

## TECHNICAL SPECIFICATION

### **1.0.Introduction**

IIT Madras invites bids from the eligible tenderers for the supply, installation, integration and training for the proposed wave generation system in the upcoming shallow wave basin facility at IITM Thaiyur campus. This bid is a “implementation test” to our worlds largest facility as part of CFLOR. The proposed facility has flume dimensions of 100m (Length) x 3.35m (Width) x 3m (height), with working water depth upto 2.5m for the wave generation as shown in Annexure III. Wave generation system inter-alia covers the following,

- Capable to generate waves with inhouse IITM-WaveGen Software, and the position information (with maximum velocity and acceleration limit should be pre-set) shall be provided by IITM. The bidder should suggest the suitable control logic and implement the same.
- The wavemaker will be controlled by an Hydraulic system.
- Wave Paddle width is 3.35m. It has a dry back system (meaning no water on one side). So, the static part need to be compensated and the dynamic part need to be controlled. The mechanism should have variable water depth compensation.
- Installation, Integration of the supplied items and electrical connections are also under the present scope. (The product component involves all the items from PC outlet to hydraulic end, except supply of PC/Laptop/fabrication of the paddle and supports.)
- Fabrication of the wavepaddle, sealing arrangement of the wave paddle and required **arrangements** for housing the cylinders, pipes (cylinders and pipes for hydraulics will be bidder scope) will be taken by IIT Madras. However, the required arrangements for hydraulic system need to be specified by bidder in the Technical documents. Modifications in the later stages will not be entertained and will be under the bidder scope to complete the project.

### **1.1. Operating modes**

Based on the requirements of proposed wave flume, the hydraulic system need to be operated by an motion controller with the profiles as shown in Appendix.

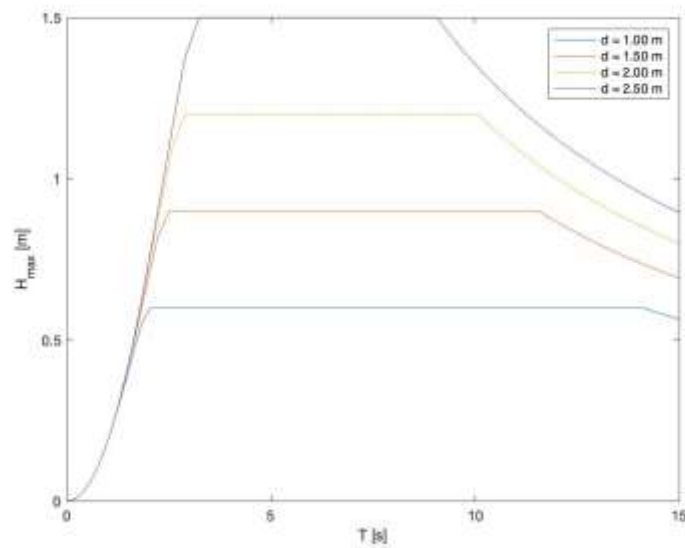
### **1.2. Wave Generating System**

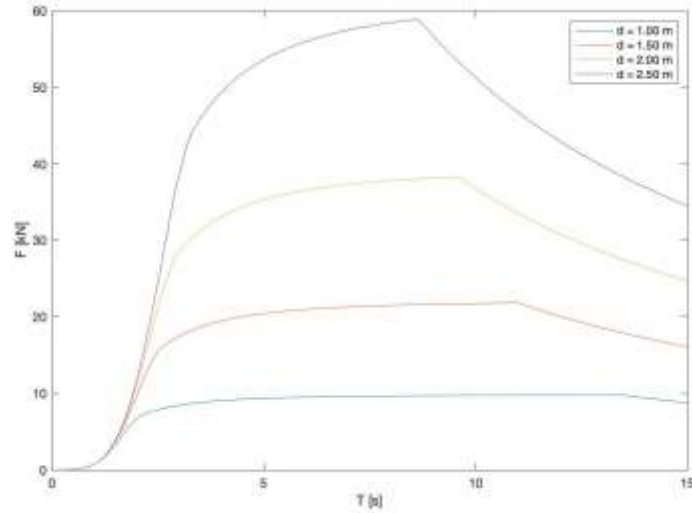
In order to obtain the required wave characteristics as shown in Fig.1, the hydraulic system is proposed. The Fig.1. is for the uni-direction wave generations, which can be taken for the design.

**Table.1-Specifications of the Hydraulic system**

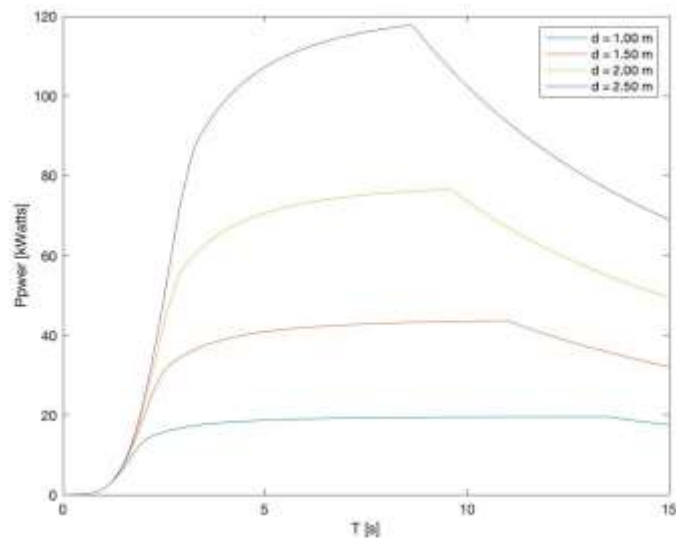
Sl.no	Parameter	Rating /Range
1	Stroke	4m
2	Max. Speed	Max. Velocity is 1.7m/s and Max. Acceleration is 2.5m/s <sup>2</sup>
3	Maximum water depth	2.5m
4	Static force to compensate	Variable from 1 m to 2.5m of water depth (for 3.35m width of the tank)  Bidder should design the hydraulic system pressure suitably.
5	Dynamic force	As per Fig.1

Note: The bidder offers confirming to the minimum threshold criteria specified above and/or with any high end specification as per the bidder architect design alone shall be considered. However, please be informed that no extra preference shall be given for high end specifications.





**Fig.1. Contd..**



**Fig.1. Required capability of the wave generation system for various depth having 3.35m width of the paddle. The maximum velocity required is 1.7m/s and maximum acceleration is  $2.5\text{m/s}^2$ . The generated graphs are for dynamic components using 1<sup>st</sup> order wavemaker theory, considering dry back system. Note: The generated wave heights are higher than the tank depth, so this is only for design considerations and not implemented practically.**

### 1.3 Controller

Real time commands from the Graphical user interface (GUI) of the IITM-Wavegen installed in a PC/laptop will be executed by the controller to generate waves. The required instantaneous wave heights, periods and wave types are given as input through the Graphical user interface (GUI), based on that position/stroke time series will be generated. The controller should communicate with the continuous control reference using an internal PID loop. The communication of the data from PC to Controller should be through Ethernet only,

this is to isolate the electric/power noise from external source. The proposed controller hardware are provided in Table 2.

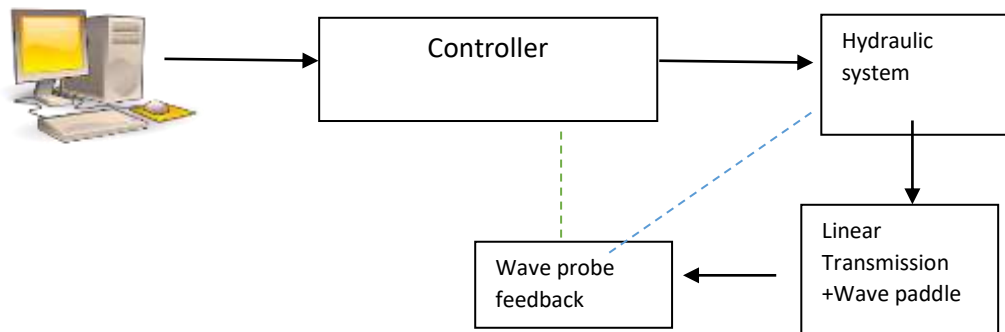
**Table.2- Specification of the Controller**

Sl.no	Parameter	Rating / Range
1	Controller Hardware	Single or Multi axis- On board Multi ethernet, multi encoder, Engineering port I/O extension digital/ analog.
2	Communication Protocol	SERCOS/ EtherCAT/FINS/SINEC/MELSEC/PROFINET/Ethernet
3	Opensource development platform (OPC)	CoDesys/Visual studio/LabVIEW/MATLAB
4	Firmware	Upgraded/Latest version of the firmware for closed loop synchronization

Note: The bidder offers confirming to the minimum threshold criteria specified above and/or with any high end specification as per the bidder architect design alone shall be considered. However, please be informed that no extra preference shall be given for high end specifications.

#### 1.4 Overall system (Wavemaker) Architecture

The bidder has to propose the suitable architecture. The technical proposal will be evaluated based on the architecture design with respect to communications, optimum and efficient use of the controller with the chosen model capability. In general, the input signal will be given to the controller through a customised Graphical User Interface (GUI) from IITM-WAVEGEN v.1.0 installed in a Personal Computer/Laptop. The bidder need to integrate this signal with the drive configurations using PLC coding or suitable protocol. The overall sample architecture is shown in Fig. 3. In Fig. 3, wave probe feedback (active absorption) and wave paddle fabrications is not the scope of the present tender.



**Fig.3. Overall Wavemaker Architecture**

The wave paddle will have a width 3.35m driven by an hydraulic system through a linear transmission. The controller should also has the pre-programmed interlocks to prevent the malfunctioning as mentioned below,

- Limit switches (2' nos) - Enables brake/Trip the Power supply/Trigger stop command to driver.
- Over current protection- Programmed on driver to prevent hardware failures.
- Over Voltage protection- Programmed on driver to prevent hardware failures.
- Under/Over Frequency protection- Programmed to Protect during DG operations.
- Over load/torque – programmed on driver to prevent mechanical failures.

### **1.5. Electrical Panel or Control Panel**

The electrical panel and its accessories such as electrical switchgears, power cables, and instrumentation cables, terminal blocks, panel cooling fans, auxiliary power supply and so on, as per the bidder specifications. This need to be integrated, labelled and installed by the bidder. The bidder should provide the internal assembly and general assembly drawings to IIT Madras for its approval before installation.

### **1.6. Mechanical Arrangements and Linear transmission details**

The mechanical and linear transmission is designed in such a way that the hydraulic system generates for the dynamic force/moving force of the water column due to the wave paddle and hydrostatic force based on water level. The isometric views of the mechanical and hydraulic cylinder arrangements of the supporting structure for motor location, linear transmission guide and wave paddle are shown in Figs. 4 to 7. The size of the paddle supporting structure is 3.35m width and 3m height which is fixed with truss structure having hydraulic cylinder inside near to the CG. The hydraulic cylinder moves along with paddle and piston rod is fixed at rear wall with fixture plate. The truss and cylinder assembly is guided by 4 guide rods for entire stroke length of 4m. Fig. 4 shows the schematic arrangement of paddle assembly side view with a marking of major parts. The proposed hydraulic system should have maximum operating pressure of 120 bar (this is the minimum, the bidder can choose greater than this depending upon their design requirements). One or more accumulator is used to compensate the pressure inside the cylinder. Guide rails are mounted at side walls to guide paddle assembly. The wave paddle in the isometric view is conceptually depicted as box section; however, the weight will be reduced by cutting and attaching suitable stiffeners. Fig. 5 shows the schematic arrangement of paddle assembly in initial position. Fig. 6 shows the schematic arrangement of paddle assembly at the end of stroke. Fig. 7 shows the schematic arrangement of paddle assembly in rear view. The linear rail guides will also have supporting guide. The power pack and valve controller for the actuator will be kept on the intermediate floor as stationery structure.

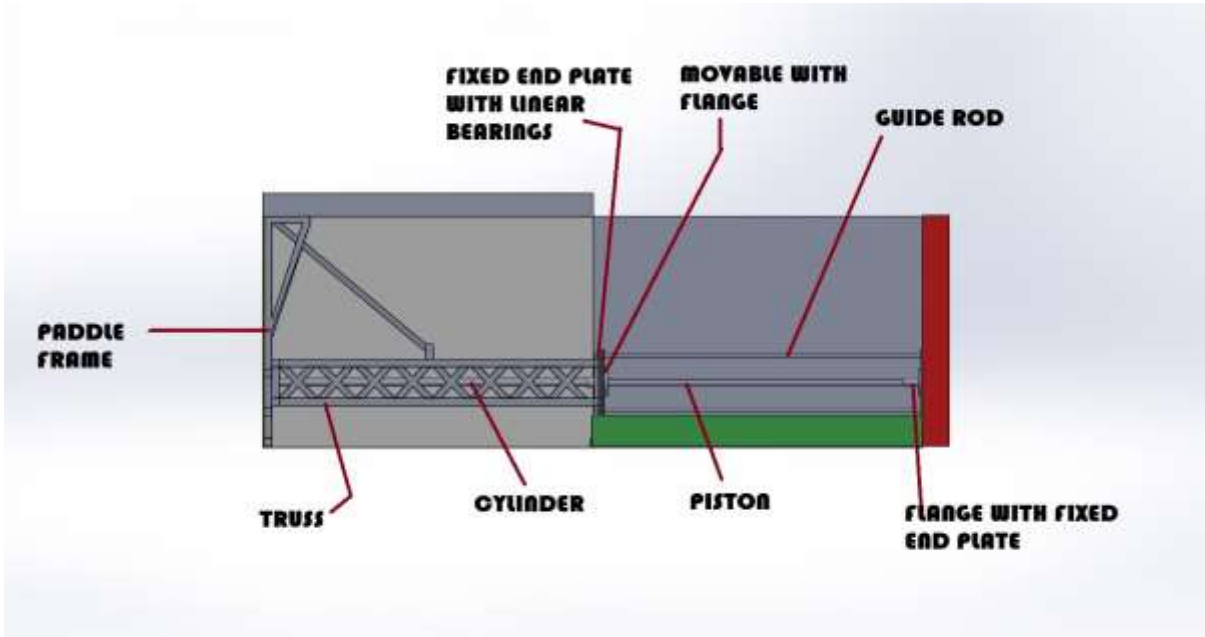


Fig. 4 Schematic arrangement of paddle assembly side view

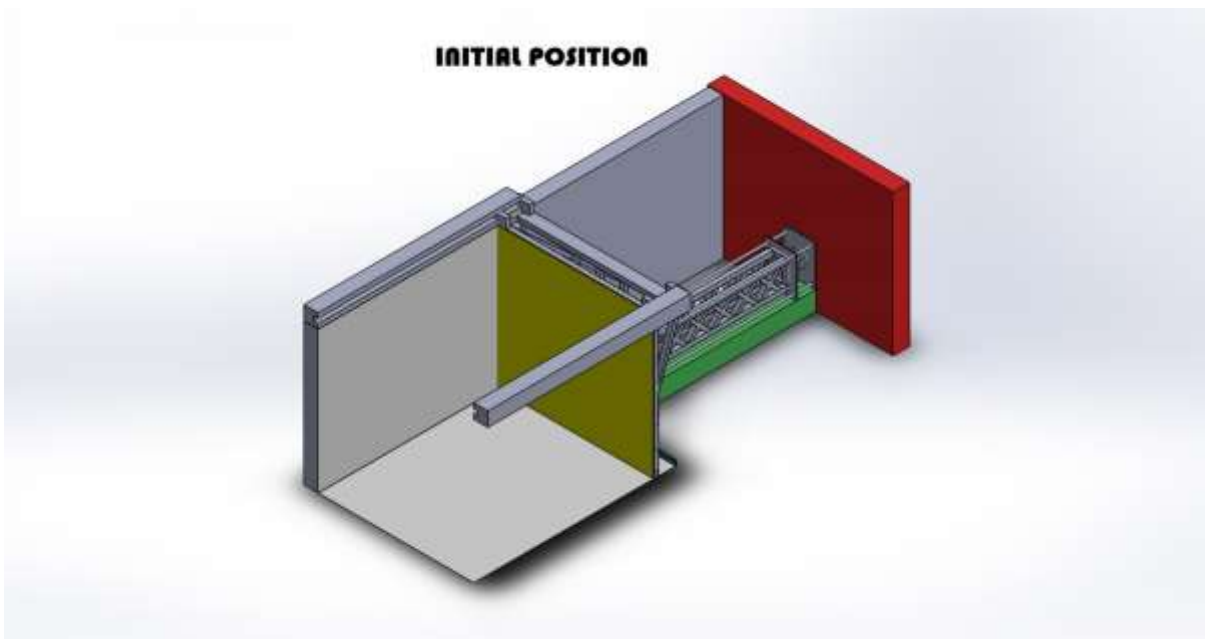


Fig. 5 Schematic arrangement of paddle assembly in initial position

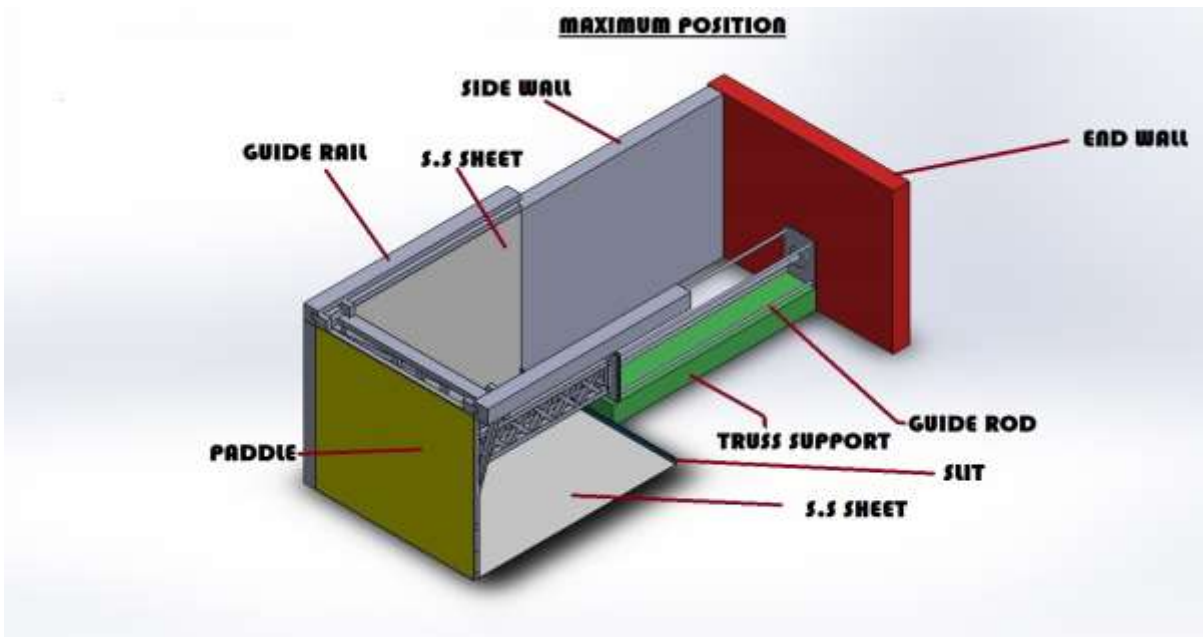


Fig. 6 Schematic arrangement of paddle assembly at the end of stroke

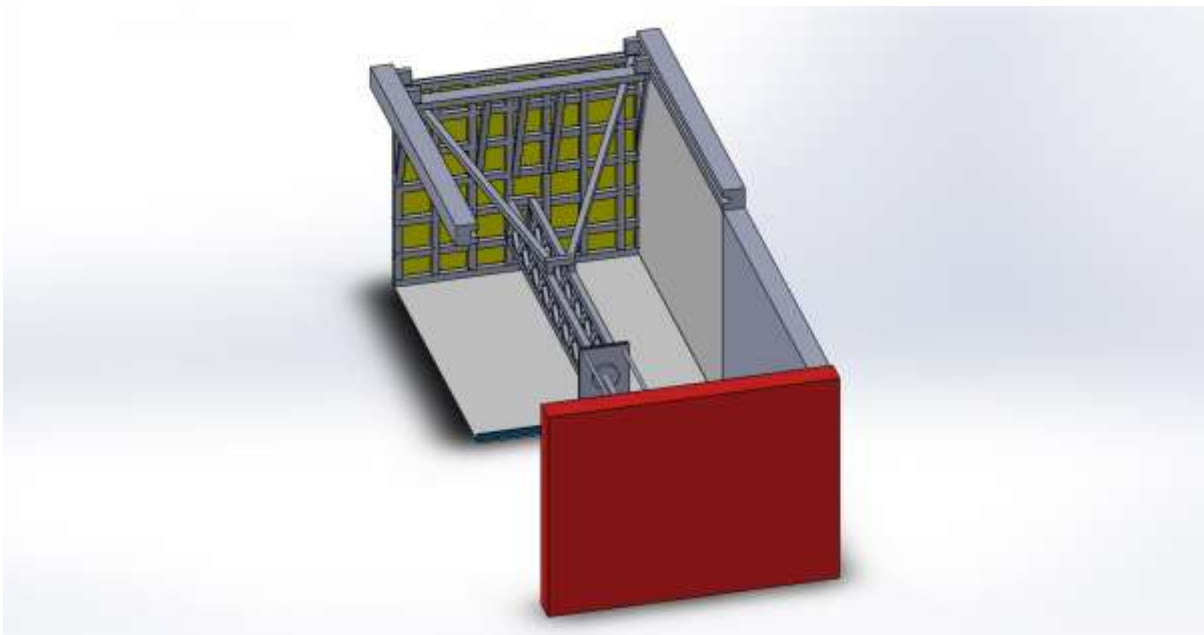


Fig. 7 Schematic arrangement of paddle assembly in rear view

### 1.7. Specification test

The following specifications test should be demonstrated by the bidder as well as during the complete installations.

1. The motion of the provided signal profile from the IITM-WaveGen for various wave period and wave heights (regular, random, multi-directional) should be

demonstrated with the feedback [laser/LVDT/inbuild encoder]. Precision required is <5mm.

2. Working capability during sudden power cut/exceeding stroke/velocity/accelerations/limit switches/force/torque.
3. Minimum time lag between the individual axis should be less than 0.0s and the same will be measured using external sensor. Further, the final displacements by the wave paddle will also be measured by the external sensors for verification. The external sensors and DAQ will be provided by us.
4. Operation capability for solitary profile, focusing wave profile (generated from IITM-WaveGen). See Appendix V.
5. The command (Displacement and time) from the IITM-Wavegen software and the process variables will be read from the controller during wave generation.



**Form I**

**Pre-qualification bid**

**Checklist for Pre-qualification bid Criteria (separate **COVER- 1** and sealed).**

1. Confirmation that the bidder has involved in designing/commissioning/servicing of the wavemakers or hydraulic systems of the wavemakers or in marine applications, anywhere in the world. The bidder is required to submit a suitable documentation proof to substantiate this requirement. IIT Madras has the rights to investigate the validity of the proof and if found not suitable/wrongly claimed, they will not be allowed to participate in future tenders from Department of Ocean Engineering for the wavemaker applications.
2. An organizational document, board resolution or its equivalent or power of attorney specifying the representative's authority to sign the bid on behalf of, and legally bind, the bidder.
3. Proof for atleast preceding last 5 years of existence in India. Company incorporation certificate, showing completion of minimum 5 years, balance sheet, P&L account.
4. Should have supplied/serviced/integrated hydraulics or servo system by the bidder to wavemaker with details of place, end user etc.,.
5. Should have supplied hydraulic system by the bidder in India for any other application, particularly control of the hydraulic machines.
6. OEM or its subsidiary of OEM/Dealers/Channel partners/System integrators/ Agents are allowed to participate in the tender. Necessary authorisation letter from OEM should be submitted by dealer/Channel partner/integrators/Agents. The entire installation should be under the direct supervision of the bidder. IITM will never entertain any other person apart from bidders.
7. Only Class I and Class II local suppliers are eligible to bid as per tender order no:
8. Warranty: One year warranty for the entire system from the date of commissioning/installation.

All the above can be either in the form of certificates from the end users and/or a confirmation in the manner specified along with printed literature specifying the above details. IITM will verify these details.

The documents shall be either in original or duly Notarized.

**Tender Technical Evaluation sheet ---- (COVER-2)**

Sl.no	Parameter	Rating / Range	Yes/No
1	Stroke	4m	
2	Operating Pressure	To be mentioned by the bidder	
3	Cylinder diameter	To be mentioned by the bidder	
4	No. of cylinder	<b>To be mentioned by the bidder</b>	
5	Designed operating maximum velocity	To be mentioned by the bidder	
6	Designed operating maximum acceleration	<b>To be mentioned by the bidder</b>	
10	Design of the power pack systems	To be provided by the bidder	
11	Design of static compensation system	To be provided by the bidder for max. static force of 110KN (3.35m width of the tank for 2.5m water depth). Should be compatible with variable water depth. For dynamic force refer figures.	
12	Enclosure	Should resist water environment.	
13	Controller Hardware	Single or Multi axis- On board Multi ethernet, multi encoder, Engineering port I/O extension digital/ analog.	
14	Communication Protocol	SERCOS / EtherCAT/FINS/SINEC/MELSEC/PROFINET/Ethernet-IP	
15	Opensource protocols	CoDesys/Visual studio/MATLAB	
16	Firmware	Upgraded/Latest version of the firmware for closed loop synchronization	
17	I/O	Two Analog input/output channels and Two Digital input / output channels for each axis/motor/paddle. This should be available to be accessed via the controller logic.  (Not required - if dedicated Analog & Digital input/output channels are provided at the controller end)	
18	Accessories	10m standard power cum encoder/Power and encoder cable/s	
31.	Training for the supplied product – troubleshooting	Yes / No	

	guidelines to the IITMadras.		
32	Know-how knowledge of the bidder in the wave generation capability/services/their product installed for Wave Flume. Proof supplied for their product.	Yes / No	
33.	Justification provided for selection of hydraulic configuration and compatibility of the requirement of the tender. Hydraulic Diagrams.	Yes / No	
34.	Architecture of the communications/integrations. Mode of operations of the wave generation – synchronization/speed in communications/ failure switches are provided.	Yes / No	
35.	Justification for control logic for generating the waves has been provided.	Yes / No	
36	Justification for the optimum selection of the controllers/drive configuration for the operating modes.	Yes / No	
37	Acceptance of the specification tests.	Yes/No	

**Note: The bidder shall enclose separate sheet if required to highlight their proposal to address each and every parameter, which will be duly considered for technical evaluation.**

**Declaration**

I hereby certify that we can supply above items as per tender specification and I agreed tender terms and conditions

Company seal

Signature

Designation

**Form II**

**Tender Conditions (This form should be in Technical bid cover). (COVER-2)**

I) We \_\_\_\_\_ agree for the following conditions

- We will demonstrate the capability of our architecture, for the specification tests as listed in tender.
- IIT Madras reserves the right to cancel/terminate the order without assigning any reason.
- We will provide the necessary support for the product supplied during failures after installation within \_\_\_\_ hours/days/months in the warranty period and \_\_\_\_hours/days/months after warranty period.

II) Confidentiality Provision :

We \_\_\_\_\_ understand that the proposed work is part of a research project undertaken by IITM and the basic concept is developed by IIT-M through its inhouse capability. We also aware of the fact that our scope of work is limited to facilitate the success of the conceptional model for the Hydrualic system and electronic control to the wave paddle.

In view of the above, we hereby solemnly affirm and undertake that the

- Concepts developed by IITM shall not be shared with any third party and not even in our future designs of theirs without a written confirmation from IITM.
- Knowledge and know-how gained out of this assignment shall be kept “confidential” and any violation to this effect shall tantamount to impeaching into the parents right.

Authorised Signatory of the OEM

**Form III**

**Template for Technical bid - (COVER-2)**

The technical bid should contain the following minimum information, but not limited to,

1. Proposed System Architecture and a detailed description for opting/recommending to IITM.
2. Model number, detailed characteristics, loading capacities of all the hydraulic parts.
3. Controller Model number, detailed characteristics.
4. Integration protocol from the IITM-Wavegen software to your drive/controller. Detailed description about the control logic that will be implemented need to be speltout and specified. Preferbly, indepth details.
5. Financial bid format without specifying the amount.

**Bill of Quantities and Rates.**  
(Financial bid format) – (Cover-3)

Item No.	Item Description	Unit	Quantity	Rate		
				INR		
				Ex-works	Local cost	GST (%)
1	Hydraulic parts and specification (Section 3.4)					
2.	Controllers as per specification (Section 3.5)					
3.	Other accessories (with detailed breakup)					
5.	Electric panel accessories as per specification/Architecture (, e.g. electrical wire, limit switch, emergency stop etc.,)					
6.	Installation and services for the supplied items					
7.	Training to the IITMadras on Hydraulic settings and troubleshooting after successful installation			<b>FREE</b>		
	<b>Total</b>					

**Note-**

- 1.The payment terms and conditions as mentioned in sections.**
- 2.Payment will be released against the supplied items as per the tender specification.**
- 3. L1 bidder will be decided based on the overall cost including all elements of payment made and ultimate landing cost to the IIT Exchequer.**
- 4. As it is a research facility, 5% GST should be considered for the product supplied as required.**
- 5. 20% of the total bid should have local content.**

**Declaration**

I hereby certify that we can supply above items as per tender specification and I agreed tender terms and conditions

Company seal

Signature

Designation



**FORM - A (Cover-3)**

**UNDERTAKING TOWARDS JURISDICTION FOR LEGAL PROCEEDINGS**

**(NON JUDICIAL STAMP PAPER VALUE RS.100/-)**

This undertaking executed at..... on this..... (Date)..... (Month) Two thousand and ..... by M/s ..... Registered under Companies Act, 1956 having its registered office at ..... hereinafter called the contractor (which expression shall where the context so admits mean and include its successors in office) and in favour of Indian Institute of Technology Madras, Chennai- 36. Hereinafter called the purchaser (which expression shall where the context so admits means and includes its successors if Office and assigns).

WHEREAS a contract for the supply of .....has been awarded in favour of the contractor under the Purchase order No.....dated.....

AND WHEREAS in accordance with the terms of the above Purchase order, the contractor has to furnish un undertaking to the effect that no suit or any proceedings in regard to any matter arising in any respect under this contract shall be instituted in any matter in any respect under this contract shall be instituted in any court other than in the High court, Madras or District court at ..... or Sub-court at .....or at the District Munsiff court at ..... as the case may be.

IN CONSIDERATION of the Board having agreed to accept the undertaking the contractor hereby undertakes that no suit or any proceedings in regard to any matter arising in respect of this contract shall be instituted in any court, save in the High court, Madras or District court at.....or sub court at ..... or at the District Munsiff court at .....as the case may be it is agreed that no other court shall have jurisdiction to entertain any suit or proceedings, even though, part of the cause of action might arise within their jurisdiction. In case any part of the cause of action might arise within the jurisdiction of any other Courts in Tamil Nadu and rest within the jurisdiction of Courts outside the State of Tamil Nadu, then it is agreed to between the parties that such suits on proceedings shall be instituted in a court within the State of Tamil Nadu and no other Court outside the State of Tamil Nadu shall have jurisdiction.

IN WITNESS WHEREOF Thiru.....of M/s ..... hereby put his hand and seal for due observance of the undertaking in the presence of the following witnesses.



**MODEL BANK GUARANTEE FORMAT FOR PERFORMANCE SECURITY (After Contract Awarded)**

**Ref. Para 7.4 of Chapter 7)**

THE REGISTRAR IIT MADRAS

WHEREAS .....  
(name and address of the supplier ) ( hereinafter called "the supplier") has undertaken, in pursuance of contract no.....dated .....to the supply ( description of goods and services) ( herein after called "the contract").

AND WHEREAS it has stipulated by you in the said contract that the supplier shall furnish you with a bank guarantee by scheduled commercial recognized by you for the sum specified therein as security for compliance with its obligations in accordance with the contract ;

AND WHEREAS we have agreed to give the supplier such a bank guarantee;

NOW THEREFORE we hereby affirm that we are guarantors and responsible to you , on behalf of the supplier ,up to a total of .....(amount of the guarantee in words and figures), and we undertake to pay you first written demand declaring the supplier to be in default under the contract and without cavil or argument, any sum or sums within the limit of (amount of guarantee) as aforesaid, Without your needing to prove or to show grounds or reasons for your demand or the sum specified therein.

" Where at any time, during the continuance of this contract, the performance in whole or in part under this contract is prevented or delayed by reason of any war, or hostility, acts of the public enemy, civil commotion, sabotage, fires, floods, explosions, epidemics, quarantine restrictions, strikes, lockouts or act of God provided notice of happenings, of any such eventuality is given by the executor within 21 days from the date of occurrence thereof, your claim for damages in respect of such performance or delay in performance under the contract shall be resumed as soon as practicable after such an event may come to end or cease to exist".

We hereby waive the necessity of your demanding the said debt from the supplier before presenting us with the demand.

We further agree the no change or additional to or the modification of the term of the contract to be performed there under or of any of the contract documents which may be made between you and the supplier shall in any way release us from any liability under this guarantee and we hereby waive notice of any such change, addition or modification.

This guarantee shall be valid until the .....day of .....,20.....

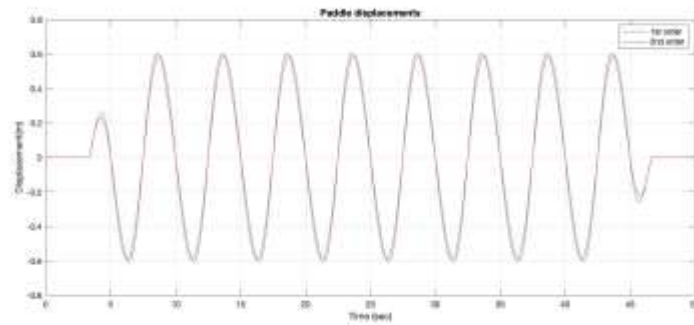
.....  
( Signature of the authorized officer of the bank)

.....  
Name and designation of the officer

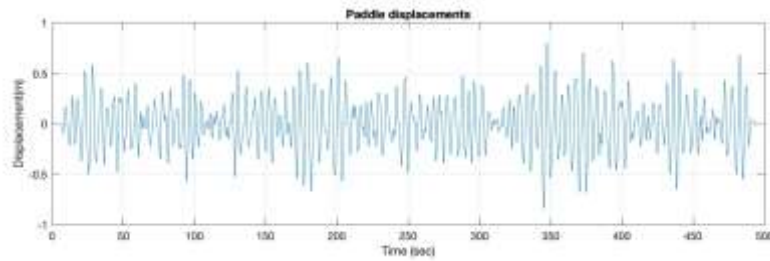
.....  
Seal, name& address of the bank and address of the branch.

APPENDIX - IV

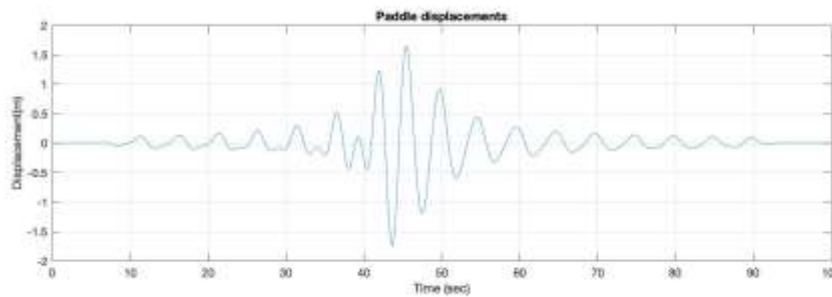
Specification Test profiles that need to be generated. The below figures are generated using IITM-Wavgen V1.5



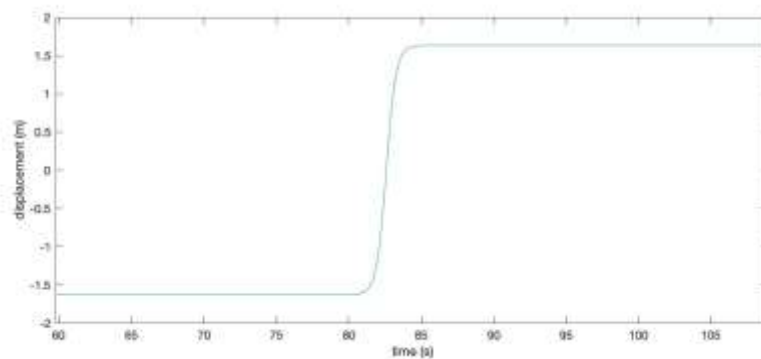
a) Typical Regular Wave Profile



b) Typical Random Wave Profile



c) Typical Focusing Wave Profile



d) Typical Solitary Wave Profile paddle displacement.

**APPENDIX III: NTCPWC Site photos where the hydraulic system will be installed.**



Installation location and size of the facility