The European Commission's science and knowledge service

Joint Research Centre

VECTO Air Drag

2018 VECTO Workshop

Ispra, November, 2018

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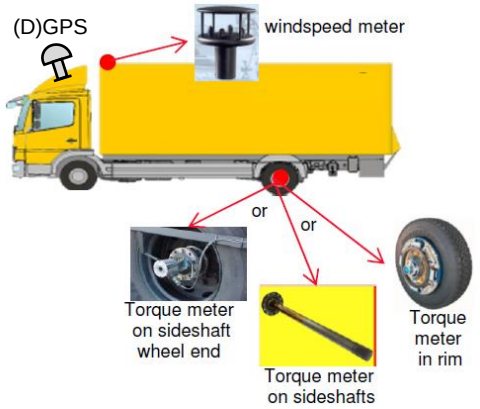
Content / Agenda

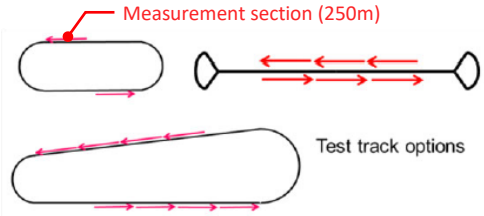
- Basic principles of the Constant Speed Test (CST)
- Overview content of Annex VIII to Commission Regulation (EU) 2017/2400
- VECTO Air Drag tool (air-drag pre-processing tool)
  - Basic tool features
  - Input data
  - Additional MS Excel tool
  - VECTO Air Drag software demonstration
  - Output data
- Q&A (ca. 15 min)

Basic principles of the Constant Speed Test (CST)

- Main measurement signals:
  - actual air velocity (vehicle velocity plus wind) and direction — Air flow
  - wheel torque of driven wheels — Total driving resistance force
  - engine speed — Total driving resistance force
  - vehicle velocity — Total driving resistance force
  - vehicle position ((D)GPS, trigger) — Calibration, allocation to "measurement sections"



- Measurement at two constant vehicle velocities:
  Low speed ("LS", ~15 km/h), High speed ("HS", ~90 km/h)
- Test sequence: Warm up, Zeroing, LS – HS – LS, Drift check
- Additional "misalignment test" to calibrate anemometer



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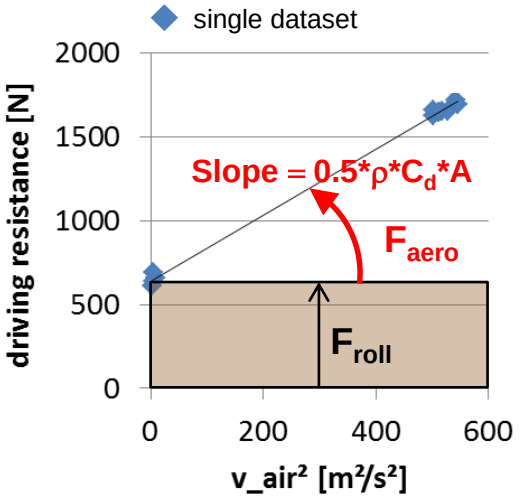
Basic principles of the Constant Speed Test (CST)

- Evaluation method:
  - Measurement data evaluated on level of single passings of measurement sections (“dataset”)
  - Only datasets which fulfill all validity criteria considered
  - Extract F_{roll} in a mathematical way from the total driving resistance forces measured at low and high speed
  - Assume constant rolling resistance force F_{roll} and air drag force F_{aero} to be quadratic to the velocity
  - Calculate for data with β between 0 and 3º, C_dxA from F_{aero} based on the actual measured air velocity and air density
  - Per vehicle group assume a generic C_dxA(β) shape and correct for cross-wind influence during measurements
  - Final result: C_dxA(β=0°)



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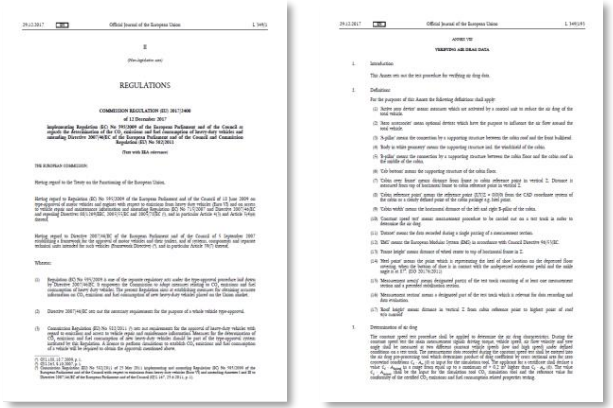
Overview content of Annex VIII of Commission Regulation (EU) 2017/2400

1. Introduction
2. Definitions
3. Determination of air drag
   - 1. Test track requirements
   - 2. Requirements for ambient conditions
   - 3. Installation of the vehicle
   - 4. Measurement equipment
   - 5. Constant speed test procedure
   - 6. Misalignment calibration test
   - 7. Testing Template
   - 8. Data processing
   - 9. Input data for VECTO Air Drag
   - 10. Validity criteria

Mainly relevant for

- vehicle testing
- data evaluation
- certification issues


REGULATIONS

COMMISSION REGULATION (EU) 2017/2400

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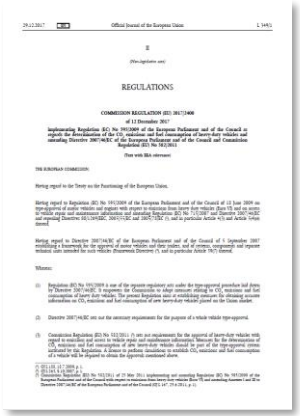
Overview Appendices to Annex VIII of Commission Regulation (EU) 2017/2400

1. Model Certificate
2. Information Document
3. Vehicle height requirements
4. Standard body and semitrailer configurations
5. Air drag family for trucks
6. Conformity of the certified CO2 emissions and fuel consumption related properties
7. Standard values
8. Markings

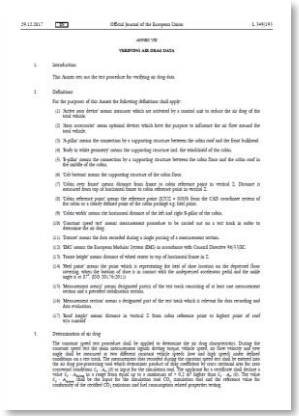
Mainly relevant for

- vehicle testing
- data evaluation
- certification issues



REGULATIONS

COMMISSION REGULATION (EU) 2017/2400



ANNEX VIII

TESTING AIR DRAG DATA

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VECTO Air Drag – User Manual

- Comprehensive User Manual (UM) distributed together with VECTO Air Drag software
- Structure and content of the following parts of this presentation follows UM structure
- Any details not covered in current presentation please first have a look into the UM
- Any further questions please contact VECTO User Support

VECTO Air Drag – Basic features (1/2)

- Written in VB.net
- Portable application (i.e. no installation required)
- File format conventions:
  - CSV (Comma Separated Values)
    - list- and decimal separator can be defined in the options (Dot ".", Comma ",", colon ":" Semicolon ";")
    - Lines starting with `#` are interpreted as comment-lines
  - JSON
    - Only used for "vehicle"-file and "job"-file
    - Automatically generated by VECTO Air Drag (job) or the pre-processing tool (veh)
- "Direct start" option provided (for automation with external scripts)

VECTO Air Drag – Basic features (2/2)

- According to Commission Regulation (EU) 2017/2400 the use of VECTO Air Drag (air-drag pre-processing tool) is mandatory
- Operation modes:
  - “Declaration Mode”:
    - Evaluation settings are fixed as set out in Commission Regulation (EU) 2017/2400
    - CdxA value only calculated if all validity criteria have been fulfilled
    - Declaration Mode to be used in order to generate official CdxA values an VECTO (sim) XML input data files
  - “Engineering Mode”:
    - All evaluation settings can be edited by the user
    - VECTO Air Drag calculates the CdxA value for the given settings whenever mathematically/physically reasonable

VECTO Air Drag – Overview input files (1/3)

File type	Default extension	Explanation
vehicle	*.csveh	information on tested vehicle configuration (e.g. vehicle test mass, anemometer height)
ambient conditions	*.csamb	ambient conditions as measured by the stationary weather station
configuration file for measurement sections ("ms config")	*.csms	• configuration of the measurement sections (coordinates, driving directions etc.) on the test track. • can be configured for the misalignment test and the constant speed test separately
measurement data	*.csdat	• contains the measurement data recorded at the vehicle consolidated in 100Hz. • Separate input files are required by for (with identical file formats): i) the misalignment test ii) the first low speed test iii) the high speed test iv) the second low speed test

VECTO Air Drag – Overview input files (2/3)

File type	Default extension	Explanation
job	*.csjob	• contains all information for a test evaluation (evaluation settings, paths to input data). • automatically created if VECTO Air Drag is operated via the GUI • can also be generated or edited e.g. by means of a text editor. • After a successful calculation VECTO Air Drag writes the main evaluation results into the job-file

VECTO Air Drag – Overview input files (3/3)

File type	Default extension	Explanation
altitude profile (optional)	*.csalt	• contains the altitude profiles of the measurement sections. • data is used for the correction of traction force for gradient influence • only applied in evaluation if the related feature is activated
criteria (optional)	*.cscrt	• can be used to save or import a set of evaluation parameters (e.g. validity criteria or settings for correction functions) • for reasons of traceability for each calculation the used parameters are in any case also stored in the job file • not relevant in Declaration Mode as evaluation settings are defined in the source code

VECTO Air Drag – Vehicle file (*.csveh, JSON)

Table 2 to Annex VIII of Commission Regulation (EU) 2017/2400

Input data	Unit	Remarks
Vehicle group code	[-]	1 - 17 for trucks
Vehicle configuration with trailer	[-]	without trailer (input “No”) or with trailer i.e. as a truck/trailer or tractor semitrailer combination (input “Yes”)
Vehicle test mass	[kg]	actual mass during measurements
Gross vehicle mass	[kg]	gross vehicle mass of the rigid or tractor (w/o trailer or semitrailer)
Axle ratio	[-]	axle transmission ratio
Gear ratio high speed	[-]	transmission ratio of gear engaged during high speed test
Gear ratio low speed	[-]	transmission ratio of gear engaged during low speed test
Anemometer height	[m]	height above ground of the measurement point of installed anemometer
Vehicle height	[m]	maximum vehicle height according to 3.5.3.1 item vii.
Gear box type	[-]	“MT_AMT” or “AT”
Vehicle maximum speed	[km/h]	maximum speed the vehicle can be practically operated at the test track

VECTO Air Drag – Ambient conditions file (*.csamb, CSV)

Table 3 to Annex VIII of Commission Regulation (EU) 2017/2400

Signal	Column identifier in input file	Unit	Measurement rate	Remarks
Time	<t>	[s] since day start (first day)	-	-
Ambient temperature	<t_amb_stat>	[°C]	At least 1 averaged value per 6 minutes	Stationary weather station
Ambient pressure	<p_amb_stat>	[mbar]		Stationary weather station
Relative air humidity	<rh_stat>	[%]		Stationary weather station

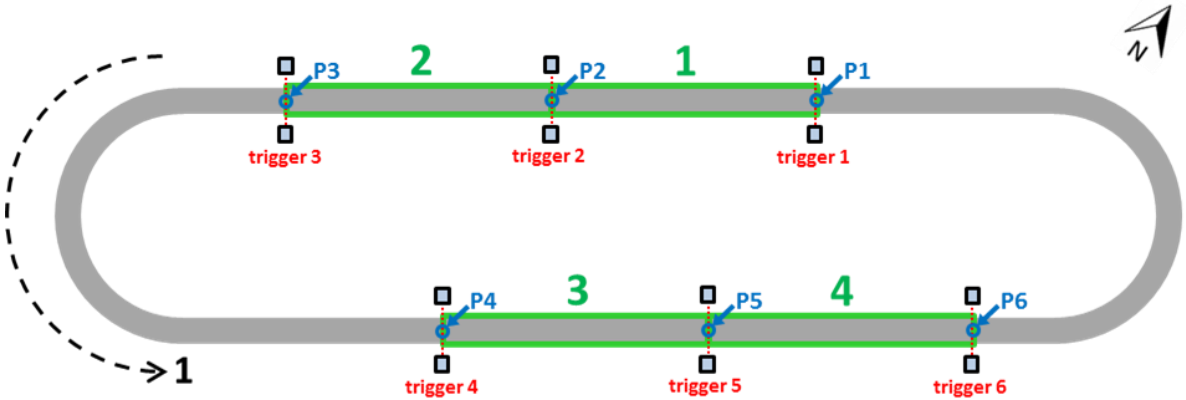
VECTO Air Drag – Measurement section configuration file (*.csms, CSV)

Table 4 to Annex VIII of Commission Regulation (EU) 2017/2400

Input data	Unit	Remarks
Trigger signal used	[-]	1 = trigger signal used; 0 = no trigger signal used
Measurement section ID	[-]	user defined ID number
Driving direction ID	[-]	user defined ID number
Heading	[°]	heading of the measurement section
Length of the measurement section	[m]	-
Latitude start point of section	decimal degrees or decimal minutes	standard GPS, unit decimal degrees: minimum 5 digits after decimal separator standard GPS, unit decimal minutes: minimum 3 digits DGPS, unit decimal degrees: minimum 7 digits after decimal separator DGPS, unit decimal minutes: minimum 5 digits after decimal separator
Longitude start point of section		
Latitude end point of section		
Longitude end point of section		
Path and/or filename of altitude file	[-]	only required for the constant speed tests (not the misalignment test) and if the altitude correction is enabled

VECTO Air Drag – Measurement section configuration file (*.csms, CSV)

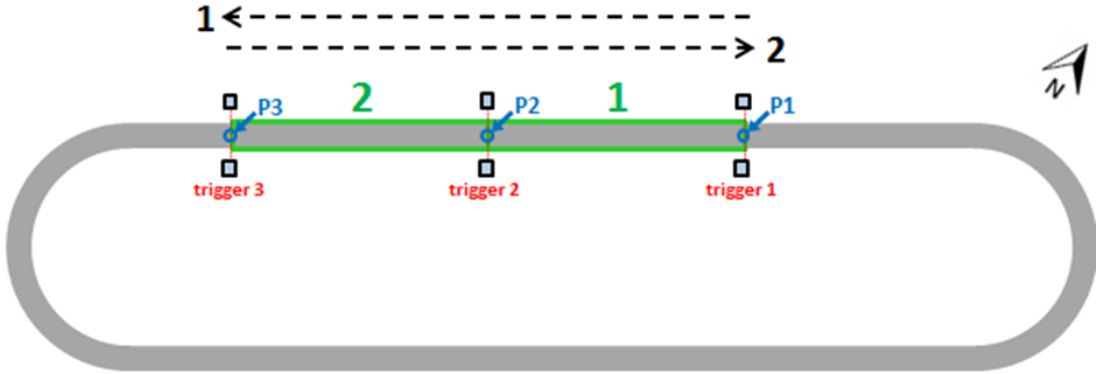
Example 1:



meas. section ID	direction ID	lenght	heading	latitude start	longitude start	latitude end	longitude end
# [id]	[id]	[m]	[°]	[mm.mm]	[mm.mm]	[mm.mm]	[mm.mm]
1	1	250	236	..P1..	..P1..	..P2..	..P2..
2	1	250	236	..P2..	..P2..	..P3..	..P3..
3	1	250	56	..P4..	..P4..	..P5..	..P5..
4	1	250	56	..P5..	..P5..	..P6..	..P6..

VECTO Air Drag – Measurement section configuration file (*.csms, CSV)

Example 2:



meas. section ID	direction ID	lenght	heading	latitude start (D)	longitude start (D)	latitude start (D)	longitude start (D)
# [id]	[id]	[m]	[°]	[dd.dd]	[dd.dd]	[dd.dd]	[dd.dd]
1	1	250	236	..P1..	..P1..	..P2..	..P2..
2	1	250	236	..P2..	..P2..	..P3..	..P3..
2	2	250	56	..P3..	..P3..	..P2..	..P2..
1	2	250	56	..P2..	..P2..	..P1..	..P1..

VECTO Air Drag – Measurement data file (*.csdat, CSV) (1/4)

Table 5 to Annex VIII of Commission Regulation (EU) 2017/2400

Signal	Column identifier	Unit	Measurement rate	Remarks
Time	<t>	[s] since day start (of first day)	100 Hz	rate fixed to 100 Hz; time signal used for correlation with weather data and for check of frequency
(D)GPS latitude	<lat>	decimal degrees or decimal minutes	GPS: ≥ 4 Hz DGPS: ≥ 100 Hz	standard GPS, unit decimal degrees: min. 5 digits behind „.“ standard GPS, unit decimal minutes: min. 3 digits behind „.“ DGPS, unit decimal degrees: min. 7 digits behind „.“ DGPS, unit decimal minutes: min. 5 digits behind „.“
(D)GPS longitude	<long>			
(D)GPS heading	<hdg>	[°]	≥ 4Hz	
DGPS velocity	<v_veh_GPS>	[km/h]	≥ 20 Hz	

VECTO Air Drag – Measurement data file (*.csdat, CSV) (2/4)

Table 5 to Annex VIII of Commission Regulation (EU) 2017/2400

Signal	Column identifier	Unit	Measurement rate	Remarks
Vehicle velocity	<v_veh_CAN>	[km/h]	≥ 20 Hz	raw CAN bus front axle signal
Air speed	<v_air>	[m/s]	≥ 4 Hz	raw data (instrument reading)
Inflow angle (beta)	<beta>	[°]	≥ 4 Hz	raw data (instrument reading); "180°" refers to air flow from front
Engine speed or cardan speed	<n_eng> or <n_card>	[rpm]	≥ 20 Hz	cardan speed for vehicles with torque converter not locked during low speed test
Torque meter (left wheel)	<tq_l>	[Nm]	≥ 20 Hz	-
Torque meter (right wheel)	<tq_r>	[Nm]	≥ 20 Hz	

VECTO Air Drag – Measurement data file (*.csdat, CSV) (3/4)

Table 5 to Annex VIII of Commission Regulation (EU) 2017/2400

Signal	Column identifier	Unit	Measurement rate	Remarks
Ambient temperature on vehicle	<t_amb_veh>	[°C]	≥ 1 Hz	
Trigger signal	<trigger>	[-]	100 Hz	optional signal; required if measurement sections are identified by opto electronic barriers (option "trigger_used=1")
Proving ground temperature	<t_ground>	[°C]	≥ 1 Hz	
Validity	<valid>	[-]	-	optional signal (1=valid; 0=invalid);

VECTO Air Drag – Measurement data file (*.csdat, CSV) (4/4)

Important requirements / features

- The temporal resolution of the *csdat files is defined with 100Hz
- It is allowed to cut out driving phases e.g. recorded outside the measurement sections
- The recordings in the *.csdat-file have to start early enough that the meaningful moving averages can be calculated at the point in time when the vehicle enters the measurement section (i.e. > 0.5 seconds for the high speed test, > 4.5 seconds for the low speed test)
- Any other provided signal in the measurement data file will be also processed by VECTO-Air Drag. For these signals the averages for the driving phases within measurement sections are calculated.

VECTO Air Drag – Altitude profile file (*.csalt, CSV) (optional file)

Table 6 to Annex VIII of Commission Regulation (EU) 2017/2400

Input data	Unit	Remarks
Latitude	decimal degrees or decimal minutes	unit decimal degrees: minimum 7 digits after decimal separator unit decimal minutes: minimum 5 digits after decimal separator
Longitude		
Altitude	[m]	minimum 2 digits after decimal separator

VECTO Air Drag – Additional MS Excel tool

- Additional MS Excel tool provided together with demo data
- Main functions:
  - Checks availability of required signals and consistency
  - Performs plausibility checks in *.csms file
    - Compares lengths specified for measurement sections (MS) with lengths calculated from start/end point coordinates
    - Compares headings specified for MS with headings calculated from start/end point coordinates
    - Checks consistency of definitions for driving directions with headings
  - Generates standards charts for data in *.csdat files consolidated with location of MS from *.csms files
  - Generates the input files for VECTO Air Drag (csv, json)
- Use of additional MS Excel tool is **not** mandatory from Commission Regulation (EU) 2017/2400

VECTO Air Drag – Additional MS Excel tool

Snapshots ...

Standard signal	Column identifier	Unit	Required	Calibration run	Low speed run 1	High speed run	Low speed run 2
time	<t>	[s] since day start	yes	available	available	available	available
(D)GPS latitude	<lat>	[mm.mm]	yes	available	available	available	available
(D)GPS longitude	<long>	[mm.mm]	yes	available	available	available	available
(D)GPS heading	<hdg>	[°]	yes	available	available	available	available
(D)GPS velocity	<v_veh_GPS>	[km/h]	yes	available	available	available	available
vehicle velocity	<v_veh_CAN>	[km/h]	yes	available	available	available	available
air speed	<v_air>	[m/s]	yes	available	available	available	available
inflow angle (beta)	<beta>	[°]	yes	available	available	available	available
engine speed	<n_eng>	[rpm]	yes	available	available	available	available
cardan speed	<n_card>	[rpm]	no				
torque meter (left wheel)	<tq_l>	[Nm]	yes	available	available	available	available
torque meter (right wheel)	<tq_r>	[Nm]	yes	available	available	available	available
ambient temperature on vehicl	<t_amb_veh>	[°C]	yes	available	available	available	available
trigger signal	<trigger>	[-]	no				
tyre temperature	<t_tire>	[°C]	yes	available	available	available	available
tyre pressure	<p_tire>	[bar]	no				
fuel mass flow	<fc>	[kg/h]	no				
validity	<valid>	[-]	no		available	available	available

Additional signals	Column identifier	Unit	Needed	Calibration run	Low speed run 1	High speed run	Low speed run 2
1	Satelites	[#]	no	available	available	available	available
2	<n_card1>	[rpm]	no	available	available	available	available

Check Data

Save Data

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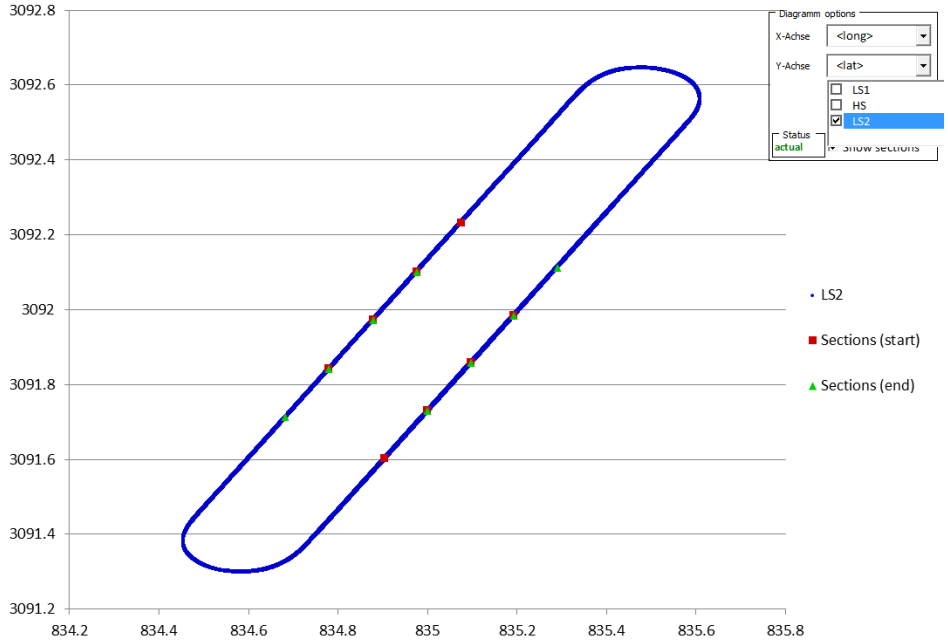
VECTO Air Drag – Additional MS Excel tool

Snapshots ...



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VECTO Air Drag – Overview evaluation algorithms (1/2)

1. Processing of data for vehicle position (coordinate conversions etc.)
2. Assignment of measurement data to measurement sections
3. Calibration of input signals
    1. Vehicle speed (error of CAN vehicle speed signal corrected via know lengths of MS)
    2. For misalignment test: Determine the anemometer misalignment error
    3. Air speed (position error) and yaw angle (misalignment)
4. Evaluation of the constant speed tests
    1. Calculation of true values for air speed, yaw angle and wind speed
    2. Calculation of forces from driving resistances
        1. Calculation of total traction force
        2. Correction for forces from road gradient and accelerations
        3. Calculation of the air density and vapour pressure
        4. (Correction of driving resistance force for the low speed tests)

VECTO Air Drag – Overview evaluation algorithms (2/2)

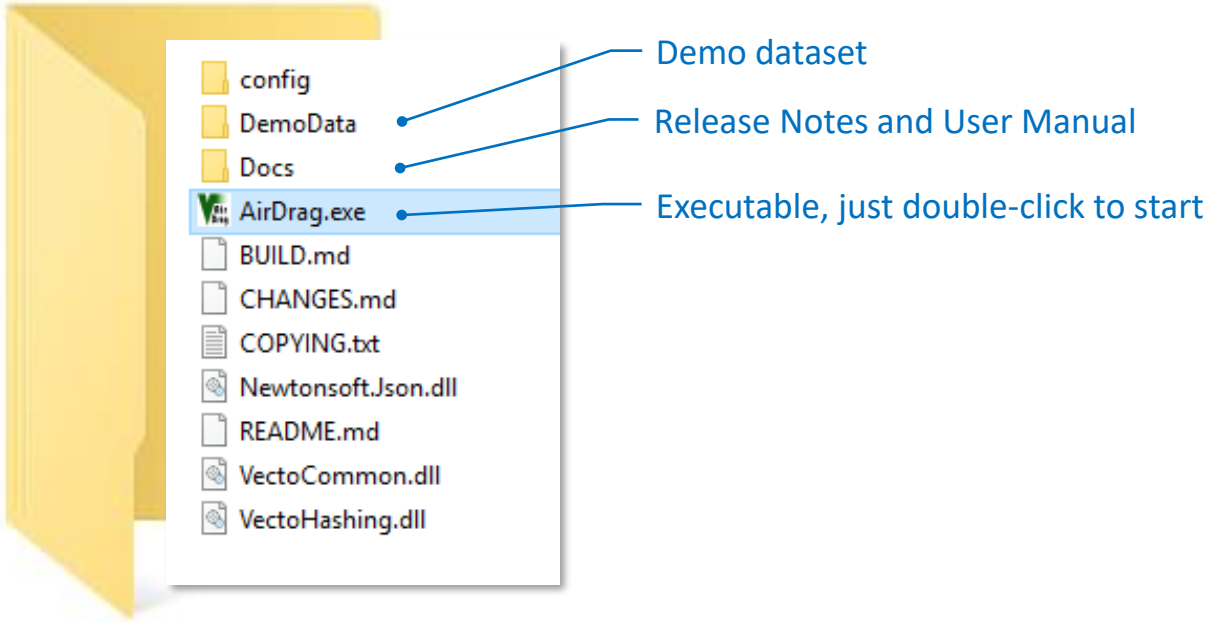
4. Evaluation of the constant speed tests (continued)
    3. Check of validity criteria for data to be included in the analysis (checks e.g. vehicle speeds, stability of driving conditions, ambient conditions, plausibility of input data)
    4. Calculation of CdxA (β) values for all combination of measurement sections and driving directions
    5. Calculation of average results over all measurement sections
    6. Check of validity criteria for complete constant speed test
    7. Correction of cross wind (β) influence
    8. Correction of CdxA to reference vehicle height and for anemometer influence

    → Final results for $\boldsymbol{CdxA\ (0)_{meas}}$ from measurement

VECTO Air Drag – Software demonstration Download package

Storyline for live demonstration and (maybe with reduced content) for video

Content of VECTO Air Drag package as downloaded from JRC server can be copied to any place on a PC/server



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VECTO Air Drag – Software demonstration
General GUI elements

Storyline for live demonstration and (maybe with reduced content) for video

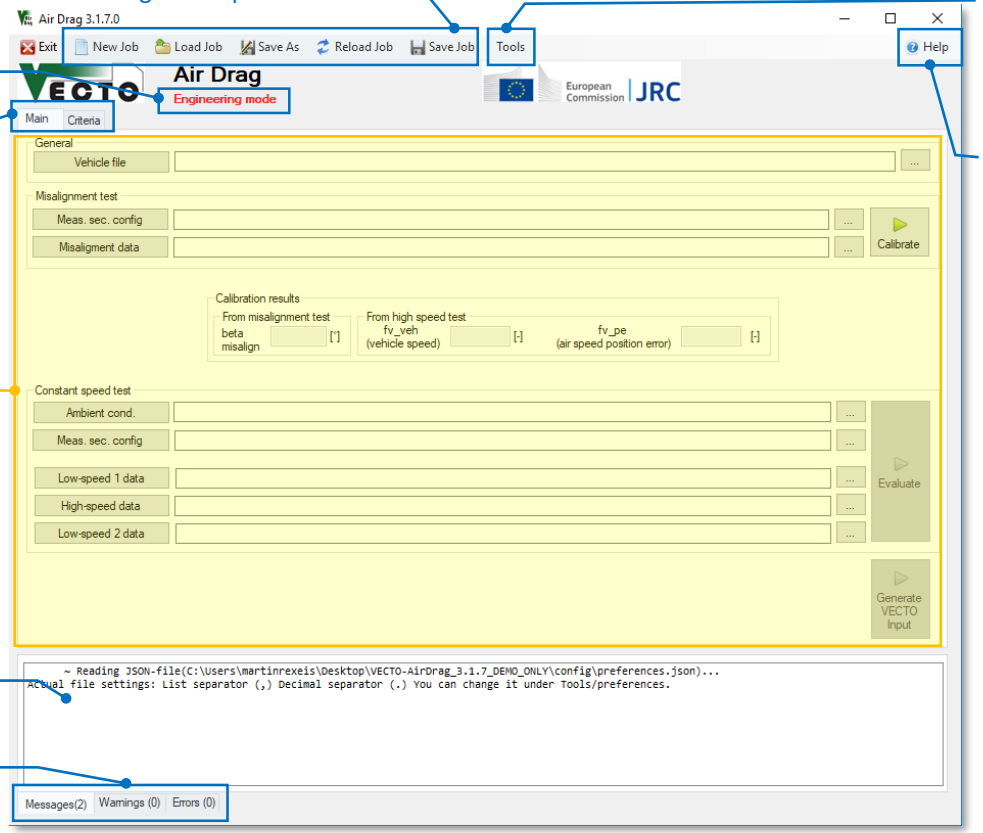
Handling of complete "Jobs"

Tools:
Log file handling
Preference settings

Click to switch between "Declaration mode" and "Engineering mode"

Switch between "Main" and "Criteria" tab

Open User Manual
Open Release Notes
Support / Report Bug from JIRA



Control elements for test evaluation

Message window

Switch between tabs for Messages, Warnings and Errors

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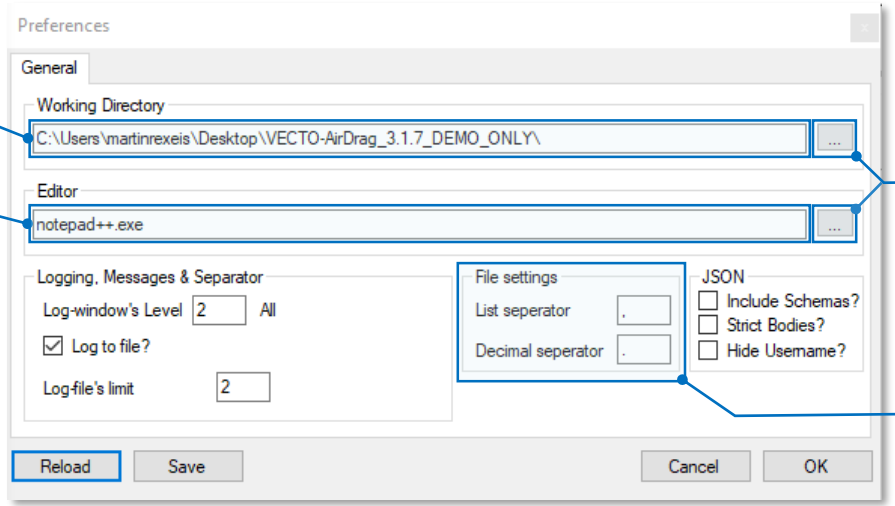
VECTO Air Drag – Software demonstration
Preference settings

Storyline for live demonstration and (maybe with reduced content) for video

At first program start it is recommended to check / adjust the main tool settings

Working directory (browser always starts in this folder)

Settings for Editor tool when opening files via GUI



Browse buttons

Important! Check settings for CVS files!

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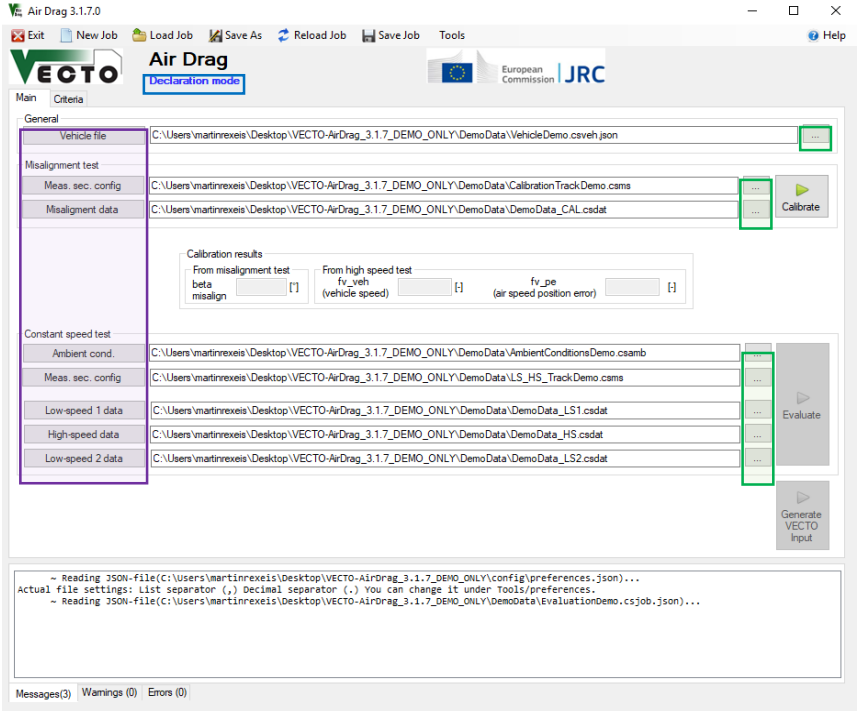
VECTO Air Drag – Software demonstration
Test evaluation (1/5)

Storyline for live demonstration and (maybe with reduced content) for video

1. Select tool mode
2. Browse for input data
3. Input files can be opened with buttons to the left



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VECTO Air Drag – Software demonstration Examples for input files

Storyline for live demonstration and (maybe with reduced content) for video

Vehicle file (JSON)

VehicleDemo.csveh.json

```
{
  "Header": {
    "Title": "VECTO-Air Drag VEHICLE",
    "FileVersion": "1.0.0",
    "AppVersion": "3.0.0",
    "ModifiedDate": "2018.08.27 13:10:56",
    "Strict": true,
    "BodySchema": null,
  },
  "Body": {
        "classCode":                    4,
        "configuration with trailer":   "no",
        "GVMMax":                       19000,
        "vVehMax":                      85,
        "vehHeight":                    3.85,
        "anemometerHeight":             4.55,
        "testMass":                     12000,
        "gearRatio_low":                "2.500",
        "gearRatio_high":               "1.000",
        "axleRatio":                    "3.600",
        "gearBox_type":                 "MT_AMT",
    }
}
```

Measurement data file (CSV)

	A	B	C	D	E	F	G	H	I	J	K	
1	<t>	<lat>	<long>	<hdg>	<v_veh_GPS:	<v_veh_CAN	<v_air>	<beta>	<n_eng>	<tq_l>	<tq_r>	<t_an
2	# [s]	[mm.mm]	[mm.mm]	[°]	[km/h]	[km/h]	[m/s]	[°]	[rpm]	[Nm]	[Nm]	[iC]
3	41413.62	2873.90385	456.78687	52	78.395	80.74685	17.5	174.5	1720.5	3443.6	3148.4	
4	41413.63	2873.90391	456.787	52	78.43	80.7829	17.435	174.5	1720	3453.4	3148.6	
5	41413.64	2873.90399	456.78713	52	78.45	80.8035	17.274	174.5	1704.5	3400.4	3160.2	
6	41413.65	2873.90407	456.78728	52	78.414	80.76642	17.026	178.53	1708.5	3348.1	3171.6	
7	41413.66	2873.90414	456.78742	52	78.414	80.76642	16.7816667	185.5	1726.5	3335.4	3166.7	
8	41413.67	2873.9042	456.78755	52	78.414	80.76642	16.7816667	185.5	1724.5	3322.9	3161.5	
9	41413.68	2873.90429	456.78769	52	78.45	80.8035	17.016	177.69	1709	3330.8	3131.5	
10	41413.69	2873.90435	456.78783	52	78.469	80.82307	17.47	175.6	1702	3338.9	3102.5	
11	41413.7	2873.90443	456.78797	52	78.432	80.78496	18.058	178.38	1700	3363.4	3140.3	
12	41413.71	2873.90449	456.78812	52	78.453	80.80659	17.971	182.73	1700.5	3387.7	3178.2	
13	41413.72	2873.90457	456.78824	52	78.505	80.86015	17.315	185.5	1702.5	3397.5	3224.7	
14	41413.73	2873.90464	456.78838	52	78.506	80.86118	16.894	184.7	1698	3407.3	3270.4	
15	41413.74	2873.90471	456.78853	52	78.508	80.86324	16.8077778	174.5	1688.5	3415.1	3267.5	
16	41413.75	2873.90479	456.78866	52	78.524	80.87972	16.8122222	174.5	1704.5	3422.5	3264.2	
17	41413.76	2873.90487	456.78879	52	78.543	80.89929	16.867	180.18	1738.5	3399.9	3233.2	
18	41413.77	2873.90494	456.78893	52	78.507	80.86221	17.206	179.35	1736	3377.9	3202.8	
19	41413.78	2873.90501	456.78908	52	78.525	80.88075	17.666	174.5	1708.5	3389.7	3209.6	
20	41413.79	2873.90508	456.78921	52	78.525	80.88075	17.905	174.5	1709	3401	3216.2	
21	41413.8	2873.90515	456.78934	52	78.507	80.86221	17.955	174.5	1729	3383.3	3213.3	

DemoData_CAL

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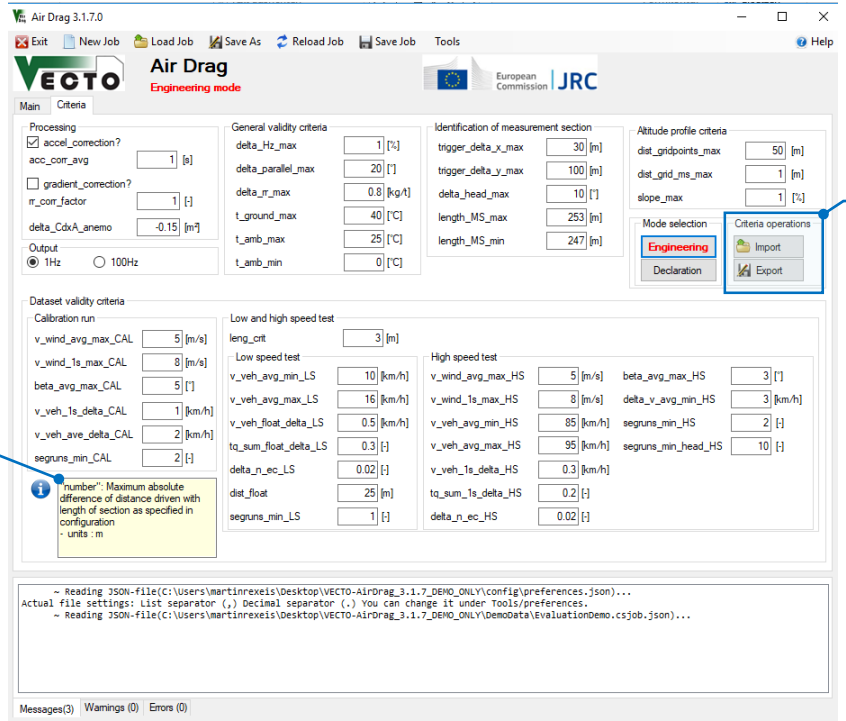
VECTO Air Drag – Software demonstration
Test evaluation (2/5)

Storyline for live demonstration and (maybe with reduced content) for video

4. Adjust evaluation settings in “Criteria Tab”

In “Declaration mode” only gradient correction can be enabled/disabled



Criteria settings can be saved / reloads

Information box explains parameter pointed at with cursor

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VECTO Air Drag – Software demonstration
Test evaluation (3/5)

Storyline for live demonstration and (maybe with reduced content) for video

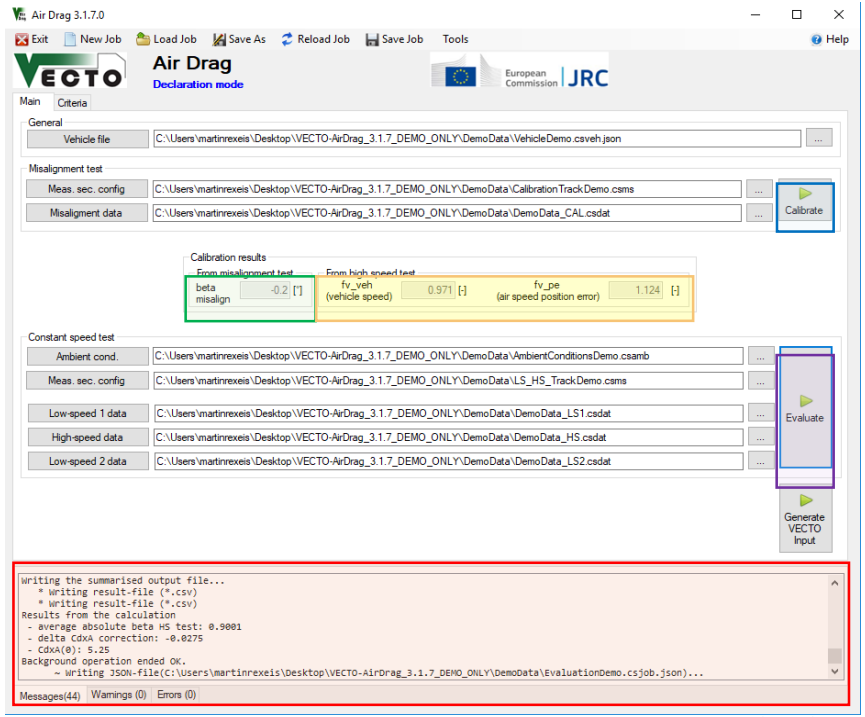
5. Press “Calibrate” to start evaluation of Misalignment test

6. Display of result for misalignment correction angle

7. Press “Evaluate” to start evaluation of Constant speed test

8. Display of result for other calibration factors

9. Status and final results displayed in Message window



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VECTO Air Drag – Software demonstration Test evaluation (4/5)

Storyline for live demonstration and (maybe with reduced content) for video

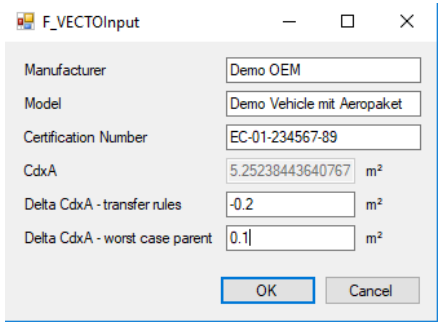
Further important remarks:

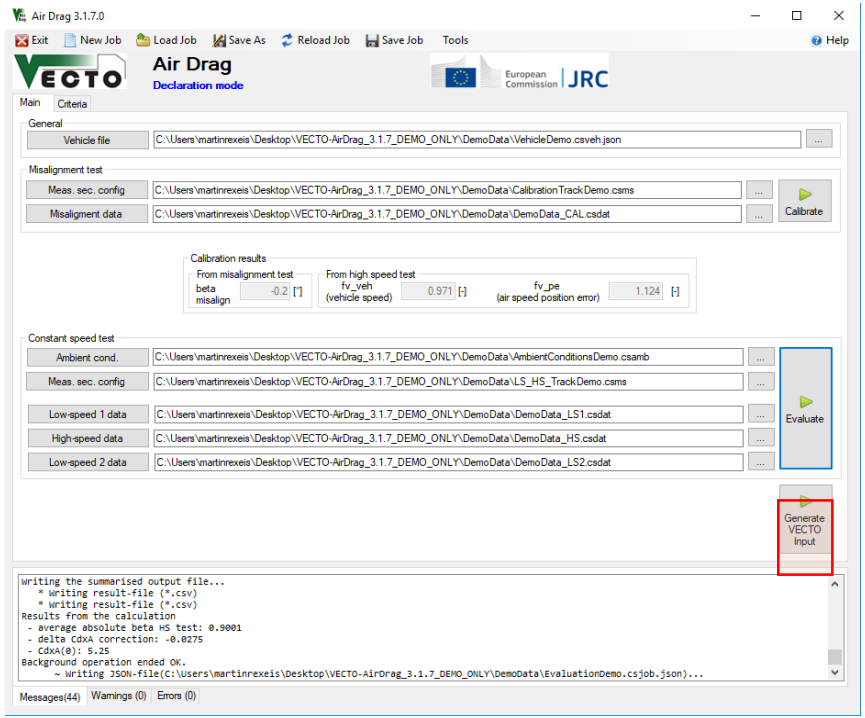
- A full set of evaluation settings (file-paths and options) can be reloaded by opening an existing job-file.
- Before start of evaluations VECTO Air Drag always saves the current settings into the current job-file. If the user does not want to current the existing job-file it has to be saved under a different name using the menu bar “Save as”.
- A misalignment test can also be evaluated without data specified for the LS-HS-LS sequence.
- If a complete measurement section in combination with a driving direction becomes invalid (e.g. because less than 2 valid HS datasets are available) VECTO Air Drag aborts the evaluation. In order to try to gain a valid test result with the remaining data, this particular measurement section (or combination of measurement section with driving direction) has to be manually removed by the user in the *.csms file.

VECTO Air Drag – Software demonstration
Test evaluation (5/5)

Storyline for live demonstration and (maybe with reduced content) for video

10. If in “Declaration mode” and evaluation was performed successfully, press “Generate VECTO Input” to create VECTO XML input file.
The following information has to be provided:





Further explanations see next slide ...

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VECTO Air Drag – Necessary input to export VECTO (Sim) input XML

Storyline for live demonstration and (maybe with reduced content) for video

- Manufacturer name
- Model name (name of air drag family)
- Certification number
- **delta** CdxA value [m²] applied to the $C_d \cdot A_{cr}$ *(0)* value as calculated by VECTO Air Drag from "transfer rules" to other vehicle groups according to Table 16 of Appendix 5 in Annex VIII (e.g. ***-0.2 m²*** if a result measured at a group 4 vehicle shall be applied to a family in vehicle group 3).
- **delta_** CdxA value [m²] applied to the $C_d \cdot A_{cr}$ *(0)* value as calculated by VECTO Air Drag from declaration of worst case parent [m²] according to point 3.11 of the main body of Annex VIII. **This input is checked to be in the range of 0 to 0.2 m²**.

VECTO Air Drag – Software demonstration
Example XML input file for VECTO

Storyline for live demonstration and (maybe with reduced content) for video

EvaluationDemo.xml

```
1  <?xml version="1.0" encoding="utf-8"?>
2  <tns:VectoInputDeclaration schemaVersion="1.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns=
   "urn:tugraz:ivt:VectoAPI:DeclarationDefinitions:v1.0" xmlns:tns=
   "urn:tugraz:ivt:VectoAPI:DeclarationComponent:v1.0" xsi:schemaLocation=
   "urn:tugraz:ivt:VectoAPI:DeclarationComponent:v1.0
   https://webgate.ec.europa.eu/CITnet/svn/VECTO/trunk/Share/XML/XSD/VectoComponent.xsd">
3    <tns:AirDrag>
4      <Data id="AD-ecd1430876e040f0868b">
5        <Manufacturer>Demo OEM</Manufacturer>
6        <Model>Demo Vehicle mit Aeropaket</Model>
7        <CertificationNumber>EC-01-234567-89</CertificationNumber>
8        <Date>2018-08-31T13:12:02.6527851Z</Date>
9        <AppVersion>VECTOAirDrag_3.1.7.0</AppVersion>
10       <CdxA_0>5.25</CdxA_0>
11       <TransferredCdxA>5.05</TransferredCdxA>
12       <DeclaredCdxA>5.15</DeclaredCdxA>
13     </Data>
14     <Signature>
15       <Reference URI="#AD-ecd1430876e040f0868b" xmlns="http://www.w3.org/2000/09/xmldsig#">
16         <Transforms>
17           <Transform Algorithm="urn:vecto:xml:2017:canonicalization" />
18           <Transform Algorithm="http://www.w3.org/2001/10/xml-exc-c14n#" />
19         </Transforms>
20         <DigestMethod Algorithm="http://www.w3.org/2001/04/xmlenc#sha256" />
21         <DigestValue>bXM0iptpI7YMjqMsbv9fnZvWIo53cOUrEsjthzFGE4g=</DigestValue>
22       </Reference>
23     </Signature>
24   </tns:AirDrag>
25 </tns:VectoInputDeclaration>
```

XML file already hashed by VECTO Air Drag tool

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VECTO Air Drag – Software demonstration
Main result file (*JobName_AirDrag.csv*)

Storyline for live demonstration and (maybe with reduced content) for video

Overall results and results per combination of measurement section with driving direction

# Resultfile Programm Air Drag 3.1.7.0 Comp 8/27/2018		
# Datafile LS1:	J:\TE-Em\Projekte\I_2018_17_VECTO Workshop_JRC\Material\VECTO Air Drag\VECTO-AirDrag_3.1.7_DEMO_ONLY\DemoData\DemoData_HS.csdat	
# Datafile HS:	J:\TE-Em\Projekte\I_2018_17_VECTO Workshop_JRC\Material\VECTO Air Drag\VECTO-AirDrag_3.1.7_DEMO_ONLY\DemoData\DemoData_LS1.csdat	
# Datafile LS2:	J:\TE-Em\Projekte\I_2018_17_VECTO Workshop_JRC\Material\VECTO Air Drag\VECTO-AirDrag_3.1.7_DEMO_ONLY\DemoData\DemoData_LS2.csdat	
#		
RESULTS CALCULATED IN DECLARATION MODE		
#		
# Results		
# fv_veh:	0.97127709	[-] calibration factor for vehicle speed
# fv_pe:	1.12354571	[-] calibration factor for air speed (position error)
# fa_pe:	1	[-] position error correction factor for measured air inflow angle (beta)
# beta_ame:	-0.19949552	[°] calibration factor for beta (misalignment)
# t_amb_LS1:	20	[°] average ambient temperature during first low speed test
# v_avg_LS:	15.1029417	[km/h] average vehicle speed used datasets low speed tests
# v_avg_HS:	85.029553	[km/h] average vehicle speed used datasets high speed test
# CdxA(ß)_H1:	5.36893299	[m²] average CdxA before yaw angle correction for heading 1
# beta_H1:	0.74127282	[°] average absolute yaw angle from high speed tests for heading 1
# CdxA(ß)_H2:	5.08575241	[m²] average CdxA before yaw angle correction for heading 2
# beta_H2:	1.05887585	[°] average absolute yaw angle from high speed tests for heading 2
# CdxA(ß):	5.2273427	[m²] average CdxA before yaw angle correction
# beta:	0.90007434	[°] average absolute yaw angle from high speed tests
# delta_CdxA_beta:	-0.02754768	[m²] correction of CdxA for yaw angle
# CdxA(0)meas:	5.19979503	[m²] average measured CdxA for zero yaw angle
# delta_CdxA_height:	0.20258942	[m²] correction of CdxA to reference vehicle height
# delta_CdxA_anemo:	-0.15	[m²] CdxA influence from anemometer
# CdxA(0):	**5.25**	**[m²] average CdxA for zero yaw angle**
#		
# validity criteria:		
# RRC:	Ok	
#		

SecID [-]	DirID [-]	HeadID [-]	NumUsed [-]	F0_singleMS [N]	F0_singleMS_LS1 [N]	F0_singleMS_LS2 [N]	CdxA(ß)_ave_singleMS [m2]	CdxA(0)_singleMS [m2]	delta_CdxA_singleMS [m2]	beta_ave_singleMS [°]	RRC_singleMS [kg/t]	RRC_singleMS_LS1 [kg/t]	RRC_singleMS_LS2 [kg/t]	valid_RRC [-]	F2_singleMS [N/(m2/s2)]	F2_singleMS_LS1 [N/(m2/s2)]	F2_singleMS_LS2 [N/(m2/s2)]
1	1	1	8	1306.37555	1348.80109	1262.1726	5.03910249	5.01154999	0.02755251	0.90023222	11.0973119	11.4577055	10.7218195	1	2.98558098	2.91008766	3.06585796
2	1	1	8	1292.04955	1332.69648	1249.75901	5.69876348	5.6809412	0.01782228	0.58231343	10.9756163	11.3209011	10.6163694	1	3.40171511	3.32390557	3.48424362
2	2	2	8	1304.66027	1310.05494	1299.55898	5.12600841	5.09625512	0.02975329	0.97213911	11.082741	11.1285672	11.0394069	1	2.99229319	2.98256905	3.00129306
1	2	2	8	1291.98682	1308.32984	1275.96748	5.04549642	5.00584758	0.03964883	1.14561259	10.9750834	11.113913	10.8390034	1	2.94258555	2.91508321	2.96929046

Software version

Main input data files

Message when evaluation was done in Declaration Mode

Calibration factors and interim results

CdxA(0) Final result

Message on RRC validity criteria

Results per MS and DIR

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VECTO Air Drag – Software demonstration
Other result files

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- The “MS files” (*EvaluationDemo*_MS_CAL.csv for the misalignment test and *EvaluationDemo*_MS_MEAS.csv for the LS-HS-LS test sequence with the results for all single recorded measurement sections differentiated by driving direction if applicable
- Each a “Hz file” (either in 1Hz or in 100Hz, depending on the settings) for the calibration run, the two low speed runs and the high speed test with all input data as well as all calculated values averaged to the specified frequency

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