16th March, 2018

Minutes of 81st Meeting of Scientific Advisory Committee (SAC) on Hydrocarbons of MoP&NG

1. The 81st Meeting of SAC was held on 14th March 2018 at Indian Oil Institute of Petroleum Management (IiPM), Gurugram. The meeting was chaired by Dr Anil Kakodkar, Chairman, Scientific Advisory Committee on Hydrocarbons of MoP&NG.

The list of participants is enclosed as **Annexure-1**.

2. Shri Brijesh Kumar, ED (CHT) welcomed the Chair & other members of SAC. He informed that the SAC has been reconstituted by MoP&NG. He further, informed about terms of reference of SAC.

3. At the outset Chairman, SAC, while welcoming members of newly constituted SAC, in his opening remarks emphasized on the following;

a. SAC should look into enabling processes to lend support and thrust to quick translation of promising lab work to commercialization.

b. Options based on use of coal and renewable energy including biomass to produce hydrocarbon fuels be given higher priority for better energy security, reduction of energy import bill & reduction of carbon footprint/improvement of local air quality. Technologies in these areas are fast appearing on the horizon; therefore actions are required for developing eco system for adoption and to reap benefit of continuous innovation for sustainable future.

c. Additional measures, in addition to EOI, are required to elicit projects in priority areas as identified in the position paper. CHT was advised to conduct meetings with targeted audience groups for information sharing on key thrust areas and CHT's scheme of funding R&D projects including system of EOI.

d. SAC and CHT should also a play proactive role in shaping projects of national importance.

4. Chairman also sought views of other members and after deliberations following points emerged out:

a. While appreciating CHT's effort in sharing of best practices, SAC advised CHT to open a dash board for sharing of best practices.

b. CHT and IOC-R&D were advised to take lead role in coordinating an industry wide laboratory inter-comparison programme involving refineries, R&Ds and SFPL,

Noida. SAC constituted a Group of following members to finalize modality and implement actions required in this regard:

1. Dr S.S.V. Ramakumar, Dir (R&D), IOC
2. Sh Brijesh Kumar, ED, CHT
3. Dr. Anjan Ray, Director, IIP
4. Sh G. Sriganesh, ED(R&D), HPCL
5. Sh Sanjay Bhargav, CGM (CRDC), BPCL
6. Sh C Shankar, Executive Director, SFPL, Noida

5. Thereafter, ED(CHT) made a detailed presentation on the agenda items as under;

a. Activities since last SAC and ATR

b. Presentation on Project Proposals

c. Closure of Completed Project

d. Review of on-going Projects

6. Activities since last SAC and ATR

a. Project review by respective PMCs (Project Monitoring Committee) completed for all ongoing projects.

b. Status of EOI:

i. EOI issued 4 times since July'16. The latest EOI was issued on 7th Feb 2018.

ii. 8 proposals (6 of EOI-4 and 2 revised proposals from previous EOIs) reviewed by Screening Committee on 13th Feb 2018.

iii. Screening Committee has recommended 2 projects (one in H_2 area and other in Pipeline Monitoring) for consideration of SAC.

c. Status of ATR

ED(CHT) informed that there are 2 pending actionable points from the previous SAC meeting as under;

1. preparation of list of equipment to be developed for self-sufficiency in vulnerable areas by EIL
2. Setting up a Catalyst Manufacturing Plant

ED (CHT) informed that a committee comprising of following has been constituted during the meeting on 'Commercialization of Indigenously Developed Technologies' held under the chairmanship of Joint Secretary (Refinery) on 30.10.2017 to study catalyst manufacturing in India:

1. Shri Ajay N. Deshpande, Dir (T), EIL (Chairman)
2. Shri R. Ramachandran, Dir (R), BPC
3. Shri V.S. Shenoy, Dir (R), HPC
4. Dr. S.S.V. Ramakumar, Dir (R&D), IOC
5. Shri Brijesh Kumar, ED (CHT)
6. Dr. Anjan Ray, Dir, CSIR-IIP

Terms of Reference:

- Assess the present as well as future requirement of catalyst (Type, Quantity & Technological Level)
- Capacity of catalyst plant with type
- Facility needed for Scale up
- Funding Mechanism for manufacturing unit
- Steps required for demonstration & promotion of commercialization of indigenous catalyst
- Strengthening infrastructure for catalyst development initiative and continual improvement

SAC advised that meeting of the committee is to be convened early by EIL/ CHT. The same committee may also work on preparing a list of equipment for self-sufficiency in vulnerable areas and developing a relevant strategy for self-reliance.

7. Project Proposals

ED (CHT) informed that following two projects have been shortlisted by Screening Committee constituted by Chairman, SAC for consideration by SAC:

- Creation of solar based hydrogen production system and dispensing station for refueling hydrogen fuel cell vehicle: IOC R&D
- Enhancing (Speedy) the Leak detection times in pipelines by deployment of real time Ethernet protocols in lieu of Legacy protocols like DNP, IEC-101/ IEC-14: HPCL-VSPL

Further, following proposal has been referred by OIDB for technical recommendation of SAC;

- Demonstration of fermentation technology developed by LanzaTech for production of Ethanol: IOC R&D

a. **Creation of solar based H_2 production system & dispensing station for refuelling H_2 fuel cell vehicle: IOC R&D**

- The proposal reviewed by Screening Committee in its meeting on 3rd October, 2017 and subsequently the revised proposal after incorporating the observation/ suggestion was presented to Screening Committee on 13th February, 2018 at Bengaluru.
- Activities proposed to be undertaken during the project:

  i. Procurement of Hydrogen infrastructure [Solar PV Panel, hydrogen generator (electrolyser), compressor, hydrogen dispenser]
  ii. PESO approval for installation of above items
  iii. Installation & Commissioning
  iv. PESO approval for on board hydrogen filling
  v. Fuel Cell Vehicle filling and data generation
  vi. Performance monitoring, data analysis & report generation

- **Project Cost**: Rs 44 Crore (**CHT Contribution**: Rs 35 Crore); **Duration**: 36 months
- The proposed facilities will comprise of following:

  - Solar HIT PV cells: 1.15 MW (Silicon based with 18% efficiency and can work with diffused light)
  - Hydrogen generation unit (through PEM electrolyser: 425 Kg/hr; 90 Nm3/hr (50% Efficiency)
  - Hydrogen Compressor : 550 bar
  - Hydrogen Storage : 180 Kg
  - Dispenser, utilities and safety systems.
  - Fuel cell vehicle from Tata Motors will be refilled and tested.

- Screening Committee observed the following:

  1. This is basically infrastructure project which would enable PSU and other R&D institutes/ OEMs in demonstration of technology development in PV Cells, Electrolysers, Hydrogen Storage, Fuel Cell vehicles and integration of the sub systems and obtain approval for PESO.
  2. Therefore, SAC may consider steering this project as national initiative for transiting into Hydrogen economy, whenever these subsystems become commercially viable.
  3. IOC (R&D) was also advised to indicate R&D initiative in each of these subsystems.

SAC extensively deliberated on the proposal and recommended the proposal for consideration of GC of CHT with following remarks;

1. **The project should have flexibility to adopt different pathways for hydrogen production and storage so as to derive cost benefit of innovation and cost cutting in future. IOC was advised to procure the best electrolyser that would minimise energy consumption through EOI route even though there may be higher initial capital cost to start with. This could be brought down later through higher turnover.**
2. **The estimated cost of project is Rs 44 crore, which may go up with suggested actions as above, however, CHT's share in the project to be capped at Rs 30 crore with the rest to be borne by IOCL.**

b. Enhancing (Speedy) Leak detection times in pipelines by deployment of real time Ethernet protocols: HPCL-VSPL/ECIL

- Cross country Pipeline suffer unexpected release of product under various situations like pinhole/small leaks due to corrosion, leak/ bursts and pilferage.
- All major cross country pipelines deploy SCADA (Supervisory Control & Data Acquisition System) & LDS (Leak Detection System). Principally, SCADA measures the operating parameters and send to LDS Servers, which in turn do the internal calculations, modelling and predicts any leak giving details of leak size, leak flow quantity and leak location.
- The challenge being faced by Pipelines is the communication protocols and the hardware/ software systems deployed, are able to complete the cycle of information exchange from field location to SCADA and to LDS in ~ 5 to 15 seconds. The data acquisition time is proposed to be brought to 10 milliseconds.
- Currently finite element approach is used with statistical method and it takes about 15 minutes to detect leak. The leak detection time is proposed to be reduced to about 2-3 minutes with an accuracy of +/-200 meters compared to current range of +/- 2 to 3 kms. ECIL will support in development of Electronics.
- The proposal is for demonstration in HPCL's Vizag-Vijaywada-Secundrabad Pipeline (VVSPL).
- In order to understand and assist in developing the project, an Expert Committee was constituted by Screening Committee in its meeting on 3rd October, 2017 at Bengaluru. The project was reviewed by the Expert Committee on 11th December, 2017 at Secundrabad Terminal of VVSPL.

- The revised proposal after incorporating the observation/suggestion of Expert Committee was presented to Screening Committee on 13th February, 2018 at Bengaluru. The Screening Committee has recommended for consideration by SAC.
- **Project cost**: Rs 1.2 Crore **Duration**: 18 months

SAC deliberated on the proposal and recommended for consideration by EC of CHT.

c. Demonstration of M/s LanzaTech, USA Fermentation Technology for production of Ethanol from refinery off gases at Panipat Refinery, IOCL

- IndianOil has proposed to set up a plant of 100 MT per day (33,000 TPA) Capacity at Panipat Refinery for production of ethanol using refinery off gases and using bio-fermentation technology from M/s Lanza Tech, USA.
- M/s LanzaTech has demonstrated this technology at 100,000 gallon/year scale at Bao Steel, in Sanghai, China (commissioned in November, 2012) and subsequently two other demonstration scale plants commissioned at Shougang Steel mill in China in 2013 and at the China Steel Corporation Mill in Taiwan in 2014.
- M/s LanzaTech is further developing process for making other products like Isopropanol and many other value added chemicals by changing microbes in existing Reactor. This will not require major hardware change.
- Indian Oil-R&D, DBT (Department of Bio-Technology) is already having an existing MoU with M/s LanzaTech to develop acetate to Lipids pathway using micro-algae for the commercial production of higher value products in two steps:
  - **i.** CO & H_2 fermentation to acetate - Process owner M/s LanzaTech
  - **ii.** Conversion of acetates through micro-algae to co-produce oil & omega-3 fatty acid - Process owner Indian Oil.
- Once successful at Panipat Refinery, the technology can be utilized by any other Refineries, Steel Mills or any other Industry in India and abroad for production of Ethanol from Off-gases containing CO,CO_2 and H_2.
- IOC R&D shared the details of pilot plant data generated at LanzaTech lab in Chicago as well as comparative economics **(Annexure-2).**
- The financial analysis of the Project has been worked out based on:
  - Capacity (Ethanol Production): 100 MT per day (33,000 TPA)

- Current market price of Ethanol @ Rs 46/litre (Base Price: Rs 39/Litre + 18% GST)
- Cash cost of production of Ethanol: Rs 34.8 per litre (with average RLNG Price of 9.1 $ / MMBtu during the period of Jan'2016 to June'2017).
- IRR: 8.62%, which is likely to increase in future with cost optimization, etc.
- Completion schedule: 26 months
- Project cost: Rs 441 Crore (approved by Board of IndianOil in Aug, 2017)

- IndianOil have requested funding of 50% (Rs 220.5 Crore) from OIDB to bring IRR from current level of 9% to 12%.

SAC extensively deliberated on the technical merits of the proposal and felt that demonstration of such a technology in the country would be necessary for larger scale deployment going forward. SAC recommended the proposal for funding by OIDB.

8. Closure of completed Project 'Feasibility Study of Improved 3-Phase Reactor Configuration for Hydro processing Applications: BPCL (R&D), EIL (R&D) and IIT Delhi

ED (CHT) presented the status as under:

- Report submitted by BPCL in Sept, 2017.
- During the last meeting, while approving extension till September, 2017, SAC expressed that association of the knowledge partners to enable scale up to larger diameters needs to be considered, if required.
- Meeting of project partners held on 24.01.2018 towards commercialisation. Further work in terms of establishing robust weeping free operation at a larger scale cold flow conditions, developing efficient pressure control strategy and hydro-processing reactions at different scales (bench and demonstration scale) will be led by BPCL without any further financial contribution from CHT.

SAC approved closure of the project.

9. Status of Ongoing R&D Projects

There are 10 ongoing projects with total project cost of Rs 140.68 crore and CHT funding of Rs 79.31 crore. ED, CHT presented details & status of projects for consideration & advice of SAC:

9.1 Coal to Liquid (CTL) Fuels Technology Project: EIL-R&D / BPCL-R&D

Objective

To develop technology for gasification of high ash Indian coal

Physical Progress

MOU Date	Start Date	End Date	Extension	Physical Progress, %
Mar 09	July 09	July 13	June 19	94

The project has been envisaged in three major steps:
Step 1: Gasification of coal to syngas
Step 2: Cleaning of syngas (Removal of H_2S, NH_3, HCN, CO_2, COS, etc.)
Step 3: Conversion of syngas to liquid fuels through Fischer-Tropsch (FT) synthesis

Financial Progress (All figures in Rs, lakh)

Agency	Contribution	Expenditure till date	2017-18			
			BE	Actual Expenditure till Feb 18	Expected in Mar 18	RBE
CHT	1483.95#	1220.95*	--	--	--	--
EIL	924	799.85	--	--	--	--
BPCL	560	421.10	--	--	--	--
Thermax	332	301.50	--	--	--	--
Total	3300	2743.40	--	--	--	--

(EIL: Rs 923.95 lakh; BPCL: 560 Rs lakh) *(EIL: Rs 799.85 lakh; BPCL: 421.1 Rs lakh)

Status

- FT technology: catalyst development, kinetic study, hydrodynamic study, reactor model development completed.
- Erection of skid mounted syngas cleaning system is completed. Plant has been commissioned with air water system and testing is being done with syngas produced in gasifier.
- Modeling of the fluidized bed gasifier done based on literature data for kinetics & hydrodynamics and data generated from HPTGA. The model can predict gasifier output

for coal and mixture of coal & petcoke. Model has been used to check the few sets of experimental data collected during gasifier operation. Kinetic expression will be updated / validated with more data generated during pilot plant operation with other high ash coals.

- Flow sheet simulations scheme for gasifier conceptualized and carried out in Aspen Plus based on Free energy minimization. Finalization of the flow sheet simulation is to be done with experimental data.
- SAC during its 80th meeting held on 6th September 2017 constituted Expert Group to carry out comprehensive overall review and look into all the possible aspects of high ash coal gasification at high pressure and recommend modifications to address issues in the continuous running of the pilot plant :
    - Dr B D Kulkarni, NCL, Pune
    - Prof. Shantanu Roy, IITD
    - Dr RR Sonde, Themax
    - Ms Vartika Shukla, EIL
    - Dr SSV Ramakumar, IOC
    - Mr Sanjay Bhargava,BPC
    - Sh Brijesh Kumar, CHT
    - Sh P.S. Guru, BHEL
    - Dr R Kumar, IISc
- 3 Meetings of Expert Group held on 11th Oct 2017, 24th Nov 2017 and 13th Feb 2018.
- The Expert Group in its meeting in Oct'17 recommended following modifications;
    i. Heat tracing of syngas line from cyclone to the flare to overcome choking due to condensation of moisture.
    ii. Rotary Valve for ash withdrawal system
    iii. Automation for steam/air flow
    iv. Modification of the feed line
    v. Additional new cyclone system at the exit of the gasifier.

Cost of Proposed Modifications

The cost of modification is Rs 242 lakh including taxes & duties (Figs in Rs Lakh);

Thermax	60.90
EIL	90.75
CHT	90.75
Total	**242.40**

1. **EIL Contribution**: Includes unspent amount of Rs 69.72 lakh out of its own committed contribution and additional contribution of Rs 21.03 lakh. Thus, EIL is increasing its contribution from Rs 923.95 lakh to Rs 944.98 lakh.
2. **CHT's contribution**: Includes unspent CHT's contribution of Rs 69.72 lakh towards EIL and re-appropriation of Rs 21.03 Lakh out of unutilized CHT's contribution to BPCL (due to savings of Rs 78.9 lakh from CHT's contribution by BPCL). The total contribution of CHT would still be only Rs 1366.08 lakh against budget of Rs 1483.95 lakh (including contingency (BPCL- Rs 60 lakh, EIL-10.15 Lakh).
3. **Thermax contribution**: 25% as per Cooperation of Agreement

- Gasifier operated in Nov'17 in combustion mode for 48 hrs with 18 % ash coal at feed rate of 10 kg/h. The temperature of 800^0C was attained. However, problems encountered in sustaining gasification with steam.
- Salient points emerged out during Expert Group meetings are as under:
    - Steam may be introduced for better heat dissipation, reducing agglomeration due to localized high temperature as well as to have control over the gas composition.
    - Steam injection to be controlled and increased slowly during transition from combustion to gasification mode. Further, ratio of oxygen and steam generally followed during gasification are to be maintained.
    - Withdrawal of ash as continuous as possible to reduce agglomeration.
    - Recycling of ash from cyclone leg
- To study softening behavior of the coal. Also effects of particle sizes on ash fusion temperature to be examined to determine if higher particle sizes may have a favorable effects on potential agglomeration through change in AFT
- Gasifier operation at 6 bar with different steam rates and the data on complete characterization of coal, gasifier operating parameters, syn gas composition, material balance, carbon conversion, the porosity of particles of different streams (in particular the ash), etc.
- Operation of the plant separately in combustion mode with oxygen

	Activities	Status	Completion Schedule
1	Heat tracing of syngas line from cyclone to the flare to overcome choking due to condensation of moisture.	Tender issued by EIL	Aug,18
2	Rotary Valve for ash withdrawal system	P.O by EIL to Thermax by 20th March,18	• Testing / pre-commissioning: Oct,18 end • Commencement of Runs: Nov,18 end
3	Automation for steam/air flow		
4	Modification of the feed line		
5	Additional new cyclone system at the exit of the gasifier.		

SAC deliberated extensively on the project progress. While appreciating the challenges in developing gasifier for high ash Indian coal, SAC emphasized that this project appears to be the most important from the point of view energy security and therefore concerted efforts are required to achieve quick success in this project. While efforts to run the gasifier and collect data with steady operations should be completed as early as possible, a parallel effort through another project for validated modeling of gasifier and develop capability for credible scale up should also be mobilised. Accordingly SAC advised EIL to parallely work on an additional project for modeling of gasifier and put together a team of CFD experts and experimentalist to realise this objective.

SAC also felt that while the objective of this project is to get liquid fuel from coal, one of the early deliverable of this project could be to get useable gaseous fuel from high ash Indian coal.

Expert committee may deliberate on this matter further and decide.

9.2 Experimental and simulation studies on coke mitigation in petroleum refinery system: BPCL & BITS Pilani (Goa)

Objective

- To study kinetics and mechanisms involved in coking on metal surfaces in high temperature heavy liquid refinery streams
- To develop predictive tools such as coking potential and coking index
- To develop coke mitigation strategies through use of additives and passivation studies

Physical Progress

MOU Date	Start Date	End Date	Extension	Physical Progress, %
May 14	Apr 15	Apr 18	Oct 18	94

Financial Progress (All figures in Rs, lakh)

Agency	Contribution	Expenditure till date	2017-18			
			BE	Expenditure till Feb 18	Expected In Mar 18	RBE
CHT*	132.97	119.67	--	--	--	--
BPCL	190.25	190.25	--	--	--	--
Total	322.22	309.92	--	--	--	--

*****Only to BITS. Balance 10% to be released upon completion of the project.

Status

- All the equipment viz. Micro Carbon Residue Tester (MCRT), High Temperature High Shear (HTHS) unit and Asphaltene Analyzer commissioned.
- Feed streams (Crude, LR, VGO, and VR) samples collected from BPC-MR, and shared with BPC R&D as well as BITS-Pilani Goa.
- All the feed streams characterized for basic properties like Density, Asphaltene, residual carbon, saturates, aromatics, resins, TAN, Ultimate Coking Potential (UCP) and Colloidal Instability Index (CII) as well as MCRT, which is a pyrolysis based experiment to predict UCP. These properties are correlated and the propensity to coke has been established.
- Experimental studies on coupon tests and model development are in progress.
    - Experimental test rigs (HTHS) designed, fabricated and commissioned to predict coking under high shear and high temperature conditions often encountered in refinery systems.
    - The effect of temperature and rpm on the deposition rate has been investigated. The cumulative deposition rate found to increase with time at a given temperature. Test runs conducted at 225 and 250^{o}C with varying RPM
    - A process model development is under progress. The model will predict rate of asphaltene deposition flowing under forced convection over a surface. Effects of operating conditions such as surface temperature, inlet velocity, asphaltene concentration and surface roughness on the heat transfer coefficient, thermal resistance, and asphaltene deposition rate will be studied numerically. The model will be validated using experimental data.
    - A protocol has been developed with regard to an in-tube geometry, governing equations and kinetics. Property equations have been derived and integration is in progress.
- Based on work done till date, the heat transfer rate is found to decrease with increase in asphaltene concentration. Shear is found to have positive effect in reducing the

asphaltene deposition rate. The fouling resistance/ heat transfer coefficient time data along with asphaltene deposition rate, thickness, and heat transfer coefficient predicted by the model can be used to design heat exchangers incorporating time variant fouling effects and also decide upon cleaning shut down time in existing refinery heat exchangers.

- Anti-foulant additive dosage optimization studies carried out for Mumbai High, Kuwait and Arab Medium crude oil and dosage quantity standardized. This will subsequently lead to choosing a representative additive for experimentation purposes. The experimental data is expected to optimize the usage of additives to mitigate fouling.

Project progress is as per the revised schedule. SAC noted the above.

9.3 Development of process know-how for indigenous production of Biphenyl for thermic fluid and other application: BPCL

Objective

To develop highly active & selective catalyst and sustainable, cost effective & energy efficient process route for biphenyl production with ease of integration with oil refinery processes.

Physical Progress

MOU Date	Start Date	End Date	Extension	Physical Progress, %
Oct 14	Mar 15	Mar 18	Oct 18	75

Financial Progress (All figures in Rs, lakh)

Agency	Contribution	Expenditure till date	2017-18			
			BE	Actual Expenditure till Feb 18	Expected in Mar 18	RBE
CHT	260	35.94	--	--	--	--

Status

- Facilities for material synthesis, characterization, metal loading and catalyst screening developed.

- The process and catalysts for the conversion of benzene to cyclohexylbenzene (CHB) and its subsequent conversion to biphenyl completed

- Biphenyl produced from the above evaluation was purified from 60% to 95% using crystallization followed by vacuum filtration technique.

- PO placed for procurement of pilot plant for process demonstration. Pilot plant delivery is expected in July 2018. Efforts are being made to expedite delivery.

Project progress is as per the revised schedule. SAC noted the above.

9.4 Parametric Study and Technology Development for Desalter Design: EIL & BPCL

Objective

- To develop Skid-mounted proto-type model De-salter to carryout Parametric Study for various crudes for better understanding of intricacies in Desalter design & operational issues
- To develop indigenous Desalter technology

Physical Progress

MOU Date	Start Date	End Date	Extension	Physical Progress, %
Feb 15	Mar 15	Mar 18	Dec 18	80

Financial Progress (All figures in Rs, lakh)

	Contribution		Expenditure till date	2017-18			
	Original	Revised		BE	Actual Expenditure till Feb 18	Expected in Mar 18	RBE
CHT#	853.0	853.0	577.37	300.0	434.61	119.97	554.58
BPCL	348.1	469.31	305.21	--	--	--	--
EIL	250.0	352.72	184.14	168.6	--	--	--
Total	1451.1	1675.03*	1066.72	468.6	434.61	119.97	554.58

CHT's contribution to EIL

* The project cost has been revised to Rs 1675.03 lakh with original CHT's contribution. Hardware cost is increased by Rs 205.44 lakh, of which BPCL shall pay Rs 121.21 lakh including GST at 18% to EIL.

Status

BPCL-R&D:

- The literature search w.r.t. crude desalting and interfacial properties and Patent landscaping for desalter designs completed.
- Instruments viz. salt content measurement unit, conductivity meter, Interfacial Tensiometer & High temperature centrifuge commissioned
- Experimental studies on interfacial tensiometer completed with respect to variation in temperature and wash water quality with Mumbai High, Arab Medium and Kuwait crude oil
- Demulsifier studies in bench top desalter completed with these crude oil

EIL-R&D: (Status of 4 MRs)

- Mix valve: Delivered at Kochi Refinery
- Transformers: Equipment expected to be dispatched by third week of March 2018.
- Special Level Control Instruments: Expected to be dispatched by third week of March 2018
- Prototype desalter: PO placed in March 2017 with delivery period of 13 months. Skid Module is being dispatched to Kochi site. 3 Trucks (out of 4) already dispatched.
- Skid Foundation Work is completed at BPC-KR site. Electrical, Instrumentation & Piping requirement for hook-up with IREP facilities (New CDU unit) completed except 110 V AC UPS Supply, for which BPCL is laying of the cable from SRR#4 Feeder to Skid Battery Limit.

Project progress is as per the revised schedule. SAC noted the above.

9.5 Development of catalyst and process for Slurry phase Residue Hydro-cracking: CSIR-IIP, HPCL, BPCL and EIL

Objective

- Development of Catalyst and Process for Slurry Phase Residue Hydrocracking;
- Process optimization; studies of hydrodynamics, simulation and modeling in suitable reactor and evaluation of the developed catalyst (s) at pilot plant

Physical Progress

MOU Date	Start Date	End Date	Extension	Physical Progress, %
June 15	July 15	July 18	--	55

Financial Progress (All figures in Rs, lakh)

Agency	Contribution	Expenditure till date	2017-18			
			BE	Actual Expenditure till Feb 18	Expected in Mar 18	RBE
CHT	1366#	1135.57*	518.0	349.19	--	349.19
HPCL	776.0	506.6	60.0	69.74	--	69.74
CSIR-IIP	93.0	93.0	--	--	--	--
Total	2235.0	1735.17	578.0	418.93	--	418.93

(CSIR-IIP: Rs.516 lakh, HPCL: Rs.850 lakh)

* (CSIR-IIP: Rs.464.42 lakh, HPCL: Rs. 671.15lakh)

Major steps and status

- IIP, HPC & BPC shall prepare catalysts and share their 3 best catalysts for testing by others (Completed).
- Performance data (yield & conversion under different operating conditions) to be generated by each for their respective catalysts (in progress).
- Selection of 3 best catalysts out of 9: in progress
- Kinetic data by IIP: in progress at diff T, P & reaction time on best catalyst
- Performance evaluation of 3 catalysts by using continuous flow reactor:
    - IIP (0.5L): Delivery by March 2018 & Commissioning by April 2018
    - HPCL (3L): Commissioning by March,2018
- Process Optimization, Study of Hydrodynamics, simulation & modelling of slurry phase system by EIL for final catalyst selected based on cost and performance.
- A base line PFD towards preparation of proposal for Phase II.

Project progress is as per the schedule. SAC noted the above.

9.6 Synthetic Aviation Lubricants (SAL) - Phase 2: CSIR-IICT, HPCL & CEMILAC

Background

A Taskforce formed to look into possibility of developing indigenous capabilities in aviation lubricants, shortlisted two commercial lubricants viz. OX-27 (meeting MIL PRF-23699F) & OX-38 (meeting DEF STAN 91-98 specifications) for indigenous development.

Phase-1: two synthetic lubricants SVS 11 & SVS 21 developed, suitable for Garrett and Orpheus aero engines with Ryder test carried out at US NAVAIR. The developed lubricants passed all the mandatory tests. Provisional Certificates for Airworthiness Approval was granted by CEMILAC for both lubricants, essential for In-flight tests.

Phase-2 (Current Project):

CSIR-IICT: To prepare 500 l base oil each for SVS11 & SVS21.

HPCL: Formulations meeting the mandatory tests for further testing by CEMILAC for Defense applications.

Physical Progress

MOU Date	Start Date	End Date	Extension	Physical Progress, %
Mar 16	Apr 16	Sept 17	Sept 18	60

Financial Progress (All figures in Rs, lakh)

Agency	Contribution		Expenditure till date	2017-18			
	Original	Revised*		BE	Actual Expenditure till Feb 18	Expected in Mar 18	RBE
CHT#	97	139.02	98.9	37.3	57.77	--	57.77
HPCL	118	169.10	--	--	--	--	--
CSIR-IICT	30	43.00	30.0	13.0	--	--	--
CEMILAC	5	7.16	--	--	--	--	--
Total	250	358.27	128.9	50.3	57.77	--	57.77

Only to IICT

*Increase in cost of Rs 108.27 lakh has been shared by participating agencies in proportion of their original contribution as approved by EC in its 23rd meeting on 30th Oct 2017. Accordingly CHT has funded additional 42 lakh out of increase in cost of Rs 108.27 lakh.

Status

- IICT supplied 250 lt of SVS-21 to 3BRD for in-flight tests in TV-2 aero engine during April 2016 and 250 lt of SVS-21 base oil to HPCL on in August 2017.
- HPCL, Mumbai has procured all the additives except one (due to some difficulties with the supplier). Formulation of SVS 21 base oil is expected by March 2018.
- During review meeting held at 3BRD on 17th July 2017, 3BRD agreed only for 50 hour trial of SVS-21 in TV-2 aero engine for demonstration as TV-2 aero engine is going to be

phased out within one year. 3BRD also agreed to test SVS-11 on the upgraded TV-3 aero engine.

- IICT has started preparing base oil of SVS11 and shall supply 150 kg to HPCL by March 2018.

Project progress is as per the revised schedule. SAC noted the above.

9.7 Biomass Hydro-pyrolysis for production of fuel grade Hydrocarbons: HPCL/ CSIR-IIP

Objective

Development of hydro pyrolysis process for the conversion of lignocellulosic biomass to hydrocarbons

The project has two phases:

Phase-1: Lab scale facilities at IIP (0.5 kg/hr) and HPCL R&D (5 kg/hr) for data generation for Demo unit.

Phase-2: Scale-up and design of Demo unit of capacity 5 MT/d, which is not in the scope of project.

Physical Progress

MOU Date	Start Date	End Date	Extension	Physical Progress, %
Sept 16	Nov 16	Nov 19	--	25

Financial Progress (All figures in Rs, lakh)

Agency	Contribution	Expenditure till date	2017-18			
			BE	Actual Expenditure till Feb 18	Expected in Mar 18	RBE
CHT	1440.0#	563.0 *	475.0	419.0	--	419.0
HPCL	966.9	165.0	220.0	200.0	20.0	220.0
Total	2406.9	728.0	695.0	619.0	20.0	639.0

(IIP: Rs 640 lakh; HPCL: 800 lakh) * (IIP: Rs 483 lakh; HPCL: 80 lakh)

Status

- Feedstocks i.e. Rice straw, sorghum and bagasse biomass samples Procured and Physico-chemical characterization completed
- Biomass (rice straw, bagasse and sorghum) compositional analysis completed
- Thermogravimetric analysis and decomposition kinetics completed.

- PO released for Characterization units such as Physisorption and Chemisorption units.
- IIP & HPCL expressed that procurement of 500 g/hr unit may not be necessary as the data required for finalizing technical specs, for designing of 5 Kg/h pilot plant at HPCL are now available as generated using existing 100 g/hr unit at IIP, procured under MNRE project. Thereafter ED (CHT) informed that CHT has already released the fund to procure this equipment as an advance as CSIR labs require fund well in advance before placing the order.
- IIP requested that procurement of analytical equipment namely Advanced Proximate analysis, Differential Scanning Calorimetry (DSC), CHNS Analyser, Bomb Calorimeter and Refinery Gas Analyser (RGA) is essential which were not envisaged in the original proposal. Therefore IIP requested for re-appropriation of fund for buying these analytical equipment.

SAC deliberated extensively and agreed in-principle for abandoning procurement of 500 g/hr unit by IIP and also agreed for requirement of analytical equipment as indicated by IIP. SAC advised CHT to convene a meeting to discuss the fund requirement for additional equipment and consider re-appropriation within the approved CHT contribution to IIP.

9.8 Renewable crude and liquid Hydrocarbon fuels from Algae: CPCL / ICGEB/ABAN

The project was recommended by SAC under two phases:

Phase-1: Cultivation of algal consortium in open pond and scale up studies in larger ponds to assess biomass productivity (with a target yield of 25 g/m2/day) with GM algal strains to enhance the yield by 20-30%.

Phase-2: Process to handle 110 kg algal slurry / day

The current project is for Phase-1 only.

Physical Progress

MOU Date	Start Date	End Date	Extension	Physical Progress, %
Dec 16	Mar 17	Mar 19	--	42

Financial Progress (All figures in Rs, lakh)

Agency	Contribution	Expenditure till date	2017-18			
			BE	Actual Expenditure till Feb 18	Expected in Mar 18	RBE
CHT	434.52#	56.87*	150	19.24	45.73	64.97

(CPCL: Rs 386.34 lakh; ICGEB: Rs 48.18 lakh) * (CPCL: Rs 40.53 lakh; ICGEB: Rs 16.34 lakh)

Objectives and their current status

CPCL/ ABAN

- Establish optimal conditions for cultivation of algal consortium in open raceway ponds ($2m^2$) using seawater (completed)
- Scale-up studies in 20 m^2 and 200 m^2 ponds to assess the biomass productivity (completed)
- Obtain productivity and yield data for biomass from algal consortium in a 4000 m2 lined open raceway pond over a year (construction of raceway pond: in progress)
- Optimize conditions for conversion of biomass into bio-crude through subcritical water extraction process using a 20 litre Hydro-Thermal Liquefaction (HTL) reactor (Tender inputs finalized for the procurement of HTL reactor)
- Characterize bio-crude and conduct true boiling point assay of blended bio-crude (All lab instruments installed)

ICGEB:

- Simple medium optimization strategy and environmental factors have resulted in the increase of algal biomass.
- Based on DNA Sequencing using 16s and 18s DNA barcodes, ABAN supplied marine algal strains were identified as Nannochloropsis Oceanica and Tetraselmis subcordiformis.
- Optimization of genetic transformation tools including the Antibiotic Sensitivity for selection marker and Low Carbon Inducing Gene (LCIA-LCIB).
- On verge of isolation of chloroplast organelles and later DNA for genome sequencing from the algal cells provided by Aban.
- Transformation of algae is being carried out through electroporation after optimization of each of the parameters including the Pulse, Voltage, Capacitance, Resistance, Concentration of preparatory and recovery medium and screening of transgenic colonies is in process.

Project progress is as per schedule. SAC noted the above.

9.9 Scale-up studies and process development for Hydrogen Production by Catalytic Decomposition of Natural Gas: HPCL-R&D, CeNS and IIT Delhi

This project is an extension of the earlier project funded under HCF and completed by HPCL-R&D in collaboration with IIT Delhi wherein the detailed kinetics, modelling and simulation

studies were carried out for fixed bed as well as fluidized bed wherein catalytic decomposition of methane (CDM) was investigated for the production of COx free H_2 and carbon nano-tubes.

The project is to be taken up in 2 phases as under:

Phase-1: Scale-up studies for production of H_2 and carbon nano tubes by catalytic decomposition of natural gas at rate of 1 kg/hr

Phase-2 - Basic engineering package for Demonstration unit at HPCL

The current project is for Phase-1 only.

Physical Progress

MOU Date	Start Date	End Date	Extension	Physical Progress, %
Feb 17	Mar 17	Mar 21	--	10

Financial Progress (All figures in Rs, lakh)

Agency	Contribution	Expenditure till date	2017-18			
			BE	Actual Expenditure till Feb 18	Expected in Mar 18	RBE
CHT	1692.10#	160.91*	400.0	--	7.92	7.92
HPCL	1253.60	417.0	--	--	--	--
Total	2945.70	577.91	400.0	--	7.92	7.92

HPCL: Rs 1489.80 lakh; IIT-D: Rs 102.30 lakh; CeNS: Rs 100.00 lakh)

*(HPCL: Rs 141.88 lakh; IIT-D: Rs 9.63 lakh; CeNS: Rs 9.40 lakh)

Status

- Catalysts prepared at IIT-Delhi with varying active metal concentration e.g. 20-60% Ni-Cu-Zn / Al2O3 for further catalyst optimization.
- Characterization of Spent catalyst is in progress by CeNS.
- CeNS requested for procurement of Probe Sonicator & High Speed Centrifuge in place of Resistivity meter in view of not using chemical route for recovering CNT from catalyst while keeping the budget same. Accordingly, re-appropriation of funds agreed as recommended by Nodal agency HPCL.
- Setting-up of 50 gm fluidized bed reactor completed at HPCL R&D.

- Based on residence time requirement of 15 mins for CNT formation, the height of pilot plant reactor (1 kg) is becoming impractical (~ 50 mtrs). HPCL & IITD will work together for new process scheme/reactor design. Hence, new lab scale FBR (25 gm) procurement at IITD is kept on hold.

SAC deliberated extensively on the challenges faced by HPCL & IITD in designing the reactor and constituted an Expert Group comprising of the following to carry out comprehensive overall review and look into all the possible aspects:

1. Prof R Kumar, IISc Bengaluru
2. Dr Deepak Kunjru (Ex IITK)
3. Dr Gautam Deb, IITK
4. Sh. G Sriganesh, HPC R&D

9.10 Development & durability testing of Ethanol-Diesel blend engine: ARAI, Pune

Objective

- To evaluate the Emission & Power performance of existing old vehicles with ethanol blended diesel vis a vis BS-VI norms.
- To evaluate vehicle performance (Gradability, CSFC, Acceleration, etc.) with ethanol blended diesel by comparing base diesel vehicle performance.

Milestones

- Phase I: Engine Durability and performance testing at 0 hrs, 20 hrs, every 100 hrs and final engine test after 500 hrs on diesel ethanol blend(3.5 months)
- Phase II: Evaluation of Vehicle performance on diesel and ethanol-diesel blend as per CMVR tests (Gradability, CSFC, Acceleration, etc.) & submission of report (2.5 months)

Physical Progress

MOU Date	Start Date	End Date	Extension	Physical Progress, %
Sept 17	Oct 17	Mar 18	--	30

Financial Progress (All figures in Rs, lakh)

Agency	Contribution	Expenditure till date	2017-18			
			BE	Actual Expenditure till Feb 18	Expected in Mar 18	RBE
CHT	129.80	10.50	--	10.50	14.51	25.01

Status

- M/s Tata Motors has supplied Tata 697 BSIV Engine in Feb 2018 as against scheduled delivery of Oct 2017. Metrology of critical components of Engine completed.
- PO placed for 400 kg of "BERAID 10" (binder & cetane improver) from M/s AkzoNobel and 2000 lit of denatured/un-hydrous ethanol from M/s Regola (will be available by 2nd week of March, 2018)
- Air assisted stirrers procured from M/s Transflow.
- 7.7% Ethanol blend in Diesel using 2% BERAID 10 additive, tested at M/s SGS lab, and met the specifications.
- Procurement of fuel conditioning system in progress (delivery by June 2018).
- ARAI informed that M/s TATA shall supply Engine and vehicle on no cost basis for which provision was made in MoU, however, there may be excess expenditure in Consumables and Equipment Utilisation cost. ARAI requested for re-appropriation of funds within approved project cost.
- ARAI indicated that the project is delayed due to delay in supply of engine and Co-solvent/ binder and requested extension of the project till Aug, 2018.

SAC considered and agreed to the above.

Annexure-1

81st Meeting of Scientific Advisory Committee (SAC) on Hydrocarbons of MoP&NG held on 14th March 2018 at IiPM, Gurugram

List of Participants

	Name	Designation	Organisation
1	Dr. Anil Kakodkar	Chairman - SAC	BARC
2	Prof. J. B. Joshi	Professor Emeritus	HBNI
3	Dr. M.O. Garg	President (R&D)	RIL
4	Prof. Shankar Narasimhan	Professor	IIT, Chennai
5	Dr. Shashi Kant	Scientist Emeritus	IOCL
6	Dr. S.S.V. Ramakumar	Director (R&D)	IOCL
7	Sh. B. V. Rama Gopal	Director (R)	IOCL
8	Sh. V.S. Shenoy	Director (R)	HPCL
9	Dr. R.K. Malhotra	Director General	FIPI
10	Dr. B. Bhargava	Director General	OEC
11	Sh. Brijesh Kumar	Executive Director	CHT
12	Sh. L. K. Vijh	Executive Director I/C (T)	EIL
13	Sh. U. Venkata Ramana	Director (T)	CPCL
14	Ms. Vartika Shukla	Executive Director (T)	EIL
15	Sh. G. Sri Ganesh	Executive Director (R&D)	HPCL
16	Sh. K. Ravi	Executive Director (RC& Sp. Proj.)	BPCL
17	Sh. Alok Tripathi	Executive Director	PCRA
18	Sh. C. Satyanarayana	CGM (R&D)	GAIL

	Name	Designation	Organisation
19	Dr. V. Ravikumar	GM, CRDC	BPCL
20	Sh. Sheo Raj Singh	Sr. GM (R&D)	EIL
21	Dr. R.N. Maiti	GM (R&D)	EIL
22	Sh. Rajesh Saini	Dy. Chief F&A Officer	OIDB
23	Dr. S. S. Thipse	Dy. Director	ARAI
24	Dr. Anshu Nanoti	Sr. Principal Scientist	CSIR-IIP
25	Sh. Susobhan Sarkar	Advisor (T)	CHT
26	Sh. Santosh Kumar Varshney	Joint Director	CHT