EVROPSKÁ UNIE
EVROPSKÝ FOND PRO REGIONÁLNÍ ROZVOJ
INVESTICE DO VAŠÍ BUDOUCNOSTI

OP Výzkum a vývoj pro inovace

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TENDER DOCUMENTATION TO PUBLIC CONTRACT COMMISSIONED IN COMPLIANCE WITH ACT NO. 137/2006 COLL., ON PUBLIC CONTRACTS, AS AMENDED (HEREINAFTER REFERRED TO AS "APC")

TECHNICAL SPECIFICATION REQUIREMENTS OF MOTORCYCLE RIDING SIMULATOR

CONTRACTING AUTHORITY IDENTIFICATION DATA

Trade name or title / trade name or name and surname:	**Centrum dopravního výzkumu, v. v. i.**
Registered Office / Seat / permanent address of individual (or forwarding address):	Líšeňská 2657/33a, 636 00 Brno - Líšeň
Company Identification Number:	44994575
Person authorized to represent or act on behalf of Contracting Authority:	prof. Ing. Karel Pospíšil, Ph.D., MBA

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General Information

Introduction

The basic function of the delivered equipment is motorcycle riding simulator. CDV is going to use the simulator for **research and development** purposes, e.g. in the field of drivers' distraction and their mental stress, when performing secondary activities while riding. The device will also be used for **education and training** purposes. Last but not least, the simulator technology is to be used in **commercial** domain, e.g. potential cooperation in the motorcycle industry for designing and testing of driver's assistance systems. The delivered equipment will be installed at CDV workplace.

Definitions and abbreviations

The following definitions and abbreviations are used in this document:

Term	Description
ABS	Anti-lock braking system
EV	Ego Vehicle
FOV	Field Of View
HMI	Human Machine Interaction
ms	milliseconds
µ	Coefficient of friction between tyre and road
SDDRM	System Development Design Review Meeting
TBS	Test Before Shipment
TN-S	Cable with separate neutral and ground conductor
UPS	Uninterrupted Power Supply

Scope of Work

The delivery shall comprise the supply and installation of a fully operational driving simulator for HMI research with the specified performance. The simulator shall have a moving base platform and a realistic equipment and design of motorcycle including commonly equipped handlebars, usual indicators, and transmission and braking control elements.

The delivery shall include:

• A fully operational driving simulator, including equipment to log data from experiments.

• Installation of all delivered equipment at CDV premises

• Transportation to the CDV site, including crating.

• Training of operating and maintenance personnel

Building conditions

The building where the simulator will be installed shall have the following characteristics:

• Normal temperature is approximately 20 °C and may range between 18 and 26°C.

• Electrical power supply, three phase 400V, 50 Hz, TN-S and single phase 230V, 50 Hz.

Equipment use

Simulator specification

Requirement	Fulfils Yes/No	Tenderer's answer (Tenderer needs to specify clearly how they meet the given requirement, e.g. technical parameters, links to specifications / tests, other possible solutions, etc.)
Requirement CDV 1: SIM laboratory must contain: Motorcycle riding simulator on a moving base with axes of movement.		
Requirement CDV 2: Must contain user interface for creating or editing scenarios, management of training/riding (functions - start, stop, replay, moving base blocking, etc.)		
Requirement CDV 3: The equipment must allow for a recording of the whole practice (logging of control components status – all synchronized with the course of training). It must be possible for instructor to play the current ride scenario immediately after its end with an option to replay the ride and		

Requirement	Fulfils Yes/No	Tenderer's answer (Tenderer needs to specify clearly how they meet the given requirement, e.g. technical parameters, links to specifications / tests, other possible solutions, etc.)
corresponding variables (speed, ride trajectory, changing gears, pedals, etc.). The instructor will have teh complex data of the recorded scene available.		
Requirement CDV 4: must allow for the evaluation of relevant physical variables describing vehicle behaviour while driving, corresponding with the behaviour of a given vehicle in the real traffic environment. The recorded data must allow evaluating of the style and characteristics of driving in the context of the traffic environment the vehicle moves in. They concern at least: • Motorcycle trajectory • Motorcycle speed • Motorcycle acceleration • Motorcycle deceleration • Critical events (skid, etc.) • Critical manoeuvres (hazardous overtaking, driving through hazardous road segments in improper speed, etc.) • Other relevant variables		
Requirement CDV 5: Colour printer for printing output data od simulator experiments and other related information in format of at least A4.		

Function and operation

Scenarios

The equipment shall be delivered with some predefined environments and scenarios. Some basic functions shall be adjustable without programming. It shall be possible for CDV to design custom scenarios and road environments. Necessary tools for this shall be included in the delivery. A description of work process and support agreement of how to handle development/support of new scenarios for CDV shall be included in the offer.

Requirement	Fulfils Yes/No	Tenderer's answer (Tenderer needs to specify clearly how they meet the given requirement, e.g. technical parameters, links to specifications / tests, other possible solutions, etc.)
Requirement CDV 6: 100 km motorway road database must be included		
Requirement CDV 7: Must contain at least 50 km rural road database. At least 10 km of roads with downhill gradient of min. 7 %.		
Requirement CDV 8: Must contain at least 10 km of urban roads database		
Requirement CDV 9: traffic environment must contain at least 10 different moving vehicles (3d models), 5 passenger vehicles, 2 trucks, 1 bus, 2 motorcycles, 2 bicycles		
Requirement CDV 10: a scenario of driving in rainy conditions must be included. This includes changes in Computer graphics, motorcycle dynamics, haptic feedback and relevant perception modalities		

Requirement CDV 11: Must allow for setting different weather conditions – at least mist, rain, speed and direction of wind, day and night.		
Requirement CDV 12: Must contain scenario of riding in wet conditions. This includes changes in Computer graphics, motorcycle dynamics, haptic feedback and relevant perception modalities.		
Requirement CDV 13: Must contain scenario of riding in strong side wind conditions. This includes changes in Computer graphics, motorcycle dynamics, haptic feedback and relevant perception modalities.		
Requirement CDV 14: two basic scenarios of hazardous behaviour of other road users must be supplied: 1. hazardous behaviour of pedestrians on road. 2. hazardous behaviour of vehicles on road.		
Requirement CDV 15: simulation of high and low beam from the vehicle – motorcycle – will be included		
Requirement CDV 16: it must be possible to modify signs and road markings (e.g. add, remove and move) on an existing road		

Requirement CDV 17: the simulator software must include the possibility to use autonomous traffic, i.e. the behaviour does not have to be specified by scenario programming software		
Requirement CDV 18: it must be possible to choose volume and composition of the autonomous traffic		
Requirement CDV 19: it must be possible to generate random scenarios by selecting some predefined events to be executed by the autonomous traffic during the test-drive		
Requirement CDV 20: activation of hazardous scenarios (e.g. puncture, fire in the engine, etc.) must be possible to be programmed in advance, randomly generated and started up directly from operator's user interface		

Data

Simulation data shall be logged to a file. The file shall include metadata specified below. It shall be possible to start/stop data logging at given signals from the controls of the controlling computer. Metadata shall include project name, test stand name, date and time, comments. It should be possible to define which data should be logged.

Requirement	Fulfils Yes/No	Tenderer's answer (Tenderer needs to specify clearly how they meet the given requirement, e.g. technical parameters, links to specifications / tests, other possible solutions, etc.)
Requirement CDV 21: It must be possible to log data from the simulated environment; all data must be logged time synchronous. The data		

recording must be possible to logged at at least 30 Hz		

Graphic system

The graphics system includes software for image generation and hardware for displaying images. It should provide a realistic view of the surrounding environment. The graphic system is expected to include high quality computer graphics of the environment and other road users.

Requirement	Fulfils Yes/No	Tenderer's answer (Tenderer needs to specify clearly how they meet the given requirement, e.g. technical parameters, links to specifications / tests, other possible solutions, etc.)
Requirement CDV 22: visualization must contain left and right rear-view mirror, both shown on the scenario display or placed directly at motorcycle handlebars (small LCD panels)		
Requirement CDV 23: front sight must be displayed on three LCD/LED panels (at least 40" FullHD 1920x1080p) or by a system of projecting on panoramic screen with parameters of simulated view of at least 120^{o} x 22^{o} (horizontal x vertical)		
Requirement CDV 24: the update frequency of the image must be at least 60 Hz		
Requirement CDV 25: the resolution in front of the drivers face must be 0.5 pixels/arc minute or higher		
Requirement CDV 26: the contrast must be sufficient for readability of road signs and traffic facilities, road signs must be visible for		

drivers from 70 m in rural areas and from 50 m in urban areas		
Requirement CDV 27: maximum latency of the visual system must be below 50 ms		
Requirement CDV 28: the graphic software must include the following moving objects: pedestrians, animals, passenger and heavy vehicles, motorcyclists, cyclists		
Requirement CDV 29: visualization of a functional navigation model must be included		

Audio

The simulator's audio system must provide driver with a realistic sensation of the sound of the motorcycle and typical accompanied noise (road, engine, etc.). It must also provide the sound of surrounding vehicles and internal and external warning sounds and other effects. The system should be able to provide directional sound, e.g. like in 5.1 sound systems.

Requirement	Fulfils Yes/No	Tenderer's answer (Tenderer needs to specify clearly how they meet the given requirement, e.g. technical parameters, links to specifications / tests, other possible solutions, etc.)
Requirement CDV 30: the sound software must produce sound of motorcycle, appropriate noise sound with a given road surface, engine and wind		
Requirement CDV 31: the sound software must produce directional sound coming from vehicles around as well as from other sound		

sources of traffic environment		
Requirement CDV 32: the sound software must be able to replay warning signals and other sounds added by the user		

Vehicle dynamics

The vehicle dynamical model describes how the vehicle itself behaves based on the inputs from the driver and the surroundings.

Requirement	Fulfils Yes/No	Tenderer's answer (Tenderer needs to specify clearly how they meet the given requirement, e.g. technical parameters, links to specifications / tests, other possible solutions, etc.)
Requirement CDV 33: must include a dynamic model of a given motorcycle		
Requirement CDV 34: in the provided motorcycle dynamics model it must be possible to change the μ-value, to simulate different levels of adhesion between road and tyre		
Requirement CDV 35: the provided motorcycle dynamics model must provide data on the motorcycle inclination when cornering, braking and accelerating		
Requirement CDV 36: the provided motorcycle dynamics model must take road unevenness as an input and be affected by it		

Requirement CDV 37: in the provided motorcycle dynamics model it must be possible to change between manual and automatic transmission		

Moving base

The simulator should include a motion system. The motion system shall be used to actuate the motorcycle. The moving base is used to generate motion cues that give that driver a sensation of lateral and longitudinal jerks and accelerations and road unevenness.

Requirement	Fulfils Yes/No	Tenderer's answer (Tenderer needs to specify clearly how they meet the given requirement, e.g. technical parameters, links to specifications / tests, other possible solutions, etc.)
Requirement CDV 38: The moving base must be actuated electrically		
Requirement CDV 39: The moving base must allow for movement in at least two axes. Motorcycle inclinations must be synchronized with the terrain on which the motorcycle currently moves. Minimum roll direction must meet these parameters: inclination angle ±15° inclination angular velocity ±50°/s Maximum pitch direction must meet these parameters: inclination angle ±15° inclination angular velocity ± 40°/s		

Driver's environment / motorcycle model

The driver's environment of motorcycle should be designed to give a realistic impression of driving. The aim is to have a complete impression of a ride on a motorcycle model. The handlebars, brake pedal and gear levers should provide as realistic haptic feed-back as possible.

Requirement	Fulfils Yes/No	Tenderer's answer (Tenderer needs to specify clearly how they meet the given requirement, e.g. technical parameters, links to specifications / tests, other possible solutions, etc.)
Requirement CDV 40: The motorcycle model must include a passenger seat.		
Requirement CDV 41: Motorcycle must contain brake and gear pedals for manual transmission, brake and clutch levers, functional acceleration grip, functional controls, tachometer, or speedometer		
Requirement CDV 42: the position/state of all driver inputs required to drive the vehicle must be available and logged. The signals must be logged synchronous with other simulator data		
Requirement CDV 43: The simulator must include a high performance force feedback of handlebars, which uses input from the vehicle dynamics model, so that road unevenness and overrun obstacles were reproduced.		

Requirement CDV 44: a system for the communication between driver and operator must be installed		

Computer system

Computers

• Shall have effective cooling, adjusted to a temperature between 20-26 degrees Celsius.

• Standard computer components should be used.

• Hardware updates (e.g. graphics card, processor etc.) should not require new version of Driving Simulator software.

Request for testing

An acceptance test will be made for a behavioural study in the driving simulator. The supplier must participate during the test and provide support throughout the process from scenario definition to data analysis.

GUI

The GUI language including all error messages must be Czech or English.

Documentation

General requirements

The documentation must clearly describe the equipment supporting service and maintenance work. This includes drawings, manuals, spare parts lists, etc.

The system hardware must be described in engineering drawings, service documentation and manuals. Engineering drawings of all the systems are to be supplied. This includes all mechanics drawings with dimensions and component lists, and all electrical documentation, including circuit diagrams down to components.

Maintenance manuals for both mechanical and electrical purposes as well as recommended spare parts lists must be included in the delivery. All documentation must be delivered in two (2) paper copies (unless otherwise indicated). The documentation must also be delivered in an electronic form.

General documents

User Manuals, Instructions, Handbooks, shall be included in the delivery.

Training

On-site training must be included for all installed systems. The training shall be focused on test engineers, operators and maintenance staff.

The total extent of the training is divided into the following areas:

- Operator training
- Scenario development
- Maintenance

A training program, including time per system and preliminary agendas for operators, test engineers and maintenance personnel, shall be supplied in the offer. The training program and training documents shall be delivered 2 weeks prior to the start of training.

Operation and maintenance

Supplier shall propose a plan for service and maintenance.