	<b>Minutes of Meeting</b>	Ref : MOM / PRMC / 01
	<b>Project Review and Monitoring Committee ( PRMC )</b>	Date : 01.08.2017
	<b>Si'Tarc Smart Pump Project</b>	Page No. 1 of 8

**Venue: PSG College of Technology, New Admin Block, Ground Floor Conference Hall**

**Time : 2:30 PM**

The Venue was changed from Si'Tarc Conference Hall to PSG College of Technology for Video Conferencing Facility with prior information to members.

### **Members Present**

- 1) Dr. D.N. Badodkar - Chairman - PRMC
- 2) Mr. K.V. Karthik - Chairman - Smart Pump Project
- 3) Dr. M. Sundaram - Convenor - Smart Pump Project
- 4) Mr. C. Muthusamy- Managing Partner - Stark Motors
- 5) Dr. V. Prasanna Moorthy - Faculty - Government college of Technology
- 6) Dr. Punit Singh - IISC-Bangalore
- 7) Dr. Prabhu - PSG-Coimbatore
- 8) Dr. Dhiman - IIT-Madras
- 9) Dr. Phani Kumar - CMERI-Durgapur
- 10) Dr. L.G. Das - CMERI-Durgapur
- 11) Mr. Fenin- IISC-Bangalore

### **Leave of Absence**


- 1) Shri. BhaskarSarkar - Executive Director - EEPIC India
- 2) Ms. Padma Ganesh - Director - Smart Pump Project / Deputy Secretary - DOC
- 3) Shri. Sanjay Chavre - Member Secretary - Smart Pump Project / SDO - DHI

Applied for leave of absence which was granted.

Dr. M. Sundaram, Convenor-Smart Pump Project welcomed the PRMC Members and requested Dr. D.N. Badodkar to chair the meeting. The meeting proceeded with following agenda.

### **Agenda**

- 1) Introduction of the Project - K.V.Karthik, Chairman, Si'Tarc Smart Pump Project (SSP)
- 2) Sharing of Responsibilities & Authority - Dr.M.Sundaram, Convenor, Si'Tarc SSP
- 3) Brief to Chairman on Review Process - Dr.D.N.Badodkar, Chairman-PRMC
- 4) Presentation by IISc, PSG CT, CMERI, IIT-M
- 5) Conclusion and Remarks
- 6) Vote of Thanks

	<b>Minutes of Meeting</b>	Ref : MOM / PRMC / 01
	<b>Project Review and Monitoring Committee ( PRMC )</b>	Date : 01.08.2017
	<b>Si'Tarc Smart Pump Project</b>	Page No. 2 of 8

### **Agenda 1 - Introduction of the Project**

1) Smart Submersible (6 inch) Pumping Solutions for Industrial and Water Supply Applications Project costs INR 8.41 Crores, out of which Government contribution is INR 6.73 Crores and Industries contribution is INR 1.68 Crores. The duration of the project is 12 months (February 2017 to January 2018).

2) Scientific and Industrial Testing and Research Centre (Si'Tarc) - (Project Leader), CRI Pumps, Deccan Industries, Sharp Industries, Indus Electronics India (P)Ltd., Perfect Engineers, Mahendra Pumps (P) Ltd., Archana Industries, PSG Industrial Institute, Sreeram Industries, The EL.P.EM Industries, Ellen Industries (P) Ltd., Aryen Motors (India) P. Ltd are the Industry Partners.

3) The Partnering Research Institutions are IIT-M, IISc, CMERI, and PSG-TECH.

4) The objective of the project is to develop and commercialize 6" Submersible Pump Set with improved efficiency attained with BLDC Motor increasing the Motor Efficiency to 90% and Pump Efficiency to 80%.

5) The output of the project is to Save Energy in domestic market, increase the Global Market Share, Import Substitution, Economic Growth and improving Skill Set of CoE.

### **6) Milestones**

a) Quarter 1 - Design of Motor & Pump, establishment of CoE facilities for raw material testing - Purchase of software and testing facilities, establishment of CoE at Si'Tarc and other Academic Partners.


b) Quarter 2 - Optimization and various analysis & establishment of CoE facilities to manufacturing Smart Pump- Electromagnetic analysis of Motor for size optimization, design of Impeller with good blade angle and vane design to increase the efficiency at high speed (4000 rpm) and installation of raw material testing equipments.

c) Quarter 3 - Manufacturing of Motor and Pump along with controller - Setting up of facilities to manufacture the motor and pump set, raw material purchase, inspection, machining, assembly and design of electronic controller and converter for motor control.

d) Quarter 4 - Integrating the electronic controller with pump set and testing with field trials - Integrating the commutation controller inside the pump set, testing and fine tuning for field trials.

### **Agenda 2 - Sharing of Responsibilities & Authority**

1) **Mr. K V Karthik - Project Coordinator - CoE** - Establishing facilities at CoE, coordinating with Academic Partners to freeze the design, testing raw materials, tool & die manufacturing,

	<b>Minutes of Meeting</b>	Ref : MOM / PRMC / 01
	<b>Project Review and Monitoring Committee ( PRMC )</b>	Date : 01.08.2017
	<b>Si'Tarc Smart Pump Project</b>	Page No. 3 of 8

proto type manufacturing, testing of finished goods at different conditions, skill development and training to the industry people and identification and development of allied products to sustain the CoE.

2) **Dr. B.V.S.S.S. Prasad - IIT - Chennai** - Modelling and analysis of pump using CFD computational facilities to optimize the fluid dynamics in impeller to meet the various specifications of pump. Reducing the dimension, weight and hence the overall efficiency of the pump-set.

3) **Dr. Punit Singh - IISc - Bangalore** - Analytical design of inlet diameter, outer diameter, curvature radius, number of vanes, breadth of impeller, inlet vane angle, exit vane. Optimization of pump parameters to meet for 4000 rpm with reduced size.

4) **Dr. Pranab Samanta & Dr. L.G. Das - CSIR-CMERI - Durgapur**- Estimation of the vane angles of diffuser casing(bowl) matching with impeller design, design of meridional plane of the casing (bowl), design of the vane profiles of casing (bowl), suction mouth piece (suction bell).

5) **Dr. T. Prabhu - PSG Tech - Coimbatore** - Optimization of blade pump bowl, discharge casing, shaft, suction casing, intermediate bowl to run at 4000 rpm and corresponding torque.

6) **Dr. M. Sundaram - PSG Tech - Coimbatore** - Analytical design, motor, electromagnetic FEM using computational tools and material selection & coordinating with Si'Tarc.

### **Agenda 3 - Brief to Chairman on Review Process**

1) The objective of PRMC is to review project for completeness, accuracy and ensure all the deliverables are completed as per DPR.


2) The responsibilities of PRMC is to ensure the CoE achieves its goals on time and submit the progress report to the Governing Council.

3) PRMC is authorized to make recommendations for efficient functioning of CoE and refuse to accept deliverables if they don't meet the specific function and submit the progress report to DHI.

### **Agenda 4 - Presentation**

#### **Dr.Punit Singh - IISc**

1) Hydrodynamic Design of Impeller and Diffuser (Head 17m, Dia < 150mm, Flow Rate - 15lps and RPM - 4000) was designed using Aetos Design & Engineering - Inverse Design (IISc Mark 1) and Epple's Method - In house Design (IISc Mark 2).

	<b>Minutes of Meeting</b>	Ref : MOM / PRMC / 01
	<b>Project Review and Monitoring Committee ( PRMC )</b>	Date : 01.08.2017
	<b>Si'Tarc Smart Pump Project</b>	Page No. 4 of 8

2) Simulation of IISC Mark 1 was done using Turbo Design and Star CCM+. Prototype creation of IISc Mark1 was completed with the help of PSG Tech, Deccan Industries and Si'Tarc. Experiments were conducted in Si'Tarc and PSG Tech separately.

3) The velocity contours at the impeller tip revealed a separation in flow which extends for around 15 % of axial chord. Lateral section at 10 % of axial chord of diffuser reveals a region of low momentum fluid close hub and suction corner. This led to recirculation in meridional direction. Two large vortices are found closer to the inlet (1,2) and the interaction of the two results in a smaller third vortex.

4) Two stage analysis was done and the results were not satisfactory.

5) Since the IISc Mark 1 didn't show the expected results, another design using Epple's Method - In house Design (IISC Mark 2) prototype was designed. The results are yet to come.

6) IISc - Test Rig Plan - Test-rig with transparent tank for flow visualization, torque measurement will help to validate CFD and get the best single stage and 5 stage performance. Negotiating with supplier on the quote.

#### Comments

1) The Chairman suggested the IISC team to study the effect of surface finish along with the clearance zone between the impeller exit and diffuser (stator) inlet. He felt that there should be an optimum level. The IISc team agreed and the losses within these zones was the agenda of research.

2) The Chairman wanted a more accurate determination of hydraulic efficiency from the overall efficiency. i.e. elimination of motor efficiency and mechanical efficiency from the test results of the RPT Model (Mark 1) at Si'Tarc facility.


3) The Chairman was looking forward to see the test-rig at IISC in operation as it would reveal the true pump's hydraulic performance.

4) The Chairman was also quite puzzled with the multi (2) stage simulation results that revealed a drop in the generated head. He requested more study to tackle this problem. The IISc team replied that there was a challenge and it would be attempted to have a progressive differential stator design to have identical and minimum losses in the stator and streamlined co-axial flow at the impeller inlet.

#### Dr. M. Sundaram - PSG

1) Since the design requirement of Brushless PM Motor (BLPM) is selected 6 inch, 15 kW, 4000 rpm, the first level initial sizing of electric motor is complete.

2) Based on guideline the volume of rotor required for continuous power was evaluated.

	<b>Minutes of Meeting</b>	Ref : MOM / PRMC / 01
	<b>Project Review and Monitoring Committee ( PRMC )</b>	Date : 01.08.2017
	<b>Si'Tarc Smart Pump Project</b>	Page No. 5 of 8

3) Permanent magnet selected was Neodymium iron Boron magnet and its sizing like load line plot and demagnetization capability, thickness of magnet required was computed and analyzed.

4) Compared to present induction motor of 2 poles which was designed to operate at 2880 rpm is shifted to BLPM of 4 pole configuration designed to operate at 4000 rpm for the best efficiency operating point of pump.

5) Performance analysis like back emf, zero cogging torque after skewing, rated torque, speed vs torque characteristics and other lumped parameter was analysed and presented.

6) Finally the Efficiency map of electric motor designed was shown that the motor designed was best operating point at the speed of 4000 rpm at the efficiency of 92-94%. Hence making the overall efficiency of the pump improved.

#### Comments

1) The Neodymium iron boron permanent magnet is to be imported from China and it is costly, hence other alternative options was suggested to reduce cost and import option.

2) Alternative machine design technique to reduce the cost by using the ferrite magnet was suggested.

#### **Dr.Prabhu - PSG**

As per the design conditions given new geometrical dimensions are developed using Turbo Design Tool. The Model is validated and verified using CFD & experiment.

#### Comments

The Chairman asked the presenter to proceed with the new design with increased efficiency.

#### **Dr.L.G. Das - CMERI**

1) The hydraulic calculation for estimation of vane angles, dimensions, development of the meridional view, and area distribution of the flow passage carried out for suction bell, diffuser and impeller.


2) The two dimension pattern drawings of the vane layout for impeller and diffuser completed.

3) Three dimensional view of the impeller, suction bell, diffuser and assembled view completed.

4) CFD analysis and development of stage is planned in the next activity.

#### **Dr.Phani Kumar - CMERI**

1) Thrust pad bearing analysis for its load bearing capacity along with rotor stability analysis was carried out using ARMD software.

	<b>Minutes of Meeting</b>	Ref : MOM / PRMC / 01
	<b>Project Review and Monitoring Committee ( PRMC )</b>	Date : 01.08.2017
	<b>Si'Tarc Smart Pump Project</b>	Page No. 6 of 8

2) A study was performed to investigate the effect of pivot location on thrust pad bearing load carrying capacity. Further, analysis has been carried out to study the effect of increased pad numbers on bearing load capacity. Influence on bearing performance by texturing micro patterns on the thrust pad surface was investigated theoretically. It was observed that the textured thrust bearings are capable of providing higher load capacity when compared to non-textured bearings.

#### Comments

1) The Chairman queried about the materials of thrust pad bearing and its collar. The presenter explained the bearing pads are made of SS420 and the collar is made of carbon material.

2) Comparison of bearing load capacities among the plain and textured thrust pad bearings obtained from theoretical analysis was presented. The Chairman asked about the possible manufacturing methods to generate the desired textured features on pad surfaces. In response the presenter explained about various methods like micro milling, etching, laser surface texturing and photo-lithography as a viable option to develop the textured features on pad surfaces.

3) The Chairman suggested to test the developed bearing in an experimental test rig. In response to this, presenter showed his concurrence with the suggestion.

#### **Dr.Dhiman - IIT-M**


1) Fluid Domain Model given by IISc was analyzed. Performance with the inlet domain seemed to have more efficiency.

2) Up to 3 Stages Hydraulic Efficiency is 79%. Analysis shows that the second and third stage efficiencies are lower than the first stage presumably because the flow condition at the entry to second (or third) stage is not identical to that at the inlet of the first stage. Attempts may be made by designers to address this aspect.

#### **Agenda 5 - Conclusion and Remarks**


1) PRMC Meeting is to be held once in 3 Months. The next PRMC Meeting was suggested to be held on 1<sup>st</sup> Week of November 2017 preferably on a Saturday.

2) The purchase of equipment's was delayed due to the implementation of GST. Suppliers were sceptical about accepting orders. Analytical Design is taking time since it is a completely new concept in engineering design and many inputs are required. Mark 1 design of pump prototype was tested, results are positive but not to expected levels, so new designs are made.

	<b>Minutes of Meeting</b>	Ref : MOM / PRMC / 01
	<b>Project Review and Monitoring Committee ( PRMC )</b>	Date : 01.08.2017
	<b>Si'Tarc Smart Pump Project</b>	Page No. 7 of 8

- 3) The unspent grant as on 31<sup>st</sup> May 2017 was 3.84 Crores.
- 4) The Project findings should be kept in strict confidentiality and prevent disclosure of all the information and the data exchanged pertaining to work assigned.
- 5) The Purchase of equipment's and Analytical Design to be completed soon and reported for completion before next PRMC.
- 6) The PRMC recommends for the release of funds for the next phase. The PRMC also highlighted the possibility of developing new types of motors and pumps with the resources acquired. The PRMC recommends to the G.C for consideration of new products like permanent magnet motors, pumps for individual application as the same can be done with minimal investment.
- 7) The Chairman found the project heading the right direction and was satisfied with the progress of the project.

The meeting ended with a Vote of Thanks to the Chair.

	<b>Minutes of Meeting</b>	Ref : MOM / PRMC / 01
	<b>Project Review and Monitoring Committee ( PRMC )</b>	Date : 01.08.2017
	<b>Si'Tarc Smart Pump Project</b>	Page No. 8 of 8

Name

Signature

- 1) Dr. D.N. Badodkar
- 2) Mr. K.V. Karthik
- 3) Dr. M. Sundaram
- 4) Mr. C. Muthusamy
- 5) Dr. V. Prasanna Moorthy
- 6) Dr. Punit Singh
- 7) Dr. Prabhu
- 8) Dr. Dhiman
- 9) Dr. Phani Kumar
- 10) Dr. L.G. Das
- 11) Mr. Fenin