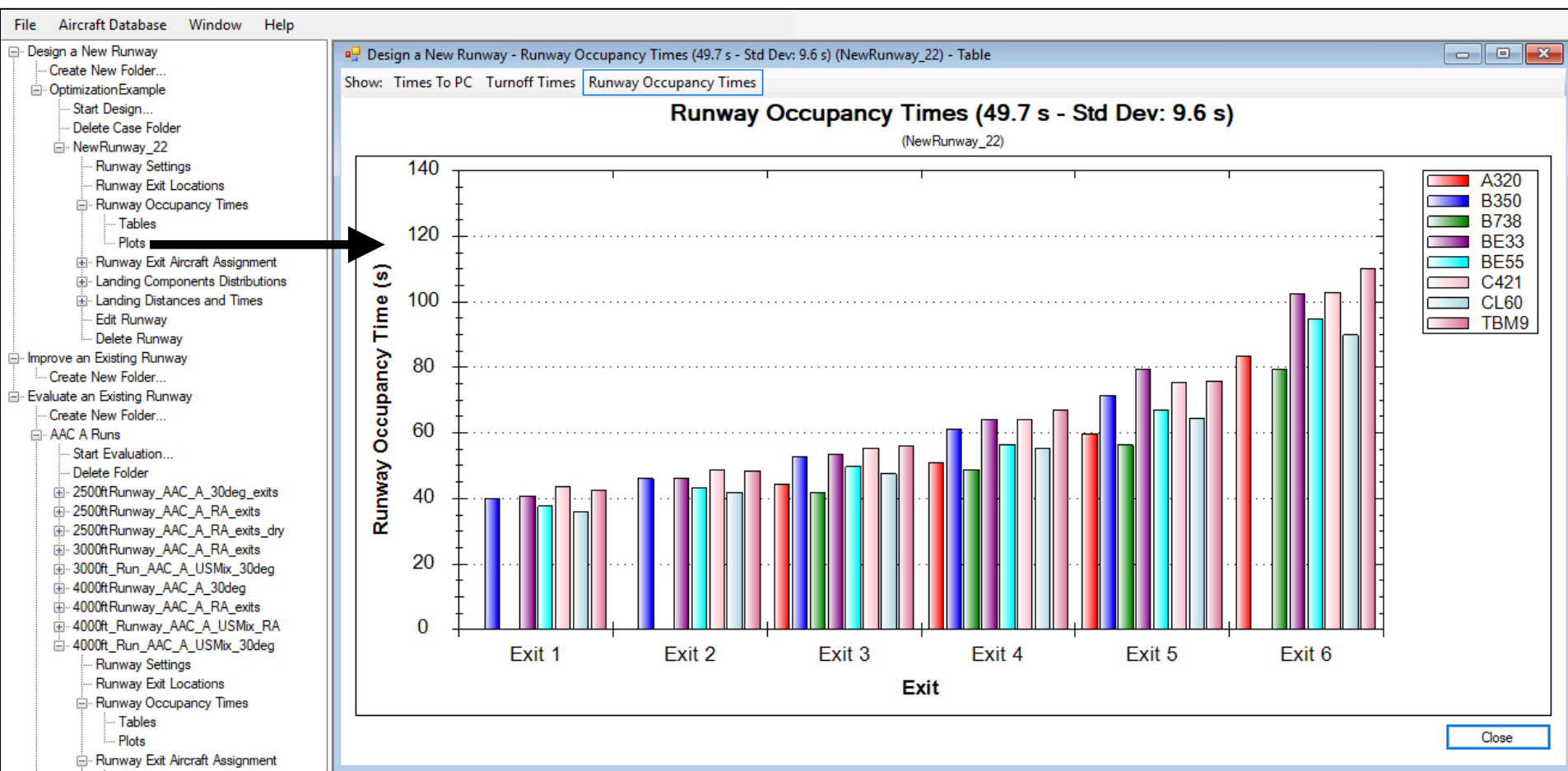
Save Table Close

Table can be saved in comma delimited format

- Runway occupancy times predicted by the model in tabular form
- ROT time starts when the aircraft crosses the threshold and ends at the point where the aircraft fuselage is out of the runway plane.



Optimization Case Study (7): Runway Occupancy Time Plot



- Runway occupancy times predicted by the model in graphical form
- ROT time is to the point where the aircraft fuselage is out of the runway plane.



Optimization Case Study (8): Runway Exit Assignment Table

File Aircraft Database Window Help

Design a New Runway
 Create New Folder...
 OptimizationExample
 Start Design...
 Delete Case Folder
 NewRunway_22
 Runway Settings
 Runway Exit Locations
 Runway Occupancy Times
 Tables
 Plots
 Runway Exit Aircraft Assignment
 Tables
 Plots
 Landing Components Distributions
 Landing Distances and Times
 Edit Runway
 Delete Runway
 Improve an Existing Runway
 Create New Folder...
 Evaluate an Existing Runway

Design a New Runway - Runway Exit Aircraft Assignment (NewRunway_22) - Table

Runway Exit Aircraft Assignment
(NewRunway_22)

Aircraft Name	Exit 1	Exit 2	Exit 3	Exit 4	Exit 5	Exit 6	Aircraft Mix
A320			4.6%	45.8%	39.7%	9.9%	9.9%
B350	40.9%	42.3%	14.4%	2.2%	0.1%		20.1%
B738			4.2%	38.3%	44.6%	13.0%	10.0%
BE33	47.6%	31.5%	13.0%	5.8%	1.4%	0.7%	10.1%
BE55	9.7%	31.9%	36.0%	18.0%	3.9%	0.5%	9.9%
C421	35.8%	35.5%	20.6%	6.8%	0.9%	0.3%	9.9%
CL60	0.9%	16.1%	42.1%	33.5%	7.0%	0.3%	20.2%
TBM9	47.5%	31.9%	13.6%	4.2%	1.7%	1.1%	9.9%
Exit Mix	22.4%	24.8%	20.6%	19.0%	10.6%	2.6%	

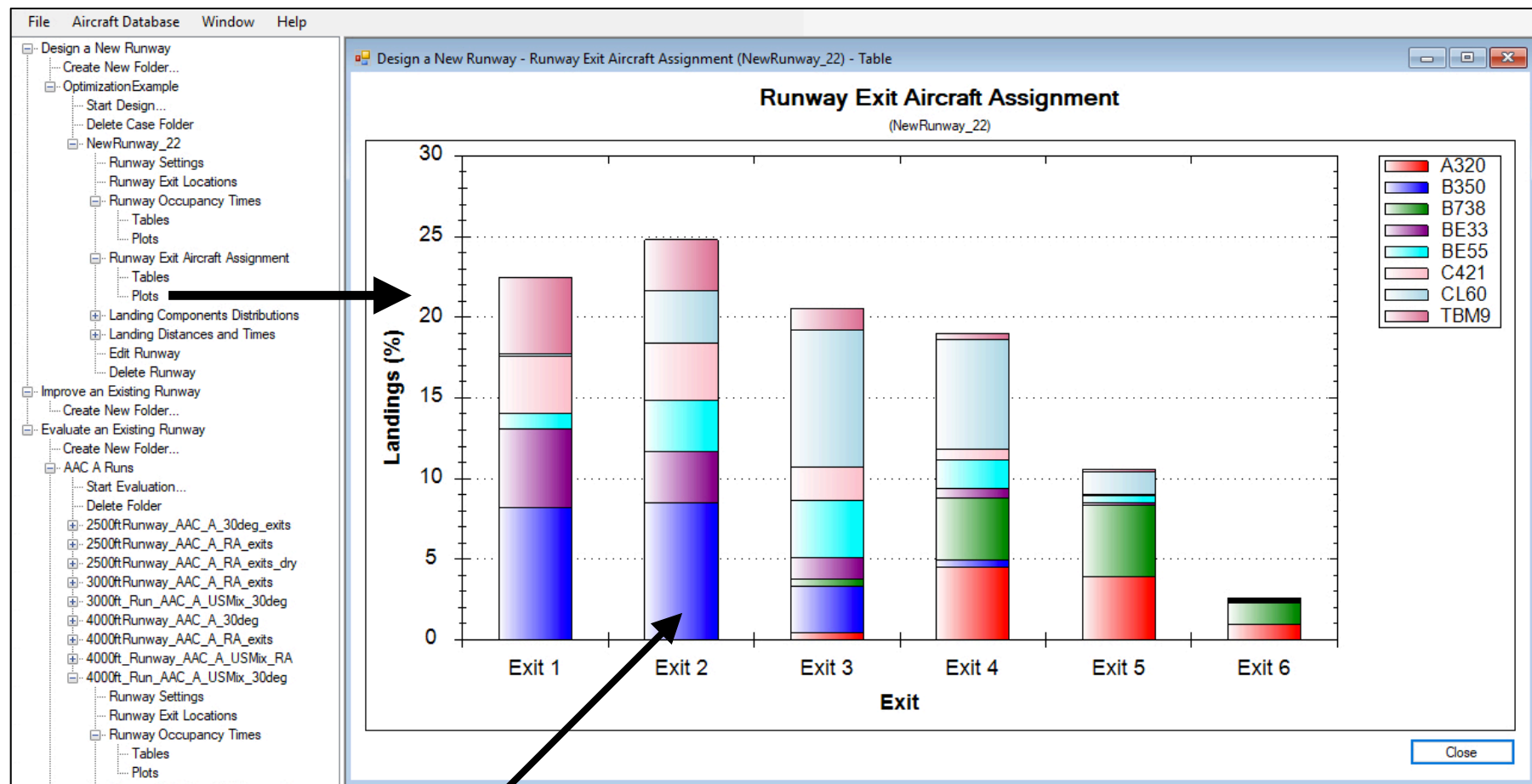
Save Table Close

Table can be saved in comma delimited format

- Runway assignments are reported in percent of the individual aircraft using each exit
- The aircraft mix simulated (in percent) is shown in the last column of the table
- The runway exit mix using each exit is shown in the last row of the table (in percent)



Optimization Case Study (9): Runway Exit Assignment Plot



Runway assignments are reported in stacked column format



Optimization Case Study (10): Landing Distribution Tables

File Aircraft Database Window Help

Design a New Runway

- Create New Folder...
- OptimizationExample
 - Start Design...
 - Delete Case Folder
- NewRunway_22
 - Runway Settings
 - Runway Exit Locations
 - Runway Occupancy Times
 - Tables
 - Plots
 - Runway Exit Aircraft Assignment
 - Tables
 - Plots
 - Landing Components Distributions
 - Tables
 - Plots
 - Landing Distances and Times
 - Edit Runway
 - Delete Runway
- Improve an Existing Runway
 - Create New Folder...
- Evaluate an Existing Runway
 - Create New Folder...
- AAC A Runs
 - Start Evaluation...
 - Delete Folder
 - 2500ftRunway_AAC_A_30deg_exits
 - 2500ftRunway_AAC_A_RA_exits
 - 2500ftRunway_AAC_A_RA_exits_dry
 - 3000ftRunway_AAC_A_RA_exits
 - 3000ft_Run_AAC_A_USMix_30deg
 - 4000ftRunway_AAC_A_30deg
 - 4000ftRunway_AAC_A_RA_exits
 - 4000ft_Runway_AAC_A_USMix_RA
 - 4000ft_Run_AAC_A_USMix_30deg

Design a New Runway - Total Distance for A320 (NewRunway_22) - Table

Choose Aircraft: A320 Metric: Distance Landing Component: Total

Total Distance for A320
(NewRunway_22)

Distance (ft)	PDF All (%)	PDF Dry (%)	PDF Wet (%)	CDF All (%)	CDF Dry (%)	CDF Wet (%)
5,682	4.6	4.9	1.1	4.6	4.9	1.1
5,707	0.0	0.0	0.0	4.6	4.9	1.1
5,732	0.0	0.0	0.0	4.6	4.9	1.1
5,757	0.0	0.0	0.0	4.6	4.9	1.1
5,782	0.0	0.0	0.0	4.6	4.9	1.1
5,807	0.0	0.0	0.0	4.6	4.9	1.1
5,832	0.0	0.0	0.0	4.6	4.9	1.1
5,857	0.0	0.0	0.0	4.6	4.9	1.1
5,882	0.0	0.0	0.0	4.6	4.9	1.1
5,907	0.0	0.0	0.0	4.6	4.9	1.1
5,932	0.0	0.0	0.0	4.6	4.9	1.1
5,957	0.0	0.0	0.0	4.6	4.9	1.1
5,982	0.0	0.0	0.0	4.6	4.9	1.1
6,007	0.0	0.0	0.0	4.6	4.9	1.1
6,032	0.0	0.0	0.0	4.6	4.9	1.1
6,057	0.0	0.0	0.0	4.6	4.9	1.1
6,082	0.0	0.0	0.0	4.6	4.9	1.1
6,107	0.0	0.0	0.0	4.6	4.9	1.1
6,132	0.0	0.0	0.0	4.6	4.9	1.1
6,157	0.0	0.0	0.0	4.6	4.9	1.1
6,182	0.0	0.0	0.0	4.6	4.9	1.1
6,207	0.0	0.0	0.0	4.6	4.9	1.1
6,232	0.0	0.0	0.0	4.6	4.9	1.1
6,257	0.0	0.0	0.0	4.6	4.9	1.1
6,282	0.0	0.0	0.0	4.6	4.9	1.1

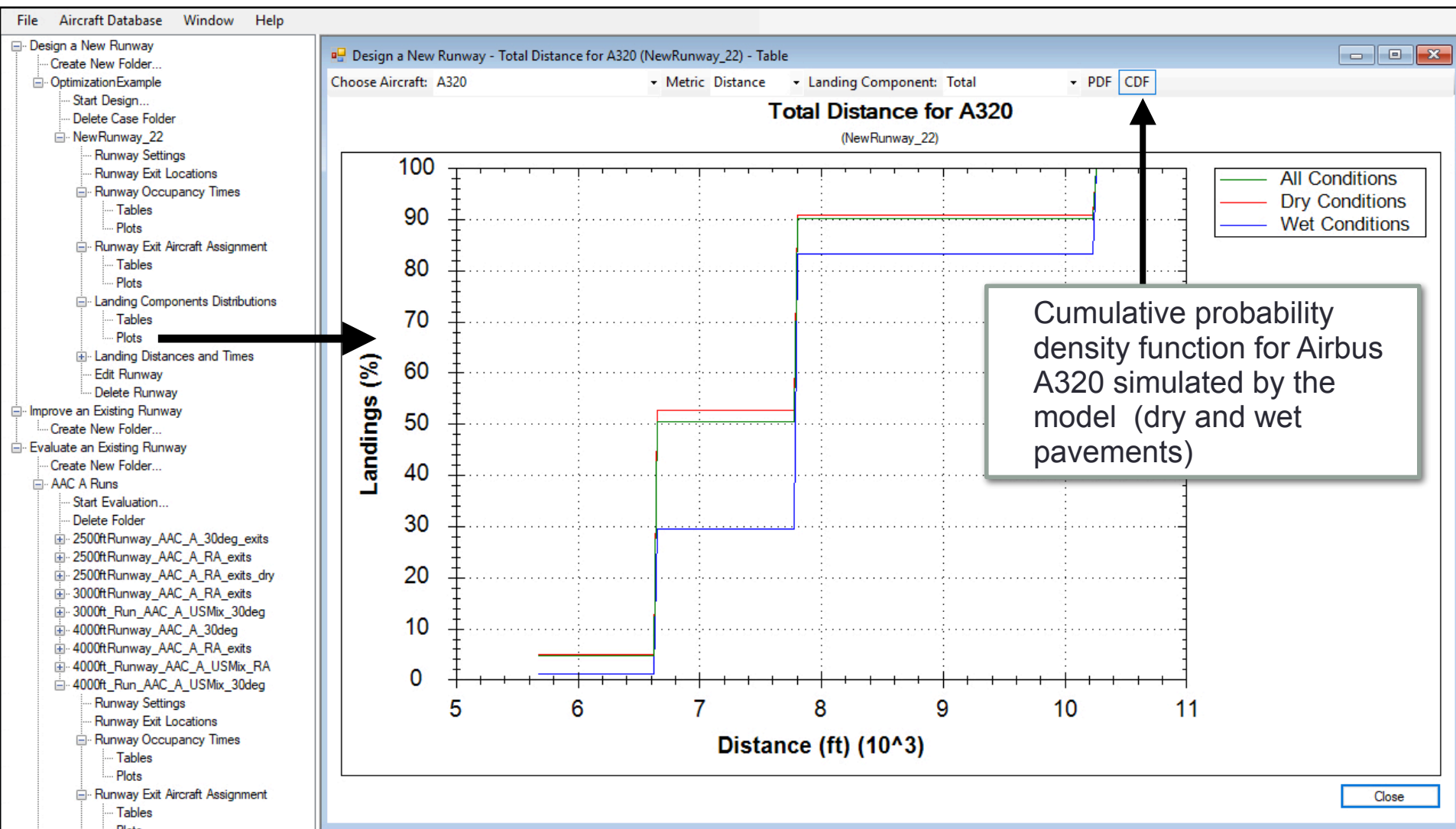
Save Table Close

Landing distance for individual landings of Airbus A320 simulated by the model

Probability density function for Airbus A320 simulated by the model (dry and wet pavements)



Optimization Case Study (11): Landing Distribution Plots



Design a New Runway - Total Distance for A320 (NewRunway_22) - Table

Choose Aircraft: A320

Metric Distance

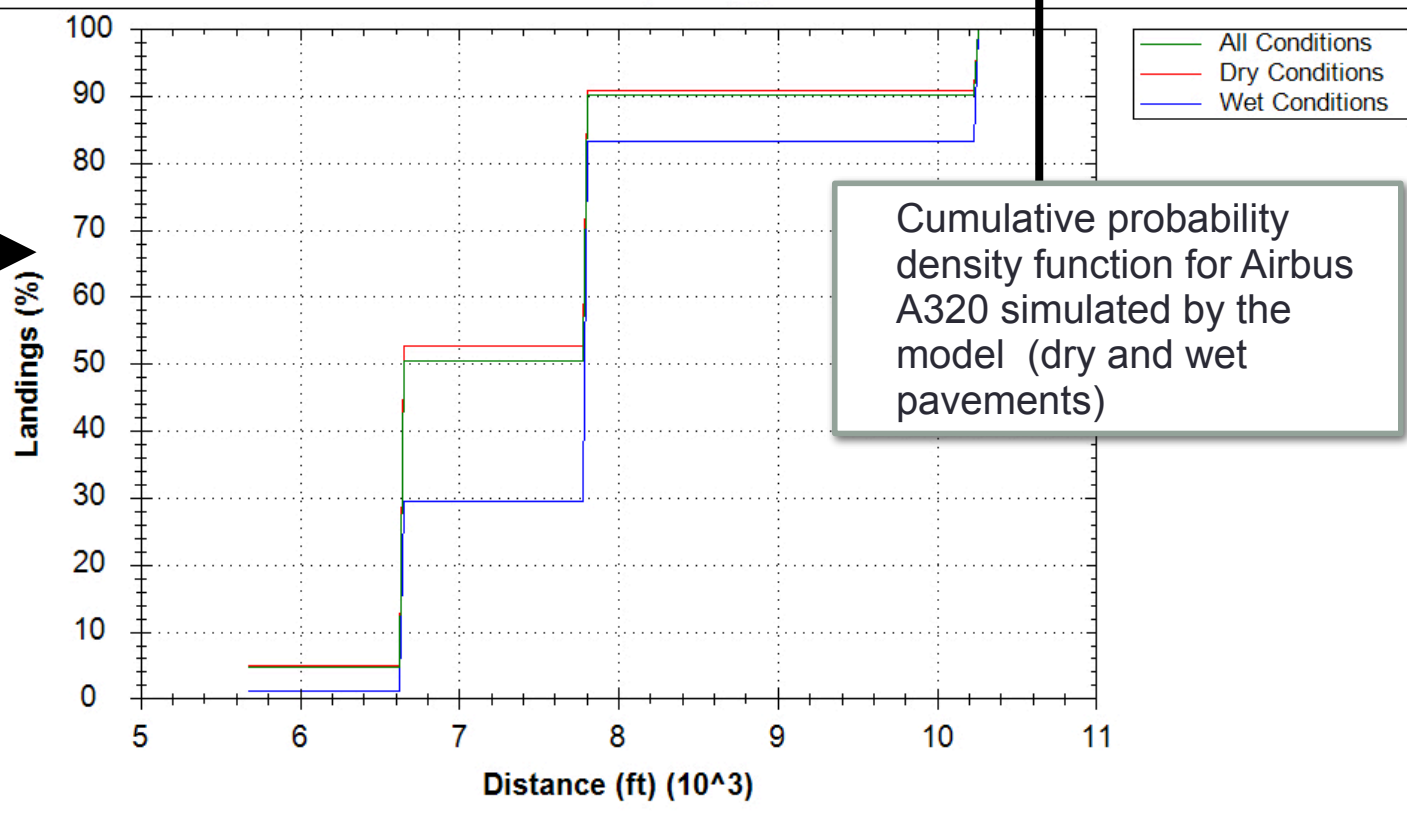
Landing Component: Total

PDF

CDF

Total Distance for A320

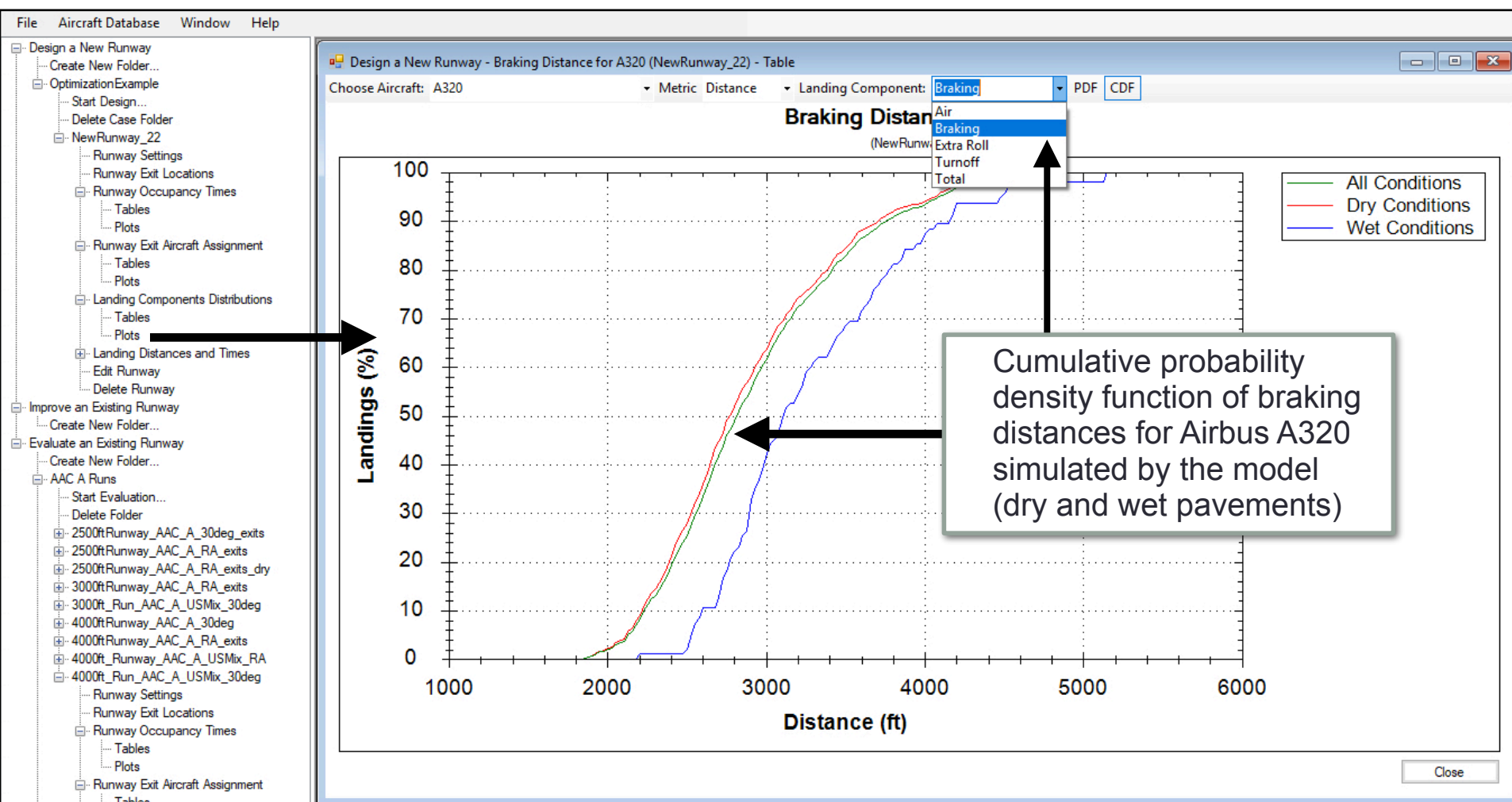
(NewRunway_22)



Close



Optimization Case Study (12): Landing Distribution Plots





Optimization Case Study (13): Landing Distances and Times

File Aircraft Database Window Help

- Design a New Runway
 - Create New Folder...
 - OptimizationExample
 - Start Design...
 - Delete Case Folder
 - NewRunway_22
 - Runway Settings
 - Runway Exit Locations
 - Runway Occupancy Times
 - Tables
 - Plots
 - Runway Exit Aircraft Assignment
 - Tables
 - Plots
 - Landing Components Distributions
 - Tables
 - Plots
 - Landing Distances and Times
 - Tables
 - Plots
 - Edit Runway
 - Delete Runway
 - Improve an Existing Runway
 - Create New Folder...
 - Evaluate an Existing Runway
 - Create New Folder...
 - AAC A Runs
 - Start Evaluation...
 - Delete Folder
 - 2500ftRunway_AAC_A_30deg_exits
 - 2500ftRunway_AAC_A_RA_exits
 - 2500ftRunway_AAC_A_RA_exits_dry
 - 3000ftRunway_AAC_A_RA_exits
 - 3000ft_Run_AAC_A_USMix_30deg
 - 4000ftRunway_AAC_A_30deg
 - 4000ftRunway_AAC_A_RA_exits
 - 4000ft_Runway_AAC_A_USMix_RA
 - 4000ft_Run_AAC_A_USMix_30deg

Design a New Runway - Landing Distances for A320 (NewRunway_22) - Table

Choose Aircraft: A320 Distances Times Speeds & Decelerations

Landing Distances for A320

(NewRunway_22)

Landing Number	Wet Conditions	Exit	Air Distance (ft)	Braking Distance (ft)	Extra Roll Distance (ft)	Turnoff Distance (ft)	Total Distance (ft)
1		Exit 5	3,134	2,487	1,925	257	7,803
2	Yes	Exit 4	2,602	2,530	1,266	257	6,658
3		Exit 4	2,703	2,461	1,234	259	6,656
4		Exit 5	2,434	3,127	1,986	257	7,803
5	Yes	Exit 5	2,875	3,328	1,343	259	7,808
6		Exit 3	2,589	2,033	792	257	5,671
7		Exit 4	2,886	2,499	1,013	259	6,657
8		Exit 5	2,966	2,539	2,042	259	7,805
9		Exit 4	2,280	2,533	1,584	259	6,657
10		Exit 4	2,299	2,527	1,572	258	6,655
11		Exit 6	2,412	4,062	3,527	265	10,265
12		Exit 4	2,594	2,772	1,032	258	6,655
13		Exit 3	2,635	1,922	856	257	5,670
14		Exit 5	2,361	3,114	2,071	259	7,805
15		Exit 4	2,588	2,398	1,412	257	6,654
16		Exit 6	3,086	3,585	3,329	267	10,267
17		Exit 4	2,321	2,741	1,335	261	6,659
18		Exit 4	2,620	2,528	1,250	257	6,654
19		Exit 4	2,170	2,549	1,679	259	6,656
20		Exit 4	2,696	2,682	1,020	257	6,655
21		Exit 5	2,866	2,815	1,865	258	7,804
22		Exit 3	2,150	2,123	1,141	259	5,672
23		Exit 4	2,467	2,302	1,738	259	6,657
Average			2,653	2,936	1,577	259	7,426

Save Table Close

Total landing distance simulated for Airbus A320
(dry and wet pavements - see second column)



Optimization Case Study (14): Landing Distances and Times

File Aircraft Database Window Help

Design a New Runway - Landing Speeds & Decelerations for A320 (NewRunway_22) - Table

Choose Aircraft: A320

Distances Times **Speeds & Decelerations**

Landing Speeds Decelerations for A320

(NewRunway_22)

Landing Number	Wet Conditions	Exit	Threshold Crossing Speed (knots)	Touchdown Speed (knots)	Nominal Speed (knots)	Speed at PC (knots)	Nominal Deceleration (m/s ²)	Deceleration to PC (m/s ²)	Deceleration after PC (m/s ²)	Touchdown Speed Coefficient	Deceleration to PC Coefficient
1		Exit 5	128	122	70	21	-1.73	-1.00	-0.34	0.95	0.58
2	Yes	Exit 4	128	122	70	32	-1.71	-1.32	-0.34	0.95	0.77
3		Exit 4	131	125	70	29	-1.89	-1.42	-0.34	0.95	0.75
4		Exit 5	137	130	70	21	-1.67	-0.97	-0.34	0.95	0.58
5	Yes	Exit 5	135	128	70	19	-1.51	-1.47	-0.34	0.95	0.97
6		Exit 3	128	122	70	20	-2.11	-2.48	-0.34	0.95	1.17
7		Exit 4	128	122	70	32	-1.71	-1.67	-0.34	0.95	0.97
8		Exit 5	129	123	70	23	-1.73	-0.93	-0.34	0.95	0.54
9		Exit 4	131	124	70	25	-1.80	-1.17	-0.34	0.95	0.65
10		Exit 4	136	129	70	21	-2.04	-1.23	-0.34	0.95	0.60
11		Exit 6	136	129	70	26	-1.26	-0.52	-0.34	0.95	0.41
12		Exit 4	125	119	70	32	-1.45	-1.64	-0.34	0.95	1.13
13		Exit 3	124	117	70	21	-2.00	-2.25	-0.34	0.95	1.12
14		Exit 5	136	130	70	25	-1.66	-0.90	-0.34	0.95	0.54
15		Exit 4	132	126	70	24	-1.97	-1.34	-0.34	0.95	0.68
16		Exit 6	135	128	70	28	-1.39	-0.54	-0.34	0.95	0.39
17		Exit 4	129	123	70	34	-1.60	-1.21	-0.34	0.95	0.75
18		Exit 4	137	130	70	23	-2.05	-1.52	-0.34	0.95	0.74
19		Exit 4	131	124	70	18	-1.79	-1.19	-0.34	0.95	0.66
20		Exit 4	130	124	70	29	-1.68	-1.72	-0.34	0.95	1.02
21		Exit 5	128	122	70	21	-1.54	-1.04	-0.34	0.95	0.68
22		Exit 3	133	126	70	15	-2.24	-1.78	-0.34	0.95	0.79
23		Exit 4	129	123	70	23	-2.00	-1.10	-0.34	0.95	0.55
24		Exit 4	130	124	70	23	-1.88	-1.32	-0.34	0.95	0.70
25		Exit 6	137	130	70	30	-1.46	-0.51	-0.34	0.95	0.35
26		Exit 4	137	130	70	28	-1.99	-1.83	-0.34	0.95	0.92
Average			134	127	70	24	-1.72	-1.33	-0.34	0.95	0.77

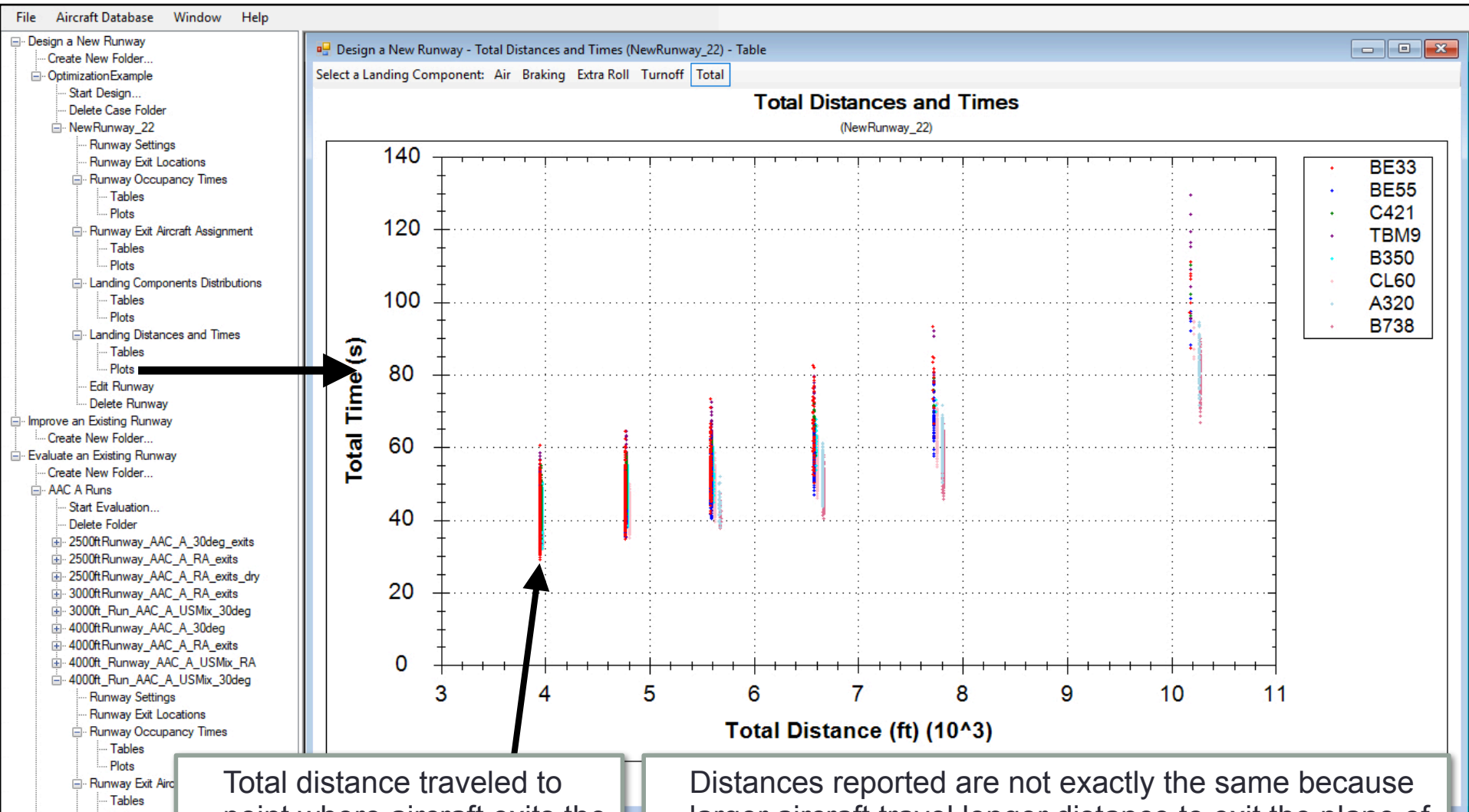
Save Table Close

Runway exit used by each simulated landing

Nominal deceleration rate for each simulated Airbus A320 landing (dry and wet pavements - see second column)

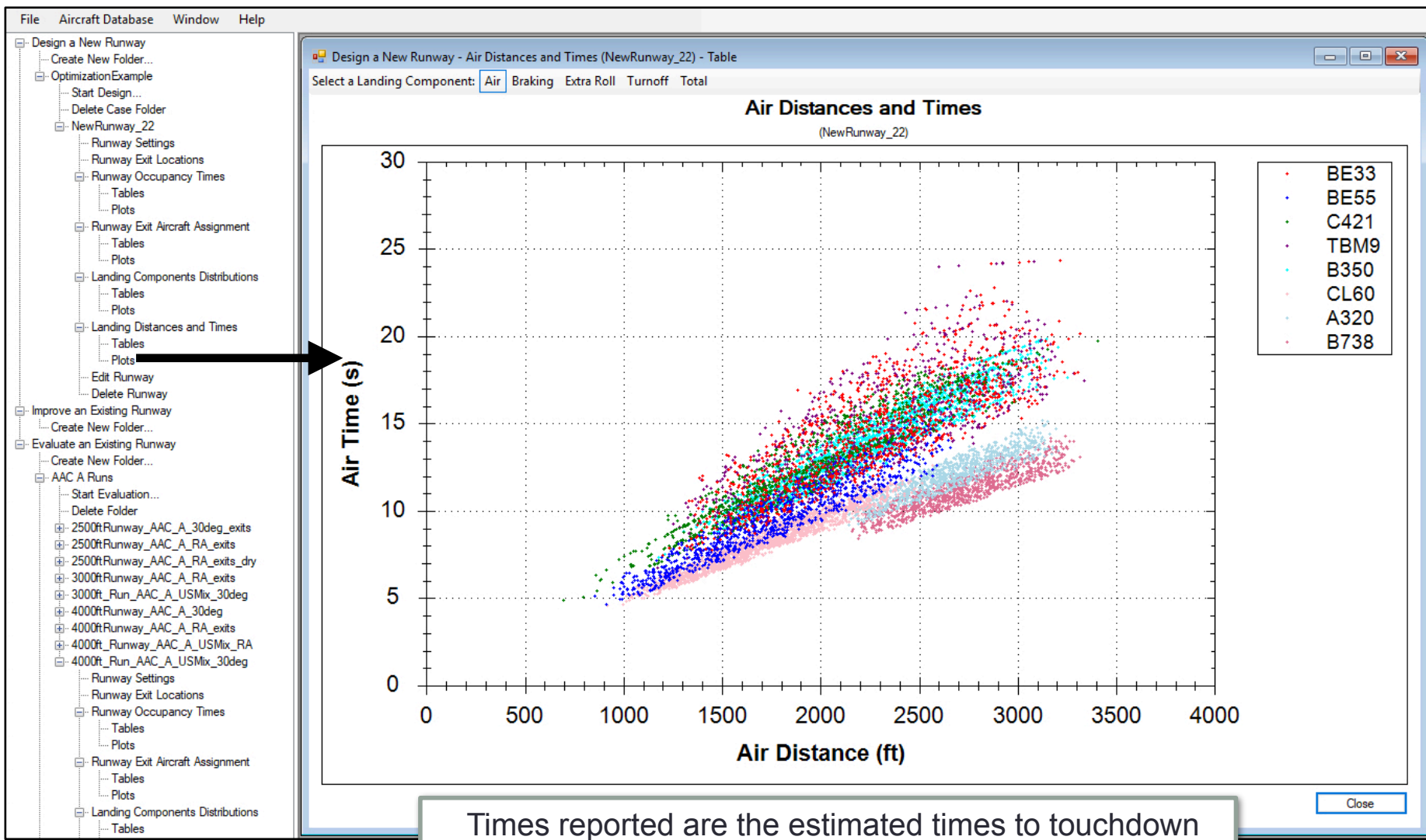


Optimization Case Study (15): Landing Distances and Times (Plots)



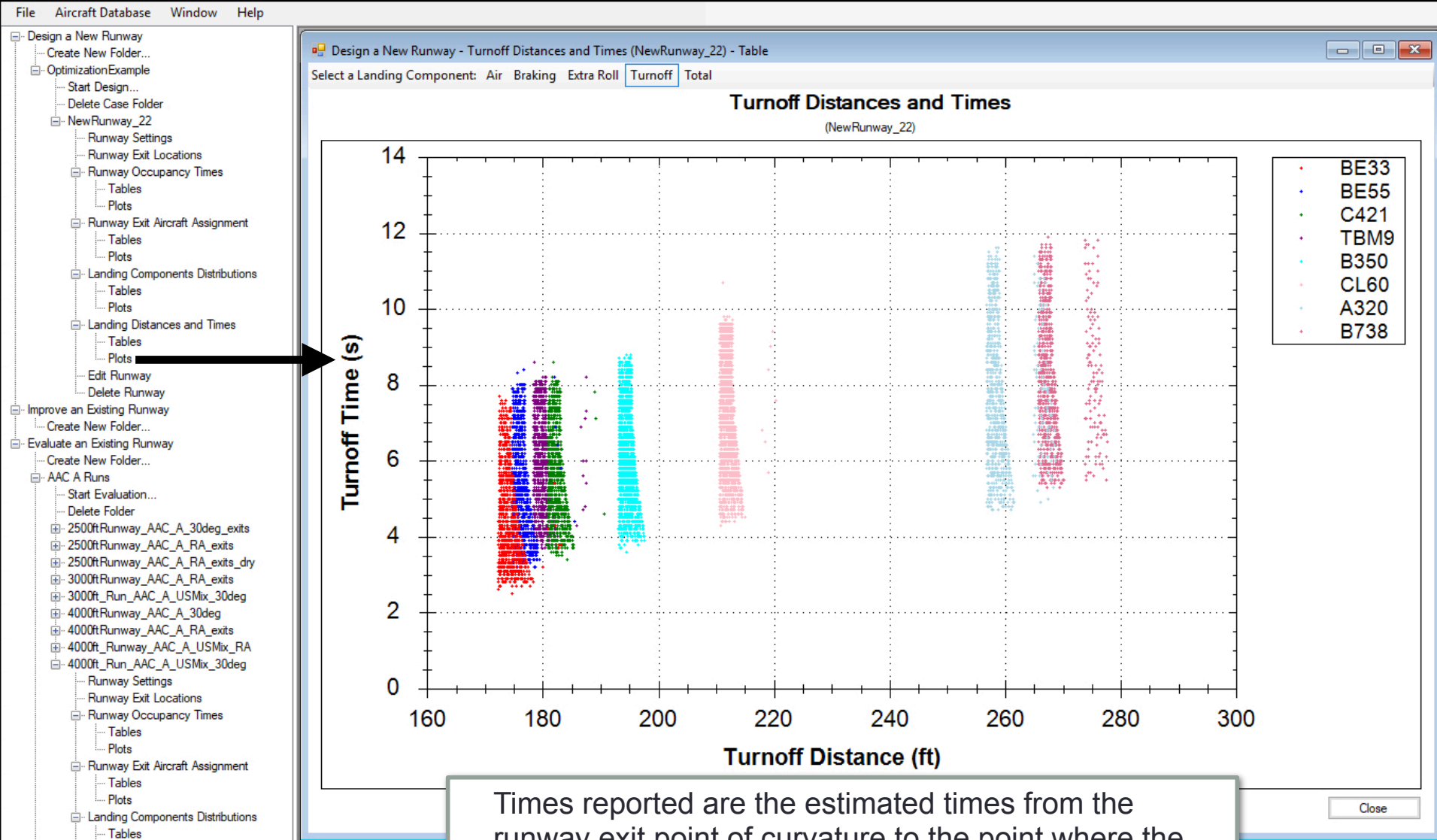


Optimization Case Study (16): Time to Touchdown (Air Times)





Optimization Case Study (17): Runway Turnoff Times



Times reported are the estimated times from the runway exit point of curvature to the point where the fuselage of the aircraft exits the plane of the runway



Runway Improvement Case Study



Summary of Improvement Case Study

- Improve an existing 9,000 ft. runway by adding 2 optimally located acute angle exits (30 deg., 1500 ft radius)
- Five existing runway exits (all 90 deg., right angle exits)
- Sea level ISA conditions
- 10% wet and 90% dry pavement conditions
- 800 feet minimum distance between runway exits

Runway Exit Name	Location of Point of Curvature (ft)	Runway Exit Type
E1	2500	90 deg.
E2	4500	90 deg.
E3	6000	90 deg.
E4	7500	90 deg.
E5	9000	90 deg.



Summary of Improvement Case Study

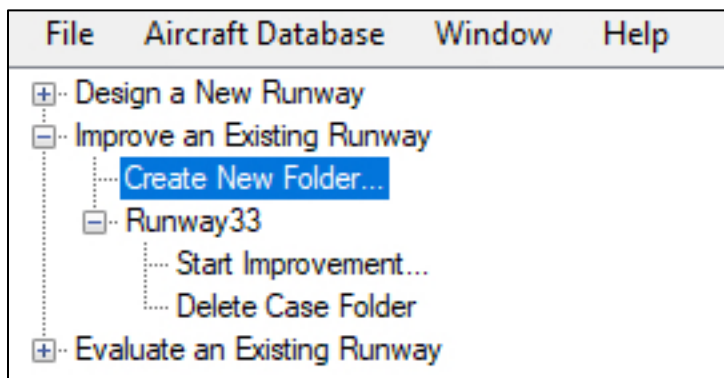
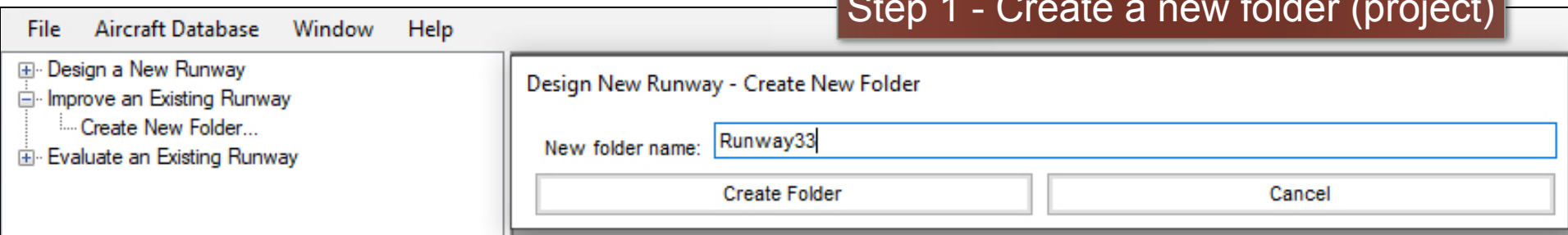
- Improve an existing runway by adding 2 optimally located acute angle exits (30 deg., 1500 ft radius)
- Eleven aircraft in fleet mix
- Sea level ISA conditions
- 10% wet and 90% dry pavement conditions
- 800 feet minimum distance between runway exits

+	Analysis Info
-	Selected Aircraft
...	BE33 - Beechcraft F33 Bonanza - 5%
...	BE55 - Beechcraft 55 Baron - 5%
...	C525 - Cessna 525 CitationJet - 10%
...	SR22 - Cirrus SR-22 - 10%
...	BE30 - Beechcraft B300 King Air - 5%
...	CL60 - Bombardier Challenger 600 - 5%
...	E145 - Embraer 145 - 10%
...	A320 - Airbus A320 - 20%
...	B738 - Boeing 737-800 - 20%
...	B744 - Boeing 747-400 - 5%
...	B773 - Boeing 777-300 - 5%
-	Analysis Constraints
...	Number Of New Exits: 2
...	New Exit Type: 30° (with 1,500 ft circular arc)
...	New Exit Locations: Between E2 & E4
-	Environmental Data
...	Airport Elevation: 0 feet
...	Airport Temperature: 59°F
...	Runway Length: 8999 feet
...	Runway Width: 148 feet
...	Minimum Exit Separation: 801 feet
...	Wet Conditions: 10%
+	Existing Exits



Improvement Case Study

Step 1 - Create a new folder (project)



Step 2 - Define the runway parameters in the newly created runway scenario



Improvement Case Study (2)

File
Aircraft Database
Window
Help

- + Design a New Runway
- Improve an Existing Runway
 - ... Create New Folder...
 - Runway33
 - ... Start Improvement...
 - ... Delete Case Folder
- + Evaluate an Existing Runway

Improve an Existing Runway - Step 1 - General Information

Step 1: General Information

Units

☐ Metric ☒ Imperial

Runway Information

Name:

Length: meters. feet.

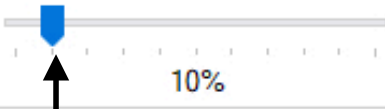
Width: meters. feet.

Minumum Exit Separation: meters. feet.

Airport Information

Elevation: meters. feet.

Temperature: degrees Celsius. degrees Fahrenheit.

Wet Conditions: 0%  100%.

Step 3 - Enter the runway general information

Cancel
<- Previous
Next ->

We suggest using 10% wet and 90% dry for design purposes for most airports



Improvement Case Study (3)

- [-] Design a New Runway
- [-] Improve an Existing Runway
 - ... Create New Folder...
 - [-] Runway33
 - ... Start Improvement...
 - ... Delete Case Folder
 - [-] Runway33_improvement
 - ... Runway Settings
 - ... Runway Exit Locations
 - [+] Runway Occupancy Times
 - [+] Runway Exit Aircraft Assignment
 - [+] Landing Components Distributions
 - [+] Landing Distances and Times
 - ... Edit Runway
 - ... Delete Runway
- [-] Evaluate an Existing Runway

Improve an Existing Runway - Step 2 - Define Aircraft Mix for New Runway

Step 2: Define Aircraft Mix for New Runway

Aircraft ID	Aircraft Name	Aircraft Design Group	Aircraft Approach Category	Aircraft Mix (%)
AT72	Aeropatiale ATR-72-200	III	B	
AT73	Aeropatiale ATR-72-300	III	B	
AT75	Aeropatiale ATR-72-500	III	B	
AT76	Aeropatiale ATR-72-600	III	B	
B712	Boeing 717-200	III	C	
B722	Boeing 727-200	III	C	
B733	Boeing 737-300	III	C	
B734	Boeing 737-400	III	C	
B735	Boeing 737-500	III	C	
B736	Boeing 737-600	III	C	
B737	Boeing 737-700	III	C	
B738	Boeing 737-800	III	D	20
B739	Boeing 737-900	III	D	
CRJ9	Bombardier CRJ 900	III	C	
DC91	Douglas DC-9-10	III	C	
DC93	Douglas DC-9-30	III	C	

Total aircraft mix allocated: 100%

Cancel
<- Previous
Next ->

Step 4 - Define the aircraft fleet mix that will use the runway



Improvement Case Study (4)

REDIM - FAA AC Runs - [REDIM]

File Aircraft Database Window Help

Design a New Runway
Improve an Existing Runway
 Create New Folder...
 Runway33
 Start Improvement...
 Delete Folder
 Runway33_improvement
 Runway Settings
 Runway Exit Locations
 Runway Occupancy Times
 Runway Exit Aircraft Assignment
 Landing Components Distributions
 Landing Distances and Times
 Edit Runway
 Delete Runway
Evaluate an Existing Runway
 Create
 AAC A
 AAC C
 AAC D
 AAC_B
 Individual_Acft_Runs
 Runway13_evaluation

Improve an Existing Runway - Step 3 - Runway Constraints

Step 3: Runway Constraints

	Exit Name	Exit Point Of Curvature Location (ft)	Exit Type	Open
▶	E1	2500	90°	<input checked="" type="checkbox"/>
	E2	4501	90°	<input type="checkbox"/>
	E3	6001	90°	<input type="checkbox"/>
	E4	7500	90°	<input type="checkbox"/>
	E5	8999	90°	<input checked="" type="checkbox"/>
				<input type="checkbox"/>

Step 5 - Define the existing runway configuration

Step 6 - Close the runway exits that you want to close to improve the runway occupancy time

Custom Exit Definition

Angle: degrees.

Radius of Central Curve: meters. feet

Path Length from Point of Curvature to Holdbar: meters. feet

Save

Cancel <- Previous Next ->



Improvement Case Study (5)

File
Aircraft Database
Window
Help

- + Design a New Runway
- Improve an Existing Runway
 - ... Create New Folder...
 - Runway33
 - ... Start Improvement...
 - ... Delete Case Folder
- + Evaluate an Existing Runway

Step 4: New Exits Specifications

Runway Constraints

Number of New Exits:

Exit Type: 30° (with 1,500 ft circular arc) ▼

Exit Locations: From: E2 ▼ To: E4 ▼

Custom Exit Definition

Angle: degrees.

Radius: meters. feet

Offset: meters. feet

Cancel
< Previous
Next >

Step 6 - Define the new runway exit parameters

Runway Exit Name	Location of Point of Curvature (ft)	Runway Exit Type
E1	2500	90 deg.
E2	4500	90 deg.
E3	6000	90 deg.
E4	7500	90 deg.
E5	9000	90 deg.

Desired range for new optimal exits



Improvement Case Study (6): Review the Results

- + Design a New Runway
- Improve an Existing Runway
 - ... Create New Folder...
 - Runway33
 - ... Start Improvement...
 - ... Delete Case Folder
 - Runway33_improvement
 - ... Runway Settings
 - Runway Exit Locations**
 - + Runway Occupancy Times
 - + Runway Exit Aircraft Assignment
 - + Landing Components Distributions
 - + Landing Distances and Times
 - ... Edit Runway
 - ... Delete Runway

Exit	Exit Status	Exit Type	Location (ft)
E1	Open	90°	2,500
E2	Closed	90°	4,501
New Exit 1	Open	30° (with 1,500 ft circular arc)	5,823
E3	Closed	90°	6,001
New Exit 2	Open	30° (with 1,500 ft circular arc)	6,808
E4	Closed	90°	7,500
E5	Open	90°	8,999

- Model suggested locations for two new acute angle runway exits are 5,823 ft. and 6,808 ft.
- Runway exit locations are the distance from the runway threshold to the point of curvature of the runway exit



Improvement Case Study (7): Runway Occupancy Times Table

Design a New Runway

Improve an Existing Runway

Create New Folder...

Runway33

Start Improvement...

Delete Case Folder

Runway33_improvement

Runway Settings

Runway Exit Locations

Runway Occupancy Times

Tables

Plots

Runway Exit Aircraft Assignment

Landing Components Distributions

Landing Distances and Times

Edit Runway

Delete Runway

Evaluate an Existing Runway

Improve an Existing Runway - Runway Occupancy Times (59 s - Std Dev: 13.1 s) (Runway33_improvement) - Table

Show: Times To PC Turnoff Times Runway Occupancy Times

Runway Occupancy Times (59 s - Std Dev: 13.1 s)

(Runway33_improvement)

Aircraft Name	E1	E2	New Exit 1	E3	New Exit 2	E4	E5
A320			49.2s		56.5s		74.8s
B738			47.8s		54.6s		72.0s
B744			49.0s		54.9s		78.1s
B773			49.3s		56.4s		77.5s
BE30	29.6s		62.6s		63.4s		
BE33	32.7s		86.6s		90.2s		108.6s
BE55	32.1s		67.9s		77.6s		
C525			61.5s		64.9s		82.9s
CL60			55.4s		59.1s		82.9s
E145			49.3s		54.6s		75.2s
SR22	33.8s		81.4s		84.0s		105.4s

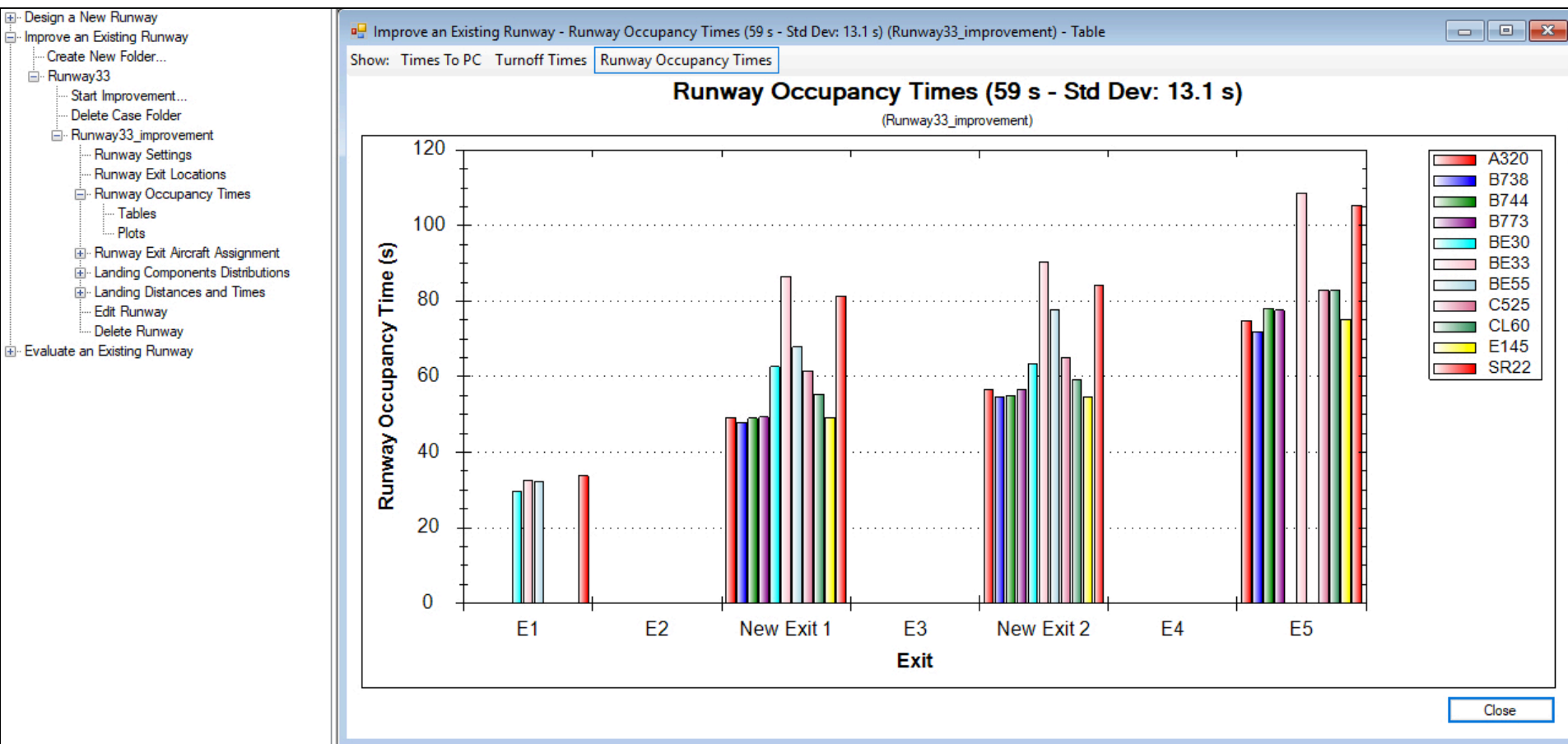
Save Table Close

Table can be saved in comma delimited format

- Runway occupancy times predicted by the model in tabular form
- ROT time starts when the aircraft crosses the threshold and ends at the point where the aircraft fuselage is out of the runway plane.



Improvement Case Study (8): Runway Occupancy Time Plot



- Runway occupancy times predicted by the model in graphical form
- ROT time starts when the aircraft crosses the threshold and ends at the point where the aircraft fuselage is out of the runway plane.



Improvement Case Study (9): Runway Exit Assignment Table

- Design a New Runway
- Improve an Existing Runway
 - Create New Folder...
 - Runway33
 - Start Improvement...
 - Delete Case Folder
 - Runway33_improvement
 - Runway Settings
 - Runway Exit Locations
 - Runway Occupancy Times
 - Tables
 - Plots
 - Runway Exit Aircraft Assignment
 - Tables →
 - Plots
- Landing Components Distributions
- Landing Distances and Times
 - Edit Runway
 - Delete Runway

- Evaluate an Existing Runway

Improve an Existing Runway - Runway Exit Aircraft Assignment (Runway33_improvement) - Table

Runway Exit Aircraft Assignment

(Runway33_improvement)

Aircraft Name	E1	E2	New Exit 1	E3	New Exit 2	E4	E5	Aircraft Mix
A320			47.5%		46.8%		5.6%	20.5%
B738			43.8%		50.1%		6.1%	19.9%
B744			20.4%		59.1%		20.5%	5.1%
B773			27.6%		57.8%		14.6%	4.9%
BE30	1.3%		98.3%		0.4%			5.0%
BE33	31.7%		67.5%		0.6%		0.2%	5.0%
BE55	1.4%		98.6%		0.1%			5.2%
C525			92.8%		6.0%		1.2%	9.8%
CL60			91.3%		8.4%		0.3%	5.0%
E145			77.1%		20.9%		2.0%	9.6%
SR22	6.9%		92.5%		0.5%		0.0%	10.0%
Exit Mix	2.4%	0.0%	64.6%	0.0%	28.5%	0.0%	4.5%	

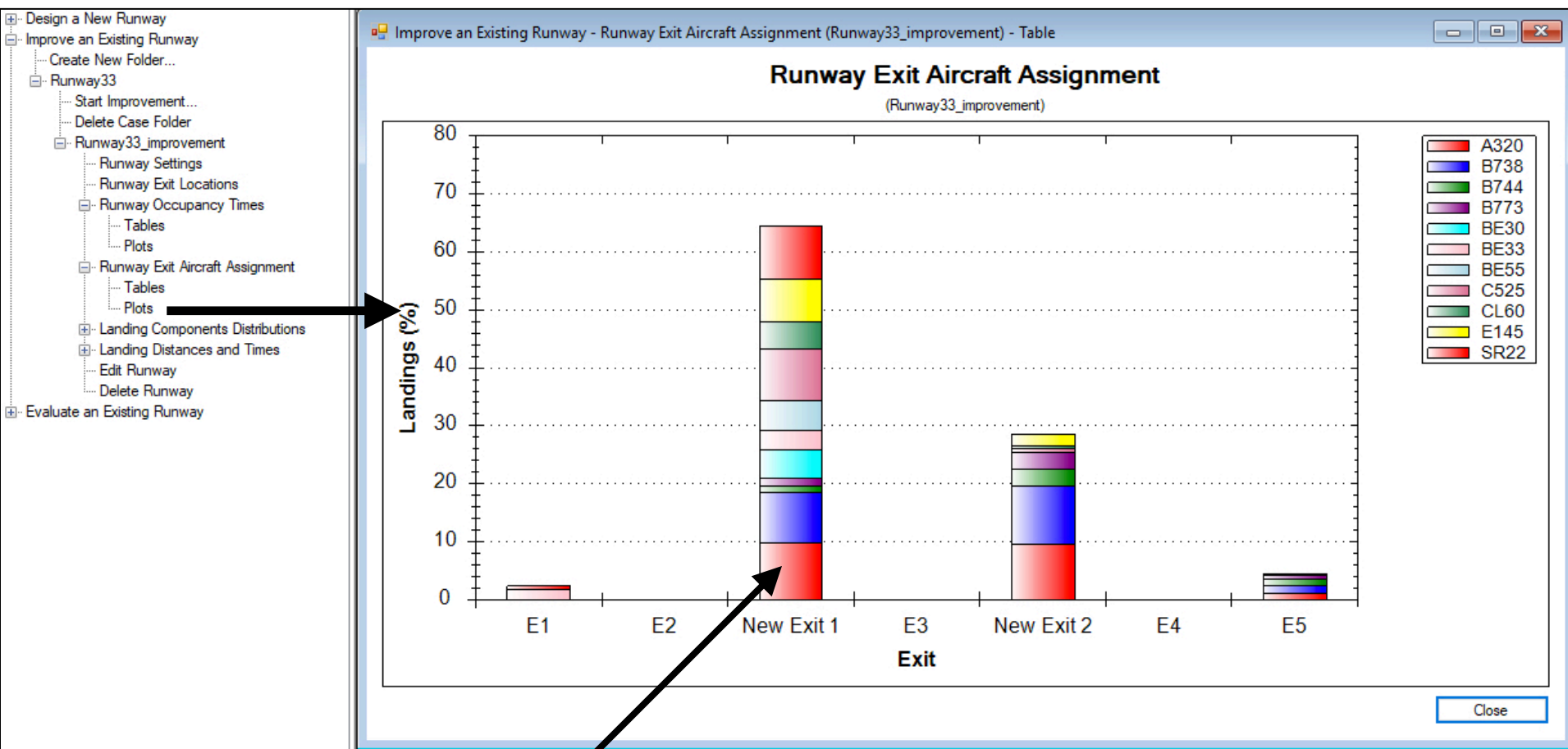
Save Table Close

Table can be saved in comma delimited format

- Runway assignments are reported in percent of the individual aircraft using each exit
- The aircraft mix simulated (in percent) is shown in the last column of the table
- The runway exit mix using each exit is shown in the last row of the table (in percent)



Improvement Case Study (10): Runway Exit Assignment Plot



Runway assignments are reported in stacked column format



Improvement Case Study (11): Landing Distribution Tables

File Aircraft Database Window Help

Design a New Runway
 Improve an Existing Runway
 Create New Folder...
 Runway33
 Start Improvement...
 Delete Case Folder
 Runway33_improvement
 Runway Settings
 Runway Exit Locations
 Runway Occupancy Times
 Tables
 Plots
 Runway Exit Aircraft Assignment
 Tables
 Plots
 Landing Components Distributions
 Tables
 Plots
 Landing Distances and Times
 Edit Runway
 Delete Runway
 Evaluate an Existing Runway

Improve an Existing Runway - Total Distance for B738 (Runway33_improvement) - Table

Choose Aircraft: B738 Metric: Distance Landing Component: Total

Total Distance for B738

(Runway33_improvement)

	Distance (ft)	PDF All (%)	PDF Dry (%)	PDF Wet (%)	CDF All (%)	CDF Dry (%)	CDF Wet (%)
▶	6,512	43.8	46.5	18.1	43.8	46.5	18.1
	6,537	0.0	0.0	0.0	43.8	46.5	18.1
	6,562	0.0	0.0	0.0	43.8	46.5	18.1
	6,587	0.0	0.0	0.0	43.8	46.5	18.1
	6,612	0.0	0.0	0.0	43.8	46.5	18.1
	6,637	0.0	0.0	0.0	43.8	46.5	18.1
	6,662	0.0	0.0	0.0	43.8	46.5	18.1
	6,687	0.0	0.0	0.0	43.8	46.5	18.1
	6,712	0.0	0.0	0.0	43.8	46.5	18.1
	6,737	0.0	0.0	0.0	43.8	46.5	18.1
	6,762	0.0	0.0	0.0	43.8	46.5	18.1
	6,787	0.0	0.0	0.0	43.8	46.5	18.1
	6,812	0.0	0.0	0.0	43.8	46.5	18.1
	6,837	0.0	0.0	0.0	43.8	46.5	18.1
	6,862	0.0	0.0	0.0	43.8	46.5	18.1
	6,887	0.0	0.0	0.0	43.8	46.5	18.1
	6,912	0.0	0.0	0.0	43.8	46.5	18.1
	6,937	0.0	0.0	0.0	43.8	46.5	18.1
	6,962	0.0	0.0	0.0	43.8	46.5	18.1
	6,987	0.0	0.0	0.0	43.8	46.5	18.1
	7,012	0.0	0.0	0.0	43.8	46.5	18.1
	7,037	0.0	0.0	0.0	43.8	46.5	18.1
	7,062	0.0	0.0	0.0	43.8	46.5	18.1
	7,087	0.0	0.0	0.0	46.5	18.1	18.1
		0.0			46.5	18.1	18.1
		0.0			46.5	18.1	18.1

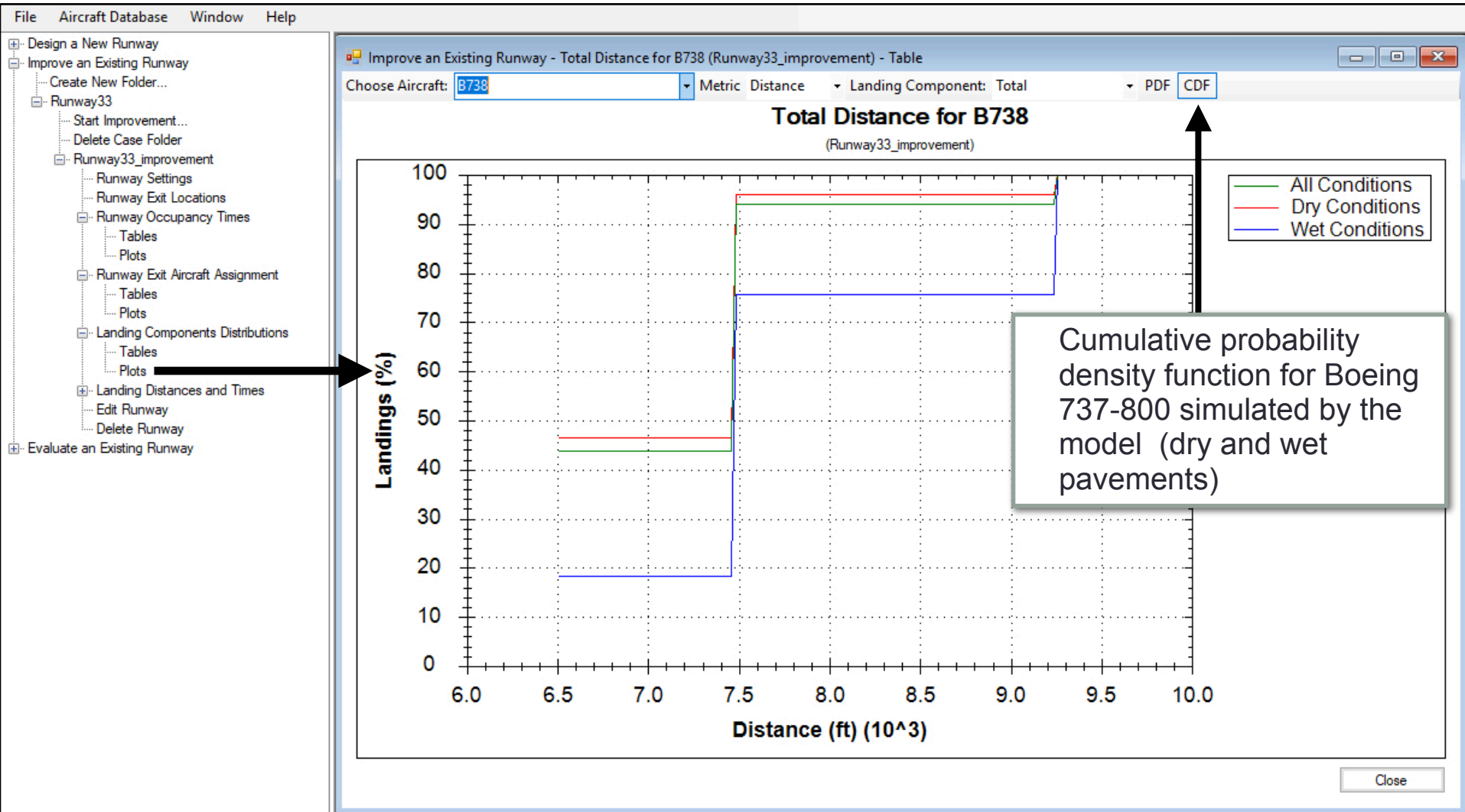
Save Table Close

Landing distance for individual landings of Boeing 737-800 simulated by the model

Probability density function for Boeing 737-800 simulated by the model (dry and wet pavements)



Improvement Case Study (12): Landing Distribution Plots





Improvement Case Study (13): Landing Distances and Times

File Aircraft Database Window Help

Design a New Runway
Improve an Existing Runway
 Create New Folder...
 Runway33
 Start Improvement...
 Delete Case Folder
 Runway33_improvement
 Runway Settings
 Runway Exit Locations
 Runway Occupancy Times
 Tables
 Plots
 Runway Exit Aircraft Assignment
 Tables
 Plots
 Landing Components Distributions
 Tables
 Plots
 Landing Distances and Times
 Tables
 Plots
 Edit Runway
 Delete Runway
Evaluate an Existing Runway

Improve an Existing Runway - Landing Distances for A320 (Runway33_improvement) - Table

Choose Aircraft: A320 Distances Times Speeds & Decelerations

Landing Distances for A320

(Runway33_improvement)

Landing Number	Wet Conditions	Exit	Air Distance (ft)	Braking Distance (ft)	Extra Roll Distance (ft)	Turnoff Distance (ft)	Total Distance (ft)
1		New Exit 2	2,831	2,944	1,033	676	7,483
2		New Exit 2	2,781	2,901	1,125	672	7,480
3		New Exit 1	2,209	2,750	865	672	6,496
4		New Exit 2	2,978	3,133	696	674	7,482
5		New Exit 1	2,195	3,016	613	674	6,498
6		New Exit 2	2,659	2,689	1,459	675	7,482
7		New Exit 1	1,911	3,001	912	673	6,496
8		New Exit 2	2,564	3,467	776	674	7,482
9		E5	2,306	3,722	2,972	258	9,257
10		New Exit 1	2,186	2,792	845	673	6,496
11		New Exit 2	2,223	3,038	1,547	672	7,480
12		New Exit 2	2,860	2,913	1,035	674	7,481
13		New Exit 2	2,318	3,476	1,014	672	7,479
14		New Exit 1	2,109	2,575	1,139	673	6,496
15		New Exit 1	1,997	2,241	1,585	674	6,497
16		New Exit 2	2,862	2,699	1,247	673	7,481
17		New Exit 1	2,585	2,372	866	671	6,495
18		New Exit 2	2,875	3,057	876	673	7,480
19		New Exit 2	2,780	3,035	874	677	7,484
Average			2,489	2,770	1,204	650	7,114

Save Table Close

Total landing distance simulated for Boeing 737-800
(dry and wet pavements - see second column)



Improvement Case Study (14): Speeds and Deceleration

File Aircraft Database Window Help

Design a New Runway
Improve an Existing Runway
Create New Folder...
Runway33
Start Improvement...
Delete Case Folder
Runway33_improvement
Runway Settings
Runway Exit Locations
Runway Occupancy Times
Tables
Plots
Runway Exit Aircraft Assignment
Tables
Plots
Landing Components Distributions
Tables
Plots
Landing Distances and Times
Tables
Plots
Edit Runway
Delete Runway
Evaluate an Existing Runway

Improve an Existing Runway - Landing Speeds & Decelerations for B738 (Runway33_improvement) - Table

Choose Aircraft: B738 Distances Times **Speeds & Decelerations**

Landing Speeds Decelerations for B738
(Runway33_improvement)

Landing Number	Wet Conditions	Exit	Threshold Crossing Speed (knots)	Touchdown Speed (knots)	Nominal Speed (knots)	Speed at PC (knots)	Nominal Deceleration (m/s ²)	Deceleration to PC (m/s ²)	Deceleration after PC (m/s ²)	Touchdown Speed Coefficient	Deceleration t PC Coefficient
1		E5	151	143	70	22	-1.92	-0.67	-0.31	0.95	0.35
2	Yes	New Exit 2	148	141	70	36	-2.07	-1.77	-0.63	0.95	0.86
3		New Exit 1	144	137	70	37	-2.34	-1.26	-0.63	0.95	0.54
4		New Exit 1	151	144	70	32	-2.62	-1.42	-0.63	0.95	0.54
5		New Exit 1	154	147	70	39	-2.40	-2.07	-0.63	0.95	0.86
6	Yes	New Exit 2	146	139	70	40	-1.87	-1.14	-0.63	0.95	0.61
7	Yes	E5	142	135	70	28	-1.70	-0.63	-0.31	0.95	0.37
8		New Exit 1	148	141	70	36	-2.69	-1.55	-0.63	0.95	0.58
9		New Exit 2	141	134	70	38	-2.12	-1.18	-0.63	0.95	0.55
10		New Exit 2	148	141	70	35	-2.00	-1.23	-0.63	0.95	0.62
11		New Exit 2	147	139	70	33	-2.29	-1.63	-0.63	0.95	0.71
12		New Exit 2	154	146	70	30	-2.02	-2.06	-0.63	0.95	1.02
13		E5	149	141	70	19	-1.91	-0.74	-0.31	0.95	0.39
14	Yes	E5	153	145	70	23	-1.66	-0.94	-0.31	0.95	0.57
15		New Exit 1	142	135	70	43	-2.44	-1.27	-0.63	0.95	0.52
16		New Exit 1	141	134	70	38	-2.44	-1.06	-0.63	0.95	0.43
17		New Exit 1	141	134	70	47	-2.06	-1.53	-0.63	0.95	0.74
18		New Exit 1	145	138	70	48	-2.66	-0.98	-0.63	0.95	0.37
19		New Exit 2	146	139	70	41	-2.29	-0.97	-0.63	0.95	0.42
20		New Exit 1	152	144	70	43	-2.68	-1.55	-0.63	0.95	0.58
21		New Exit 2	150	142	70	32	-2.08	-1.75	-0.63	0.95	0.84
22		New Exit 2	155	147	70	51	-2.35	-1.43	-0.63	0.95	0.61
23		New Exit 2	155	148	70	44	-2.33	-1.10	-0.63	0.95	0.47
24		New Exit 2	146	139	70	33	-2.06	-2.23	-0.63	0.95	1.08
25		New Exit 2	154	147	70	36	-2.48	-1.13	-0.63	0.95	0.45
Average			147	140	70	38	-2.25	-1.48	-0.61	0.95	0.66

Save Table Close

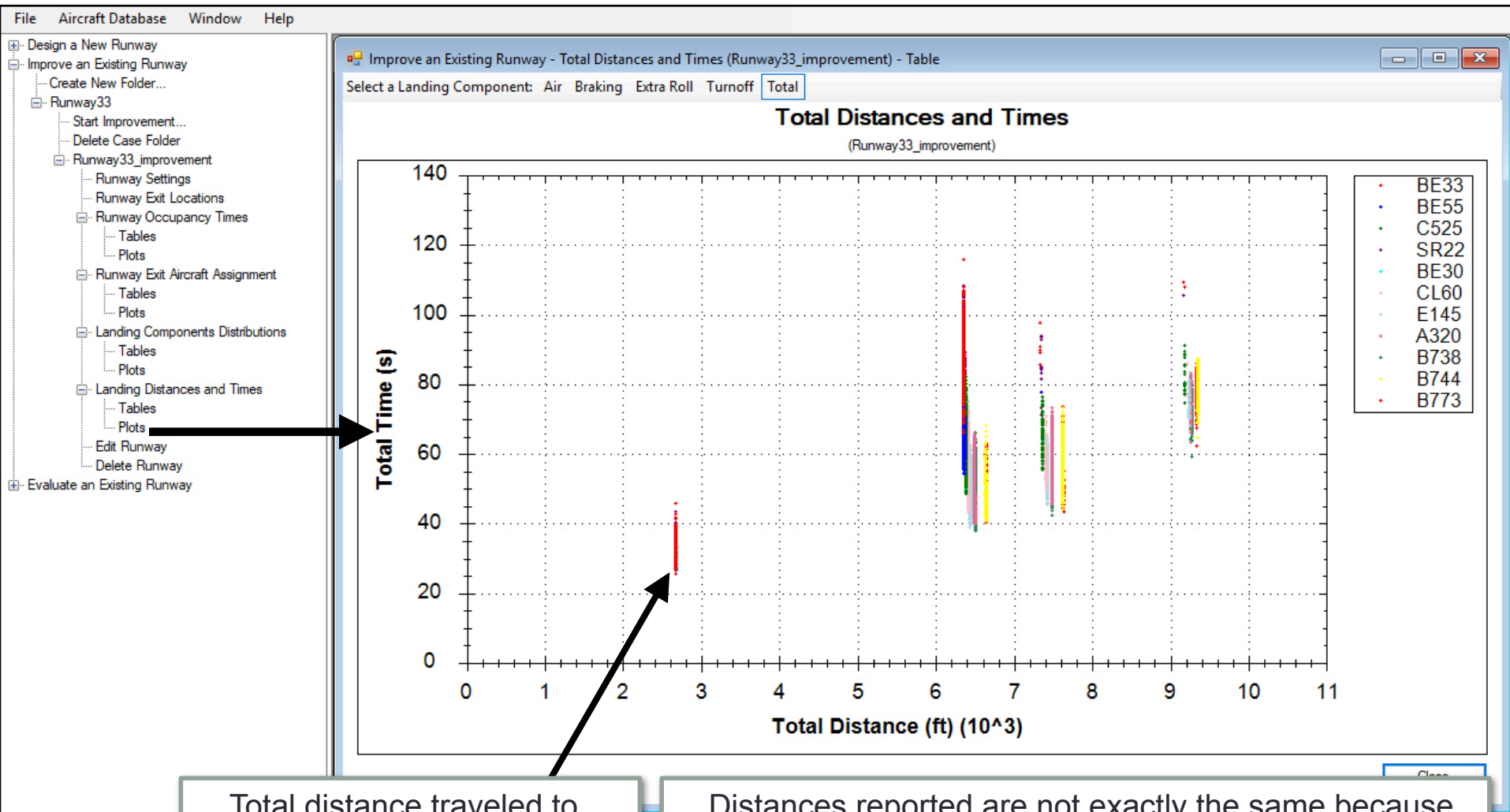
Speed and deceleration tab

Runway exit used by each simulated landing

Nominal deceleration rate for each simulated Boeing 737-800 landing (dry and wet pavements - see second column)



Improvement Case Study (15): Landing Distances and Times (Plots)

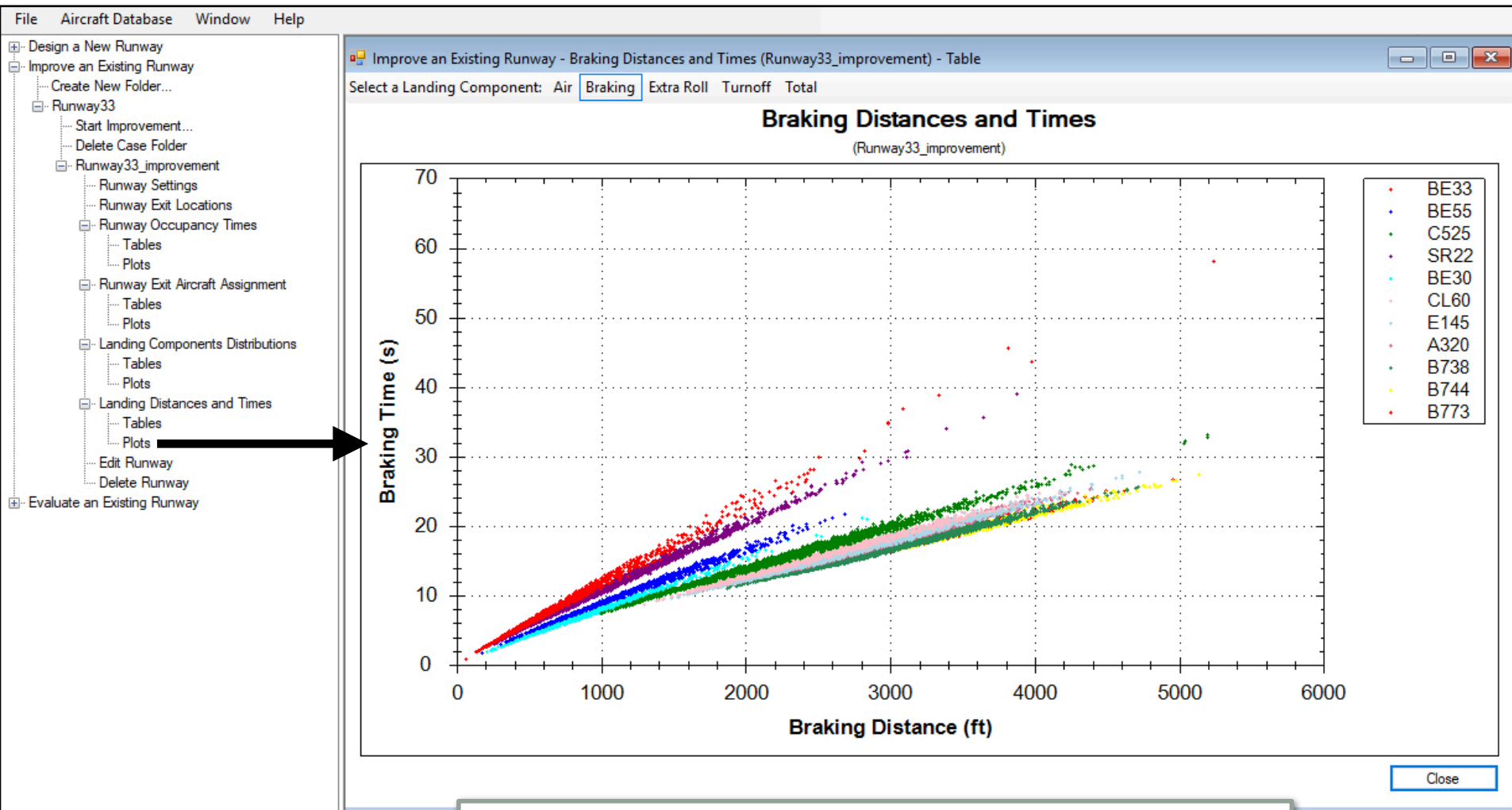


Total distance traveled to point where aircraft exits the plane of the runway

Distances reported are not exactly the same because larger aircraft travel longer distance to exit the plane of the runway



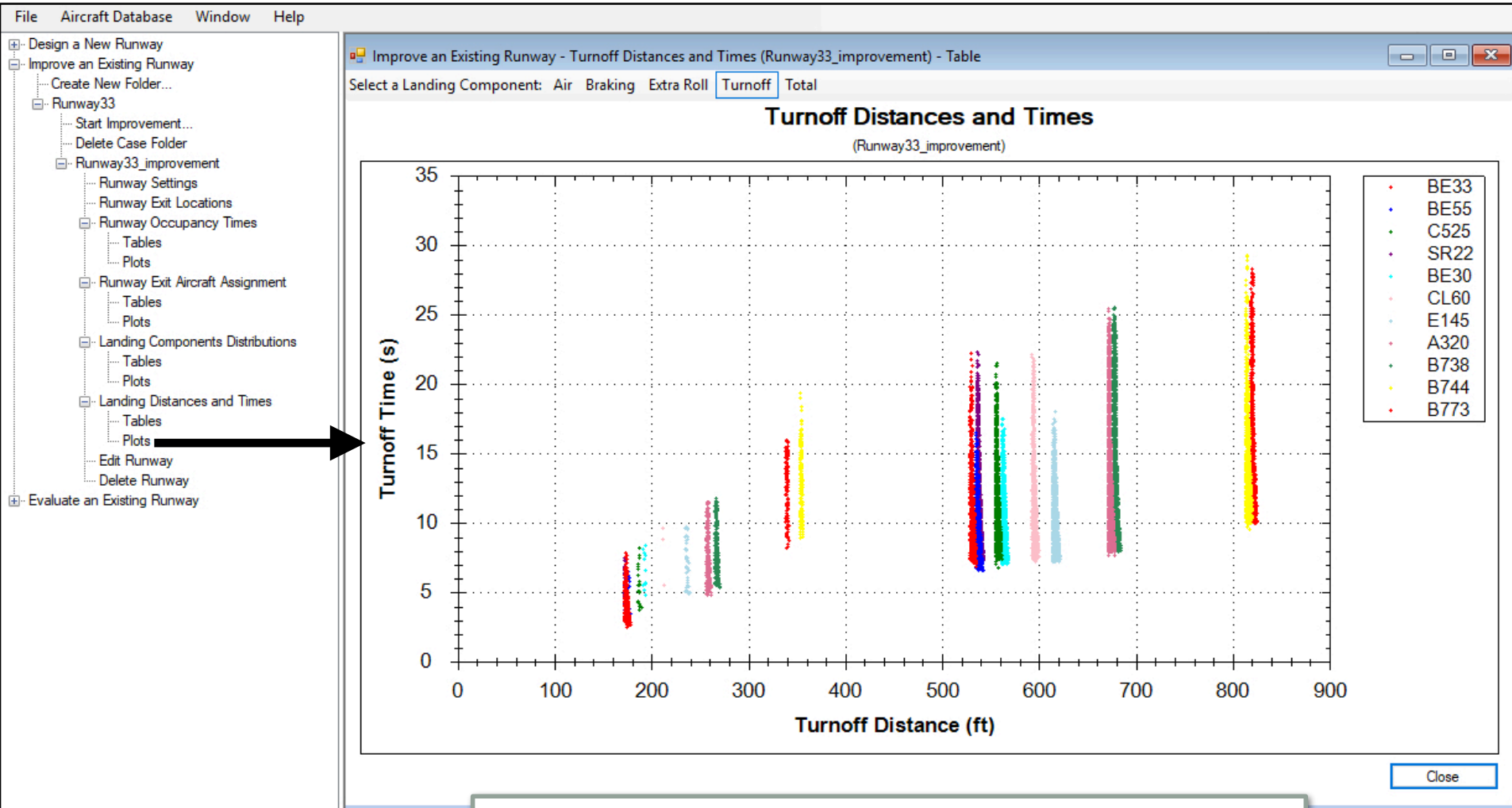
Improvement Case Study (16): Landing Braking Times



Braking times reported are the estimated times in the braking phase of the landing



Improvement Case Study (17): Runway Turnoff Times



Times reported are the estimated times from the runway exit point of curvature to the point where the fuselage of the aircraft exits the plane of the runway



Runway Evaluation Case Study



Summary of Evaluation Case Study

- Evaluate an existing 9,000 ft. runway with mixed runway exits as shown in the table
- Five existing runway exits
- Sea level ISA conditions
- 10% wet and 90% dry pavement conditions

Runway Exit Name	Location of Point of Curvature (ft)	Runway Exit Type
E1	2500	90 deg.
E2	5300	30 deg., 1500 ft radius
E3	6500	30 deg., 1500 ft radius
E4	7800	90 deg.
E5	9000	90 deg.



Summary of Evaluation Case Study

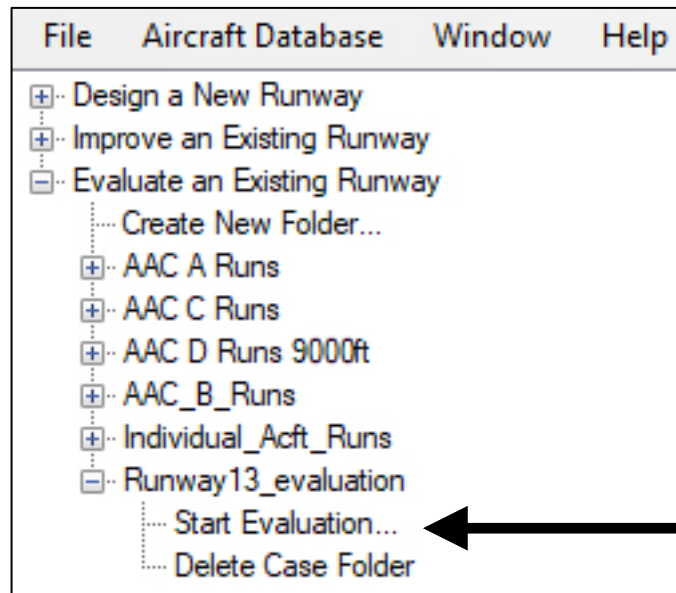
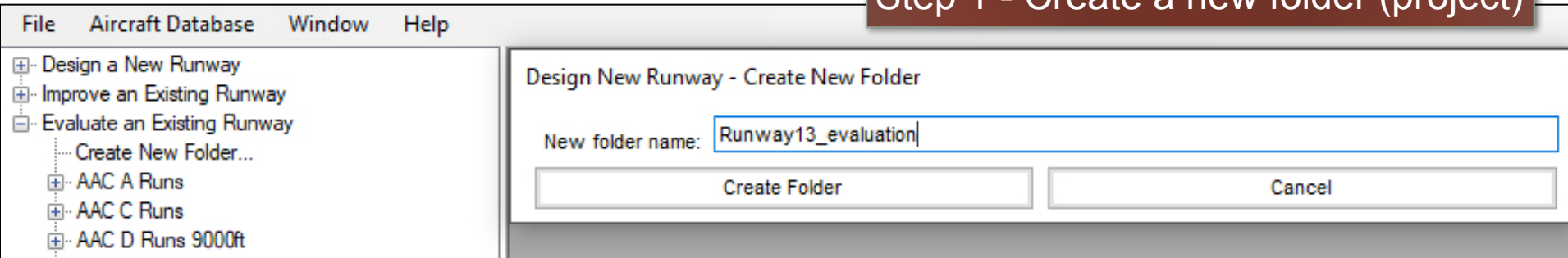
- Evaluation an existing runway with 5 runway exits
- Eleven aircraft in fleet mix
- Sea level ISA conditions
- 10% wet and 90% dry pavement conditions

+	Analysis Info
-	Selected Aircraft
...	BE33 - Beechcraft F33 Bonanza - 5%
...	BE55 - Beechcraft 55 Baron - 5%
...	C525 - Cessna 525 CitationJet - 10%
...	SR22 - Cirrus SR-22 - 10%
...	BE30 - Beechcraft B300 King Air - 5%
...	CL60 - Bombardier Challenger 600 - 5%
...	E145 - Embraer 145 - 10%
...	A320 - Airbus A320 - 20%
...	B738 - Boeing 737-800 - 20%
...	B744 - Boeing 747-400 - 5%
...	B773 - Boeing 777-300 - 5%
-	Analysis Constraints
...	Number Of New Exits: 2
...	New Exit Type: 30° (with 1,500 ft circular arc)
...	New Exit Locations: Between E2 & E4
-	Environmental Data
...	Airport Elevation: 0 feet
...	Airport Temperature: 59°F
...	Runway Length: 8999 feet
...	Runway Width: 148 feet
...	Minimum Exit Separation: 801 feet
...	Wet Conditions: 10%
+	Existing Exits



Evaluation Case Study

Step 1 - Create a new folder (project)



Step 2 - Define the runway parameters in the newly created runway scenario



Evaluation Case Study (2)

FileAircraft DatabaseWindowHelp

+

Design a New Runway

+

Improve an Existing Runway

-

Evaluate an Existing Runway

...

Create New Folder...

+

AAC A Runs

+

AAC C Runs

+

AAC D Runs 9000ft

+

AAC_B_Runs

+

Individual_Acft_Runs

-

Runway13_evaluation

...

Start Evaluation...

...

Delete Case Folder

Step 3 - Enter the runway general information

Evaluate an Existing Runway - Step 1 - General Information

Step 1: General Information

Units

☐ Metric
☒ Imperial

Runway Information

Name:Runway13_myAirport

Length:2743meters.9000feet

Width:45meters.148feet

Airport Information

Elevation:0meters.0feet

Temperature:15degrees Celsius.59degrees Fahrenheit

Wet Conditions: 0%100%10%

We suggest using 10% wet and 90% dry for design purposes for most airports

Cancel

<- Previous

Next ->

Air Transportation Systems Laboratory

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Evaluation Case Study (3)

File
Aircraft Database
Window
Help

- Design a New Runway
- Improve an Existing Runway
- Evaluate an Existing Runway
 - Create New Folder...
 - AAC A Runs
 - AAC C Runs
 - AAC D Runs 9000ft
 - AAC_B_Runs
 - Individual_Acft_Runs
 - Runway13_evaluation
 - Start Evaluation...
 - Delete Case Folder

Evaluate an Existing Runway - Step 2 - Define Aircraft Mix for New Runway

Step 2: Define Aircraft Mix for New Runway

Aircraft ID	Aircraft Name	Aircraft Design Group	Aircraft Approach Category	Aircraft Mix (%)
C550	Cessna 550 Citation II	II	B	
C560	Cessna 560 Citation Ultra	II	B	
C56X	Cessna 560X Citation Excel	II	B	5
C650	Cessna 650 Citation III	II	B	
C680	Cessna 680 Sovereign	II	B	
C750	Cessna 750 Citation X	II	B	
CL30	Bombardier Challenger 300	II	B	
CL35	Bombardier Challenger 350	II	B	
CL60	Bombardier Challenger 600	II	B	5
CRJ2	Bombardier CRJ 200	II	C	
CRJ7	Bombardier CRJ 700	II	C	10
D328	Domier 328	II	C	
E120	Embraer 110 Brasilia	II	B	
E135	Embraer 135	II	C	
E145	Embraer 145	II	C	5
E35L	Embraer 135 Long Range	II	C	

Total aircraft mix allocated: 100%

Cancel
<- Previous
Next ->

Step 4 - Define the aircraft fleet mix that will use the runway



Evaluation Case Study (4)

File Aircraft Database Window Help

Design a New Runway
Improve an Existing Runway
Evaluate an Existing Runway
 Create New Folder...
 AAC A Runs
 AAC C Runs
 AAC D Runs 9000ft
 AAC_B_Runs
 Individual_Acft_Runs
 Runway13_evaluation
 Start Evaluation...
 Delete Case Folder

Evaluate an Existing Runway - Step 3 - Runway Constraints

Step 3: Runway Constraints

	Exit Name	Exit Point Of Curvature Location (ft)	Exit Type		Open
	E1	2500	90°	▼	<input checked="" type="checkbox"/>
	E2	5300	30° (with 1,500 ft circular arc)	▼	<input checked="" type="checkbox"/>
	E3	6500	30° (with 1,500 ft circular arc)	▼	<input checked="" type="checkbox"/>
	E4	7800	90°	▼	<input checked="" type="checkbox"/>
▶	E5	9000	90°	▼	<input checked="" type="checkbox"/>
*				▼	<input type="checkbox"/>

Step 5 - Define the existing runway configuration

Custom Exit Definition

Angle: degrees.

Radius of Central Curve: meters. feet

Path Length from Point of Curvature to Holdbar: meters. feet

Save

Cancel <- Previous Next ->



Evaluation Case Study (5): Review the Results

File Aircraft Database Window Help

- Design a New Runway
- Improve an Existing Runway
- Evaluate an Existing Runway
 - Create New Folder...
 - AAC A Runs
 - AAC C Runs
 - AAC D Runs 9000ft
 - AAC_B_Runs
 - Individual_Acft_Runs
 - Runway13_evaluation
 - Start Evaluation...
 - Delete Case Folder
 - Runway13_myAirport
 - Runway Settings
 - Runway Exit Locations
 - Runway Occupancy Times
 - Tables
 - Plots
 - Runway Exit Aircraft Assignment
 - Tables
 - Plots
 - Landing Components Distributions
 - Tables
 - Plots
 - Landing Distances and Times
 - Tables
 - Plots
 - Edit Runway
 - Delete Runway

Evaluate an Existing Runway - Runway Exit Locations (Runway1...

Runway Exit Locations

(Runway13_myAirport)

Exit	Exit Status	Exit Type	Location (ft)
E1	Open	90°	2,500
E2	Open	30° (with 1,500 ft circular arc)	5,299
E3	Open	30° (with 1,500 ft circular arc)	6,499
E4	Open	90°	7,799
E5	Open	90°	8,999

Save Table Close



Evaluation Case Study (6): Runway Occupancy Times Table

File Aircraft Database Window Help

Design a New Runway
Improve an Existing Runway
Evaluate an Existing Runway
 Create New Folder...
 AAC A Runs
 AAC C Runs
 AAC D Runs 9000ft
 AAC_B_Runs
 Individual_Acft_Runs
 Runway13_evaluation
 Start Evaluation...
 Delete Case Folder
 Runway13_myAirport
 Runway Settings
 Runway Exit Locations
 Runway Occupancy Times
 Tables
 Plots
 Runway Exit Aircraft Assignment
 Tables
 Plots
 Landing Components Distributions
 Tables
 Plots
 Landing Distances and Times
 Tables
 Plots

Evaluate an Existing Runway - Runway Occupancy Times (56.4 s - Std Dev: 10.1 s) (Runw... [min] [max] [close]

Show: Times To PC Turnoff Times Runway Occupancy Times

Runway Occupancy Times (56.4 s - Std Dev: 10.1 s)
(Runway13_myAirport)

Aircraft Name	E1	E2	E3	E4	E5
A321		43.2s	53.2s	59.2s	68.4s
A333		51.7s	61.2s	65.0s	71.3s
B738		43.2s	52.6s	58.9s	67.1s
B748		47.3s	58.2s	66.9s	75.3s
B773		45.6s	54.2s	63.1s	70.8s
BE30	28.9s	56.6s	62.2s	74.8s	
BE58	31.0s	60.6s	62.6s		
C206	37.0s	78.9s	89.6s		
C510	29.4s	59.7s	66.1s	73.6s	85.1s
C56X		52.8s	60.2s	68.4s	
CL60		50.4s	57.1s	66.1s	75.1s
CRJ7		44.7s	53.8s	61.9s	72.1s
E145		45.0s	52.8s	61.7s	68.5s
LJ60		48.7s	54.5s	61.7s	
SR22	33.5s	73.5s	77.8s	90.9s	

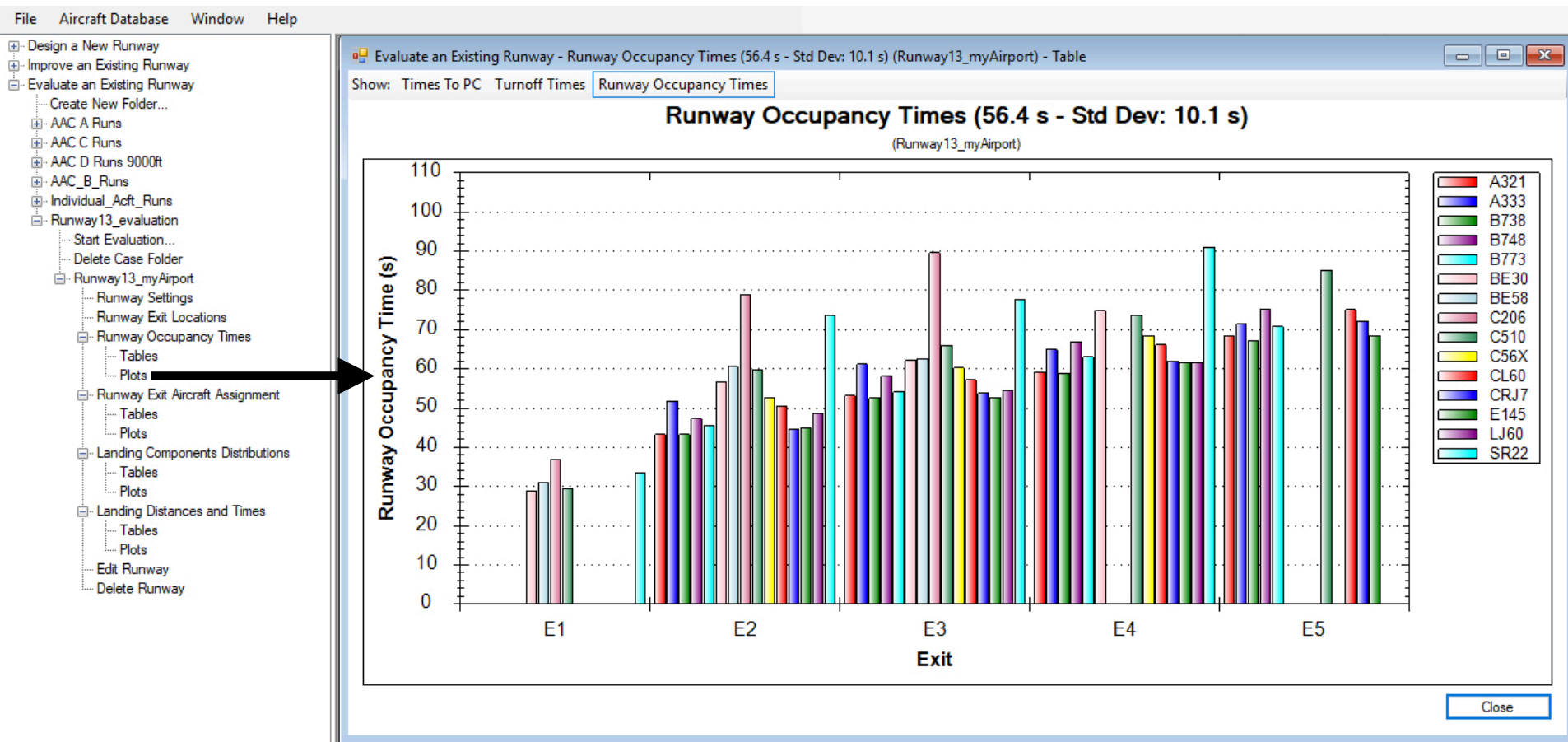
Save Table Close

Table can be saved in comma delimited format

- Runway occupancy times predicted by the model in tabular form
- ROT time starts when the aircraft crosses the threshold and ends at the point where the aircraft fuselage is out of the runway plane.



Evaluation Case Study (7): Runway Occupancy Time Plot



- Runway occupancy times predicted by the model in graphical form
- ROT time starts when the aircraft crosses the threshold and ends at the point where the aircraft fuselage is out of the runway plane.



Evaluation Case Study (8): Runway Exit Assignment Table

File Aircraft Database Window Help

- Design a New Runway
- Improve an Existing Runway
- Evaluate an Existing Runway
 - Create New Folder...
 - AAC A Runs
 - AAC C Runs
 - AAC D Runs 9000ft
 - AAC_B_Runs
 - Individual_Acft_Runs
 - Runway13_evaluation
 - Start Evaluation...
 - Delete Case Folder
 - Runway13_myAirport
 - Runway Settings
 - Runway Exit Locations
 - Runway Occupancy Times
 - Tables
 - Plots
 - Runway Exit Aircraft Assignment
 - Tables
 - Plots
 - Landing Components Distributions
 - Tables
 - Plots
 - Landing Distances and Times
 - Tables
 - Plots
 - Edit Runway
 - Delete Runway

Evaluate an Existing Runway - Runway Exit Aircraft Assignment (Runway13_myAirport) - Table

Runway Exit Aircraft Assignment

(Runway13_myAirport)

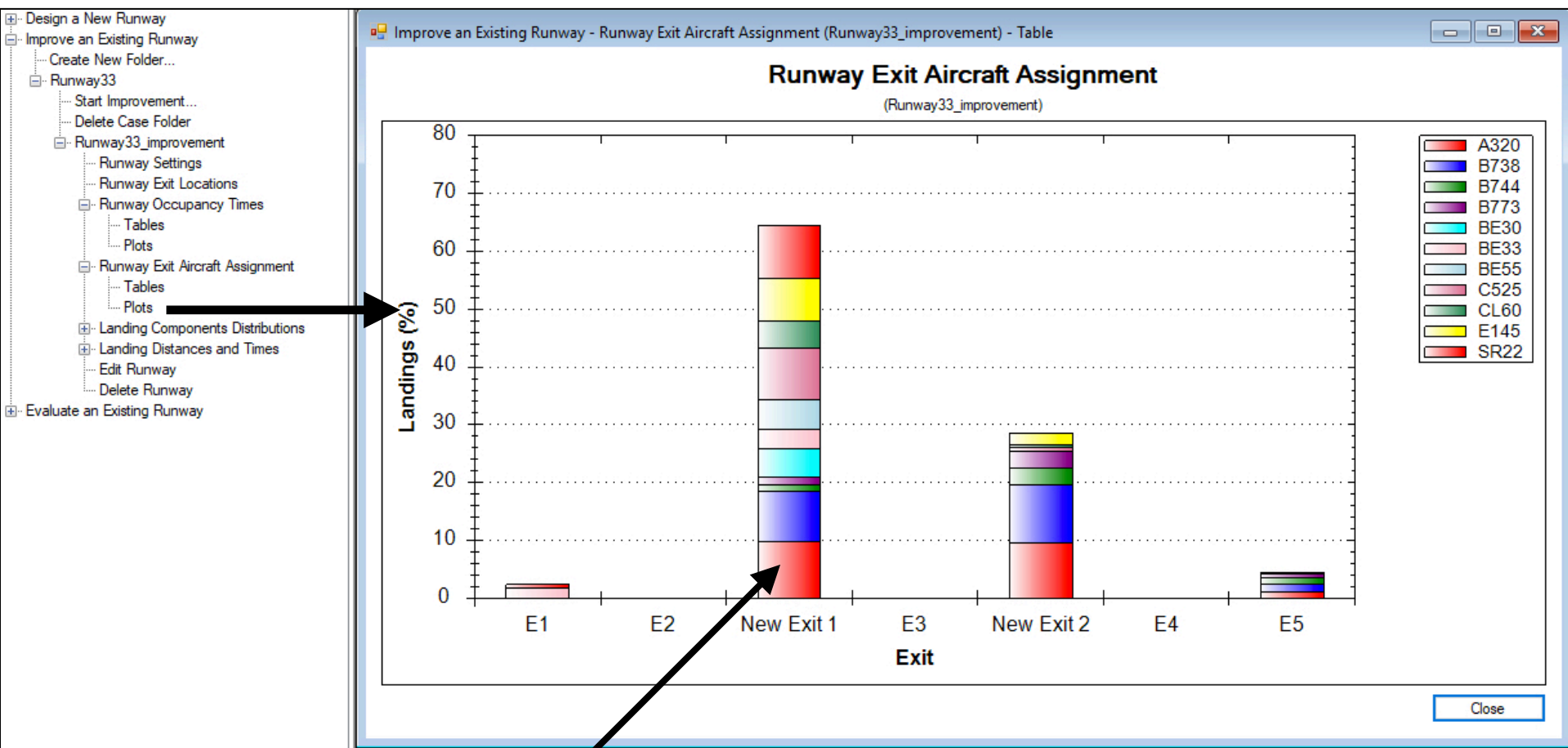
Aircraft Name	E1	E2	E3	E4	E5	Aircraft Mix
A321		5.2%	61.3%	31.5%	2.0%	10.3%
A333		4.2%	64.6%	30.4%	0.8%	5.1%
B738		12.7%	72.9%	14.3%	0.2%	14.9%
B748		2.3%	55.2%	38.3%	4.2%	4.9%
B773		4.9%	67.2%	26.4%	1.5%	5.1%
BE30	2.2%	95.9%	1.8%	0.1%		10.0%
BE58	3.4%	96.3%	0.3%			5.0%
C206	28.6%	71.2%	0.2%			5.2%
C510	0.1%	71.0%	22.6%	4.6%	1.7%	4.9%
C56X		78.8%	19.7%	1.5%		5.0%
CL60		75.4%	23.2%	1.3%	0.1%	5.0%
CRJ7		34.9%	56.8%	8.1%	0.2%	9.7%
E145		53.9%	41.0%	4.9%	0.3%	5.1%
LJ60		69.4%	27.3%	3.3%		4.9%
SR22	6.3%	91.9%	1.6%	0.2%		5.1%
Exit Mix	2.2%	46.4%	39.0%	11.7%	0.7%	

Save Table Close

- Runway assignments are reported in percent of the individual aircraft using each exit
- The aircraft mix simulated (in percent) is shown in the last column of the table



Evaluation Case Study (9): Runway Exit Assignment Plot



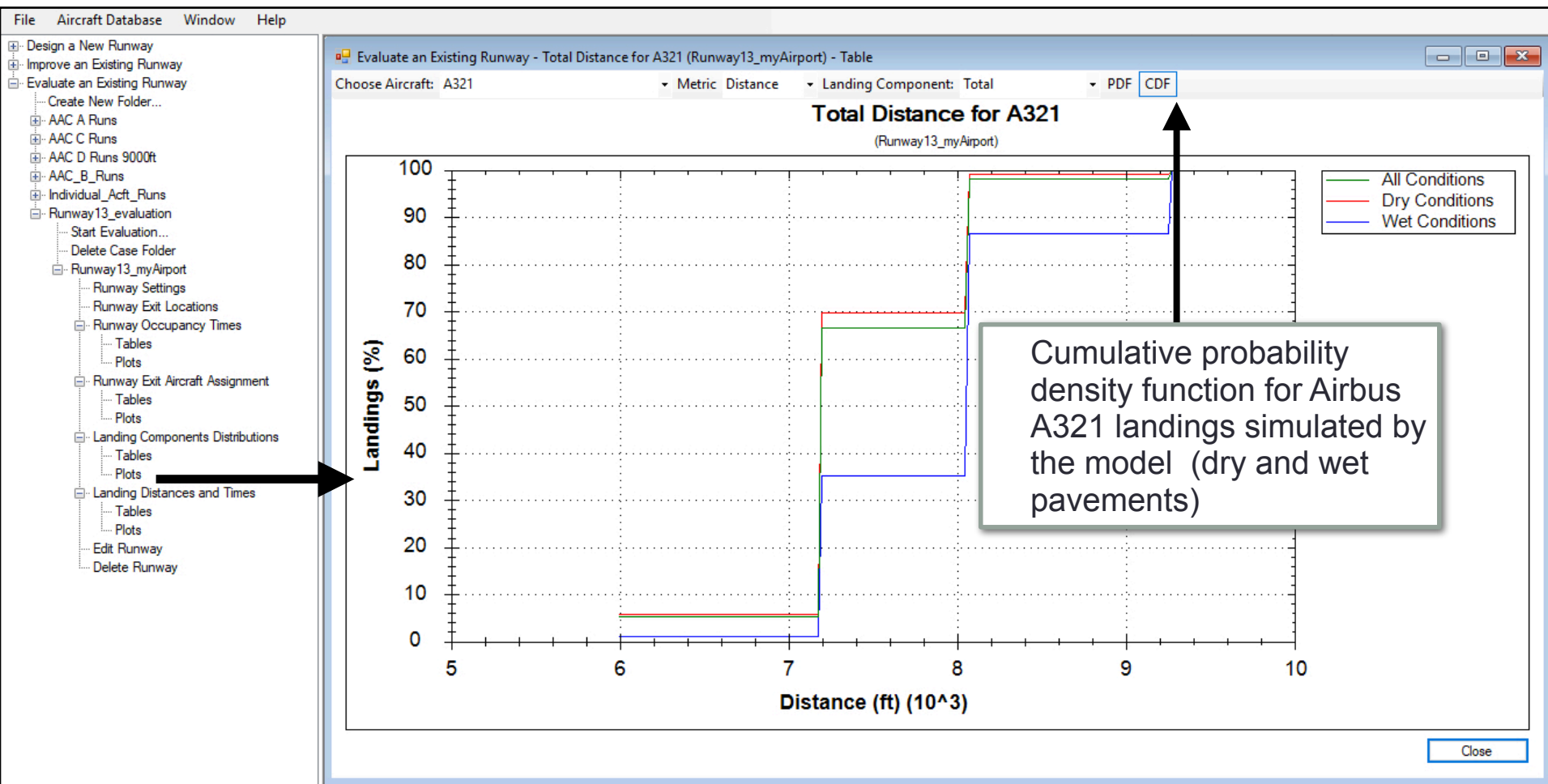
Runway assignments are reported in stacked column format

File Aircraft Database Window Help

Probability density function for Airbus A321 simulated by the model (dry and wet pavements)



Evaluation Case Study (11): Landing Distribution Plots





Evaluation Case Study (12): Landing Distances and Times

File Aircraft Database Window Help

Design a New Runway
Improve an Existing Runway
Evaluate an Existing Runway
Create New Folder...
AAC A Runs
AAC C Runs
AAC D Runs 9000ft
AAC_B_Runs
Individual_Acft_Runs
Runway13_evaluation
Start Evaluation...
Delete Case Folder
Runway13_myAirport
Runway Settings
Runway Exit Locations
Runway Occupancy Times
Tables
Plots
Runway Exit Aircraft Assignment
Tables
Plots
Landing Components Distributions
Tables
Plots
Landing Distances and Times
Tables
Plots
Edit Runway
Delete Runway

Evaluate an Existing Runway - Landing Distances for A321 (Runway13_myAirport) - Table

Choose Aircraft: A321 Distances Times Speeds & Decelerations

Landing Distances for A321

(Runway13_myAirport)

Landing Number	Wet Conditions	Exit	Air Distance (ft)	Braking Distance (ft)	Extra Roll Distance (ft)	Turnoff Distance (ft)	Total Distance (ft)
1		E4	2,422	3,912	1,464	282	8,081
2		E3	3,105	2,215	1,179	689	7,188
3		E4	2,804	3,262	1,732	282	8,080
4		E3	2,365	3,122	1,013	688	7,187
5		E3	2,566	2,803	1,130	688	7,188
6		E3	2,452	3,276	772	691	7,190
7		E3	3,036	2,676	787	687	7,186
8		E3	2,443	3,052	1,004	689	7,188
9		E3	2,550	3,250	699	687	7,187
10		E4	2,689	3,838	1,272	281	8,080
11		E3	3,023	2,286	1,190	688	7,188
12		E4	3,129	3,096	1,574	279	8,078
13		E3	2,569	2,895	1,035	687	7,186
14		E3	2,548	2,853	1,099	690	7,189
15		E3	2,737	2,558	1,204	689	7,188
16	Yes	E4	2,532	4,054	1,212	283	8,085
17		E3	2,196	2,848	1,455	687	7,187
18		E2	2,438	2,343	518	690	5,988
19		E3	2,628	3,074	797	689	7,188
20		E3	2,628	2,301	1,571	687	7,186
21		E3	2,712	2,486	1,302	691	7,190
22		E5	3,156	3,971	1,872	281	9,280
23		E3	2,242	3,230	1,028	691	7,190
24		E3	2,829	2,771	899	689	7,189
Average			2,768	2,919	1,209	552	7,448

Total landing distance simulated for Airbus A321 (dry and wet pavements - see second column)



Evaluation Case Study (13): Speeds and Deceleration

File Aircraft Database Window Help

Design a New Runway
Improve an Existing Runway
Evaluate an Existing Runway
Create New Folder...
AAC A Runs
AAC C Runs
AAC D Runs 9000ft
AAC_B_Runs
Individual_Acft_Runs
Runway13_evaluation
Start Evaluation...
Delete Case Folder
Runway13_myAirport
Runway Settings
Runway Exit Locations
Runway Occupancy Times
Tables
Plots
Runway Exit Aircraft Assignment
Tables
Plots
Landing Components Distributions
Tables
Plots
Landing Distances and Times
Tables
Plots
Edit Runway
Delete Runway

Evaluate an Existing Runway - Landing Speeds & Decelerations for A321 (Runway13_myAirport) Table

Choose Aircraft: A321

Distances Times **Speeds & Decelerations**

Speed and deceleration tab

Landing Speeds Decelerations for A321
(Runway13_myAirport)

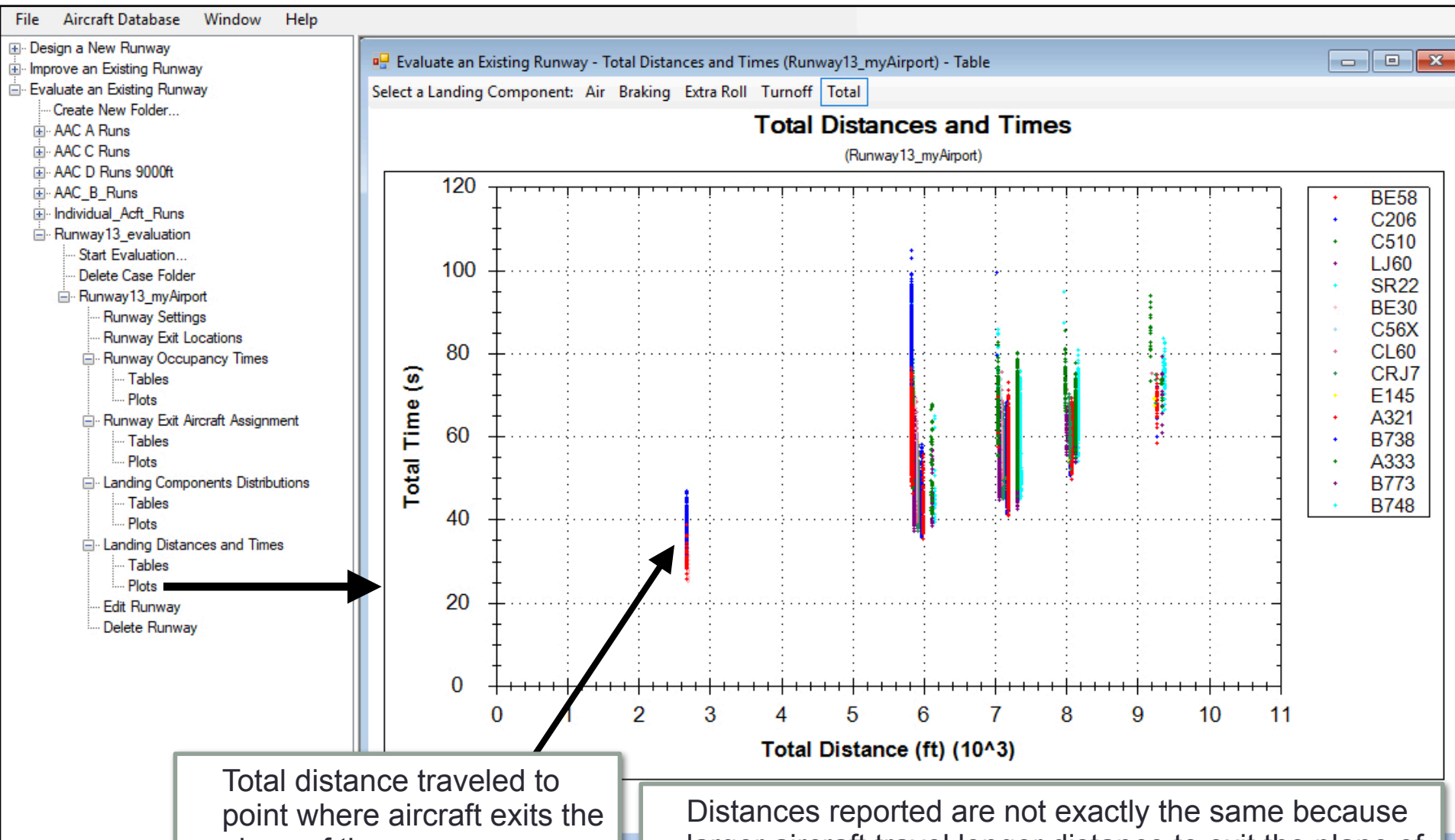
Landing Number	Wet Conditions	Exit	Threshold Crossing Speed (knots)	Touchdown Speed (knots)	Nominal Speed (knots)	Speed at PC (knots)	Nominal Deceleration (m/s ²)	Dec P
1		E4	151	144	70	24	-1.75	
2		E3	139	132	70	45	-2.45	
3		E4	141	134	70	29	-1.73	
4		E3	151	143	70	27	-2.17	
5		E3	150	142	70	29	-2.38	
6		E3	142	135	70	39	-1.76	
7		E3	147	140	70	38	-2.38	
8		E3	152	144	70	39	-2.26	
9		E3	151	144	70	34	-2.11	
10		E4	152	144	70	27	-1.80	
11		E3	145	138	70	38	-2.68	
12		E4	143	136	70	22	-1.91	
13		E3	144	137	70	42	-2.06	
14		E3	149	141	70	35	-2.30	
15		E3	137	131	70	36	-2.06	
16	Yes	E4	147	140	70	29	-1.56	
17		E3	141	134	70	29	-2.00	
18		E2	145	138	70	36	-2.60	
19		E3	144	137	70	29	-1.95	
20		E3	138	131	70	31	-2.33	
21		E3	148	140	70	46	-2.59	
		E5	153	146	70	21	-1.78	

Runway exit used by each simulated landing

Approach speeds for each simulated Airbus A321 landing (dry and wet pavements - see second column)

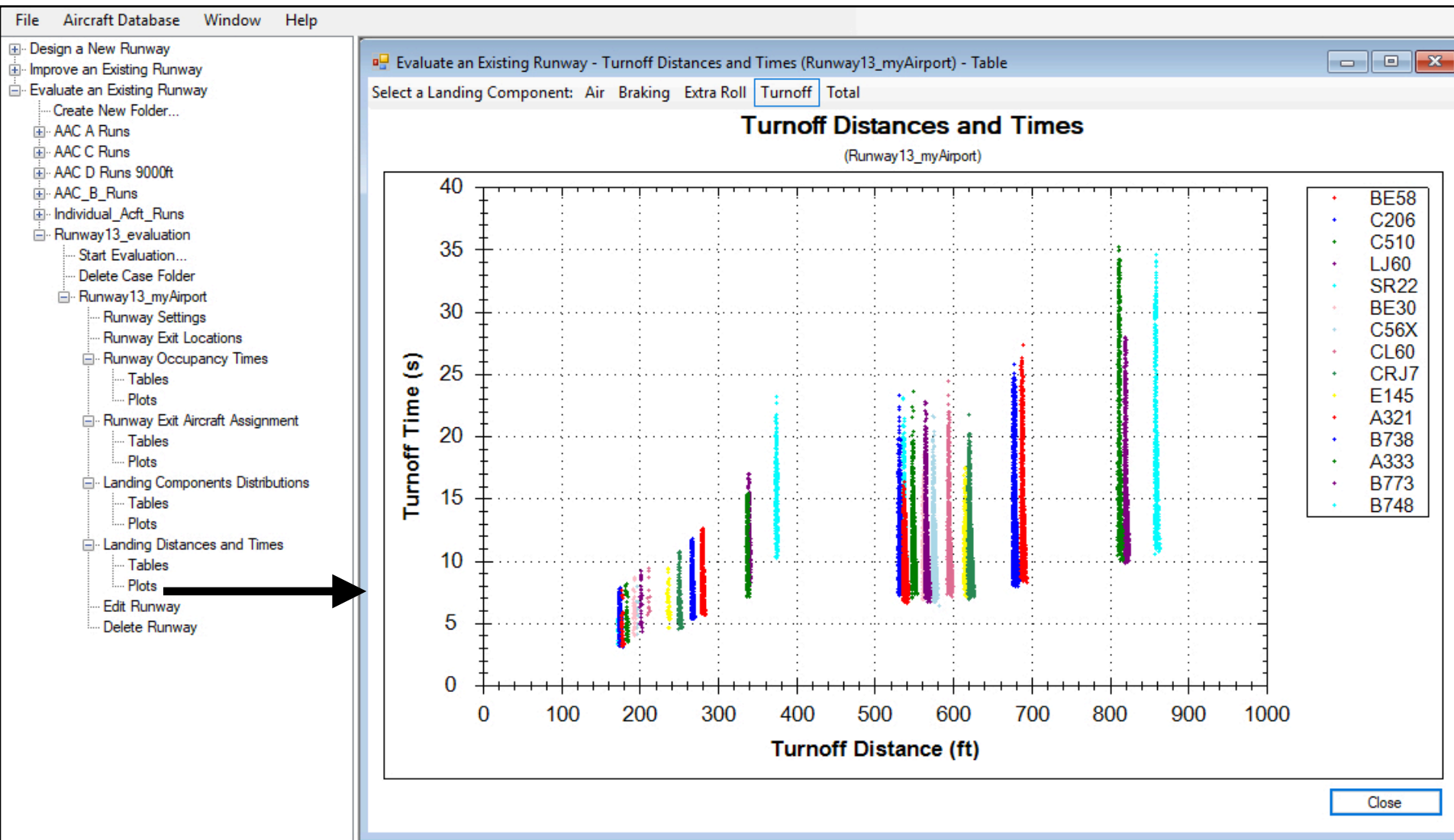


Evaluation Case Study (14): Landing Distances and Times (Plots)





Evaluation Case Study (15): Runway Turnoff Times





Known Issues with Small Aircraft

- Small General Aviation (GA) aircraft behavior improvements are on-going at Virginia Tech
 - We plan to release version 3.1 in May addressing small single engine aircraft behavior
- If you need to simulate single-engine piston or turboprop powered aircraft for your airport project we suggest using the following aircraft:
 - Beechcraft Bonanza (BE36) - piston
 - Cessna Caravan (C208) - turboprop
 - Socata-Daher TBM 800 (TBM8) - turboprop