

The European Commission's science and knowledge service

Joint Research Centre



UNECE GRPE Real Driving Emissions IWG

First instructions to use the EMROAD Tool within the RDE-IWG

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European Commission – Joint Research Centre

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Outline

- **General information**
- **Objective of the present document**
- **Instructions**
- **Road Map**

General information

- **EMROAD is a Microsoft Excel add-in for analysing vehicle emissions data recorded with Portable Emissions Measurement Systems (PEMS). In the frame of the European legislative PEMS programs for heavy-duty vehicles (HDV), non-road mobile machinery (NRMM), and light-duty vehicles (LDV)**
- **EMROAD was developed as a research tool, primarily used to support the development of PEMS data evaluation methods for emissions legislation.**
- **These legislative developments being completed, EMROAD is updated by the JRC on a regular basis to meet the latest applicable methods and requirements are laid down in the EU Regulations for light-duty, heavy-duty vehicles and non-road mobile machinery.**
- **Some golden data files are now provided to benchmark calculations conducted with other software and for the EU regulatory settings only.**

General information

- **Introduction during the 4th Session of the RDE-IWG**
- **Current (official) version of EMROAD is 6.03 Build 2**
- **Documentation: Quick start guide, User's Guide, Release Notes**
- **Mailing list for notifications of new releases**

Link to download:

<https://circabc.europa.eu/w/browse/79a4a9b6-4003-4e02-956d-048dcef1a169>

Objective of the present document

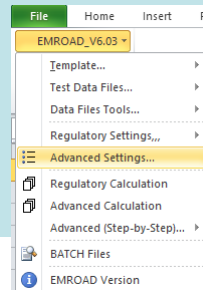
- **In the EU context: EMROAD is primarily used as a reference tool for calculations according to the EU regulations (that have specific settings for all applications, i.e. RDE-LDV, ISC-HDV and ISM-NRMM)**
- **EMROAD is proposed as a tool to support the work within the RDE-IWG**
- **This presentation is intended to provide set of instructions to modify the (default EU) RDE settings and to conduct evaluations of PEMS data in a way that might be of interest to the RDE-IWG working group**

Main principles (Reminder)

- **EMROAD is a Microsoft Excel add-in, importing and processing PEMS data in a pre-defined template**
- **EMROAD PEMS data files generated by the main PEMS instruments on the market (AVL, HORIBA, SENSORS) and Exchange Files (EXF, as soon as available from instrument providers)**
- **EMROAD uses the reference units set by the EU Regulations**
- **EMROAD is able to conduct:**
 - **Regulatory calculations (Calculation settings according to the chose Regulation)**
 - **Advanced calculations (Advanced users, step-by-step functions, **not supported**)**

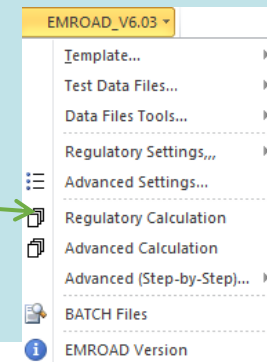
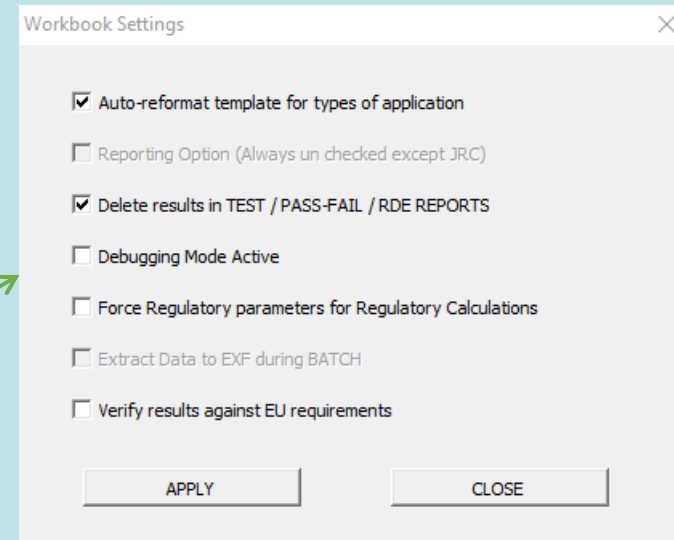
Instructions – Preamble

- Any PEMS data file generated by the main PEMS instruments on the market (AVL, HORIBA, SENSORS) may be used, provided that the data upload settings are correct.
- JRC provides the data by the Contracting Parties both with the original formats and as Exchange Files (EXF, as soon as available from instrument providers)
- NB: these exchange files contain both the PEMS test data and some vehicle specific data (e.g. the reference CO2 values on the phases of the WLTP)
- **For ad-hoc RDE-IWG analysis in version 6.03, users have to proceed through the “Advanced Settings” interface**



Instructions – Overview

- Proceed with the modification of the settings according to the slides detailing the advanced interface settings.
- **(IMPORTANT !)** Under **Advanced Settings**, tab **“Workbook”**, deactivate **“Force Regulatory parameters for Regulatory Calculations”** and **“Verify against EU requirements”** (as shown)
- **(IMPORTANT!)** Save your work
- Press **“Regulatory Calculation”**
- The RDE results are reported in the **RDE REPORT worksheet**



RDE-IWG Specific instructions

- **Detailed instructions for the “Advanced Settings”**

Instructions – General

ADVANCED SETTINGS

GENERAL | CALCULATION STEPS | EXCLUSIONS | SEGMENTS | LIMITS | MOVING WINDOW | ADVANCED

Vehicle-Engine Type: LIGHT-DUTY VEHICLE - M1-N1 CLASS 1

Fuel Type: DIESEL (B7)

Exhaust Flow: EXHAUST FLOW METER

Distance: GPS

Fuel Rate: NONE

Engine Torque: NONE

DATA SOURCE: EXF-FILE

APPLY CLOSE

Select vehicle type (EU classification, affects the emissions limits the type of powertrain (ICE, OVC- HEV, NOVC)

Select Fuel

Keep "EXHAUST FLOW METER" – unless the PEMS data file does not contain such data

Select the speed source used to calculate the distance (ECU/GPS/SENSOR)

Select the type of PEMS file

Instructions – Calculation Steps

ADVANCED SETTINGS

GENERAL | **CALCULATION STEPS** | EXCLUSIONS | SEGMENTS | LIMITS | MOVING WINDOW | ADVANCED

CALCULATION STEP >	1	2	3		1	2	3	
Find Segments	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		Integrated Emissions Complete	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Test Start-End Detection	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		Integrated Emissions Segments	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Exclude Data	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		Cold Start Emissions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Drift Corrections	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Idling Emissions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Instantaneous Emissions	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		MAW Analysis	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
MAW Emissions	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Trip Composition	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Screen Data	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Final Emissions	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

UNSELECT ALL

DATA SOURCE: EXF-FILE

APPLY CLOSE

DO NOT MODIFY ANYTHING

Instructions – Exclusions

ADVANCED SETTINGS

GENERAL | CALCULATION STEPS | EXCLUSIONS | SEGMENTS | LIMITS | MOVING WINDOW | ADVANCED

Cold Start

- Max. Duration [min] 5
- Coolant Temperature [%] 343
- Coolant Stab. Duration [min] 5
- Distance [km] 0

- Min. Bar. Pressure [kPa] 1000
- NRMM Non-working events
- DPF Periodic Regeneration - Set Value > 0
- Idling [Zero vehicle speed]

DATA SOURCE: EXF-FILE

APPLY CLOSE

The cold start emissions are included in the calculations. These settings will only define the duration cold start period (i.e. if applicable and based on the maximum duration and/or coolant temperature). This duration is then used to verify some operational characteristics during the cold start phase (e.g. average speed, idling duration at test start,...)

Maximum cold start duration

Maximum coolant temperature at the end of cold start

Instructions – Segments

ADVANCED SETTINGS

GENERAL | CALCULATION STEPS | EXCLUSIONS | SEGMENTS | LIMITS | MOVING WINDOW | ADVANCED

Speed Based (RDE LDV and HDV ISC Euro VIc)

First Acceleration Method (HDV ISC Euro VIId and Euro VIe)

Non-Road Mobile Machinery

DATA SOURCE: EXF-FILE

APPLY CLOSE

DO NOT MODIFY ANYTHING

This selection will determine the type of method used to segment the trip according to the **speed boundaries** (e.g. 60/90 km/h are the boundaries defining the EU maximum speeds for urban/rural driving)

The speed boundaries can be modified under the ADVANCED Tab, button "Speed Ranges (For Trip Segmentation)

Instructions – Limits

ADVANCED SETTINGS

GENERAL | CALCULATION STEPS | EXCLUSIONS | SEGMENTS | LIMITS | MOVING WINDOW | ADVANCED

LDV EURO 6 - M1 - N1 CLASS 1 - COMP. IGNITION

CO	500	HC+NOx	170
NOx	80	CH4	
THC		NMHC	
PN	6.0E+11	PM	4.5

Application

- Light-Duty
- Heavy-Duty
- Non-Road
- Other

Unit

- mg/km
- g/kWh

DATA SOURCE: EXF-FILE

APPLY CLOSE

DO NOT MODIFY ANYTHING

Instructions – Moving Window

ADVANCED SETTINGS

GENERAL | CALCULATION STEPS | EXCLUSIONS | SEGMENTS | LIMITS | MOVING WINDOW | ADVANCED

Reference Quantity

CO2

Value [*] 1.9 [kg]

Threshold [s]

Moving Window Unit

Brake-Specific (g/kWh)

Distance-Specific (g/km)

CO2-Specific (g/kg CO2)

Mass (g)

Engine Max. Power (HDV and NRMM only)

Engine Max. Power (kW) 1

DATA SOURCE EXF-FILE

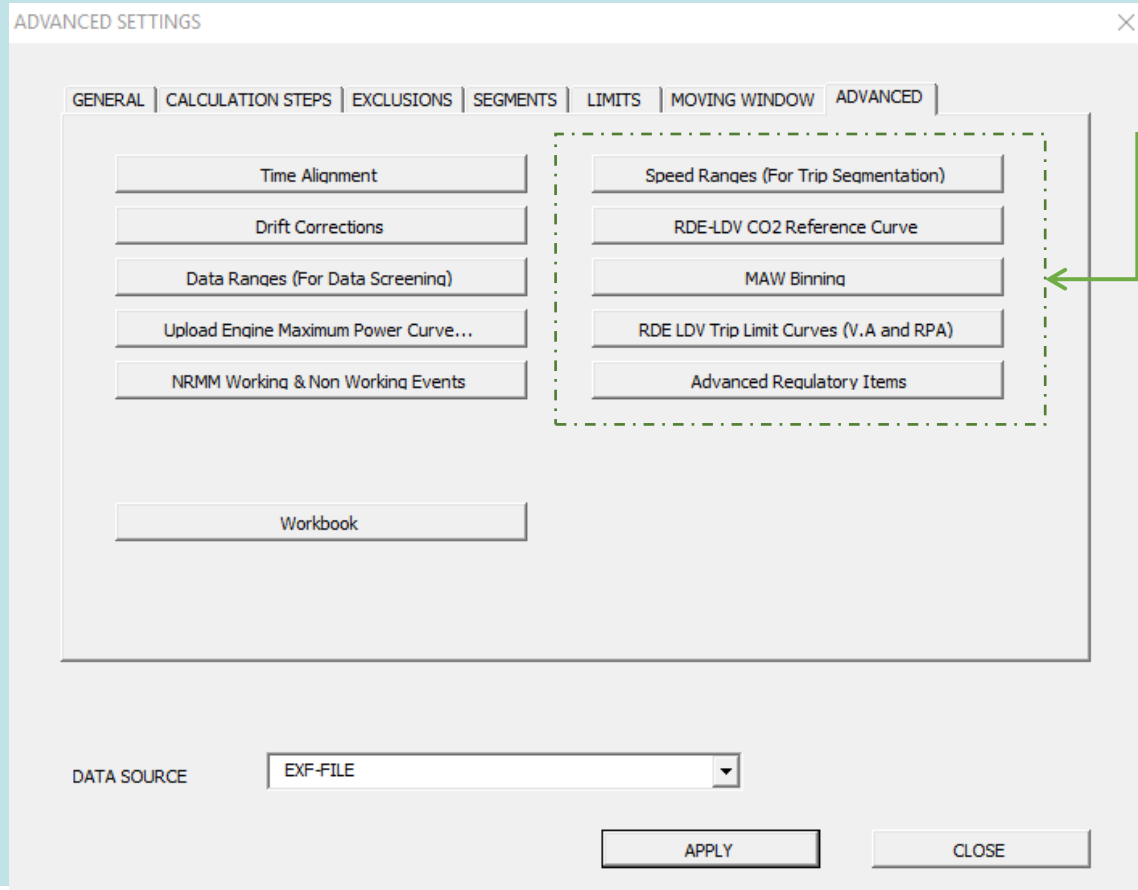
APPLY CLOSE

Always Select CO2

Always Select g/km

Input the reference CO2 value used for the MAW calculations (e.g. half of the vehicle WLTP CO2 mass emissions)

Instructions – Advanced –



If your settings deviate from the EU-RDE regulatory settings, you may adjust some parameters in this interface, through the sub-interfaces.

Instructions – Advanced – Speed Ranges

ADVANCED SETTINGS

GENERAL | CALCULATION STEPS | EXCLUSIONS | SEGMENTS | LIMITS | MOVING WINDOW | **ADVANCED**

Time Alignment

Drift Corrections

Data Ranges (For Data Screening)

Upload Engine Maximum Power Curve...

NRMM Working & Non Working Events

Workbook

Speed Ranges (For Trip Segmentation)

RDE-LDV CO2 Reference Curve

MAW Binning

RDE LDV Trip Limit Curves (V.A and RPA)

Advanced Regulatory Items

DATA SOURCE: EXF-FILE

APPLY CLOSE

Speed boundaries for the Trip Segmentation

Speed Ranges for Trip Segmentation

Low Speed or Urban Bin - Max Value [km/h]: 60

Medium Speed or Rural Bin - Max Value [km/h]: 90

Zero Speed Tolerance [km/h]: 1

Urban Speed 1 [km/h]: 0

Rural Speed 1 [km/h]: 0

APPLY CLOSE

Maximum Speed for Urban (resp. Low Speed) operation

Maximum Speed for Rural (resp. Medium Speed) operation

Maximum stop speed for vehicle stop

Instructions – Advanced – CO2 Ref. curve

ADVANCED SETTINGS

GENERAL | CALCULATION STEPS | EXCLUSIONS | SEGMENTS | LIMITS | MOVING WINDOW | **ADVANCED**

Time Alignment

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Upload Engine Maximum Power Curve...

NRMM Working & Non Working Events

Workbook

Speed Ranges (For Trip Segmentation)

RDE-LDV CO2 Reference Curve

MAW Binning

RDE LDV Tri

Adve

DATA SOURCE: EXF-FILE

APPLY

CO2 Characteristic Curve

Reference Cycles CO2 Values [g/km]

Phase	CO2 [g/km]	Av. Speed [km/h]
Phase 1	175.000	18.882
Phase 2	165.000	37.773
Phase 3	155.000	56.664
Phase 4	155.000	91.997

Curve Type

Bi Linear (Intersect Point @ Phase 3)

Order 3 + Linear Phase 4

Custom

UPLOAD CURVE...

Curve Type and Tolerances

Tol_1H_MAW Bin 1[%]: 45

Tol_1H_MAW Bins 2&3[%]: 40

Tol_1L_MAW Bin 1[%]: 25

Tol_1L_MAW Bins 2&3[%]: 25

Tol2_H[%]: 100

Tol2_L[%]: 100

APPLY

CLOSE

Values to establish the Ref. CO2 curve and tolerances

Vehicle CO2 per phase [g/km] and corresponding cycle average speeds

Curve shape

Tolerances (Can be defined separately for **MAW** urban/ rural and motorway (Resp. Low /Medium and High Speed) **average speed** ranges)

Instructions – Advanced – MAW Binning

ADVANCED SETTINGS

GENERAL | CALCULATION STEPS | EXCLUSIONS | SEGMENTS | LIMITS | MOVING WINDOW | ADVANCED

Time Alignment

Drift Corrections

Data Ranges (For Data Screening)

Upload Engine Maximum Power Curve...

NRMM Working & Non Working Events

Speed Ranges (For Trip Segmentation)

RDE-LDV CO2 Reference Curve

MAW Binning

RDE LDV Trip Limit Curves (V.A and RPA)

Advanced Regulatory Items

Workbook

DATA SOURCE: EXF-FILE

APPLY CLOSE

MAW average speed boundaries for MAW binning

Moving Averaging Window - Binning Settings

Binning Type

Vehicle Average Speed Engine Average Power

Binning Intervals

Automatic Manual

Number of Bins (Max. 10): 2

Min. Value: []

Max. Value: []

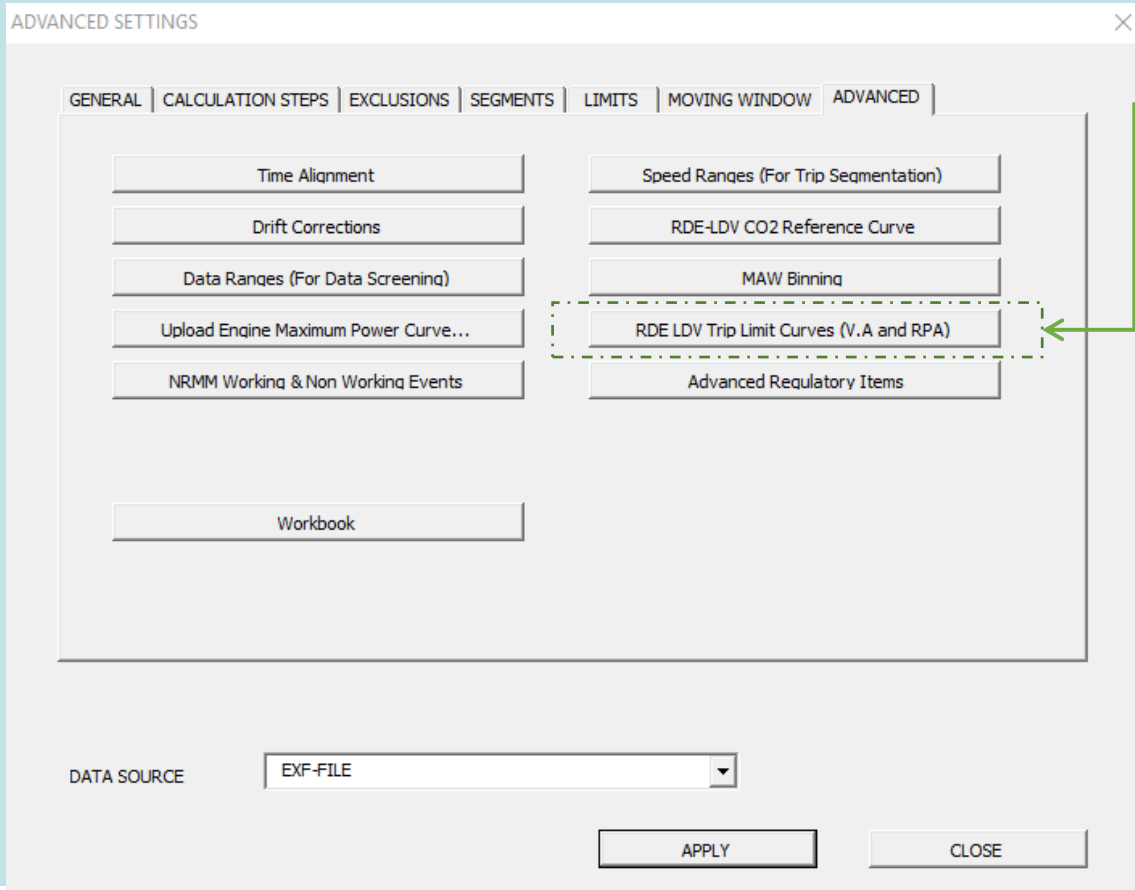
Bins	MIN=	MAX
Bin 1	0	45
Bin 2	45	80
Bin 3	80	200

Maximum average speed for Urban (resp. Low Speed) Windows

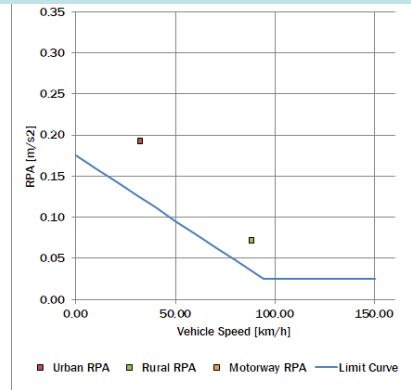
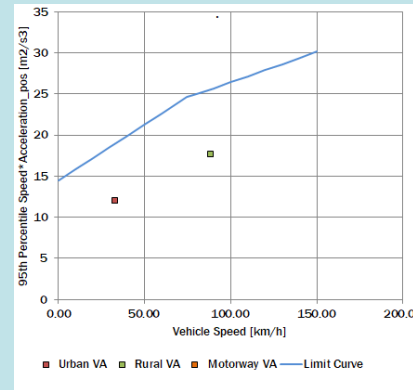
Maximum average speed for Rural (resp. Medium Speed) Windows

Maximum average speed for Motorway (resp. High Speed) Windows

Instructions – Advanced – MAW Binning



Possibility to modify the limit curves for the 95th percentile of (VxA) and the RPA indicators (using .csv file)



Instructions – Advanced – MAW Binning

ADVANCED SETTINGS

GENERAL | CALCULATION STEPS | EXCLUSIONS | SEGMENTS | LIMITS | MOVING WINDOW | **ADVANCED**

Time Alignment

Drift Corrections

Data Ranges (For Data Screening)

Upload Engine Maximum Power Curve...

NRMM Working & Non Working Events

Speed Ranges (For Trip Segmentation)

RDE-LDV CO2 Reference Curve

MAW Binning

RDE LDV Trip Limit Curves (V.A and RPA)

Advanced Regulatory Items

Workbook

DATA SOURCE: EXF-FILE

APPLY CLOSE

Other regulatory settings. These settings affect the assessment of the trip validity only if more than 1% of the data is outside the conditions. Otherwise, it affects only the emissions calculations:

- Correction for extended conditions
- Measurement uncertainty factors (multiplier of the applicable limits)

Advanced Regulatory Settings

MAW Direction

Backwards

Forward

Moderate - Extended Conditions

Moderate Altitude Max [m]: 700

Extended Altitude Max [m]: 1300

Moderate Temperature Min [C]: -2

Moderate Temperature Max [C]: 30

Extended Temperature Min [C]: -7

Extended Temperature Max [C]: 35

Extended Factor 1 [-]: 1.60

Extended Factor 2 [-]: 1.60

Measurement Uncertainty Factors

NOx: 2.10

PN: 1.50

CO: 1.00

APPLY CLOSE

Instructions – Advanced – MAW Binning

ADVANCED SETTINGS

GENERAL | CALCULATION STEPS | EXCLUSIONS | SEGMENTS | LIMITS | MOVING WINDOW | **ADVANCED**

Time Alignment

Drift Corrections

Data Ranges (For Data Screening)

Upload Engine Maximum Power Curve...

NRMM Working & Non Working Events

Speed Ranges (For Trip Segmentation)

RDE-LDV CO2 Reference Curve

MAW Binning

RDE LDV Trip Limit Curves (V.A and RPA)

Advanced Regulatory Items

Workbook

DATA SOURCE: EXF-FILE

APPLY CLOSE

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Advanced Regulatory Settings

MAW Direction

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Moderate - Extended Conditions

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Measurement Uncertainty Factors

NOx: 2.10

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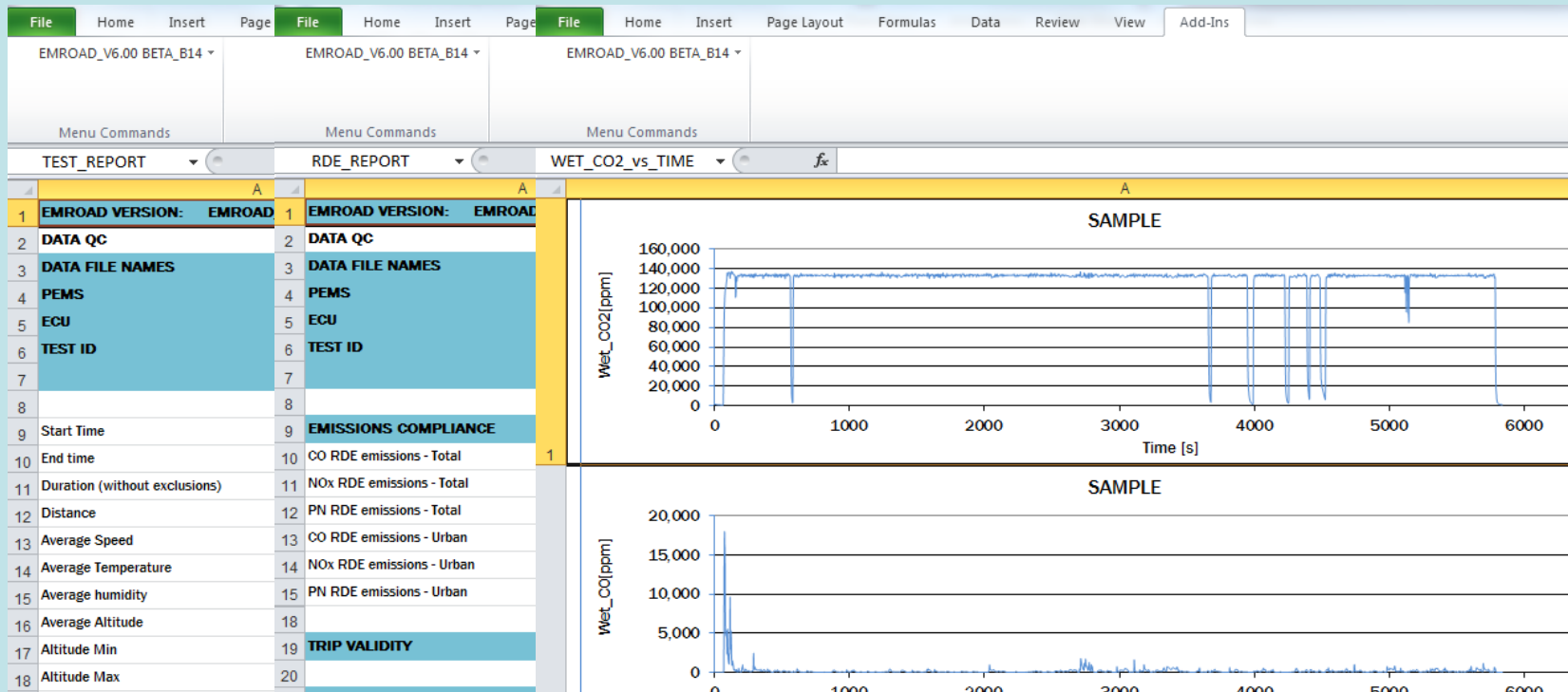
APPLY CLOSE

Backup slides

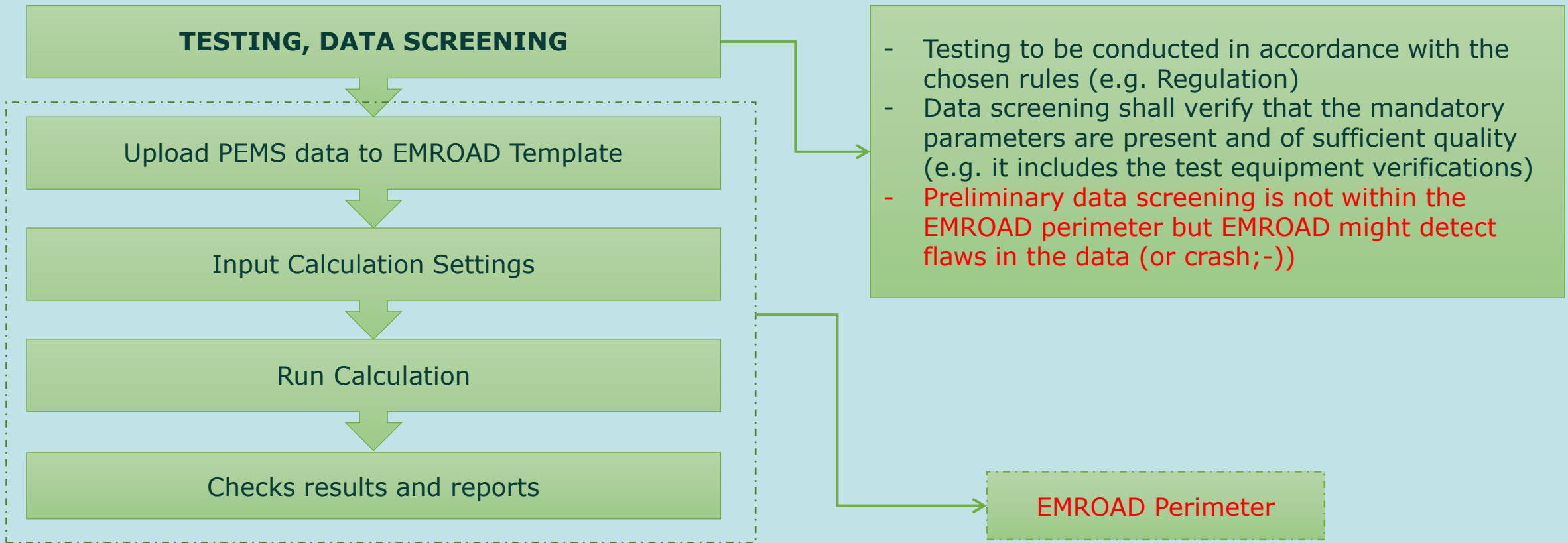
- **General EMROAD functioning**
- **From 4th Rde-IWG session in Tokyo**

Main principles

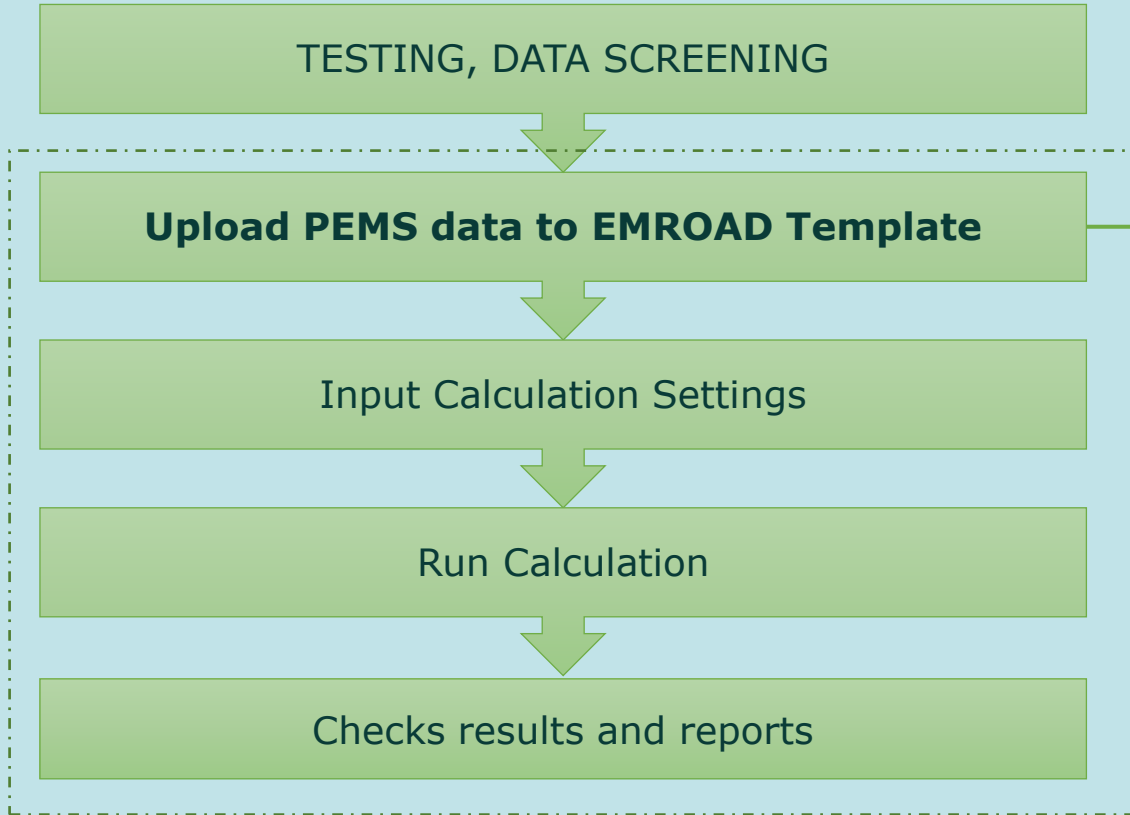
- **EMROAD Template**



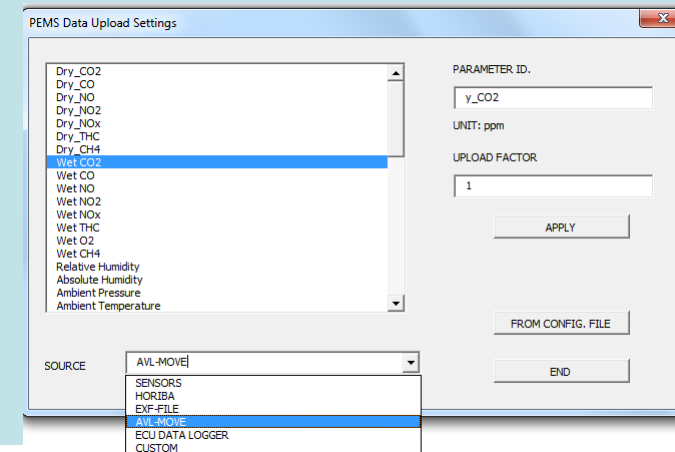
Main principles - Sequence



Main principles - Sequence



- All types of PEMS instruments data files, or custom
- EU data exchange files (EXF) also containing analyzers checks and vehicle information according to EU-RDE requirements
- Custom Upload Settings
- Uploads the data to the TEST DATA worksheets and converts the data to the EU reference units



Main principles - Sequence

TESTING, DATA SCREENING

Upload PEMS data to EMROAD Template

Input Calculation Settings

Run Calculation

Checks results and reports

- EU-Regulatory (LDV, HDV, NRMM) with simplified interfaces
- Non-regulatory calculations (advanced, not supported)
- Possibility to run step-by-step (advanced, not supported)

RDE LDV - SIMPLIFIED CALCULATION SETTINGS

Data Source	AVL-MOVE
Vehicle Type	LIGHT-DUTY VEHICLE - M1-N1 CLASS 1
Fuel Type	DIESEL (B7)
Emissions Limits	LDV EURO 6 - M1 - N1 CLASS 1 - COMP. IGNITION
Exhaust Flow	EXHAUST FLOW METER
Distance	GPS

Vehicle Conditioning: Cold Hot

Start Altitude: GPS Manual [] [m]

Moving Averaging Window - Reference Quantity & WLTC Reference CO2 Values [g/km]

Reference CO2 Mass (WLTP/2) [kg]	1.474		
WLTP [g/km]	126.714	[OVC-HEV] WLTP Charge Sustaining	[]
Low Speed Phase [g/km]	152.893	High Speed Phase [g/km]	118.370
Medium Speed Phase [g/km]	111.963	Extra High Speed Phase [g/km]	135.040

Euro 6 - RDE Stage

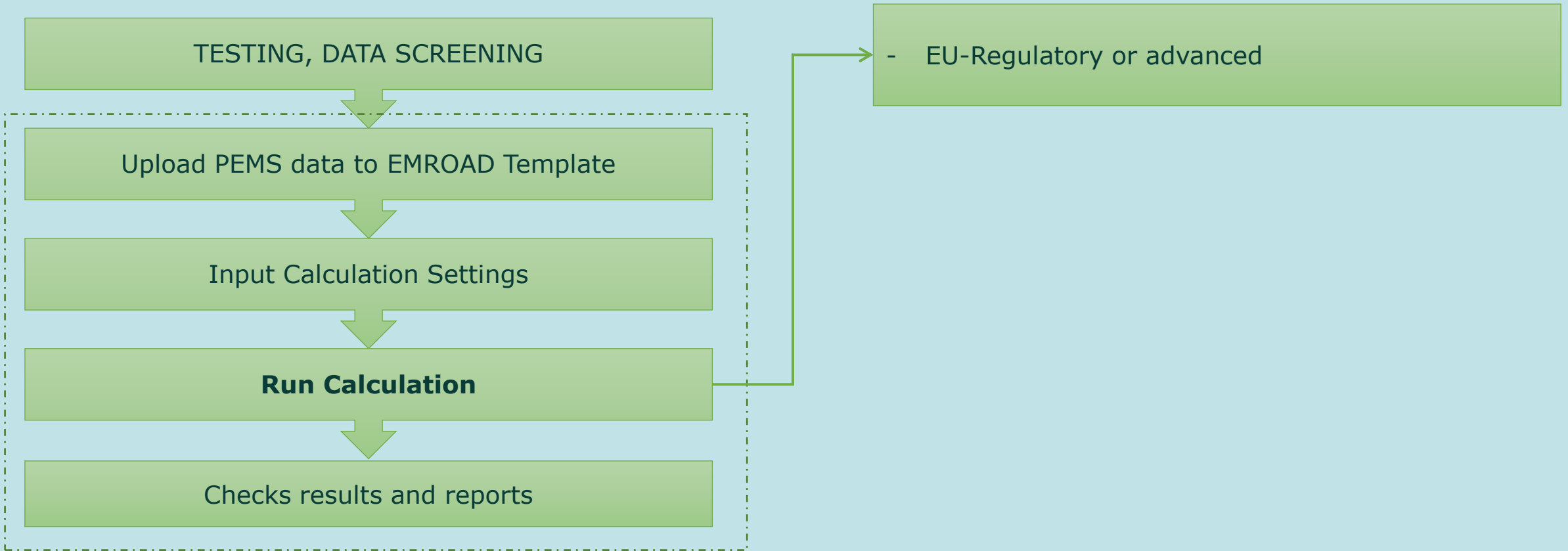
Type Approval after 1/1/2020 RDE3 [RC]

INFO
In this simplified interface, only test and vehicle specific parameters may be input - The parameters specific to the RDE evaluation are set as default values. (e.g. Speed binning of windows, CO2 characteristic curve, Trip...)

ADVANCED... APPLY CLOSE

EU-RDE-LDV Settings interface

Main principles - Sequence



Main principles - Sequence

TESTING, DATA SCREENING

Upload PEMS data to EMROAD Template

Input Calculation Settings

Run Calculation

Checks results and reports

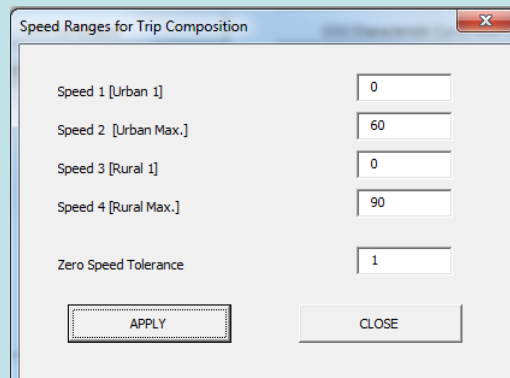
- Instantaneous emissions and MAW results in CALCULATED data
- Integrated and average values (no regulatory processing)
- EU-Regulatory (RDE REPORT for LDV, PASS-FAIL REPORT FOR HDV and NRMM): **verification of emissions and all parameters for test validity**

EMROAD VERSION:	EMROAD_V6_00_BETA_B14_IRC			
DATA QC		ANALYZERS	DATA QUALITY	DATA CHECKS
PEMS	C:\Users\bonnepi\Documents\EMROAD CASES\RDE IWG\INPUT\TUG01_Ries04			
ECU	0.00			
TEST ID	TUG01_Ries04_E6			
EMISSIONS COMPLIANCE	[Yes/No]		YES	
CO RDE emissions - Total	mg/km		35.15	
NOx RDE emissions - Total	mg/km		92.73	
PN RDE emissions - Total	#/km		4.63E+09	
CO RDE emissions - Urban	mg/km		39.77	
NOx RDE emissions - Urban	mg/km		58.50	
PN RDE emissions - Urban	#/km		4.72E+09	
TRIP VALIDITY	[Yes/No]		NO	
TRIP CHARACTERISTICS [Annex IIIa, TRIP REQUIREMENTS]			INVALID	
Total trip distance	km		85.25	
Total trip duration	min. [90-120]		107.17	
Cold start duration	min. [-5]		0.22	
Urban distance	km [>16]		27.26	
Rural distance	km [>16]		29.02	
Motorway distance	km [>16]		28.97	

Example: EU-RDE-LDV Report

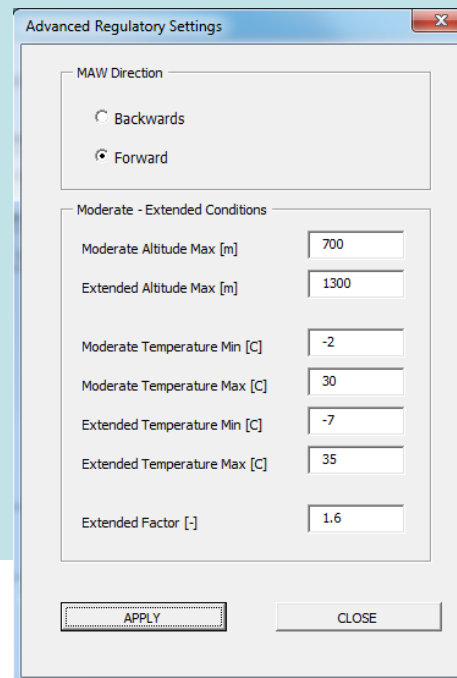
Application to RDE-IWG

- **Possibility to input regional settings**
 - **Speed binning values defining the speed based conditions (e.g. low, high speed)**
 - **MAW Speed binning values**
 - **Altitude and temperature values for moderate and extended conditions**
 - **Shape of the CO2 characteristic curve for MAW calculations**
 - **Conformity factors**



Speed Ranges for Trip Composition

Speed 1 [Urban 1]	<input type="text" value="0"/>
Speed 2 [Urban Max.]	<input type="text" value="60"/>
Speed 3 [Rural 1]	<input type="text" value="0"/>
Speed 4 [Rural Max.]	<input type="text" value="90"/>
Zero Speed Tolerance	<input type="text" value="1"/>



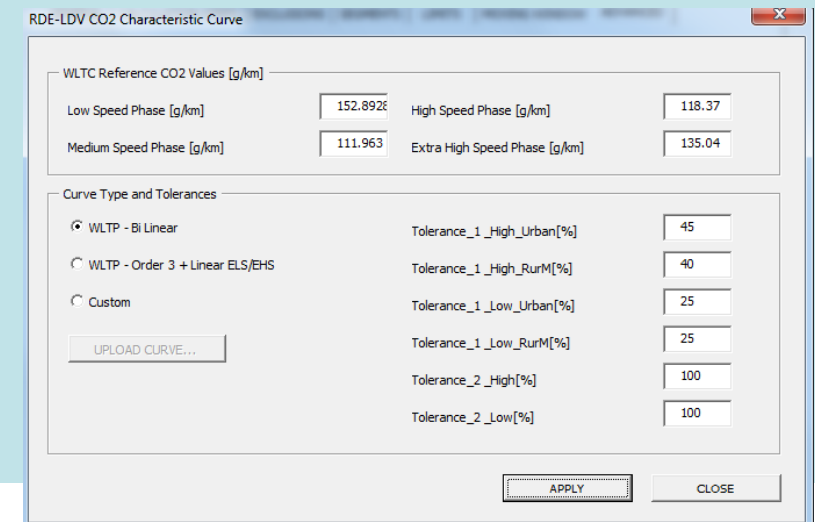
Advanced Regulatory Settings

MAW Direction

Backwards
 Forward

Moderate - Extended Conditions

Moderate Altitude Max [m]	<input type="text" value="700"/>
Extended Altitude Max [m]	<input type="text" value="1300"/>
Moderate Temperature Min [C]	<input type="text" value="-2"/>
Moderate Temperature Max [C]	<input type="text" value="30"/>
Extended Temperature Min [C]	<input type="text" value="-7"/>
Extended Temperature Max [C]	<input type="text" value="35"/>
Extended Factor [-]	<input type="text" value="1.6"/>



RDE-LDV CO2 Characteristic Curve

WLTC Reference CO2 Values [g/km]

Low Speed Phase [g/km]	<input type="text" value="152.8928"/>	High Speed Phase [g/km]	<input type="text" value="118.37"/>
Medium Speed Phase [g/km]	<input type="text" value="111.963"/>	Extra High Speed Phase [g/km]	<input type="text" value="135.04"/>

Curve Type and Tolerances

WLTP - Bi Linear
 WLTP - Order 3 + Linear ELS/EHS
 Custom

Tolerance_1_High_Urban[%]	<input type="text" value="45"/>
Tolerance_1_High_RurM[%]	<input type="text" value="40"/>
Tolerance_1_Low_Urban[%]	<input type="text" value="25"/>
Tolerance_1_Low_RurM[%]	<input type="text" value="25"/>
Tolerance_2_High[%]	<input type="text" value="100"/>
Tolerance_2_Low[%]	<input type="text" value="100"/>

RDE-IWG

- **RDE specific values might be reported upon request in the RDE REPORT worksheet**
- **Current version: 6, open for BETA testers and EU Regulatory calculations**
- **The tool is available in the CIRCABC group "New light duty test procedures: WLTP, MAC, ...", in the section "RDE-LDV Reference documents and tools".**
- **Access to this section is open to all and does not require any registration or membership:**
<https://circabc.europa.eu/w/browse/79a4a9b6-4003-4e02-956d-048dcef1a169>
- **Release of functions useful for the RDE IWG in May**