TECHNICAL SPECIFICATIONS AND OTHER ALLIED REQUIREMENTS

Sl No.	Description of items	Quantity
File No.	**PUR/36/ERT/RK/E/2024-25**	
1	**SUPPLY OF THREE DIMENSIONAL (3D) COMPUTATIONAL FLUID DYNAMICS (CFD) SIMULATION SOFTWARE FOR HYDROGEN-FUELED INTERNAL COMBUSTION ENGINES.** **(DETAILED SPECIFICATIONS AS PER ANNEXURE – I)**	02-Solver Licenses for 5-years each

1. DELIVERY, INSTALLATION, COMMISSIONING:

The delivery, installation and commissioning are to be completed within 45 days from the date of issue of Purchase Order. The installation and commissioning shall be carried out by your expert-engineers of supplier/Manufacture. During installation & commissioning necessary training on operation and maintenance of the goods/system shall be imparted to relevant Scientist/Engineer/Technicians.

1.1. Training, Installation and Proving Out on Desktop/ Workstation PC is the responsibility of the Supplier. The Supplier should provide training for at least five working days to the complete satisfaction of the end User.

2. PAYMENT TERMS:

100% payment shall be paid within 30 days after delivery, installation and commissioning of Three Dimensional (3D) Computational Fluid dynamics (CFD) Simulation Software for Hydrogen-fueled Internal Combustion Engines and acceptance of the material upon submission of claim supported by the acceptance certificate issued by the purchaser.

3. BID SECURING DECLARATION FORM:

Bid Securing Declaration is to be submitted by the Bidder as per the format prescribed in the tender document.

4. WARRANTY:

05-years warranty will be provided by the supplier form the date of satisfactory installation and commissioning of ordered goods.

5. MANUFACTURER AOTHORISATION FORM:

Manufacturer Authorisation Form will be provided by the supplier.

6. PLACE OF DELIVERY:

CSIR- Central Mechanical Engineering Research Institute, M.G. Avenue, Durgapur- 713209, West Bengal.

7. MAKE IN INDIA CERTIFICATE FOR LOCAL CONTENT

Certificate for local content to be provided by the supplier in form 14 (Format attached along with Tender Document). Percentage of value addition & Name and address of the factory where the value addition was made should be mentioned clearly in the Form 14.

Annexure-I

Supply of three-dimensional (3D) Computational Fluid Dynamics (CFD) Simulation Software for Hydrogen-fueled Internal Combustion Engines

The 3D CFD simulation software for engine combustion modelling should offer detailed solutions for the flow, spray, and combustion processes inside a hydrogen-fueled internal combustion engine, with movement of intake & exhaust valves (open cycle) & piston, and flow inside the ports. It should also be able to simulate an 'engine sector' (in case of axisymmetric bowl), and a full cylinder (for offset bowl or inclined injector). The software should have advanced models for spray breakup, droplet collision & coalescence, wall interaction, and advanced soot modelling with detailed chemistry.

General Features of the software:

1. Operating System Compatibility:

- The software should be able to run on Windows 10/11 operating system in standalone mode.

2. Pre-processor:

- The software should be able to import CAD data in a simple file format which is compatible with all CAD software.
- It must have the capability to repair the surface for errors such as holes, non-manifold edges, and intersections.
- The meshing should be completely automatic. As the engine has moving parts, and meshing is very critical & time consuming, the software should be able to handle the meshing without much intervention & time consumption of the user. However, the user should have full control over meshing, and the parameters defined from within the pre-processor.
- It should be able to translate boundaries (for e.g. piston, valves) along a measured direction.
- In-built examples/templates for different types of engines.
- Ability to define engine parameters such as bore, stroke, connecting rod length etc. directly through the software.

- Ability to have time varying and spatially varying boundary conditions, imported in the form of tables.
- Initial conditions for species mass fractions should be calculated by the software based on equivalence ratio and EGR%.
- All physical models should be fully defined from the pre-processor, and it should have a facility to check the settings for any errors.

3. Solver:

The solver should have all the following capabilities:

- Finite volume solver which should be robust and should work in both steady state and transient cases.
- Variable time step algorithm based on CFL number, to get better accuracy (by reducing time step when required) and faster run time (by increasing it when gradients are low).
- Model the valve opening & closing events.
- Ability to define fine mesh in desired locations (for e.g. valve curtain, or spray), and the ability to turn it off when not required (i.e. after closure of the valve, or end of spray).
- Automatically refine the mesh during the simulation to capture the high gradients in the flow such as high-velocity hydrogen injection. This could be during valve opening/closing events, and during combustion when the gradients are very high.
- The solver should have various RANS based Turbulence models, and for advanced turbulence modelling it should also have LES & DES turbulence models.
- Advanced models for spray modelling such as Injector modelling, Particle Size distribution, Spray breakup & Droplet Drag, Collision and coalescence, Droplet wall interaction models, Liquid film models, and Eulerian-Lagrangian Spray Atomization model.
- The solver should have an in-built detailed chemistry solver utilizing complex reaction mechanisms for hydrogen and various fuels, and yet have an algorithm to reduce the computational cost.
- The detailed chemistry solver should be able to import mechanisms in Chemkin format.
- It should also have the following simplified models (G-Equation, ECFM-3Z, Shell ignition, CTC model, & Surface chemistry).
- Ability to model emissions using one of the above models (preferably detailed chemistry) such as NOx, CO, HC, and Soot.

- The solver should have the ability to do Conjugate Heat Transfer, and solve combustion and solid conduction at the same time. The Conjugate Heat Transfer model should have a method to reduce the computational time for the solid to reach steady state.
- Volume of Fluid (VOF): To model flow in nozzles along with cavitation, this model is required. One should also be able to model VOF-Lagrangian coupling.
- Solver should have an in-built optimization tool based on the 'Genetic Algorithm'. This module should be able to optimize based on various input conditions, and also geometry that is defined parametrically (i.e. piston bowl).
- Capable to couple with GT-Suite or other 1-D software for 1D-3D co-simulation.
- The solver should provide the ability to have user coding (UDFs) for adding customized capability.

4. Post Processing:

- The Software should output data in simple text files showing various quantities (for e.g. Pressure, Temp, Turbulence, Species etc.) during the simulation. This data should be able to be plotted in graphs, and the software should have 2-D plotting capability.
- The software should provide a 3D post processor, or be able to export data into various formats to be post processed with third party software like Tecplot.

5. Other applications and advanced features:

- The software should be able to do engine after-treatment (exhaust) modelling (for e.g. SCR systems).
- Ability to model blended gas mixtures and multiple sprays with different fuel.
- Capable of doing multi-cylinder analyses.

Terms & Conditions:

1. Provide "Authorization Certificate" from the manufacturer, in case the quotation is submitted by an Indian Agent.

2. Prices should be FOR CSIR-CMERI, Durgapur.

3. Validity of quotation should be at least for 90 days.

4. License Duration: Five years from the date of installation and commissioning.

5. All necessary components required for proper functioning of system must be mentioned in the offer.

6. Training, installation and proving out on Desktop / Workstation PC is the responsibility of the supplier. The supplier should provide training for at least five working days to the complete satisfaction of the end user.

7. Validation and testing of the software with published data for at least five test problems related to moving mesh to assess accuracy and reliability of the computational simulation using the software.