AVL Advanced Simulation Technologies

Tools and Solutions for Next-Level Simulation

Customer Services Catalogue

Software Related Services

- Training and Support
- Knowledge Transfer
- Project Work

Overview of Training courses in Graz 2020

BOOST™	EXCITE™ Timing Drive	TABKIN™
February 05-06	April 07-08	January 15-16
October 06-07	September 15-16	March 11-12
		September 02-03
		November 11-12
CRUISE™	**EXCITE™ Piston&Rings**	**CRUISE™ M VTMS**
February 12-13	February 25-26	March 03-06
September 09-10	May 12-13	October 27-30
	October 13-14	
CRUISE™ M	**FIRE™**	**CRUISE™ M MOBEO Cylinder**
January 21-23	January 14-16	March 24-26
May 26-28	March 10-12	October 13-15
August 25-27	September 01-03	
November 24-26	November 10-12	
EXCITE™ Designer	**FIRE™ M**	**CRUISE™ M Flow**
February 04-05	February 18-20	May 05-06
June 16-17	March 31 – April 02	December 01-02
September 22-23	May 26-28	
	September 29 – October 01	
	November 17-19	
EXCITE™ Power Unit	**Model.CONNECT™**	**CRUISE™ M VTMS MOBEO**
January 28-29	February 11-12	June 02-05
April 21-22	April 01-02	November 30 – December 03
September 08-09	June 30 – July 01	
November 03-04	September 16-17	
	October 21-22	
FIRE™ - SAMOS	**AVL VSM™**	**PreonLab**
March 24-25	March 17-19	April 15
October 06-07	June 16-18	October 20
	September 22-24	
	November 03-05	

PRICES:

- For scheduled training courses held in Graz, the price is:
  - **a)** 400 euro per day and participant **b)** 200 euro per day and participant for Universities
- For training on request, the total price for one AST engineer for one full day training is:
  - **a)** In Graz: 1200 euro for max. 4 participants
  - **b)** In Europe: 1850 euro for max. 6 participants at the customer location, including travel and accommodation
  - **c)** Rest of World: 5200 euro for 2 days training, including travel and accommodation.
    For each additional day 1200 euro.

Register online: www.avl.com

Table of Contents

1. Introduction

This document describes all AVL AST software product related services offered by the customer services group (AST / CC).

- From a Software Provider to a Solution Provider

Besides the development of easy-to-use software products, AVL AST provides development of methods and advanced simulation solutions. The transfer of engineering and application know-how is necessary for an extensive use of advanced simulation technologies in daily work, in addition to training in the usage of a software tool.

- Create Values for Customers

AST offers various services in different levels to support our customers in the best way to shorten the initial phase from first contact with our products to the effective usage in the development process.

In addition we provide services for improvement of the applied methods and for development of new simulation methods in close co-operation with the customer up to complex project work including simulation-measurement comparison for validation of methods or taking over design responsibility.

- From Engineer to Engineer

All our engineers participate in method development and advanced simulation work, software training and support. This is definitely a challenging task for all engineers involved, but for the customer it offers the significant benefit that by each contact with our service group he is in contact with highly experienced engineers, who know their tools and the application, work in close contact to the software development and can link their engineering experience with the information coming from software support of various customers.

- Our message to customers is: "***We assist our customers in developing advanced simulation excellence***"

Graz, April 2020

Thomas Resch (AST CC / Head of Customer Services)

Christian Vock (AST CCS / Customer Support Manager)

2. Overview of AST Customer Services

The customer services group comprises the three modules

- **Tool focused** - Training & Software Support
- **Application and methodology focused** – Training, Technology Seminars & Engineering Support
- **Project work focused** – Advanced Solutions

An overview of the entire chain from basic training and standard software support via enhanced know-how transfer up by technology seminars and specific engineering support up to specific advanced solutions, performed as project work, is shown in following figure. These services are valid for AST worldwide.

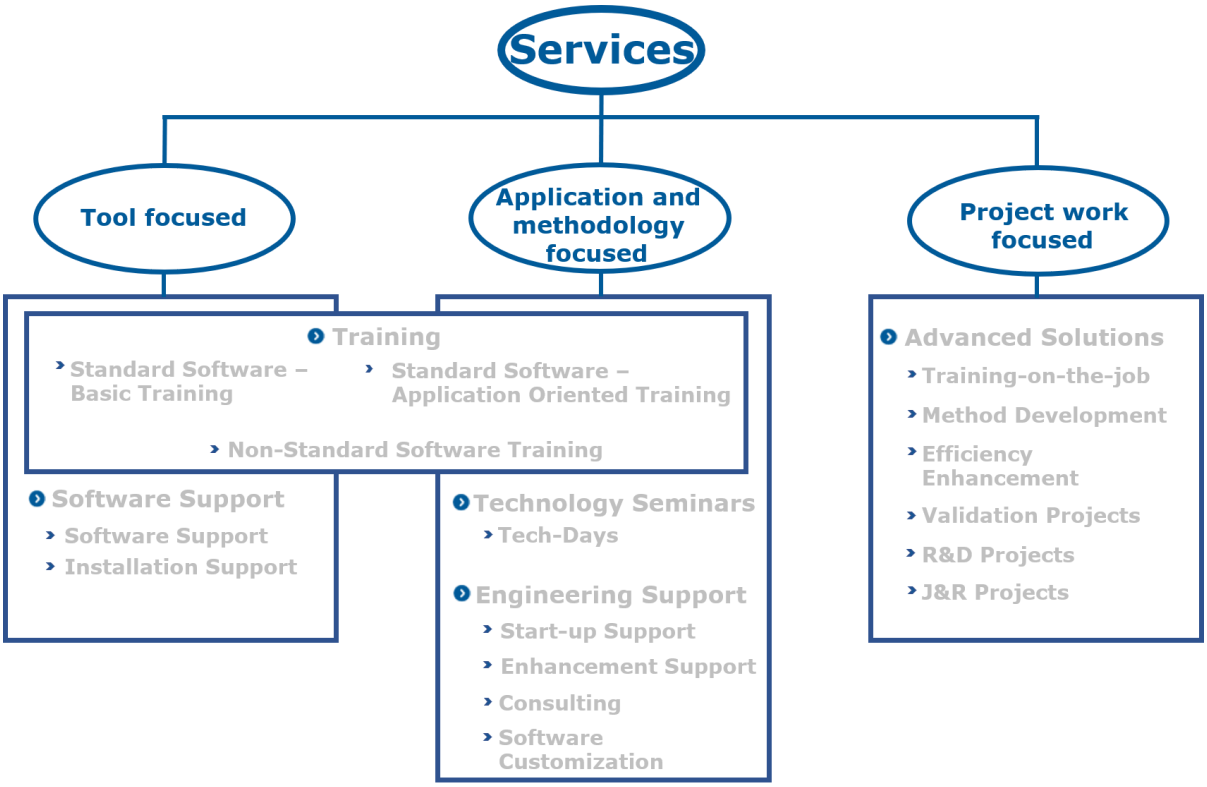


Figure 1: Overview of AST Customer Services

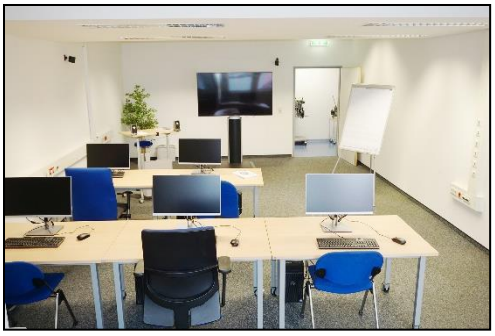
2.1 Validity of Prices and Training Content

* All **prices** given in this document as well as **training content** is related to activities done by AVL AST Graz and can differ for local affiliates.

  For more details contact your local support and sales organization.

2.2 AST Training Center

- 3 modern-equipped and air-conditioned training rooms
- Training by support and application engineers
- Hardware examples for demonstration purpose



3. Training & Software Support

This module focuses mainly on the usage and installation of the AVL AST software tools:

- AST offers support for *installation of software tools* at customer specific environment.
- AST offers for all its software products *standardized software training* for getting started.
- For software related questions AST offers *software support* according to the AST customer support process.

3.1 Installation Support

This module deals with the installation of our software at customer specific environment.

ID	Service
CC_31	Installation Support

Purpose:

Basic step is the installation of the software on a single computer or on a file server. Second step is valid for more complex installations as multi-processor environment on clusters or the connection of AVL AST software with a queuing system such as LSF or another customer specific queuing system.

Validity:

Basic installation is valid for all AST tools, multi-processor option for FIRE and connection with a queuing system is valid for AWS software and FIRE.

Content:

- Software installation from CD / DVD, ready to work.
- Installation performed by AST engineer.
- Customization of AWS interfaces according to the requirements of the queuing system.

Requirements:

- Basic requirements to the system are given by AVL in advance and have to be fulfilled.
- AVL engineer has to get administration privileges during the installation phase.

Customer Benefit:

- Fast start-up to get a valid installation running.
- Best possibility to enable the usage of all features of the software.

Duration:

- Half a day for basic installation.
- Connection with queuing system depends highly on the complexity of this system and has to be done in close co-operation between AST and system administration on customer side. For LSF system installation will take approximately one day, for other systems around 3 days.

Price (excl. Tax): * see chapter 2.1

Installation will be done at customer side. Price for installation by one AST engineer is:

- Basic installation: 500 euro * see chapter 2.1
- Installation in complex system environment and connection to queuing system: 1200 euro per day * see chapter 2.1

Travel and accommodation will be charged separately.

Contact	
Additional Information	Responsible Sales Manager
Proposal	Responsible Sales Manager

3.2 Standard Software Training

Standard training courses are provided and performed by AST using standard training material and calculation models. AST offers basic and application training modules.

Training courses are available for each AVL AST software product and are provided in Graz, at AVL affiliates or on-site at customer.

General training language is English or local language at AVL affiliates.

Register at the AVL Homepage using the **AVL AST Trainingcenter** to search for a course and submit an inquiry, after which you will receive a Confirmation E-Mail.

Cancellations must be made in written form 1 week before the start of the course.

Training at AVL Graz

- Training courses will take place at AST Headquarters, Alte-Poststraße 152, A-8020 Graz, Austria.
- AST will organize accommodation for customers, if requested.
- At AVL affiliates arrangements are to be made with the affiliates.
- Training courses held in Graz have the additional benefit for customers to get in contact with various application engineers from AVL.

Training at Customer's Site

- On-site training will be held by one engineer from AST. The customer is asked to provide a training room with equipment and necessary hardware.
- Software should be pre-installed by the customer. Additional licenses during the training can be provided by AST.

Contact	
Training Content	Link to Homepage
Training Schedule	AVL Training Calendars
Training Registration	AVL Homepage

3.2.1 Basic Software Training

An overview of the handling and usage of the product is given as well as a general introduction in main applications. A standard model for the simulation is presented and possible applications are discussed.

ID	Service
CC_321	Basic Software Training

Purpose:

- Overview about the software tool
- Enables the user to build up and run calculation models, prepared by AVL

Validity:

Basic training courses are offered for all AVL AST software products.

Content: * see chapter 2.1

- Introduction, theory, primer examples, modeling, simulation and post-processing

Goals:

- Basic knowledge
- Capability of software handling

Customer Benefit:

- Fast and efficient way to start using the software tool

Duration:

- Depending on training (see subsequent product listing)

Price (excl. Tax): * see chapter 2.1

- For scheduled training courses held in Graz, the price is:
  a) 400 euro per day and participant
  b) 200 euro per day and participant for Universities

  AVL offers fixed dates for scheduled training courses, typically one training per quarter of the year. At these training courses engineers from different companies can participate (max. 12 people).

- Alternatively training can be held on request. For training on request, the total price for one AST engineer for one full day training is:
  - In Graz: 1200 euro for max. 4 participants
  - In Europe: 1850 euro for max. 6 participants at the customer location, including travel and accommodation
  - Rest of World: 5200 euro for 2 days training, including travel and accommodation. For each additional day 1200 euro.

Contact	
Information & Organization	Training Organization – Bettina Strini (bettina.strini@avl.com)
Registration	link to registration (inquiry) on the AVL Homepage
Training Schedule	AVL Training Calendars

3.2.2 Application Software Training

Application training courses are also standard, but focus on specific applications and are based on the knowledge given by standard basic training.

For some products various course parts for different applications are offered. They can be combined individually according to the customer requirements.

ID	Service
CC_322	Application Software Training

Purpose:

The application software training will improve the knowledge about the software tool and will train the user the methodology of special application methods.

Validity:

Application training courses are offered for all AVL AST software products.

Content: * see chapter 2.1

- Application method, special theory, application examples
- Special modeling, post-processing technology

Goals:

- Special application oriented knowledge

Customer Benefit:

- Fast and efficient way to learn a new software application field

Duration:

- Depending on training (see subsequent product listing)

Price (excl. Tax): * see chapter 2.1

- For scheduled training courses held in Graz, the price is:
  - 400 euro per day and participant
  - 200 euro per day and participant for Universities

  AVL offers fixed dates for scheduled training courses, typically one training per quarter of the year. At these training courses engineers from different companies can participate (max. 12 people).
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Contact	
Information & Organization	Training Organization – Bettina Strini (bettina.strini@avl.com)
Registration	link to registration (inquiry) on the AVL Homepage
Training Schedule	AVL Training Calendars

Further information:

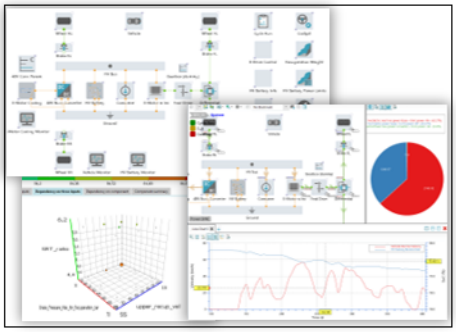
- Application training courses are on request after completing the basic training.
- Pre-requisites: Completed the related Basic Training Course

3.2.3 Electrification Trainings

3.2.3.1 Electrification Trainings Vehicle

TELV-01 / Battery and Range Extended Electric Vehicle Concept Finding & Layout

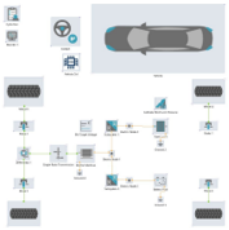
Models:
Basic_Electronic_Circuits.proj
DCDC_example.proj
El_Consumer_Modeling.proj
lowpass_filter.proj
Mech_Consumer_Modeling.proj
E-Machine_Speed_Control.proj
Battery_Electric_Vehicle_DoE_03.proj
Battery_Electric_Vehicle_OP.proj
Range_Extended_Electric_Vehicle_02.proj



Module 1* Basic	Module 2 Application	Module 3 Application
1 Day	1 Day	1 Day
Introduction • CRUISE M GUI, Pre- and Post-processing • Mechanical domain in CRUISE M • Electric domain in CRUISE M • Basic model setup with calculation tasks	BEV powertrain model • Simple powertrain • Advanced powertrain • Introduction to BMS • E-motor current control • Model analysis	Applications & REEV powertrain model • Cycle run & FLA • Parameters, scenarios and DoE • REEV & controller • Simple thermal model • Model analysis

TELV-02 / Fuel Cell Electric Vehicle Concept Finding & Layout

Models:
FC_testbed.proj
Basic_Electronic_Circuits.proj
DCDC_converter_basics.proj
Battery_parametrization.proj
Aut_FWD.proj
HeatFlow_QuasiSteady.proj
WaterSeparator.proj
Humidifier.proj
PEMFC_basic_interactive.proj
FCEV_BoP_Anode.proj
FCEV_BoP_Cathode_part1.proj
FCEV_BoP_Cathode.proj
FCEV_BoP_Anode.proj
FCEV_BoP_Thermal_management_part1.proj
FCEV_BoP_Thermal_management_part2.proj
FCEV_BoP_Thermal_management.proj
FCEV_BoP_Assembly.proj



Module 1* Basic	Module 2 Application	Module 3 Application
1 Day	1 Day	1 Day
Introduction • CRUISE M GUI, Pre- and Post-processing • Control domain in CRUISE M • Mechanical domain in CRUISE M • Electric domain in CRUISE M • Basic model setup with calculation tasks • Simple powertrain	FCEV powertrain model • Gas path domain in CRUISE M • Liquid domain in CRUISE M • Thermal domain in CRUISE M • FC Control • E-motor current control • Model analysis	Applications & FCEV powertrain model • Advanced powertrain • Cycle run & FLA • Parameters, scenarios & BoP • FCEV & controller • Model analysis • Energy Management • Electrochemical Fuel Cell

- Module 1* (Basic Training for CRUISE M) only have to be done once
- Module 2 and 3 (Application Training) can only be done together

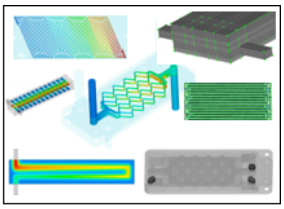
TELV-03 / Hybrid Electric Vehicle Concept Finding & Layout

Models:
HEV_P2_AMT_FWD.proj
Series_Hybrid_RE_Basic_Model.proj
Man_FWD.proj
PX_PMG_AMT_FWD.proj

Module 1* Basic	Module 2 Application	Module 3 Application
1 Day	1 Day	1 Day
Introduction • CRUISE M GUI, Pre- and Post-processing • Mechanical domain in CRUISE M • Electric domain in CRUISE M • Basic model setup with calculation tasks	HEV powertrain model • Run basic vehicle model with post-processing • Overview on hybrid concepts Px • Modify basic vehicle to a hybrid configuration P0+P2 • Simple control function implementation	HEV powertrain model • Simple control function implementation • Introduction to BMS • E-motor current control • Simple thermal model

3.2.3.2. Electrification Training Fuel Cell (PEM)

TELF-01 / PEM Fuel Cell Module Performance Analysis



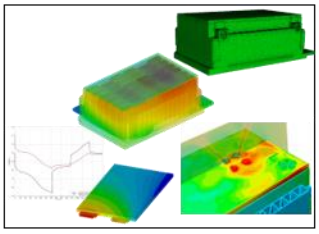
Models:
9106_LTPEM_FC_Straight_Channel
9335_LTPEM_FC_Cooling
9336_LTPEM_FC_Discretized_ZBT_50
9337_LTPEM_FC_Discretized_Homogenized_ZBT_50
9507_LTPEM_FC_CAD_Workflow

Module 1** Basic	Module 2 Application	Module 3 Application
1 Day	1 Day	1 Day
Introduction • FIRE M introduction • SDT GUI, Pre- and Post-processing • Case definition, parameters and job submission • Basic model set-up	PEM FC Basic Training • PEM FC surface preparation • Interactive meshing (Single Serpentine Flow Channel PEM FC) • Automatic meshing (FC Diamond) • Basic simulation setup for fuel cell module	PEM FC Application Training • Advanced surface repair (ZBT PEM FC) • Specific oriented simulation setup for fuel cell module • Analysis of FC specific results (Post-processing and discussion)

- Module 1* (Basic Training for CRUISE M) only have to be done once
- Module 2 and 3 (Application Training) can only be done together

3.2.3.3 Electrification Training Battery

TELB-01 /Battery Thermal and Hazard Investigation



Models:
9107_Battery_Cooling
9320_ET_Battery
9321_EC_Battery (existing model)
9322_Battery_Thermal_Runaway

Module 1** Basic	Module 2 Application	Module 3 Application
1 Day	1 Day	1 Day
Introduction • FIRE M introduction • SDT GUI, Pre- and Post-processing • Case definition, parameters and job submission • Basic model set-up	Thermal analysis • Introduction to battery technology and simulation • Preparation of CAD data and meshing • Basic model setup for Battery Cooling	Hazard investigation • Introduction to battery thermal runaway • Setup for thermal runaway simulations • Analysis of results (Propagation times, flammability)

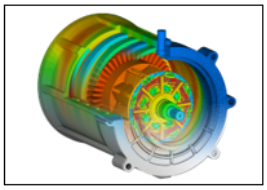
Module 4 Application
1/2 Day
Electrothermal & -chemical models • Introduction to ET & EC battery models • Data requirements and processing for ET & EC models • Setup of ET & EC simulations

- Module 1** (Basic Training for FIRE M) only have to be done once
- Module 2 and 3 (Application Training) can only be done together

3.2.3.4 Electrification Trainings Electric Motor

TELM-01 / PMSM E-Machine Electromagnetics and Thermal Investigation

Models:
9504_E-Motor Cooling Workflow (existing model)
2 new e-motor EM analysis installation examples
(ready for 2020.1 release)

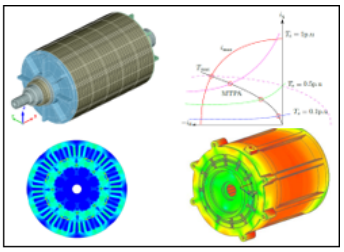


Module 1** Basic	Module 2 Application	Module 3 Application
1 Day	1 Day	1 Day
Introduction • FIRE M introduction • SDT GUI, Pre- and Post-processing • Case definition, parameters and job submission • Basic model set-up	E-machine electro-magnetic analysis • Intro of 2.5D electro-magnetic capabilities and modelling appr. • E-machine modeling using EMT*** and from CAD import • Setup of EM simulation • Results evaluation • Export results for further analyses • Modify model	E-machine thermal analysis • Intro of thermal capabilities and 3D modelling approaches • Calculation of losses • CAD preparation and meshing • Model setup with combined liquid and air cooling • Analysis of temperatures

- Module 1** (Basic Training for FIRE M) only have to be done once
- Module 2 and 3 (Application Training) can only be done together

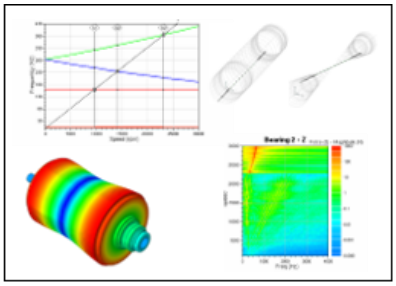
TELM-02 / E-Machine NVH Analysis with Electrical Network

Models:
EMC0 + Stator Forces
EMC1



Module 1 Basic	Module 2 Application
1/2 Day	1 Day
Introduction • FIRE M introduction • SDT GUI, Pre- and Post-processing • Case definition, parameters and job submission • Basic model set-up	Model Set-up • Data generation with EMT (Electric Machine Tool) • Set-up of Models for NVH task (frequency domain/time domain) – EMC0 & stator forces + post processing • Set-up of model for higher electrical order effects and (low speed) rotor dynamics– EMC1 • Data check with property assistant

TELM-03 / Electric Machine Rotor-Dynamics

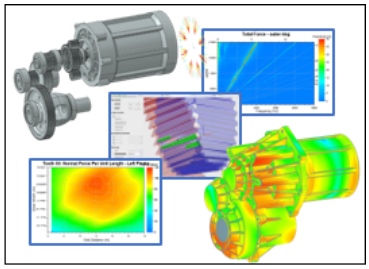


Models:
RotDyn.ex
RotDynBearingStiffness.ex
RotorDyn_3D.ex

Module 1 Basic	Module 2 Application	Module 3 Application
1/4 Day	1/4 Day	1/2 Day
Rotor-dynamics Theory Introduction • Introduction to Rotor-dynamics theory • Basics about critical speeds, upward and backward whirling modes	Complex Modal Analysis • Introduction to Shaft Modeler tool • Setup of the Shaft Modeler Rotor • Bearing Stiffness calculation • Complex Modal Analysis of the rotor	Transient Dynamic Analysis • Setup of the E machine Excite model for Rotor-dynamics • Introduction to the EMC joint in Excite • Results Evaluation

3.2.3.5 Electrification Training E-Axle

TELA-01 / E-Axle NVH and Durability Analysis



Models:
eAxle_PGS.ex
eAxle_PGS_flex.ex

Module 1 Basic	Module 2 Application
1 Day	1 Day
Advanced simulation • Introduction of EXCITETM Power Unit capabilities and modelling approaches to simulate eAxles with cylindrical and planetary gear stages • Creating an advanced eAxle model • Results evaluation using Impress Chart and Impress 3D (Data Recovery), gear mesh evaluation	Extended simulation Modelling extensions: • Microgeometry – contact plots • FlexGear - retained nodes • Stator – teeth forces RCA (Root Cause Analysis) • MA (Modal Analysis) • NTPA (Numerical Transfer Path Analysis) • TF (Transfer Functions)

3.2.4 BOOST Training Courses

BOOST Basic Training Course	TBCS-01
Content: TBCS-01 ♦ Introduction and Theory ♦ Create a Model of a 4-stroke Gasoline or Diesel Engine (1 cylinder gasoline model optional - aimed for customers dealing with the motorcycle engines) ♦ Series Calculation ♦ Post-processing ♦ Control Elements ♦ MATLAB Interfaces ♦ BURN module: combustion – rate of heat release evaluation based on measurement data ♦ Transient Calculation (on request as additional ½ day)	Duration: 2 days

BOOST Application Training Courses	TBCS-02 to 04
Content: TBCS-02: Aftertreatment (1.5 days) ♦ Introduction and Theory ♦ Examples: DOC Light Off and DPF Regeneration ♦ Kinetic Parameters Calibration Using Optimization Tool ♦ Introduction to AST User Coding Interface TBCS-03: Linear and Non-Linear Acoustics (1 day) ♦ Introduction and Theory ♦ Example: Exhaust Muffler Model (Rockdrill) ♦ Advantages/Disadvantages of Linear vs. Non-linear Solution ♦ Transmission Loss Adjustment Using Optimization Tool TBCS-04: Turbocharger (1 day) ♦ Introduction and Theory ♦ BOOST Simplified Turbocharger Model ♦ Turbocharger Matching and Full Turbocharger Model	Duration: 1 / 1.5 days

3.2.5 CRUISE Training Courses

CRUISE Basic Training Course	TCSS-01
Content: TCSS-01 ♦ Introduction ♦ Workflow to Create a Vehicle Model ♦ Explanation of Available Calculation Tasks ♦ Explanation of Different Calculation Types (Variations) ♦ Post-processing	Duration: 2 days

HEV and EV Modeling	TCSS-02
Content: TCSS-02 ♦ Introduction of Electrical Components ♦ Basic Controller Usage (No Controller Development) ♦ Model Setup and MATLAB Interfacing	Duration: 1 day

CRUISE Application Training Courses	TCSS-03 to 06
Content: TCSS-03: Interfaces (1 day) ♦ MATLAB / SIMULINK ♦ MATLAB API ♦ Function ♦ Map TCSS-04: CRUISE GSP (2 days) ♦ Gear Shifting Map Generation & Optimization TCSS-05: Realtime Porting for HiL (2 days) ♦ Demonstrate the workflow needed to port CRUISE model on a realtime (RT) PC for SiL or HiL applications For preparation and porting CRUISE models on AVL PUMA testbed, there is separate dedicated commissioning service (refer to CC_425). TCSS-06: Vehicle Dynamic Simulation (2 days) ♦ Coupling CRUISE with IPG CarMaker Note that interfacing between CRUISE (or CRUISE M) and AVL VSM is done via Model.CONNECT and part of the related trainings.	

3.2.6 CRUISE M Training Courses

3.2.6.1 CRUISE M Basic Training Courses

CRUISE M Physical Engine Basic Training Courses	TCME-01 – TCME-02
Content:	Duration: 3 days
TCME-01: CRUISE M Physical Engine / GASOLINE (3d) TCME-02: CRUISE M Physical Engine / DIESEL (3d) ♦ Introduction ♦ GUI / Simple Model Pre- & Post-Processing ♦ Parameters, Data Pool & Cases ♦ Interfaces ♦ Physical Engine Theory ♦ Engine Air Path ♦ Turbocharger Modeling ♦ Model Calibration ♦ Transient Model ♦ Control Functions ♦ Co-Simulation with other Domains	

CRUISE M MoBEO Engine Basic Training	TCME-03 – TCME-04
Content:	Duration: 3 days
TCME-03: CRUISE M MoBEO Engine Basic / GASOLINE (3d) TCME-04: CRUISE M MoBEO Engine Basic / DIESEL (3d) ♦ Introduction ♦ GUI / Simple Model Pre- & Post-Processing ♦ Parameters, Data Pool & Cases ♦ Interfaces ♦ MoBEO Engine Theory ♦ Engine Air Path ♦ Turbocharger Modeling ♦ Model Calibration (incl. Cylinder Wizard) ♦ Transient Model ♦ Control Functions ♦ Co-Simulation with other Domains	

CRUISE M MoBEO EAS Training	TCME-05 – TCME-06
Content: TCME-05: CRUISE M MoBEO EAS / GASOLINE (2d) TCME-06: CRUISE M MoBEO EAS / DIESEL (2d) ♦ Introduction ♦ GUI / Simple Model Pre- & Post-Processing ♦ Parameters, Data Pool & Cases ♦ Interfaces ♦ EAS Theory ♦ Different EAS Systems ♦ Concept and Calibration Level Model ♦ Model Refinement bades on Test Data ♦ Coupling with Engine Model	Duration: 2 days

CRUISE M Flow Basic Training	TCMF-01
Content: TCMF-01: CRUISE M Flow Basic ♦ Introduction ♦ GUI / Simple Model Pre- & Post-Processing ♦ Parameters, Data Pool & Cases ♦ Interfaces ♦ Flow Theory ♦ Flow / Thermal Network Models ♦ Hydraulic / Thermal Calibrations ♦ Outlook on (VTMS) Applications	Duration: 2 days

3.2.6.2 CRUISE M Application Training Courses w/o prerequisites

CRUISE M Application Training Courses	TCMA-01 to TCMA-02
Content: TCMA-01: CRUISE M Physical Engine VTMS Training / GASOLINE (4d) TCMA-02: CRUISE M Physical Engine VTMS Training / DIESEL (4d) ♦ Introduction ♦ GUI / Simple Model Pre- & Post-Processing ♦ Parameters, Data Pool & Cases ♦ Interfaces ♦ Physical Engine Theory ♦ Engine Air Path ♦ Turbocharger Modeling ♦ Transient Model ♦ Flow Theory ♦ Flow / Thermal Network Models ♦ Hydraulic / Thermal Calibration ♦ Driveline Theory ♦ Simulation Set-up ♦ Coupling with other Domains ♦ VTMS Model Basic Control Functions	Duration: 4 days

CRUISE M Application Training Courses	TCMA-11 – TCMA-14
Content: TCMA-11: CRUISE M Engine & MoBEO EAS/ GASOLINE (4d) TCMA-12: CRUISE M Engine & MoBEO EAS / DIESEL (4d) (available for Physical and MoBEO Engine Type) ♦ Introduction ♦ GUI / Simple Model Pre- & Post-Processing ♦ Parameters, Data Pool & Cases ♦ Interfaces ♦ Physical or MoBEO Engine Theory ♦ Engine Air Path ♦ Turbocharger Modeling ♦ Model Calibration (inc. Cylinder Wizard) ♦ Transient Model ♦ Control Functions ♦ EAS Theory ♦ Different EAS Systems ♦ Concept and Calibration Level Model ♦ Model Refinement based on Test Data ♦ Coupling with Engine Model	Duration: 4d
Content: TCMA-13: CRUISE M Physical Engine & EAS / GASOLINE (4d) TCMA-14: CRUISE M Physical Engine & EAS / DIESEL (4d) ♦ Introduction ♦ GUI / Simple Model Pre- & Post-Processing ♦ Parameters, Data Pool & Cases ♦ Interfaces ♦ Physical Engine Theory, Engine Air Path ♦ Turbocharger Modeling ♦ Model Calibration ♦ Transient Model ♦ Control Functions ♦ EAS Theory, Different EAS Systems ♦ Measurement Comparison ♦ Model Refinement based on Test Data ♦ Coupling with Engine Model	Duration: 4d

CRUISE M Application Training Courses	TCMA-15 – TCMA-16
Content:	Duration: 5d

TCMA-15: CRUISE M Conventional Powertrain Training for Performance and RDE Evaluation / GASOLINE (5d)

TCMA-16: CRUISE M Conventional Powertrain Training for Performance and RDE Evaluation/ DIESEL (5d)

(available for Physical and MoBEO Engine Type)

- Introduction
- GUI / Model Pre- & Post-Processing
- Parameters, Data Pool & Cases
- Interfaces
- Physical or MoBEO Engine Theory, Engine Air Path
- Turbocharger Modeling
- Model Calibration (incl. Cylinder Wizard for MoBEO)
- Transient Model, Control Functions
- EAS Theory, Different EAS Systems
- Concept and Calibration Level Model
- Model Refinement based on Test Data
- Coupling EAS with Engine Model
- Driveline Theory, Simulation Setup
- RDE Cycle Definition
- Coupling with Engine and EAS Model

	TCMA-17 – TCMA-18
Content: TCMA-17: CRUISE M Hybrid Powertrain Training for Performance and Energy Consumption / GASOLINE (5d) TCMA-18: CRUISE M Hybrid Powertrain Training for Performance and Energy Consumption / DIESEL (5d) (available for Physical and MoBEO Engine Type) ♦ Introduction ♦ GUI / Model Pre- & Post-Processing ♦ Parameters, Data Pool & Cases ♦ Interfaces ♦ Physical or MoBEO Engine Theory, Engine Air Path ♦ Turbocharger Modeling ♦ Model Calibration (incl. Cylinder Wizard for MoBEO) ♦ Transient Model, Control Functions ♦ EAS Theory, Different EAS Systems ♦ Concept and Calibration Level Model ♦ Model Refinement based on Test Data ♦ Coupling EAS with Engine Model ♦ Driveline Theory, Simulation Setup ♦ RDE Cycle Definition ♦ Hybrid Functions/Features, Basic HCU ♦ Model/Controller Calibration ♦ Coupling with Engine and EAS Models	Duration: 5d

3.2.6.3 CRUISE M Application Training Courses with prerequisites

CRUISE M Application Training Courses	TCMA-05 – TCMA-10
Content: TCMA-05: CRUISE M Flow / GASOLINE (1d) Required Training: CRUISE M Physical Engine (TCME-01) or MoBEO Engine Basic (TCME-03) TCMA-06: CRUISE M Flow / DIESEL (1d) Required Training: CRUISE M Physical Engine (TCME-02) or MoBEO Engine Basic (TCME-04) ♦ Flow theory ♦ Flow / Thermal Network Models ♦ Hydraulic / Thermal Calibration ♦ Outlook on (VTMS) Applications	Duration: 1d
TCMA-07: CRUISE M Driveline / GASOLINE (1d) Required Training: CRUISE M Physical Engine (TCME-01) or MoBEO Engine Basic (TCME-03) TCMA-08: CRUISE M Driveline / DIESEL (1d) Required Training: CRUISE M Physical Engine (TCME-02) or MoBEO Engine Basic (TCME-04) ♦ Driveline theory ♦ Simulation Set-Up ♦ Model Calibration ♦ Co-Simulation with other Domains	Duration: 1d
Content: TCMA-09: CRUISE M HEV/EV / GASOLINE (1d) TCMA-10: CRUISE M HEV/EV / DIESEL (1d) Required Training: CRUISE M Driveline (TCMA-07 or TCMA-08) ♦ Hybrid Concepts ♦ Hybrid Functions / Features ♦ Basic HCU ♦ Model / Controller Calibration	Duration: 1d

CRUISE M MoBEO Software Training for VTB	TCMV-01 – TCMV-02
Content:	Duration: 8d

TCMV-01: CRUISE M MoBEO Software Training for VTB / GASOLINE (8d)

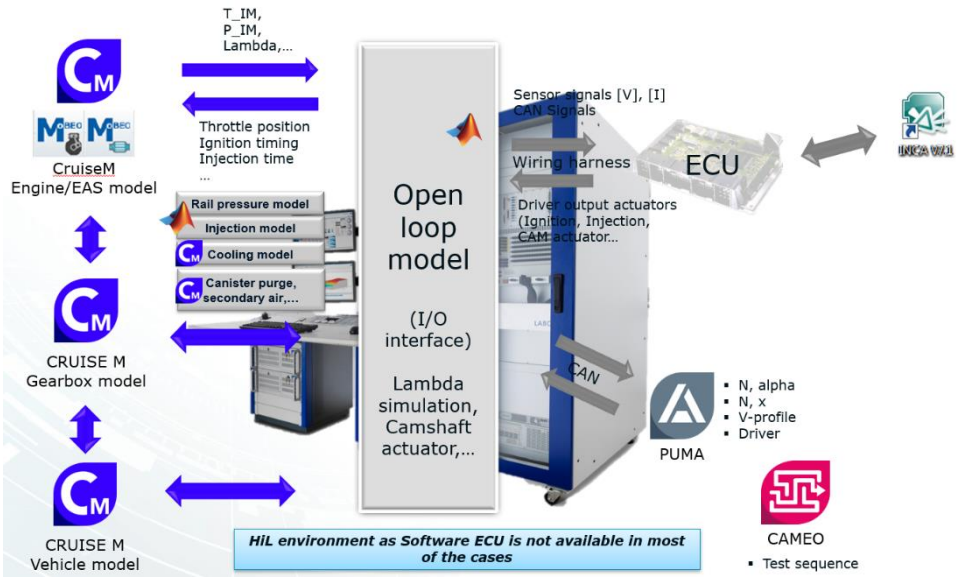
(internal Number: FAT2CFXD52.01)

TCMV-02: CRUISE M MoBEO Software Training for VTB / DIESEL (8d)

(internal Number: FAT2CFXD53.01)

Required Prerequisites: Customer order of VTB (Virtual TestBed) from AVL ITS.

- Introduction
- GUI / Simple Model Pre- & Post-Processing
- Parameters, Data Pool & Cases
- Interfaces
- MoBEO Engine Theory
- Engine Air Path
- Turbocharger Modelling
- Engine Model Calibration (incl. Cylinder Wizard)
- Transient Engine Model
- Control Functions
- Co-Simulation with other Domains
- Gas Exchange and Combustion Analysis (GCA)
- Data Visualization for entire Engine Map
- VTB Model Configuration
- EAS Theory, Different EAS Systems
- EAS Measurement Comparison
- EAS Model Refinement based on Test Data
- EAS Coupling with Engine Model
- Physical Engine Theory (on request)



3.2.7 EXCITE Designer Training Course

EXCITE Designer Basic Training Course	TEDE-01
Content:	Duration: 2 days
TEDE-01 ♦ Introduction and Theory ♦ Create a Model of an Engine Powertrain ♦ Post-processing	

3.2.8 EXCITE Piston&Rings Training Courses

EXCITE Piston&Rings Basic Training Courses	TEPR-01 & TEPR-02
Content:	Duration: 1 + 1 days
TEPR-01: Piston Dynamics ♦ Introduction and Theory ♦ Create a Model of a Gasoline/Diesel Engine ♦ Post-processing TEPR-02: Ring Dynamics ♦ Introduction and Theory for Ring Dynamics, LOC and Blow-by ♦ Create a Model of a Gasoline/Diesel Engine ♦ Post-processing	

3.2.9 EXCITE Power Unit Training Courses

EXCITE Power Unit Basic Training Course	TEPU-01
Content: TEPU-01 ♦ Introduction and Theory ♦ Bodies and Joints ♦ Loads and Initial Conditions ♦ Crank Train Dynamics ♦ Matrix Reduction of Volumetric and Structured Models ♦ Set-up of Analysis Cases and Simulation Control ♦ Create a Simple Multi-Body Dynamics Model ♦ Create a Model of a Single Cylinder ♦ Post-processing	Duration: 2 days

EXCITE Power Unit Application Training Courses	TEPU-02 to TEPU-15
Content: TEPU-02: Crankshaft Dynamics (2 days) Required Training: TEPU-01 ♦ Introduction and Theory ♦ Modeling Guidelines ♦ Create a Full Engine Model (Inline 4-cylinder Diesel) ♦ Post-processing TEPU-03: Crankshaft Stress Analysis (1 day) Required Training: TEPU-02 ♦ Overview on Strength Analysis based on MBD ♦ Stress Analysis using FEA and Fillet Modeler based on the Inline 4-cylinder Example TEPU-04: Main Bearing and Conrod Bearing Analysis (1 day) Required Training: TEPU-01 ♦ Introduction and Theory ♦ Elasto-hydrodynamics ♦ Oil Supply Line ♦ Modeling Guidelines ♦ Create a Model of a Main Bearing and a Conrod Bearing ♦ Post-processing TEPU-05: Main Bearing Wall and Conrod Stress Analysis (1 day) Required Training: TEPU-04 ♦ Overview on Strength Analysis based on MBD ♦ Stress Analysis using FEA based on the Examples in TEPU-04	

TEPU-06: 3D Piston Dynamics (1 day)

Required Training: TEPU-01

- Introduction and Theory
- Modeling Guidelines
- Create a Piston-Liner Contact Analysis Model
- Post-processing

TEPU-07: Noise, Vibration & Harshness Structural (1 day)

Required Training: TEPU-02

- Introduction and Theory
- Modeling Guidelines
- Data Recovery
- NVH Example based on the Inline 4-Cylinder Example
- Post-processing

TEPU-08: Transmission MT or AT (2 days)

Required Training: TEPU-01

- Introduction and Theory
- Gear Joints and Other Transmission Elements
- Create a Model of a Manual or Automatic Transmission for Gear Noise Investigation
- Post-processing

TEPU-09: Driveline Vehicle Integration (2 days)

Required Training: TEPU-01

- Introduction and Theory
- Driveline Components
- Create a Model of a Front Wheel Drive for Shuffle and Clonk Investigation
- Post-processing

TEPU-11: EXCITE Fatigue (0.5 day)

Required Training: TEPU-03 or TEPU-05

- Introduction and Theory
- Fatigue Evaluation based on Stress Tensors from Strength Analysis using TEPU-03 or TEPU-05 Examples

TEPU-12: Micro-contact Analysis (0.5 day)

Required Training: TEPU-04 or TEPU-06

- Roughness Data Import
- Contact Data Evaluation
- Contact Data Selection in EXCITE

TEPU-13: User Defined Joint (UDJ) (1 day)

Required Training: TEPU-01

Required Knowledge: Fortran 90

- Coding of UDJ
- UDJ Usage within EXCITE

TEPU-14: Wind Turbine (1 day)

Required Training: TEPU-01

- Introduction and Theory
- Wind Turbine Specific Loads and Initial Conditions
- Set-up of Analysis Cases and Simulation Control
- Create a Model of a Complete Wind Turbine Drive Line
- Post-processing

TEPU-15: Acoustics (Air Born Noise) (1 day)

Required Training: TEPU-01

- Introduction and Theory of EXCITE Acoustics
- Workflow and Model Set-up
- Result Evaluation (Field, Microphones)

TEPU-0xL: Large Engine (2 days)

TEPU-02, TEPU-04 and TEPU-09 can be ordered with specific large engine content and examples

3.2.10 EXCITE Timing Drive Training Courses

EXCITE Timing Drive Basic Training Courses	TETD-01 to TETD-05

Content:

TETD-01: Basic Dynamics Calculation (2 days)

- Introduction and Theory
- Single Valve Train Dynamics
- Shaft Systems
- Gear Train Dynamics
- Timing Drive Dynamics
- Simple Chain & Belt Drives
- Result Analysis

TETD-02: Cam Design (1 day)

- Introduction and Theory
- Setting up of Application Example
- Result Analysis

TETD-03: Single Valve Train (1 day)

- Introduction and Theory
- Single Valve Train Dynamics
- Setting up of Application Example
- Result Analysis

TETD-04: Gear Train (1 day)

- Introduction and Theory
- Gear Train Modeling
- Setting up of Application Example
- Result Analysis

TETD-05: Chain & Belt Drives (2 days)

- Modeling General Mechanical Systems
- Overview of Macro Elements for Chains and Belts
- Setting up of Application Example
- Result Analysis
- Modeling General Hydraulic Systems

3.2.11 FIRE Training Courses

FIRE Basic (Engine Related) Training Course	TFEN-01
Content: TFEN-01 ♦ Introduction ♦ Model Generation (non-moving boundaries, moving boundaries) ♦ Solver Steering File ♦ Main program: (initial and boundary conditions, convergence, under-relaxation, differencing schemes, turbulence modeling) ♦ Phisical models basics: species transport, spray module, combustion modele, emissions, knocking ♦ Post-processing and Result Analysis	Duration: 3 days

FIRE Basic (General Purpose) Training Course	TFGP-01
Content: TFGP-01 ♦ Introduction ♦ Model generation (non-moving boundary, rotating systems) ♦ Solver steering file ♦ Main program (initial and boundary conditions, convergence, under-relaxation, differencing schemes, turbulence modeling) ♦ Post-processing and Result Analysis	Duration: 1 day

FIRE M Basic Training Course	TFIM-01
Content: TFIM-01 ♦ Introduction ♦ Surface Repair ♦ Model Generation Intake Port/Water Cooling Jacket (used tool FAME Poly – including Multi-material) ♦ Model Generation Intake Manifold (used tool FAME Block) ♦ Solver Steering File ♦ Main program: initial and boundary conditions, convergence, under-relaxation, differencing schemes, turbulence modelling ♦ Post-processing and Result Analysis incl. Reports	Duration: 2 days

FIRE Application Training Courses	
Content: APPLICATION SPECIFIC: TFEN-02: IC Engine – Diesel Injection Nozzle (2 days) Subject: DI Diesel Injection Nozzle Covered Program Parts: FIRE General Purpose, FAME Engine, Eulerian Multiphase Module Required Training: TFEN-01 or TFGP-01 ♦ Introduction to the nozzle flow simulation ♦ Performance Parameter: discharge rate, flow uniformity at the outlet, cavitation intensity, erosion probability ♦ Eulerian Multiphase Models, cavitation model, erosion model, nozzle interface ♦ Model generation ♦ Mesh movement; moving mesh or movement by formula ♦ Set-up of the solver steering file ♦ Running and monitoring of the simulation ♦ Result analysis; 2D and 3D ♦ Application specific 2D result analysis ♦ Optional demo: Lagrangian spray coupling using the nozzle file as input on a simple spray-box geometry TFEN-03: IC Engine – GDI Nozzle (2 days) Subject: GDI Nozzle Covered Program Parts: FIRE General Purpose, FAME Engine, Eulerian Multiphase Module Required Training: TFEN-01 or TFGP-01 ♦ Introduction to the GDI nozzle flow simulation ♦ Performance Parameter: discharge rate, flow uniformity at the outlet, cavitation intensity, erosion probability ♦ Eulerian Multiphase Models, flash boiling cavitation model, erosion model, nozzle interface ♦ Block structured model generation, full multi-hole model consideration ♦ Mesh movement; moving mesh or movement by formula ♦ Set-up of the solver steering file ♦ Running and monitoring of the simulation ♦ Result analysis; 2D and 3D ♦ Application specific 2D result analysis ♦ Optional demo: Lagrangian spray coupling using the nozzle file as input on a simple spray-box geometry	TFEN-02 to 18

TFEN-04: IC Engine – Piston cooling Analysis (1 day)

Subject: Piston cooling simulation

Covered Program Parts: FIRE Engine Based, FAME Engine, Eulerian Multiphase Module

Required Training: TFEN-01

- Introduction to the Eulerian multiphase
- Eulerian Multiphase Models, Two-fluid model, Adhesive force
- Moving mesh setup
- Model generaton
- Simulation setup
- Postprocessing and result analysis

TFEN-05: IC Engine – Injector Flow VOF Analysis (2 days)

Subject: Low-Pressure (SCR) Nozzles

Covered Program Parts: FIRE General Purpose, FAME Engine, Eulerian Multiphase Module

- Introduction to the Eulerian multiphase and VOF simulations in AVL FIRE M™
- Model generation; Block structured, FAME poly, Hanging node refinement
- Simulation setup
- Detailed Particle Break-up Analysis (Spray Plane Analyser)
- Postprocessing and result analysis
- Particle size evaluation and analysis

TFEN-06: Head Block Compound (2 days)

Subject: HBC Thermal load analysis (steady)

Covered Program Parts: FIRE M General Purpose, FAME Poly meshing, Single Phase boiling and Solid Stress Analysis Modules

Required Training: TFEN-01 or TFIM-01

- Introduction to the HBC application and simulation specifics
- Preparation of input model (CAD data)
- Multi-domain model generation
- Set-up of the simulation
- Heat transfer model parameters and their influences on the results
- Starting and monitoring of the simulation
- Result analysis
- Mapping of 3D AVL FIRE results to the FEM mesh

TFEN-07: Head Block Compound (1 day)

Subject: HBC Thermal load analysis (transient) – Thermo-mechanical fatigue (TMF)

Covered Program Parts: FIRE M General Purpose, FAME Poly meshing

Required Training: TFIM-01 or TFEN-18

- Introduction to the HBC transient operation and simulation specifics

- Preparation of input data (System level VTMS – 1D simulation)
- Preparation of input data (Cylinder Inner flow – 3D simulation)
- Set-up of the simulation
- Transient simulation specific parameters and their influences on the results
- Starting and monitoring of the simulation
- Result analysis
- Mapping of 3D AVL FIRE results to the FEM mesh

TFEN-08: Liner Cavitation (FIRE) (1 day)

Subject: Cavitation and Erosion modeling

Covered Program Parts: FIRE M General Purpose, FAME Poly meshing, Cavitation and Erosion modeling

Required Training: TFGP-01 or TFIM-01

- Introduction to the Liner Cavitation application and simulation specifics
- Preparation of excitation data (obtained with EXCITE simulation)
- Model generation
- Set-up of the simulation
- Simulation specific parameters and their influences on the results
- Starting and monitoring of the simulation
- Result analysis

TFEN-09: IC Engine – Injector Wetting Analysis (1 day)

Subject: Low pressure (SCR) and High pressure (GDI) injection Nozzles

Covered Program Parts: FIRE General Purpose, FAME M Poly, Lagrangian Multiphase Module

Required Training: TFEN-01 or TFGP-01 + TFEN-02

- Quick overview of eulerian nozzle flow specific simulation settings and nozzle file
- Description of engineering problem for low & high pressure injector wetting
- Model generation using the FAME M Poly
- Performance Parameter: spray penetration depth, spray shape, particle size distribution, mass and area of wallfilm on the wetted nozzle
- Lagrangian Spray models, Primary Blob breakup model, Secondary TAB breakup model, Possibility to use multi component fuel, flash boiling model, Wallfilm modeling
- Most effective methods for tuning the langrangian spray model
- Set-up of the solver steering file
- Running and monitoring of the simulation
- Result analysis; 2D and 3D
- Application specific 2D, 3D result analysis
- Optional: Usage of AVL spray data wizard for additional spray analysis

TFEN-10: FIRE M – Automatic Optimization (1 day)

Subject: Vehicle diffuser design

Covered Program Parts: FIRE General Purpose, FAME M Poly, CAD based Optimization

Required Training: TFGP-01

- Description of engineering problem
- CAD model preparation
- CAD model tessellation
- Model volume mesh generation using the FAME M Poly
- Solver setup and simulation of the base case
- Performance Parameter: Negative Lift, Drag
- Definition of optimization objectives (Negative lift (max), Drag (min))
- Set-up of the optimization (CAD model variables, objectives, optimization algorithm)
- Running and monitoring of optimization
- Optimization result analysis
- Comparison of base and optimized design with 2D, 3D results
- Optional: Further improvement of best design by using the adjoint solver mesh deformation optimiziation approach

TFEN-11: Multi-component Fuel Modelling (1 day)

Subject: Fuel Injection Chamber

Covered Program Parts: FIRE General Purpose, Eulerian Multiphase Module, Lagrangian Multiphase Module

Required Training: TFEN-01 or TFGP-01

- Introduction to multi-component fuels
- Introduction to multi-component Lagrangian spray
- Introduction to multi-component wall-film
- Set-up of simulation control file
- Result analysis

TFEN-12: Advanced Turbulence Modelling (1 day)

Subject: External and Internal Flows (PANS, LES)

Covered Program Parts: FIRE General Purpose, FIRE M General Purpose

Required Training: TFEN-01 or TFGP-01

- Introduction to LES and PANS turbulence models
- The illustration of LES/PANS simulations for different applications
- Model generation (Intake port?)
- Set-up simulation control file
- Specific results output (time averaging)
- Result analysis (LES/PANS)

TFEN-13: Vehicle Aerodynamics (1 day)

Subject: Vehicle Body

Covered Program Parts: FIRE General Purpose, Surface preparation, FAME HEXA meshing, Solver Setup, Formula Interface, User-function Interface, MRF, Postprocessing

Required Training: TFGP-01

- Introduction to Vehicle Aerodynamics
- Surface preparation and Meshing
- Formula Editor Interface, User-function Interface
- Set-up of Solver Steering File for Transient Simulation
- Result Analysis

TFEN-14: Vehicle Underhood Thermal Analysis (1 day)

Subject: Vehicle Underhood (Engine compartment)

Covered Program Parts: FIRE General Purpose, Surface preparation, FAME HEXA meshing, Sovler Setup, Formula Interface, User-function Interface, Porosity Module, MRF, Heat Exhanger Module, Postprocessing

Required Training: TFGP-01

- Introduction to the Vehicle Underhood Thermal Analysis
- Surface preparation and Meshing
- Formula Editor Interface, User-function Interface
- Set-up of Solver Steering File for Steady Simulation
- Set-up of Solver Steering File for Hot Soak Simulation
- Result Analysis

TFEN-15: IC Engine – Intake Port Flow (1 day)

Subject: 4-stroke Diesel or Gasoline Intake Port Configuration

Covered Program Parts: FIRE General Purpose, Formula Interface, User-function Interface

Required Training: TFEN-01 or TFGP-01

- Introduction to Port Flow Simulation
- Performance Parameter: Discharge Rate, Swirl/Tumble
- Model Generation (reference TFGP-01)
- Formula Editor Interface, User-function Interface
- Set-up of Solution Control File
- Result Analysis

TFEN-16: IC Engine – In-cylinder Flow (2 days)

Subject: 4-stroke Diesel or Gasoline Engine

Covered Program Parts: FIRE General Purpose, FAME Engine Plus, Lagrangian Multiphase module, Combustion and Emission Module

Required Training: TFEN-01

- Introduction to Internal Combustion Engine Simulation
- Performance Parameter: Pressure Trace, Heat Release, Equivalence Ratio (Wallfilm), Turbulence
- Advanced Model Generation (reference TFEN-01)
- Physical Models related to IC Engine Simulations
- Set-up of Solution Control File
- Result Analysis

TFEN-17: IC Engine – Aftertreatment – TWC & GPF (1 day)

Subject: Three-way Catalyst, Gasoline Particulate Filter

Covered Program Parts: FIRE General Purpose, Exhaust Gas Aftertreatment – Gasoline Module, Porosity, Detailed Chemistry Solver

Required Training: TFEN-01 or TFGP-01

- Introduction to Aftertreatment Simulation (BOOST / CM / FIRE)
- Performance Parameter: Uniformity, Species Conversion, Soot Loading/Regeneration
- Introduction to Automatic Kinetic parametrization
- Model Generation (general approach)
- Exhaust Gas Aftertreatment Module
- Setup of Simulation Control File
- Result Analysis

TFEN-18: IC Engine – Aftertreatment – SCR & DPF (2 days)

Subject: Diesel Exhaust Gas Aftertreatment

Covered Program Parts: FIRE General Purpose, Diesel Exhaust Gas Aftertreatment Module, Lagrangian Multiphase Module, Thin Walls, Porosity, Detailed Chemistry Solver, Kinetic model parametrization

Required Training: TFEN-01 or TFGP-01

- Introduction to Aftertreatment Simulation (CM / FIRE)
- SCR Simulation workflow: steady – transient, speed up
- Performance Parameter: AdBlue Injection, Uniformity of Ammonia, Wall film, Species Conversion, Deposits
- Model Generation (HD example approach)
- Exhaust Gas Aftertreatment Module, Lagrangian Multphase Module
- Setup of Simulation Control File
- Result Analysis
- SCR kinetic model parametrization
- DeNOx performance simulation

MODULE SPECIFIC:

TFEE-01 to 06

TFEE-01: ESE Diesel GUI (1 day)

Subject: Diesel Segment Model

Required Training: TFEN-01

- Introduction to Internal Combustion Engine Simulation
- Specifics of Segment Models
- Performance Parameter: Pressure Trace, Heat Release, Equivalence Ratio, (Wallfilm), Turbulence
- Model Generation using ESE Diesel
- Geometry Description
- Grid Generation Options
- Compression Volume, Compensation Volume
- Modeling Centric / Non-centric Combustion Chamber / Injection Nozzle
- Pre-defined Simulation Control File
- Run the Simulation using a Predefined Simulation Control File

TFEE-02: Combustion & Emission Module (1 day)

Required Training: TFGP-01 or TFEN-01

- Part 1: Theory
- Species Transport
- Detailed Chemistry Solver
- In-built Combustion Models
- Ignition Modeling
- Combustion Models
- Emission Models
- User-function Interface
- Part 2: Practice
- Discussion of Characteristic Combustion Data
- Discussion of Reference Data
- Influence of Major Model Parameters on Ignition, Combustion and Emission (Heat Release, NOx, Soot) based on Combustion Bomb Simulations
- Matching Simulation Results to Measured Data
- Recommended Model Selections for Selected Applications

TFEE-03: Coupling Module CAE Engine (1 day)

Required Training: TFEN-01

- Part 1: Theory
- Existing Coupling Interfaces
- Work Principle of ACCI
- Part 2: Practice (on idealized examples)
- Co-simulation of AVL FIRE with 1D Thermodynamic Cycle Simulation Tools, Model Setup and Execution for AVL BOOST and GT Power

- Co-simulation of AVL FIRE with 1D Hydrodynamics Simulation Tools, Model Setup and Execution for AVL BOOST / HYDSIM
- Co-simulation of Multiple AVL FIRE Tasks, Model Setup and Execution

TFGP-02: Coupling Module CAE General Purpose (1 day)

- Required Training: TFGP-01
- Part 1: Theory
- Existing Coupling Interfaces
- Work Principle of ACCI
- Part 2: Practice (on idealized examples)
- Co-simulation of Multiple AVL FIRE Tasks, Model Setup and Execution
- Co-simulation of AVL FIRE with Structural Analysis Software, Model Setup and Execution for SIMULIA ABAQUS
- Sequential Coupling of AVL FIRE with Structural Analysis Software, Model Setup and Execution for SIMULIA ABAQUS

TFEE-04: Eulerian Multiphase Module (2 days)

Required Training: TFGP-01 or TFEN-01 and TFEN-02

- Part 1: Theory on Eulerian multi-phase module
- Available multi-phase specific modeling approaches in FIRE
- Cavitation model
- Erosion model
- Quenching model
- Eulerian spray
- Part 2: Practice cavitating flow
- Discussing standard input; geometry and boundary conditions
- Influence of Major Model Parameters on Cavitating (eroding) Flows
- Part 3: Practice Eulerian Spray
- Discussing Characteristic Spray Data
- Influence of Major Model Parameters on Fuel Sprays (penetration, size and velocity spectra) based on Spray Bomb Simulations (Diesel or Gasoline)
- Applications

TFEE-05: Lagrangian Multiphase Module (1 day)

Required Training: TFGP-01 or TFEN-01

- Part 1: Theory
- Discrete Droplet Model
- Primary and Secondary Break-up
- Drag
- Turbulent Dispersion
- Collision / Coalescence
- Evaporation (Single Component, Multi-component)

- Wall Interaction, Wall Film
- Nozzle Interface
- Grid Insensitive Spray Model
- Fuel Property Database
- User-function Interface
- Part 2: Practice
- Discussing Characteristic Spray Data
- Discussing Reference Data
- Influence of Major Model Parameters on Fuel Sprays (Penetration, Size and Velocity Spectra) based on Spray Bomb Simulations (Diesel or Gasoline)
- Matching Simulation Results to Measured Data

  Recommended Model Selections for Selected Applications

TFEE-06: Quenching (2 days)

Subject: Direct quenching (alloys and steel)

Covered Program Parts: FIRE General Purpose, FAME Engine, Eulerian Multiphase Module

Required Training: TFEN-01 or TFGP-01

- Introduction to the quenching application and simulation specifics
- Model Generation
- Eulerian Multiphase Models, quenching model
- Specific quenching model parameters and their influences on the results
- Set-up of the solver steering file
- Starting and monitoring of the simulation
- Result analysis
- Mapping of 3D AVL FIRE results to the FEM mesh
- Discussion on the application of the input files in FE analyses
- Discussion on the value of the FE results

3.2.12 TABKIN Training Course

TABKIN Basic Training Course	TTAB-01
Content: TTAB-01 ♦ Introduction to Tabulated Detailed Chemistry Combustion Approach ♦ Generation of Look-up Chemistry Table ♦ Workflow Definition using FIRE ♦ Example Model Set-up using FIRE (FGM Combustion Model) ♦ Post-processing and Interpretation of Results ♦ Emission Analysis	Duration: 2 days

3.2.13 SAMOS Training Course

SAMOS Basic Training Course	TSAM-01
Content: TSAM-01 ♦ Introduction ♦ SAMOS AT Avalanche Model ♦ Dense Flow Model ♦ Powder Snow Model ♦ Numerical Solution ♦ SAMOS AT Software ♦ Simulation Setup ♦ Evaluation of Results	Duration: 1 day

3.2.14 DoE and Optimization Training Course

The training model depends on the client (supported clients are BOOST, EXCITE & FIRE).
Training is based on Design Explorer. Basic training for related client is required.

Design Explorer Training Course	TAWS-01
Content: TAWS-01 ♦ Functionality and Theory ♦ Model and analysis set-up ♦ Result evaluation	Duration: 1 day

3.2.14 MATLAB / Simulink Interface Training Course

The training model depends on the client (supported clients are CRUISE, BOOST, EXCITE and Model.CONNECT). Basic training for related client is required.

MATLAB / Simulink Interface	TAWS-02
Content: TAWS-02 ♦ Interfacing ♦ Model and analysis set-up	Duration: 1 day

3.2.15 Model.CONNECT Training Course

Model.CONNECT Office Basic Training Course	TMCO-01
Content: TMCO-01 Recommended Training: CRUISE (TCSS-01), CRUISE M (TCRM-01), VSM (note: support for VSM is available via cruise@avl.com) ♦ Introduction ♦ (Co-Simulation) Theory ♦ Model Preparation, Simulation & Post-processing ♦ Example Model build with VSM, CRUISE and CRUISE M ♦ Data & Element Pool ♦ Co-Simulation on distributed Systems ♦ Overview on Optimization / Co-Simulation on RT-Systems ♦ Overview on Co-Simulation on RT-Systems	Duration: 2 days

3.2.16 PreonLab Training Course

PreonLab Basic Training Course	TPREO-01
Content: TPREO-01 ♦ Introduction ♦ Import of rigid body geometry ♦ Definition of rigid body kinematics ♦ Physical properties of the fluid phase ♦ Physical properties of rigid bodies ♦ Simulation analysis ♦ Visualization	Duration: 1 day

3.2.17 Software Conception

Python Basic Training Course	TPYT-01
Content: TPYT-01 ♦ Introduction ♦ Overview of the language ♦ Python data types ♦ Control statements ♦ Input/output facilities ♦ Functions and modules ♦ Object-oriented programming ♦ ½ day working session	Duration: 2 days

COMPOSE Basic Training Course	TCOM-01
Content: TCOM-01 ♦ Introduction ♦ Custom app development ♦ COMPOSE debugging ♦ SDT environment setup ♦ COMPOSE examples ♦ STFT app analysis ♦ COMPOSE app components	Duration: 1 day

3.2.18 VSM Training Courses

VSM Basic Training Courses	TVSM-01
Content: TVSM-01 ♦ Introduction ♦ Overview of Applications ♦ Workflow ♦ Creating a Vehicle Model ♦ Maneuver & Track Generation ♦ Simulation & Variation ♦ Post-Processing	Duration: 3 days

3.2.19 SPA Training Courses

SPA Basic Training Courses	TSPA-01
Content: TSPA-01 ♦ Introduction – What is AVL SPA™? ♦ What are the customer benefits? ♦ AVL SPA™ Criteria Introduction ♦ Input Data / Input GUI Guide ♦ Setting up a model & Workflow (Example 1) ♦ Multi-case Simulation & Parameterization (Example 2) ♦ Virtual Calibration – Improving a rating (Example 3) ♦ Further topics (Reporting, Data check errors, Export/Import, KPIs,…) (Example 4)	Duration: 1 day

3.3 Non-Standard Software Training

AVL AST offers also non-standard training courses for specific customer interest and based on customer models as training-on-the-job.

Such training courses are treated as separate projects. Content, duration and price will be defined individually according to the specific needs and requests. A separate project proposal will be given by AVL AST (refer also to **chapter 5**).

For FIRE possible application topics for such non-standard training courses are as follows:

FIRE Engine Related Application

Content:

- Integrated Diesel Injector Flow, Spray & Combustion Simulation and ESE Diesel
- Engine Cooling Systems (Water Cooling Jacket)
- Engine Thermal Analysis
- Aftertreatment Suite
- Injector Flow & Spray Simulation
- 1D/3D Intake System Design
- Intake Port Analysis
- Two-stroke Engine Simulation
- Spark Ignited Gasoline Injection Engine – Mixture Formation
- Spark Ignited Gasoline Injection Engine – Flame Propagation & Knock Offset
- HCCI Combustion
- Parametric Optimization using external optimization tool

FIRE General Purpose CFD Application

Content:

- Meshing Complex Geometries (2 days)
  - Complex non-moving and sliding geometries
- Multi-Fluid Approach (2 days)
  - Filling processes,
  - Hydraulic engineering examples
- Steady Combustion & Radiation (2 days)
  - Basic examples for radiation and combustion
- Examples of Automotive and Aerospace Applications

Contact	
Additional Information	Responsible Sales Manager
Proposal	Responsible Sales Manager

3.4 Software Support

The software support at AST is organized according to the AST Customer Support Process (CSP).

The CSP defines the process steps for answering all regular customer questions and requests related to AVL AST software products. The defined process does not cover customer contact which takes place within project work or joint research developments.

The CSP includes a level concept:

- 1st level support is done by local AST affiliates (if no local affiliate is available, 1st level support is done by AST in Graz)
- 2nd level support by AST in Graz headquarter

AST offers support by email. Telephone support is offered for 1st level support at some AST affiliates. Telephone support is not given by AST in Graz or for 2nd level support generally.

For each product or product group a Support Master is defined, who is responsible for all related support requests and distributes the support requests to the different support engineers.

To receive software support, it is mandatory to have a valid maintenance contract and to have participated in a related training course held by AVL. Within the "university partnership program" (UPP) a dedicated person is defined who acts as contact person to our support organization.

ID	Service
CC_33	Software Support

Purpose:

The software support via email is the single point of contact for customers regarding software related issues (besides sales information).

AST support engineers are highly experienced calculation engineers, who also perform software training and project work in simulation projects within AVL's engine development process or separate pilot, validation or method development projects for customers.

Validity:

The CSP is defined worldwide and is valid for all AVL AST software tools.

Content:

- Answer software related questions
- Take over change requests or enhancement requests from customers and transfer to development and product management.

Goals:

- Help the customer with daily problems
- Improve product quality and customer satisfaction
- Support development with information about customer needs and recommendations
- Improve customer relationship

Customer Benefit:

- One contact for all software related questions
- Application know-how of all AST support engineers

Duration:

- 30 hr per year software support is included with each license.
- If this limit is exceeded, it will be charged separately and treated as consulting or project work.

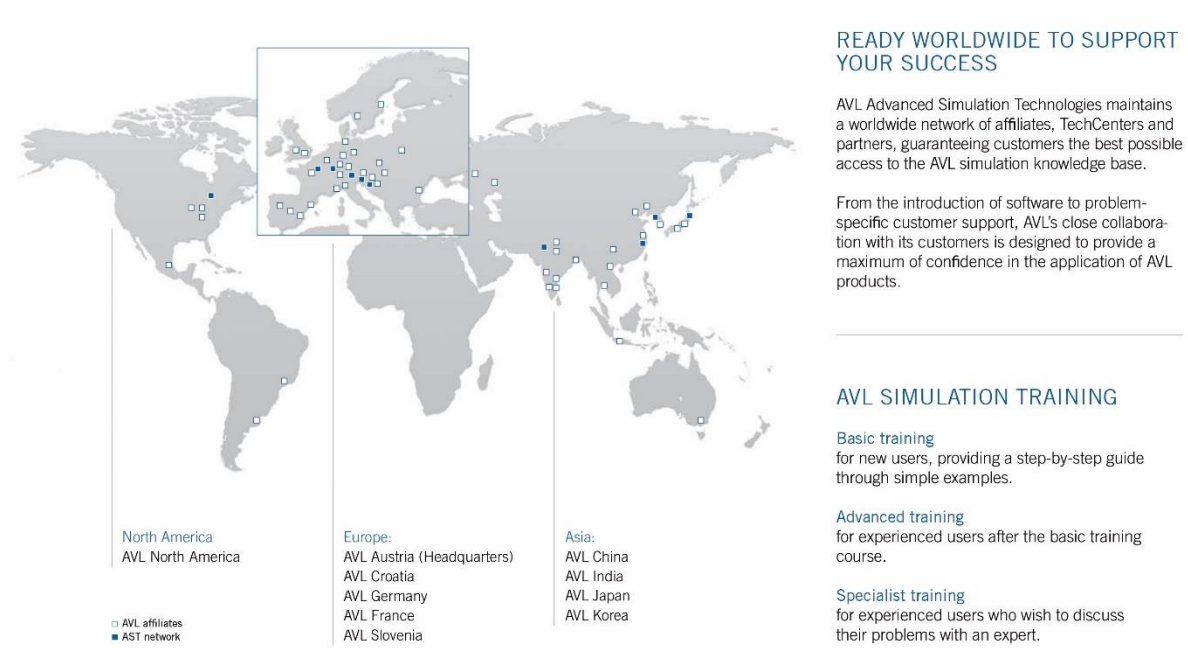
Price (excl. Tax):

The software support via email is free of charge for every customer of AST products.

Contact		
About the Process	Customer Support Manager – Christian Vock (christian.vock@avl.com)	
Product		Email Address
BOOST		boost@avl.com
CRUISE, VSM		cruise@avl.com
CRUISE M, MoBEO		cruise_m@avl.com
EXCITE Designer		excite-d@avl.com
EXCITE Piston&Rings		excite-pr@avl.com
EXCITE Power Unit, AutoShaft, Shaft Modeler,		excite@avl.com
EXCITE Timing Drive		excite-td@avl.com
FIRE, PreonLab, Tabkin		fire@avl.com
Model.CONNECT		Model.CONNECT@avl.com
Who is my local support?	Please contact your local sales manager or local support via email.	

3.4.1 Local Support

Local support is available for the following countries and products:



	Product	Email Address	Phone Number
Austria	BOOST™	BOOST@avl.com	
	CRUISE™	CRUISE@avl.com	
	EXCITE™	EXCITE@avl.com	
	FIRE™	FIRE@avl.com	
	Model.CONNECT™	Model.CONNECT@avl.com	
	PreonLab	PREONLAB@avl.com	
	SPA™	SPA@avl.com	
	TABKIN™	TABKIN@avl.com	
	VSM™	VSM@avl.com	
	LICENSE	ast_license@avl.com	
China	BOOST™	BOOST_support_china@avl.com	+86 21 2053 5536 // +86 21 2053 5537
	CRUISE™	CRUISE_support_china@avl.com	+86 21 2053 5625 // +86 21 2053 5626
	EXCITE™	mechanical_support_china@avl.com	+86 21 2053 5627 // +86 21 2053 5628
	FIRE™	cfd_support_china@avl.com	+86 21 2053 5536 // +86 21 2053 5537
	Model.CONNECT™	cruise_support_china@avl.com	+86 21 2053 5626
	PreonLab	Cfd_support_.china@avl.com	+86 21 2053 5536 // +86 21 2053 5534
	SPA™	Cruise_support_china@avl.com	+86 21 2053 5626 // +86 21 2053 5538
	TABKIN™	Cfd_support_china@avl.com	+86 21 2053 5536 // +86 21 2053 5537
	VSM™	Cruise_support_china@avl.com	+86 21 2053 5626 // +86 21 2053 5538
France	BOOST™	BOOST.france@avl.com	+33 1 30 154 190
	CRUISE™	CRUISE.france@avl.com	
	EXCITE™	EXCITE.france@avl.com	
	FIRE™	FIRE.france@avl.com	
	Model.CONNECT™	Model.CONNECT_france@avl.com	
	PreonLab	PREONLAB.france@avl.com	
	SPA™	SPA.france@avl.com	
	TABKIN™	TABKIN.france@avl.com	
	VSM™	VSM.france@avl.com	
Germany	BOOST™	BOOST_support_d@avl.com	+49 1805 233 283
	CRUISE™	CRUISE_support_d@avl.com	
	EXCITE™	EXCITE_support_d@avl.com	+49 1805 233 284
	FIRE™	cfd_support_d@avl.com	+49 1805 233 285
	Model.CONNECT™	Model.CONNECT_d@avl.com	+49 1805 233 283
	PreonLab	PREONLAB.germany@avl.com	+49 89 307 497 469
	SPA™	SPA.germany@avl.com	+49 1805 233 283
	TABKIN™	TABKIN.germany@avl.com	+49 1805 233 285
	VSM™	VSM.germany@avl.com	+49 1805 233 283
India	BOOST™	ast_support_india@avl.com	+91 124 4090300 x240
	CRUISE™	ast_support_india@avl.com	
	EXCITE™	ast_support_india@avl.com	
	FIRE™	ast_support_india@avl.com	
	Model.CONNECT™	Model.CONNECT_india@avl.com	
	PreonLab	PREONLAB.india@avl.com	
	SPA™	SPA.india@avl.com	
	TABKIN™	TABKIN.india@avl.com	
	VSM™	VSM.india@avl.com	

Italy	BOOST™	BOOST.italy@avl.com	
	CRUISE™	CRUISE.italy@avl.com	
	EXCITE™	EXCITE.italy@avl.com	
	FIRE™	FIRE.italy@avl.com	
	Model.CONNECT™	Model.CONNECT_italy@avl.com	
	PreonLab	PREONLAB.italy@avl.com	
	SPA™	SPA.italy@avl.com	
	TABKIN™	TABKIN.italy@avl.com	
	VSM™	VSM.italy@avl.com	
Japan	BOOST™	BOOST.japan@avl.com	+81 44 455 9221
	CRUISE™	CRUISE.japan@avl.com	
	EXCITE™	EXCITE.japan@avl.com	
	FIRE™	FIRE.japan@avl.com	
	Model.CONNECT™	Model.CONNECT_japan@avl.com	
	PreonLab	PREONLAB.japan@avl.com	
	SPA™	SPA.japan@avl.com	
	TABKIN™	TABKIN.japan@avl.com	
	VSM™	VSM.japan@avl.com	
	License	AST-license.japan@avl.com	
Korea	BOOST™	ast_korea@avl.com	+82 2 580 5884
	CRUISE™	ast_korea@avl.com	
	EXCITE ™	ast_korea@avl.com	
	FIRE™	ast_korea@avl.com	
	Model.CONNECT™	Model.CONNECT_korea@avl.com	
	PreonLab	PREONLAB.korea@avl.com	
	SPA™	SPA.korea@avl.com	
	TABKIN™	TABKIN.korea@avl.com	
	VSM™	VSM.korea@avl.com	
UK	BOOST™	BOOST.uk@avl.com	
	CRUISE™	CRUISE.uk@avl.com	
	EXCITE™	EXCITE.uk@avl.com	
	FIRE™	FIRE.uk@avl.com	
	Model.CONNECT™	Model.CONNECT_uk@avl.com	
	SPA™	SPA.uk@avl.com	
USA	BOOST™	BOOSTsupport@avl.com	+1 877 285 4278
	CRUISE™	CRUISEsupport@avl.com	
	EXCITE™	EXCITEsupport@avl.com	
	FIRE™	FIREsupport@avl.com	
	Model.CONNECT™	Model.CONNECT_na@avl.com	
	PreonLab	PREONLAB.na@avl.com	
	SPA™	SPA.na@avl.com	
	TABKIN™	TABKIN.na@avl.com	
	VSM™	VSM.na@avl.com	

Further information:

- Customer Support Process --> An overview of the CSP is given in Appendix 7.1.

4. Know How Transfer & Engineering Support

This service group sets its focus on engineering know how and transfer to the customer.

Contact	
Additional Information	Responsible Sales Manager
Proposal	Responsible Sales Manager

4.1 Technology Seminars

Technology seminars are organized as TechDays by AST Graz or a local affiliate. They can be performed for and at a specific customer or as a corporate event where different customers can participate.

The seminars are partly done in co-operation with AVL business unit PTE.

ID	Service
CC_41	Technology Seminars / TechDays

Purpose:

Within a technology seminar a specific engineering topic and application field is discussed, including theoretical background, application field, problems and solutions. Focus is set on simulation related problems and solutions.

Validity:

All engineering topics, which are connected to AST software products, can be addressed. Although the seminar content is kept more general and not focusing on AST products, AST specific solutions and benefits are presented as AST know-how is based on those methods and tools.

Content:

- Definition of the entire topic
- Theoretical background
- Components and functionality
- Problems and engineering tasks, which have to be solved
- Technical solutions and applied methods

Goals:

- Generate understanding on the engineering topic
- Transfer of application know-how for the specific topic
- Understanding of cross effects

Customer Benefit:

- Compressed know-how transfer of state-of-the-art technology for a specific application field.

Duration:

- The duration depends on the specific topic, but typically is between 1 and 3 days.

Price (excl. Tax): * see chapter 2.1

♦ Seminar fee for a TechDay starts from 300 euro per participant and may diversify.

Actually available seminar topics are:

- Engine Development Process (Concept, Layout and Design Phases)
- Chain & Belt Drive
- NVH & Durability / From Engine via Transmission to Entire Drive Line
- Vehicle NVH and Power Unit Mount Vibration Analysis
- Efficiency Enhancement
- Marine Engine & Drive Line System Modeling and Analysis
- HEV&EV Development and SW Application Seminar
- DoE, Optimization and Robust Design

4.2 Engineering Support

This module focuses mainly on the usage of AVL AST software products in daily life and real development projects including interpretation of results and dealing with variants (*application oriented*).

Specific services are:

- Start-up support
- Enhancement support
- Consulting
- Software customization and specific software development
- CRUISE-on-PUMA Commissioning Service

4.2.1 Start-up Support

ID	Service
CC_421	Start-up Support

Purpose:

A start-up support is a training-on-the-job for a standard application using a specific customer model. It is organized as a separate project for a defined period of time. The target is to get started with a real application example. The start-up support can be performed at AST in Graz, on-site or partly on-site at the customer. Typically AST performs the main steps of the investigation and afterwards re-performs each step on-site together with the customer and makes use of these models and results for detailed explanation of each working step.

Validity:

Start-up support is offered for all standard applications and all AST products. The standard applications refer to the standard training courses, offered by AST.

An input sheet defining all required data and models is sent to the customer in advance.

Content:

- Explanation of workflow and all working steps
- Set-up of necessary models, perform analysis and evaluation and interpretation of results
- Explanation of introduction of modifications
- Hints and significant information about the application
- Workflow and entire work performed will be documented in a report

Goals:

- Entire workflow performed
- Customer can perform the specific application by himself

Customer Benefit:

- Knowledge transfer from AVL for standard application
- Usage of customer models
- Short time for customer to get efficient with new tool and application
- Maximum training effect

Duration:

- Total duration of a start-up support is **8 to 10 weeks**.
- 3 weeks of this period are defined as customer and AVL engineers working together. This can be either held at AVL in Graz or on-site at customer.
- The specific customer model should be sent to AST about 2 weeks before to ensure that the AST engineer gets familiar with the model and performs all necessary modifications in the model or defines these modifications.
- Main working steps are done by AVL separately to keep on-site period at maximum efficiency. All work performed is documented and explained.

Price (excl. Tax):

Total costs are in the range of **20,000 to 50,000 euro** (depending on the application and complexity of work). Travel and accommodation for AVL engineer are charged separately.

4.2.2 Enhancement Support

The enhancement support is offered to experienced users of AVL AST software tools. Within this module know-how about very specific new features or methods is investigated, transferred to the customer and implemented into the specific development process.

The enhancement support is guided by a specific model and application, using customer specific data. A comparison to previous methods and validation by measurements could be part of this work.

ID	Service
CC_422	Enhancement Support

Purpose:

Enhancement support is a training-on-the-job for the usage of a new feature or method, offered by AST software, using a specific customer model. It is organized as a separate project for a defined period of time. The target is to integrate this feature or method in the customer specific application work.

The enhancement support can be performed at AST in Graz, on-site at the customer.

The specific customer model should be sent to AST about 2 weeks before to ensure that the AST engineer gets familiar with the model and performs all necessary modifications in the model or defines these modifications. Requirements to the model are sent to the customer in advance.

Validity:

Enhancement support is offered for all AST products.

Content:

- Explanation about functionality of the feature and the method
- Update of customer specific methodology and workflow
- Application on a customer model
- Comparison of old and new workflow, model changes and results
- Hints and significant information

Goals:

- Detailed know-how transfer about new features and methods
- Customer can perform the specific application by himself

Customer Benefit:

- Knowledge transfer from AVL for new features and method
- Usage of customer models
- Short time for customer to get efficient with new feature and method
- Maximum training effect

Duration:

- Total duration of an enhancement support is **1 to 5 weeks**.
- Entire period is defined as customer and AVL engineer working together. This can be either held at AVL in Graz or on-site at customer.

Price (excl. Tax): * see chapter 2.1

Price for one AST engineer for one week (5 full working days) at customer and preparation phase is:

- Preparation phase: **3000 euro*** see chapter 2.1
- **6000 euro per week**; excl. travel and accommodation* see chapter 2.1

Travel and accommodation for AVL engineer are charged separately.

4.2.3 Consulting

This module describes the possibility to book highly skilled and experienced engineers from AST for defined period of time for on-site work at customers.

ID	Service
CC_423	Consulting

Purpose:

AST offers on-site work of highly skilled and experienced engineers for various advanced applications using AST tools.

Any specific material such as models or results for the on-site work should be sent to AST in advance, minimum 2 weeks before in order to be well prepared to increase efficiency of the on-site work.

Validity:

Consulting work is valid for all applications where AST tools are the main simulation tools and which are covered by training and support activities from AST.

Content:

- AST engineers can be booked for single days, weeks or longer duration.
- The customer also has the possibility to book a contingent of hours or days, which is valid for a period of one year. Within this year the agreed amount of time can be used whenever it is required. Purchase of on-site work has to be given at least 2 weeks before the trip.

Goals:

- AST engineers work in the customer environment in close co-operation with local engineers

Customer Benefit:

- Problem investigation by experienced AST engineers
- Usage of latest methodology and features of AST software
- Know how transfer to customer engineers; integration of methods into specific development process
- Fast solution of pending problems; direct contact to software developers
- Extends capacity on customer side

Duration:

Depending on definition.

Price (excl. Tax): * see chapter 2.1

Total price for one AST engineer for 1 full day at customer is:

- **1200 euro**; excl. travel and accommodation * see chapter 2.1
- **1850 euro** (in Europe) ; including travel and accommodation * see chapter 2.1

Preparation work is included in the given price.

4.2.4 Software Customization and Specific Software Development

AST offers the possibility to customize its software according to the specific needs and requirements of the customer. AVL AST software offers various options for **customization** (depending on the specific software tool) such as:

- User defined joints
- Python scripts (i.e. for post-processing)
- User functions
- Macros
- Apps and Workflows using COMPOSE
- MATLAB models, using existing interfaces

Update of the general GUI and kernel is not part of this service, although this service can be offered as **customer specific software development**. In such cases a separate agreement has to be made. The new features and enhancements will be implemented in subsequent releases of the standard AST release. AVL grants the customer an exclusive use of the developed features for a time period of 6 months after receiving a written approval of the extension from the customer. AST will also guarantee compatibility of the developed feature for subsequent releases, if it is part of the standard AST release.

ID	Service
CC_424	Software Customization

Purpose:

AST offers the possibility to customize its software according to the specific needs and requirements of the customer. Work is typically done at AST. A training on usage and implementation of the customized part is included.

Validity:

Software customization is valid for all features developed for customization, offered for a specific AST tool (see above). Customer specific software development is treated separately.

Content:

- Set-up of customer specific functionality
- Testing of the new functionality using a standard model or a customer model.
- Training on usage and implementation of the new functionality

Goals:

- Customized functionality ready to use
- Know-how transfer on usage, modification and implementation of the functionality

Customer Benefit:

- Implement customer specific solutions
- Independent from release cycle

Duration:

- This depends on the complexity of the requirement. Minimum effort is in the range of 1 week.

Price (excl. Tax): * see chapter 2.1

Total price for one AST engineer for 1 full day is:

- **1200 euro (at AVL AST in Graz)** * see chapter 2.1

Total price of the final training and know-how transfer (1 day) is:

- **1850 euro** (in Europe) ; including travel and accommodation * see chapter 2.1

4.2.5 Model.CONNECT and Testbed.CONNECT Commissioning Service

This module describes the implementation work of an existing Model.CONNECT model on a PUMA Open engine test bed (commissioning) as hardware-in-the-loop (HiL) application.

ID	Service
CC_425	Model.CONNECT and Testbed.CONNECT Commissioning Service

Purpose:

Model.CONNECT and Testbed.CONNECT Commissioning Service means creating an interface in Model.CONNECT model and testing and commissioning the model on a Testbed.CONNECT workstation for the customer. The target is to integrate a specific model (vehicle, control unit) on PUMA Engine Test Bed (ETB) for real-time applications as emission cycle testing, drivetrain testing, hybridization and driveability.

The installation service can be performed at AVL in Graz and on-site at the customer.

The specific customer model should be sent to AST about 2 weeks in advance to ensure that the AST engineer gets familiar with the model and performs all necessary modifications in the model or defines these modifications. Requirements to the model are sent to the customer at beginning of the project.

Validity:

Supported are CRUISE, CRUISE M and third party (Simulink, Amesim, GT…) driveline and vehicle models.

Content:

- Preparation phase:
  - Take over simulation model and perform basic functionality check in office mode
  - Create Model.CONNECT project and testbed interface
  - Testbed.CONNECT non-real time model integratin using Modl.CONNECT interface or direct realtime model integration (for CRUISE, CRUISE M, Simulink or Amesim)
  - Testing on PUMA simulator
- Implementation on test bed at customer
- Customer training on usage of model on ETB

Goals:

- Running simulation at customer ETB
- Customer can modify/operate the HiL simulation by himself

Customer Benefit:

- Detailed know-how transfer
- Short time for customer to get from office to ETB
- Usage of customer models with arbitrary vehicle configuration (standard, hybrid or other)

Duration:

- Total duration of a commissioning service is **2 to 5 weeks** (depending on model complexity and quality)

Price (excl. Tax): *** see chapter 2.1**

Price for one AST engineer for preparation phase and one week (5 full working days) for implementation at customer is:

- Preparation phase: **6000 Euro** per week*** see chapter 2.1**
- Implementation and training: **8000 Euro** (in Europe); including all costs for travel and accommodation

  *** see chapter 2.1**

Price for commissioning service in other countries is given on request.

5. Project Work

In addition to the services described in the previous chapters, we provide services for improvement of the applied methods and for development of new simulation methods in close co-operation with the customer up to complex project work including simulation-measurement comparison for validation of methods or taking over design responsibility.

AST offers a wide range of simulation project work using analytical and numerical methods as FEM, BEM (for noise radiation) and CFD in the field of automotive and non-automotive industry.

Simulation work is offered for

- Mechanical applications
- Thermo-fluid dynamics in 1D or 3D
- Multi-body dynamics
- System simulation
- Combined applications

And is typically, but not necessarily done using AVL AST software products.

The project can cover the entire simulation including model set-up, definition of boundary conditions, analysis and result evaluation and interpretation. AST will give clear conclusions and recommendations on the analysis performed and the investigated design.

Each project is performed according to the AST project process, guided by continuous documentation and finalized by a report describing all steps, the models used and the results obtained. Typically know-how transfer is done at the end of the project.

Typical project definitions are:

- Development of new methodologies
- Increase of efficiency and advanced solutions
- Validation projects including comparison to measurements
- Research and development (R&D) projects
- Dedicated projects or joint and research (J&R) projects

Measurements could be performed at AVL or at customer side.

Projects could be performed by AST alone or together with customer (sharing the work) as joint and research projects (J&R).

For further information or a specific project proposal, contact your responsible AST Sales Manager.

6. Identification of Material Properties for Simulation Model Input

Within this service AST takes care on specific measurements and the generation of fully parameterized and validated simulation models. Measurements are either done at and by AVL or by selected partners.

Available for:

- **Surface Measurement** and Contact Data Extraction - EXCITE Micro-slide Analysis (EXCITE Power Unit EHD or EPIL joints)
- **Belt Characteristics Measurement** of a Poly-V Belt (EXCITE Timing Drive)

- **Engine or Transmission Mount Characteristics** – static (0-50Hz) and dynamic mount characteristic (50-~1-2kHz) (EXCITE Power Unit)
- **Dual Mass Flywheel Characteristics** - DMF's parameters like basic hysteresis, quasi-static characteristics and dynamic stiffness characteristics (EXCITE Power Unit or Timing Drive)

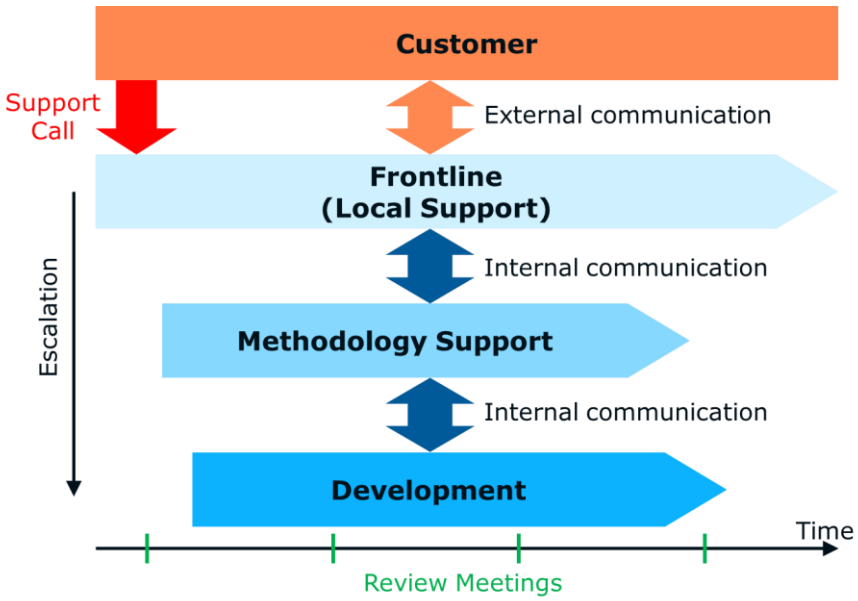
For the price, see standard proposals (ask your sales contact)

7. Appendix

7.1 AST Global Customer Support Process (GCSP)

- GCSP defines the process steps for handling all customer questions and requests related to the usage software products maintanined by AVL AST.
- It describes all interactions between the customer, the frontline team (local affiliate support team), the methodology support team at the service base, and the development team during handling of support cases.
- The GCSP defines when and how a development request is generated out of a support case.

These main functions are summarized in the following figure:



GCSP: Basic Process

7.1.1 Local Point of Contact

The local support teams at the affiliates collect all customer requests and they are also responsible for the entire communication between customer and AVL support. Information about contacts within our service organization can be found in chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** or on the AVL homepage (http://www.avl.com ➔ Customer Services ➔ Simulation Technologies).

7.1.2 Level Concept

The AST GCSP has different levels.

- Frontline support (1st level) is done by local AST affiliates (if no local affiliate is available, 1st level support is done by AST Service Base)
- Methodology support (2nd level) is done by by AST Service Base

For each Support Team (individual for different products/product groups and locations) a Support Master is defined, who is responsible for all related support requests and distributes the support requests to the different support engineers.

7.1.3 Escalation Model

The escalation depends on the time scale and category of the support case.

The escalation model defines the treatment of critical support cases, which require special effort and extended capacity. The escalation is done based on regular review meetings by the review team involving support masters, local and global support managers, and application responsibles.

Main Target:

- Identify possible high importance problems in an early phase of the support chain in order to define necessary measures before the problem escalates between the customer and AVL.
- Possible measures are to provide the necessary capacity and to shift priority between other tasks.

Training courses 2020 - Graz

January	February	March	April	May	June	July	August	September	October	November	December
1 T National Holiday	1 S	1 S	1 W FIRE M, Model. CONNECT	1 F National Holiday	1 M National Holiday 23	1 W Model.CONNECT	1 S	1 T FIRE	1 T FIRE M	1 S National Holiday	1 T CRUSE M Flow, CRUISE M VTMS MoBEO
2 T	2 S	2 M 10	2 T FIRE M, Model. CONNECT	2 S	2 T CRUISE M VTMS MoBEO	2 T	2 S	2 W FIRE, TABKIN	2 F	2 M 45	2 W CRUISE M Flow, CRUISE M VTMS MoBEO
3 F	3 M 6	3 T CRUISE M VTMS	3 F	3 S	3 W CRUISE M VTMS MoBEO	3 F	3 M 32	3 T FIRE, TABKIN	3 S	3 T EXCITE Power Unit, VSM	3 T CRUISE M VTMS MoBEO
4 S	4 T EXCITE Designer	4 W CRUISE M VTMS	4 S	4 M 19	4 T CRUISE M VTMS MoBEO	4 S	4 T	4 F	4 S	4 W EXCITE Power Unit, VSM	4 F
5 S	5 W EXCITE Designer, BOOST	5 T CRUISE M VTMS	5 S	5 T CRUISE M Flow	5 F CRUISE M VTMS MoBEO	5 S	5 W	5 S	5 M 41	5 T VSM	5 S
6 M National Holiday 2	6 T BOOST	6 F CRUISE M VTMS	6 M 15	6 W CRUISE M Flow	6 S	6 M 28	6 T	6 S	6 T BOOST, FIRE Samos	6 F	6 S
7 T	7 F	7 S	7 T EXCITE Timing Drive	7 T	7 S	7 T	7 F	7 M 37	7 W BOOST, FIRE Samos	7 S	7 M 50
8 W	8 S	8 S	8 W EXCITE Timing Drive	8 F	8 M 24	8 W	8 S	8 T EXCITE Power Unit	8 T	8 S	8 T National Holiday
9 T	9 S	9 M 11	9 T	9 S	9 T	9 T	9 S	9 W EXCITE Power Unit, CRUISE	9 F	9 M 46	9 W
10 F	10 M 7	10 T FIRE	10 F	10 S	10 W	10 F	10 M 33	10 T CRUISE	10 S	10 T FIRE	10 T
11 S	11 T Model.CONNECT	11 W FIRE, TABKIN	11 S	11 M 20	11 T National Holiday	11 S	11 T	11 F	11 S	11 W FIRE, TABKIN	11 F
12 S	12 W Model. CONNECT, CRUISE	12 T FIRE, TABKIN	12 S	12 T EXCITE Piston & Rings	12 F	12 S	12 W	12 S	12 M 42	12 T FIRE, TABKIN	12 S
13 M 3	13 T CRUISE	13 F	13 M National Holiday 16	13 W EXCITE Piston & Rings	13 S	13 M 29	13 T	13 S	13 T EXCITE Piston & Rings, CRUISE M MoBEO Cylinder	13 F	13 S
14 T FIRE	14 F	14 S	14 T	14 T	14 S	14 T	14 F	14 M 38	14 M EXCITE Piston & Rings, CRUISE M MoBEO Cylinder	14 S	14 M 51
15 W FIRE, TABKIN	15 S	15 S	15 W PreonLab	15 F	15 M 25	15 W	15 S National Holiday	15 T EXCITE Timing Drive	15 T CRUISE M MoBEO Cylinder	15 S	15 T
16 T FIRE, TABKIN	16 S	16 M 12	16 T	16 S	16 T VSM, EXCITE Designer	16 T	16 S	16 W EXCITE Timing Drive, Model. CONNECT	16 F	16 M 47	16 W
17 F	17 M 8	17 T VSM	17 F	17 S	17 W VSM, EXCITE Designer	17 F	17 M 34	17 T Model.CONNECT	17 S	17 T FIRE M	17 T
18 S	18 T FIRE M	18 W VSM	18 S	18 M 21	18 T VSM	18 S	18 T	18 F	18 S	18 W FIRE M	18 F
19 S	19 W FIRE M	19 T VSM	19 S	19 T	19 F	19 S	19 W	19 S	19 M 43	19 T FIRE M	19 S
20 M 4	20 T FIRE M	20 F	20 M 17	20 W	20 S	20 M 30	20 T	20 S	20 T PreonLab	20 F	20 S
21 T CRUISE M	21 F	21 S	21 T EXCITE Power Unit	21 T National Holiday	21 S	21 T	21 F	21 M 39	21 W Model.CONNECT	21 S	21 M 52
22 W CRUISE M	22 S	22 S	22 W EXCITE Power Unit	22 F	22 M 26	22 W	22 S	22 T EXCITE Designer, VSM	22 T Model.CONNECT	22 S	22 T
23 T CRUISE M	23 S	23 M 13	23 T	23 S	23 T	23 T	23 S	23 W EXCITE Designer, VSM	23 F	23 M 48	23 W
24 F	24 M 9	24 T FIRE SAMOS, CRUISE M MoBEO Cylinder	24 F	24 S	24 W	24 F	24 M 35	24 T VSM	24 S	24 T CRUISE M	24 T
25 S	25 T EXCITE Piston & Rings	25 W FIRE SAMOS, CRUISE M MoBEO Cylinder	25 S	25 M 22	25 T	25 S	25 T CRUISE M	25 F	25 S	25 W CRUISE M	25 F Christtag
26 S	26 W EXCITE Piston & Rings	26 T CRUISE M MoBEO Cylinder	26 S	26 T CRUISE M, FIRE M	26 F	26 S	26 W CRUISE M	26 S	26 M National Holiday 44	26 T CRUISE M	26 S Stefanitag
27 M 5	27 T	27 F	27 M 18	27 W CRUISE M, FIRE M	27 S	27 M 31	27 T CRUISE M	27 S	27 T CRUISE M VTMS	27 F	27 S
28 T EXCITE Power Unit	28 F	28 S	28 T	28 T CRUISE M, FIRE M	28 S	28 T	28 F	28 M 40	28 W CRUISE M VTMS	28 S	28 M 53
29 W EXCITE Power Unit	29 S	29 S	29 W	29 F	29 M 27	29 W	29 S	29 T FIRE M	29 T CRUISE M VTMS	29 S	29 T
30 T		30 M 14	30 T	30 S	30 T Model.CONNECT	30 T	30 S	30 W FIRE M	30 F CRUISE M VTMS	30 M CRUISE M VTMS MoBEO 49	30 W
31 F		31 T FIRE M		31 S		31 F	31 M 36		31 S		31 T

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Training courses 2020 – North America

January	February	March	April	May	June	July	August	September	October	November	December
1 T National Holiday	1 S	1 S	1 W PreonLab	1 F	1 M 23	1 W	1 S	1 T	1 T	1 S	1 T
2 T	2 S	2 M 10	2 T	2 S	2 T	2 T	2 S	2 W	2 F	2 M 45	2 W PreonLab
3 F	3 M 6	3 T EXCITE Piston Rings	3 F	3 S	3 W PreonLab	3 F National Holiday	3 M 32	3 T	3 S	3 T FIRE	3 T
4 S	4 T EXCITE Power Unit	4 W EXCITE Piston Rings	4 S	4 M 19	4 T	4 S	4 T	4 F	4 S	4 W FIRE	4 F
5 S	5 W EXCITE Power Unit	5 T	5 S	5 T EXCITE Power Unit	5 F	5 S	5 W PreonLab	5 S	5 M 41	5 T	5 S
6 M 2	6 T	6 F	6 M 15	6 W EXCITE Power Unit	6 S	6 M 28	6 T	6 S	6 T BOOST	6 F	6 S
7 T	7 F	7 S	7 T	7 T	7 S	7 T	7 F	7 M National Holiday 37	7 W BOOST	7 S	7 M 50
8 W	8 S	8 S	8 W	8 F	8 M 24	8 W	8 S	8 T	8 T	8 S	8 T CRUISE
9 T	9 S	9 M 11	9 T	9 S	9 T EXCITE Designer	9 T	9 S	9 W EXCITE Power Unit	9 F	9 M 46	9 W CRUISE
10 F	10 M 7	10 T CRUISE	10 F National Holiday	10 S	10 W EXCITE Designer	10 F	10 M 33	10 T EXCITE Power Unit	10 S	10 T	10 T
11 S	11 T	11 W CRUISE	11 S	11 M 20	11 T	11 S	11 T	11 F	11 S	11 W National Holiday	11 F
12 S	12 W PreonLab	12 T	12 S	12 T FIRE	12 F	12 S	12 W	12 S	12 M 42	12 T	12 S
13 M 3	13 T	13 F	13 M 16	13 W FIRE	13 S	13 M 29	13 T	13 S	13 T	13 F	13 S
14 T BOOST	14 F	14 S	14 T BOOST	14 T	14 S	14 T BOOST	14 F	14 M 38	14 M PreonLab	14 S	14 M 51
15 W BOOST	15 S	15 S	15 W BOOST	15 F	15 M 25	15 W BOOST	15 S	15 T EXCITE Timing Drive	15 T	15 S	15 T
16 T	16 S	16 M 12	16 T	16 S	16 T CRUISE	16 T	16 S	16 W EXCITE Timing Drive	16 F	16 M 47	16 W
17 F	17 M National Holiday 8	17 T	17 F	17 S	17 W CRUISE	17 F	17 M 34	17 T	17 S	17 T EXCITE Power Unit	17 T
18 S	18 T	18 W	18 S	18 M 21	18 T	18 S	18 T	18 F	18 S	18 T EXCITE Power Unit	18 F
19 S	19 W EXCITE Designer	19 T	19 S	19 T EXCITE Piston Rings	19 F	19 S	19 W	19 S	19 M 43	19 T	19 S
20 M National Holiday 4	20 T EXCITE Designer	20 F	20 M 17	20 W EXCITE Piston Rings	20 S	20 M 30	20 T	20 S	20 T EXCITE Designer	20 F	20 S
21 T	21 F	21 S	21 T EXCITE Timing Drive	21 T	21 S	21 T	21 F	21 M 39	21 W EXCITE Designer	21 S	21 M 52
22 W	22 S	22 S	22 W EXCITE Timing Drive	22 F	22 M 26	22 W	22 S	22 T CRUISE	22 T	22 S	22 T
23 T	23 S	23 M 13	23 T	23 S	23 T	23 T	23 S	23 W CRUISE	23 F	23 M 48	23 W
24 F	24 M 9	24 T	24 F	24 S	24 W	24 F	24 M 35	24 T	24 S	24 T	24 T National Holiday
25 S	25 T FIRE	25 W	25 S	25 M National Holiday 22	25 T	25 S	25 T FIRE	25 F	25 S	25 W	25 F National Holiday
26 S	26 W FIRE	26 T	26 S	26 T	26 F	26 S	26 W FIRE	26 S	26 M 44	26 T National Holiday	26 S
27 M 5	27 T	27 F	27 M 18	27 W	27 S	27 M 31	27 T	27 S	27 T EXCITE Piston Rings	27 F	27 S
28 T	28 F	28 S	28 T	28 T	28 S	28 T	28 F	28 M 40	28 W EXCITE Piston Rings	28 S	28 M 53
29 W	29 S	29 S	29 W	29 F	29 M 27	29 W	29 S	29 T	29 T	29 S	29 T
30 T		30 M 14	30 T	30 S	30 T	30 T	30 S	30 W	30 F	30 M 49	30 W
31 F		31 T		31 S		31 F	31 M 36		31 S		31 T National Holiday

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Training courses 2020 - France

January	February	March	April	May	June	July	August	September	October	November	December
1 T	1 S	1 S	1 W	1 F	1 M 23	1 W	1 S	1 T	1 T	1 S	1 T
2 T	2 S	2 M 10	2 T	2 S	2 T	2 T	2 S	2 W	2 F	2 M 45	2 W
3 F	3 M 6	3 T	3 F	3 S	3 W	3 F	3 M 32	3 T	3 S	3 T	3 T
4 S	4 T	4 W	4 S	4 M 19	4 T	4 S	4 T	4 F	4 S	4 W	4 F
5 S	5 W	5 T	5 S	5 T	5 F	5 S	5 W	5 S	5 M 41	5 T	5 S
6 M 2	6 T	6 F	6 M 15	6 W	6 S	6 M 28	6 T	6 S	6 T	6 F	6 S
7 T	7 F	7 S	7 T	7 T	7 S	7 T	7 F	7 M 37	7 W CRUISE M	7 S	7 M 50
8 W	8 S	8 S	8 W	8 F	8 M 24	8 W	8 S	8 T	8 T CRUISE M	8 S	8 T
9 T	9 S	9 M 11	9 T	9 S	9 T	9 T	9 S	9 W	9 F	9 M 46	9 W
10 F	10 M 7	10 T	10 F	10 S	10 W	10 F	10 M 33	10 T	10 S	10 T	10 T
11 S	11 T	11 W Model. CONNECT	11 S	11 M 20	11 T	11 S	11 T	11 F	11 S	11 W	11 F
12 S	12 W CRUISE M	12 T Model. CONNECT	12 S	12 T	12 F	12 S	12 W	12 S	12 M 42	12 T	12 S
13 M 3	13 T CRUISE M	13 F	13 M 16	13 W	13 S	13 M 29	13 T	13 S	13 T	13 F	13 S
14 T	14 F	14 S	14 T	14 T	14 S	14 T	14 F	14 M 38	14 M Model. CONNECT	14 S	14 M 51
15 W	15 S	15 S	15 W	15 F	15 M 25	15 W	15 S	15 T	15 T Model. CONNECT	15 S	15 T
16 T	16 S	16 M 12	16 T	16 S	16 T	16 T	16 S	16 W EXCITE PU	16 F	16 M 47	16 W
17 F	17 M 8	17 T	17 F	17 S	17 W	17 F	17 M 34	17 T EXCITE PU	17 S	17 T	17 T
18 S	18 T	18 W	18 S	18 M 21	18 T	18 S	18 T	18 F	18 S	18 T	18 F
19 S	19 W	19 T	19 S	19 T	19 F	19 S	19 W	19 S	19 M 43	19 T	19 S
20 M 4	20 T	20 F	20 M 17	20 W	20 S	20 M 30	20 T	20 S	20 T	20 F	20 S
21 T	21 F	21 S	21 T	21 T	21 S	21 T	21 F	21 M 39	21 W	21 S	21 M 52
22 W EXCITE PU	22 S	22 S	22 W	22 F	22 M 26	22 W	22 S	22 T	22 T	22 S	22 T
23 T EXCITE PU	23 S	23 M 13	23 T	23 S	23 T	23 T	23 S	23 W FIRE	23 F	23 M 48	23 W
24 F	24 M 9	24 T	24 F	24 S	24 W	24 F	24 M 35	24 T FIRE	24 S	24 T	24 T
25 S	25 T	25 W	25 S	25 M 22	25 T	25 S	25 T	25 F	25 S	25 W	25 F
26 S	26 W	26 T	26 S	26 T	26 F	26 S	26 W	26 S	26 M 44	26 T	26 S
27 M 5	27 T	27 F	27 M 18	27 W	27 S	27 M 31	27 T	27 S	27 T	27 F	27 S
28 T	28 F	28 S	28 T	28 T	28 S	28 T	28 F	28 M 40	28 W	28 S	28 M 53
29 W FIRE	29 S	29 S	29 W	29 F	29 M 27	29 W	29 S	29 T	29 T	29 S	29 T
30 T FIRE		30 M 14	30 T	30 S	30 T	30 T	30 S	30 W	30 F	30 M 49	30 W
31 F		31 T		31 S		31 F	31 M 36		31 S		31 T

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