Ref : GP/1001/147/EOI-Tech-Firm Dated 09-12-2023

M/s. BEML LIMITED,

BEML SOUDHA,

SAMPANGIRAMNAGAR,

BENGALURU - 560002

Invitation for Expression of Interest(EoI) from Indian / Global companies For

"Engaging of Technical Design Consultant Firm (Global / Indian) For Design & Development of

(a) Indigenous Power pack (Diesel Engines & Transmission), with Power ratings 600hp to 1500 hp for Defence application & Integration Engines with Transmission / Integration of Powerpack Power pack on Armoured Fighting Vehicle,

(b) Development of Marine Engines 3MW to 10 MW and

(c) Development of Critical Engine Aggregates"

Reference No:	**1001/147/EOI-Tech-Firm Dated 09.12.2023**
Due closing date:	**10.01.2024**
EoI response mail ID:	**bemleoi@beml.co.in**
Contact for Clarifications:	**Engines : Mr. Mahadev Nellur, DGM, Engine D&D** **Email : gpe@beml.co.in, Mobile : 8618735789** **Transmission/Integration : Mr.Ramesh Raju, DGM, R&D,** **Email : gawrr@beml.co.in, Mobile : 9972001894**

Issued by
M/s. BEML, Limited
(Under Ministry of Defence)

Expression Of Interest (EOI)

INTRODUCTION

BEML Limited was established in May 1964 as a Public Sector Undertaking and plays a pivotal role serving India's core sectors such as Defence, Rail, Power, Mining and Infrastructure. The manufacturing units located at Bangalore, Kolar Gold Fields (KGF), Mysore and Palakkad along with all India Sales & Service network and backed up by a strong R&D base. For more details please visit www.bemlindia.in.

Qualification Criteria :

Design Consultant firm must be GLOBALLY well known firm in the areas of Design and development of Power Pack (including heavy duty diesel engines and Transmissions) and engineering of Power pack on equipments. Firm must have executed design and development of Engine / Transmission /Power pack of power rating of 1000hp and above from Concept design stage to Proto built up / Serial production.

Sl. No	Qualification Criteria	Firm Response **Yes / No**	Supporting documents Needs to be submitted during tendering stage, if firm is selected
1	a) The bidder shall have experience in the V- Type diesel engine & transmission (Power pack) design and development of 1000 hp or more power rating for defense applications (Armoured Fighting Vehicle) with similar power to volume ratio and power to weight ratio. One such design should have been successfully developed, manufactured, tested, proven and productionised.		A scanned copy of proof to be submitted either copy of contract or PO copy or self certificate (in case of confidentiality) on company letter head signed by competent authority for (a) & (b).
	b) The firm shall have expertise for formulating Quality Assurance Plan for conducting durability test of the critical components and engine and transmission.		
2	The firm shall have the expertise man power in 1D & 3D simulation (FEA& CFD) & Analysis, Design of engine & transmission components, FMEA, Vehicle Integration etc.		Please furnish the details of manpower with domain knowledge in the enclosed "MAN POWER / EXPERTISE DETAILS" below table
3	The firm shall have the following commercially available engine / transmission specific software and shall possess, expertise in using these engine specific software.		Please furnish the details of the software, users in India, along with the details of manpower with domain knowledge on these software.

	a) Engine Thermodynamic simulation, b) Crank train simulation and analysis, c) Valve train simulation and analysis, d) Combustion & heat transfer analysis, e) Vehicle performance simulation, f) Transmission design, simulation & matching software		
4	The firm shall associate BEML engineers during the entire design and development period. Further firm shall agree to provide complete details of design calculations, drawing and design documents to BEML.		Please furnish the details with related documents / willingness letter on company letter head signed by competent authority
5	a) Details of Geometric modeling (Preferably Creo-Ver09), and tolerance stack-up analysis software available, including details on number of copies and platform. b) The firm shall have experts to work on the above software.		Please furnish the details in your company letter head.
6	a) The firm shall have experience in using CRDI (Common Rail Direct Injection) Fuel System and optimization. b) The firm shall have experience in interfacing Military standard ECU with transmission control unit.		Attach the proof of implementation of CRDI, ECU integration technology in your engine development by self certificate (in case of confidentiality) on company letter head signed by competent authority
7	The firm shall have Engine combustion development facility & testing facility such as a large dynamometer with capacity of up to 6MW. OR Alternatively the firm shall have a tie-up with any organization for such facility.		Please furnish the details of the facilities with your firm/ details of the facilities available with your collaborator/partner.
8	The firm shall confirm that it would get the permission from its Government for exporting this technology related to the engine development to India for Military applications (as applicable).		Please furnish the details in your company letter head.
9	The firm shall have the expertise in identification of suitable supplier for supply of engine sub-systems/performance related components for this development activity.		Please indicate your firm association in an engine development program.
	Information on financial and managerial capabilities		
10	Firm is NOT blacklisted by Ministry of Defence / Govt. Of India / Public Sector Organizations in India?		Submit Certificate in the attached below format as per **Annexure (**attached**)** in your company letter head

11	Average annual turnover for the last three years should be more than rupees 100 crore (In Indian Currency).		Audited documents to be enclosed for last three years.

Scope of Work :

Consultant firm is required to design and develop V-type heavy duty diesel Engines & Transmissions from 600 hp to 1500 hp for Armoured Fighting vehicles like for defence applications, design/development/marinisation of engines of 6MW capacity and development of critical engine aggregates like CRDI fuel system.

Consultant firm to involve BEML design team during every design stage right from Concept stage to final design stage including activities like CFD simulation analysis, structural analysis, material / process selection criteria, component evaluation evolving testing & component acceptance procedures etc. For Transmission, conceptual stage to final design stage including activities like feasibility study, conceptual / kinematic layout, concept & detail design of Transmission with torque converter, integrated brake, integrated steering & its related controls (mechanical, electrical & hydraulic/pneumatic), simulation using modern CAE / FEA tools, FMECA, design vetting, control software and functional development, preparation of 2D manufacturing drawings, preparation of acceptance test procedure for qualification & acceptance testing, design modification / improvements based on the manufacturing & testing feedback, mean time to repair, mean time to failure, durability & reliability analysis, etc., Detailed know how technology to be shared to BEML Design team.

Firm to provide technical guidance to BEML design team during entire project i.e, Concept Design stage, Final design stage, Supplier selection, Component development, Proto built up, first firing, engine & transmission calibration, endurance testing, vehicle integration, limited field test trials and fault analysis during failure of any system/sub-systems.

Consultant Firm needs to work jointly with BEML design teams, Engine Division Design-Mysore on engine and R&D team KGF for Transmission related for the following New Defence projects.

1. **Development of 1500hp engine& Transmissionfor Existing MBT :** Reconfiguration of BEML developed 1500 hp Engine & CVRDE developed transmission and its related peripherals to existing Main Battle Tank within the equipment space claim. This project work includes the design and development of all new parts, supplier selection, Guidance during Proto Engine& transmission build up & testing, performance demonstration, vehicle integration, field trials and to provide guidance during every stage of the project. Existing 1500hp engine design will be provided.

2. **Development of Power pack for Battle Tank :** Design and development of 1200hp to 1500hp engine & Transmission for BattleTank within the given vehicle envelope of the tank. This new Engine shall be 4-stroke, 12 Cylinder , V-type, Turbocharged, With Water cooled CAC, Electronic Diesel Engine. This project work includes the design and development of all new parts, supplier selection for Engine critical / vital parts, Guidance during Proto Engine & Transmission build up & testing, Engine & Transmission calibration to meet the performance & demonstration, Transmission integration with Engine, vehicle

integration with powerpack, support for field trials and to provide guidance during every stage of the project.

3. **Development of Power pack for Battle Tank :** Design and development of 1000hp engine and Transmission for Battle Tank within the given vehicle envelop. This new Engine shall be 10 cylinder variant of Existing 12 Cylinder , V-type, 1500 hp FRCV /NGMBT Engine. This project work includes the design and development of all new parts, supplier selection for Engine critical / vital parts, Guidance during Proto Engine build up & testing, Engine calibration to meet the performance & demonstration, Transmission integration with Engine, vehicle integration with powerpack, support for field trials and to provide guidance during every stage of the project.

4. **Development of 800 hp to 1000 hp engine for Combat Vehicle :** This new Engine shall be 4-stroke, 8 cylinder / 10 Cylinder , V-type, Turbocharged, With Water cooled CAC, Electronic Diesel Engine. Engine with related accessories must fit within the given vehicle envelop. Firm should support for supplier selection for Engine critical / vital parts, Guidance during component manufacturing, Proto Engine build up & testing, Engine calibration to meet the performance & demonstration, Transmission integration with Engine, vehicle integration with powerpack, support for field trials and to provide guidance during every stage of the project.

5. **Design and Development of Defence Engine Aggregates :** Design & Development of Defence Engine Aggregates like CRDI fuel system, 20kW Oil cooled Generator, Large Turbocharger (Marine Engines), Air Staring System, SCAF (Self Clean Air Filtration System) etc.

6. **Design / Marinisation capability for the Following Marine Engines :**

6.1: Development of 6 MW engine for Marine: Design and Development of Indigenous 6MW Marine Engine for Indian Defence Service. Engine should be scalable from 3 MW to 10MW, (Design Protected for 10 MW) .

Engine Description: Engine to be 4 stroke, V type, Medium Speed, Non-reversible, Unidirectional, Turbocharged, Intercooled, Direct Injection Electronic diesel engine with Pneumatic started as per DEF STAN 02-313 or IACS rules and specifications indicated in RFI. This engine to be supplied duly mounted on steel fabricated common Base frames with SV (Shock and Vibration) mounts.

6.2 : Design and Development of 750hp High speed Diesel engine: Design & Development of Light weight, High speed diesel engine for **Fast Intercept Craf**t for Indian Navy.

Engine Description: 4 Stroke, V configuration, Electric Started, Turbocharged, Charge Air Cooled, Coolant cooled with Common Rail Fuel System diesel engine.

6.3 : Design and Development of 330hp High speed Diesel engine: Design & Development of Light weight, **High speed boat engine** for Indian Navy. Engine rated speed is 4000 rpm. Design and development of Stern Drive through reverse engineering.

Engine Description:

Reciprocating, 4 Stroke, Inline / V configuration, Electric Started, Turbocharged, Charge Air Cooled, Coolant cooled with Common Rail Fuel System diesel engine.

For projects serial No.1 to 4, detailed existing hull structure to be studied for engine & transmission room space claim and mounting configuration needs to be studied and concept design of Engine & Transmission to be arrived.

The primary Engine & transmission design target is weight, space and reliability apart from Engine & transmission performance. Engine & transmission Design from Concept stage to Proto build up stage, including, Simulation, system/sub-system Layout, Analysis of components, detailed 3D , 2D manufacturing drawings, Inspection standards (ATP's), Supplier selection, Component material selection, Proto build up, testing and performance optimization, vehicle engineering and technical support during limited field trials.

Following engine components / sub-systems needs to be designed and analysis study to be carried out

Sl.No.	Engine Sub System	New Design / Modifications
01	Engine concept design & Layout including, Intake system, Exhaust system, cooling system, lubrication system, Crank train & valve train, fuel system, cold start kit, Starting system (Air & Electrical), etc.	Engine concept design and 1D layout to be done to meet the Engine performance and Engine performance to be performed with various ambient / environmental conditions. Further 1D analysis to carried out for Cooling layout / circuit, Crank train & valve train Lubrication layout / circuit, Intake and Exhaust layout / circuit.
02	Freezing of Base Engine design parameters	Engine base parameters like Bore, Stroke, Connecting Rod length, Bore pitch, Compression ratio etc., to be finalized with the evidence of analysis reports of calculations.
03	Engine 3D layout & Design	i) All systems 3D layout to be outlined which are required for Engine analysis and various FEA, CFD analysis to be carried out to meet the best bench marking design requirement of this segment. ii) Outcome of this result, Complete Engine 3D model to be made and freeze. If required re analysis to be carried out. iii) The above analysis shall include the supplier input data wherever required / applicable.

04	Preparation of 2D - component manufacturing drawings	i) Manufacturing 2D drawings of all the developed components are to be prepared. ii) Installation or Mounting drawings of off-the-shelf or proprietary components drawing may be received from the respective suppliers. iii) 2D layout drawings are to be prepared for all sub assembly of components including system wise. iv) Casting and forging drawings are to be prepared only for critical components.
05	Engineering of off-the-shelf or proprietary components	Consultant shall engineer the off-the-shelf or proprietary components wherever required by obtaining necessary data from the supplier and synchronize with the Engine to meet the performance and reliability like Piston, Turbocharger, Torsional Vibration Damper, Common Rail Fuel system (CRDI), Turbocharger, Filters, Starters, Generator, Pumps, Actuators, Solenoid Valves, Sensors, etc.,
06	Air Intake System	Single / twin turbocharger to be engineered from the potential supplier with light weight manifolds to increase the power.
07	Exhaust System	Light weight and reliable exhaust manifold to withstand high temperature ~ 800 °C temperature with electronic waste gate actuator
08	Cooling System	Define the requirement for Design of High pressure and high flow Water pump to meet the Engine to run continuously at 125 °C temperature. High temperature turbocharged compressed air , Lubricating Oil & Fuel (Return Line) etc., to be cooled by the Engine coolant.
09	Lubrication System	Define the requirement Engine lubricating system shall operate continuously at 140 °C temperature and engine shall able to operate any failures in the components of lubricating circuit. Active Lubrication to be considered wherever possible.
10	Crank train system	Light weight, rugged and reliable crank train components shall be design with supplier co-ordination. Latest technology shall be considered on material selection and design to meet the above target.
11	Fuel system	Preferably Electronically controlled common rail direct injection (CRDI) fuel system shall be adopted to increase the power and identification of suppliers to suit the packaging.
12	Alternate Engine Starting System	An alternate Engine starting system shall be designed / Engineered like Air, Hydraulic etc.(electric must),
13	Electrical system	All electrical electronic components are selected / developed to meet latest Mil-STD, Environmental standards
14	Cold Starting	Engine shall operate at -40 °C temperature and suitable Air, Fuel, Coolant, Engine Oil heating system to be selected and engineered.
15	Engine Tilting	Engine shall operate at 35° at all direction , Oil Pan and scavenging pump system design to suit for the same.

16	FFCH, Glow plug, Smoke Generation kit	Selection / Design of parts and design of piping's & fittings.
17	Engine Mechanical & Combustion development test	Consultant shall carry out Mechanical and Combustion development test to prove the performance of the each PRP (Performance related Parts) and Engine performance and finalizing of Engine calibration to meet the power and torque requirement simulated during 1D simulation analysis for Provided all projects rating.
18	Survey and Certification for Marine Engines	Survey, Technical documentation filing and Certification of Engine to be done as per IRS CLASS (Indian Register of Shipping), ARS Class (American Register of Shipping) and Lloyd's Register Class.

- Vibration analysis/ Modal/ Structural (FEA) to be carried out for designed / modified parts.
- Consultant will carry out complete 3D layout, design and analysis of the modified configuration of the engine& Transmission. During this stage the specification of modified major sub system shall be finalized.
- Refinement of Existing Acceptance Test procedure (ATP) & Acceptance Test criteria (ATC), stack up analysis for all Engine components/ Sub-systems.
- Technical support during Proto Engine & Transmission build up & First Firing, base engine calibration.
- Selection of Material for Marine applications to meet requirements like Weight, Sea Worthiness and Environmental Conditions (Ambient Temp, Water Temp, RH, Salinity of Water- Min and Max.).

- Technical support for Integration of Engine with Transmission & whole Power pack installation
- Technical support during vehicle test trials and engine calibration on vehicle.
- Engine BOM to be provided with final 3D model.

Unique Features of Main Battle Tank Engine:

1) Engine shall be designed to using latest available technologies and shall be rugged to meet the main battle tank application.
2) Engine design shall cater to accommodate on the given enclosure with high power density (High power in low volume) concept.
3) Main Battle Tank Engine shall be designed to operate continuously between -40 °C to +55 °C accordingly all simulation activities are to be carried out. Shall be able to operate 35°gradability at all side.Shall be able to operate 5000 m altitude safely with minimum power de-ration. Shall operate with coolant temperature up to 125 °C and oil temperature up to 140 °C.
4) The engine shall use either a self cleaning air filtration system as the primary system or a conventional 2-stage air filtration system.
5) Engine minimum torque backup shall be 20 % at 60 % of the engine rated power.

6) Preferably Electronically controlled High Pressure common rail direct injection fuel system shall be used.
7) The air filter shall offer a life of 500 km / 50 hours of operation before cleaning / replacement when the dust concentration is 2 g/m3 and engine is operating at a load of 70 % at rated speed. The dust extraction from the primary filter shall be by a combination of electrically driven scavenge fans & exhaust scavenge. Engine shall be subjected to operations in extreme desert environment. Air filtration system shall be robust to withstand these conditions.
8) The engine compartment temperature is expected to be around 110 °C while in extreme operation. This is to be considered during the design stage of ECU, electronic parts, sensors, hardware, wiring harness, rubber parts.
9) Engine shall have requisite features for integration with transmission & cooling system as a modular unit (Power pack concept).
10) Engine shall cater 3 overhauling with minimum reconditioning / change of engine components.
11) Design for Service-Engine shall ease of maintenance and servicing. Oil and fuel filter shall have cleaning / replacement frequency of 200 hours.
12) Ground running shall be possible to check the engine's functionality when coupled to the transmission as a power pack.
13) The vehicle will be performing water fording operations up to a depth of 5 m. Hence, the engine exhaust outlet will be fitted with an exhaust flap valve that will function at a water depth of 5 m. The engine should be able to work with the resulting back pressure effects.
14) The engine should be able to run un-hindered in case of water accumulation in the engine compartment to a height of 250 mm from compartment floor.
15) A smoke generation kit should be installed in the engine. Smoke should be generated by injecting fuel through a solenoid controlled injector, into the exhaust stream just before discharge from the engine (after the turbine).
16) Lifting provisions for engine have to be provided.
17) Manufacture of all engine components, excluding major subsystems (ie., Fuel Injection System & Air filtration system), should be possible within India.

Engine Constituents:

The engine consists of the following systems in addition to core engine. The core engine includes all the components & systems required by the engine to operate & meet the laid down specifications.

1. Engine oil tank with required capacity
2. Coolant tank with required capacity
3. Coolant cooled engine oil cooler (inlet temp potential is 18 °C)
4. Coolant cooled charge air cooler (designed to meet the capacity for coolant inlet temperature of 90 °C at standard conditions)
5. Generator with inbuilt lubrication and cooling system
6. Electrical & Air Starting systems including starting aids
7. Engine Electricals & Instrumentation panel for all levels, filter clogs, sensors, switches & actuators
8. Oil and fuel filters
9. Air filtration system (Self cleaned)
10. Fuel cooler
11. Fuel water separator
12. High pressure Air compressor: Required for starting purpose. It should cater for 5 no,s of starts. Also 25 litre storage is catered outside the engine compartment. Or any other compact starting aid other than electric starter.
13. Exhaust smoke generation kit

Transmission & its related peripherals:

The two types of transmissions are:

1. Automatic Transmission
   - Conversion of existing U-type to T-type configuration i.e. transmission related modification to be carried out and redesign & control program shall be modified suitably as required to meet the technical requirements and develop.
   - PTO shall be designed & developed.
   - Weight optimization shall be done, if required.
   - Major systems are
     (a) Intermediate gearbox
     (b) Hydrodynamic torque converter
     (c) Direction Change and Change Speed Gearbox
     (d) Mechanical Steering Unit
     (e) Steering gear train
     (f) Engagement mechanism
     (g) Fluid coupling retarder
     (h) Main brake
     (i) Brake actuator mechanism
     (j) Final drive
     (k) Fan bevel unit
     (l) Hydraulic aggregates
2. Manual / Mechanical Transmission
   - Feasibility study of existing design and redesign to higher power and redesign suitably as required to meet the technical requirements and develop.

- New design to accommodate in the existing space envelope.
- Weight optimization shall be done, if required.
- Major systems are:
  (a) Intermediate gear box , (b) Gear box & side gear box
  (c) related peripherals to control / operate above (a) & (b)

Scope of supply shall be:

1. 3D models of engine & transmission and its related peripherals
2. 2D manufacturing drawings & special processes of engine & transmission and its related peripherals
3. All generated technical documents including all calculation & analysis reports related to the above scope of work.

NOTE:

- All the design modifications are to be supported by proper 1D & 3D Simulation and FEA Analysis
- Consultant Firm shall have knowledge / technical source on selection of technology & material on Corrosion and Rust preventive components.
- Consultant firm shall transfer Engine Design IPR (Intellectual Property Rights) to BEML LIMITED, India.
- All Engine components are designed to accommodate within the given Engine envelope (Will be provided).
- BEML will finalise commercials with all recommended suppliers with modified components.
- BEML will realise all hardware (Including tooling's & Fixtures), inspection and testing.

BENEFITS OF PARTNERING WITH BEML

BEML ltd has an extensive marketing network and service centers. BEML has good manufacturing, engine & transmission testing facility and R&D team.

Projected requirement of these engines for Indian MoD and Home affairs and potential for Export market.

SUBMISSION OF THE EOI

The EOI response to be submitted online through BEML E-mail: **bemleoi@beml.co.in**, stating compliance to each point, along with the enclosures to be forwarded by interested reputed firms, super scribing **"Engaging of Technical Design Consultant Firm (Global / Indian) For Design & Development of**
(a) Indigenous Power pack (Diesel Engines & Transmission), with Power ratings 600hp to 1500 hp for Defence application & Integration Engines with Transmission / Integration of Powerpack Power pack on Armoured Fighting Vehicle,
(b) Development of Marine Engines 3MW to 10 MW and
(c) Development of Critical Engine Aggregates"
For any Technical Clarifications, Please Contact

1) **Mahadev Nellur , DGM, Engine D&D for Engines**

   Email ID : gpe@beml.co.in

2) **Mr. Ramesh K Raju (For Transmission / integration)**

3) Deputy General Manager – R&D (Defence), Email ID: gawrr@beml.co.in

Annexure

Undertaking Letter

(To be printed by Bidder on Company's letter Head)

To,

The Dy. General Manager

Corporate Materials

BEML Ltd.,

23/1,4th Main,

S.R. Nagar, Bangalore

Sub:- Undertaking with respect to Blacklisting / Debarment

Dear Sir,

We hereby confirm and declare that we, M/s ----------, is not blacklisted/ De-registered/ debarred by any Government department/ Public Sector Undertaking/ Private Sector/ or any other agency in India / abroad for which we have Executed/ Undertaken the contract during the last 5 years from the date of tender opening.

Place:

Date :

(Signature of the Bidder)

Full name with seal