P1- SAC-file

उच्च प्रौद्योगिकी केन्द्र
(पेट्रोलियम एवं प्राकृतिक गैस मंत्रालय)

सी एच टी

Centre for High Technology
(Ministry of Petroleum & Natural Gas, Govt. of India)

CHT/AKA/SAC

Date: 12th May 2009

To,

1. Chairman, all members and permanent invitees of the Scientific Advisory Committee on Hydrocarbons of MOP&NG (as per list attached)
2. Chief Executives of PSU Oil Companies – IOC, BPCL, HPCL, EIL, ONGC
3. MD – BRPL, MRPL, NRL, CPCL
4. ED, IOC (R&D)
5. Prof. J.P.Gupta, RGIPT; Prof. S.Sivasanker, IIT Madras

Dear Sir,

Sub: **Minutes of the 65th Meeting of the Scientific Advisory Committee on Hydrocarbons of MOP&NG**

Enclosed please find a copy of the Minutes of the 65th Meeting of the Scientific Advisory Committee on Hydrocarbons of MOP&NG held on 23rd March 2009 at BPCL, Corporate Office and on 24th March 2009 at Mumbai Refinery, for your kind information and necessary action.

Thanking you,

Yours faithfully,

(Dr.K.S.Balaraman)
Executive Director /
Member Secretary, SAC

Encl. As above.

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CHT/AKA

Date: 12th May 2009

Minutes of the 65th Meeting of Scientific Advisory Committee (SAC) on Hydrocarbons of MOP&NG held on 23rd March 2009 at BPCL, Corporate Office and on 24th March 2009 at Mumbai Refinery:

Day-1 deliberations:

65.1 **Opening of the Session:**

65.1.1 Shri S.S.Sundararajan, Manager (PR) BPCL welcomed the members, invitees, academia and scientists to the 65th SAC meeting. Shri R.K.Singh, Director (R) BPCL welcomed Shri M.B.Lal, Chairman SAC by giving him Bouquet. Shri P.S.Bhargava, ED BPCL Mumbai Refinery presented the bouquet to Dr.K.S.Balaraman, ED CHT.

65.1.2 Dr.K.S.Balaraman, Executive Director CHT briefed on the agenda of the SAC meeting.

65.1.3 Shri M.B.Lal, Chairman SAC expressed his happiness said that he was happy to have good representation from refineries. In his opening remarks, he touched upon the challenges ahead considering that surplus refining capacity, state of the art refineries, demand / supply situation etc. Demand for petroleum products in 2009 is going to shrink by 1 M bbl / day. This will put pressure on margins. Challenges are known to us. Some of these are price, quality of products, viable residue conversion technologies, CTL, NGL etc. R&D can give vital clues in this direction.

The Chairman mentioned that during the last meeting, seven working groups were constituted for preparing approach paper on R&D strategies for submission to MOP&NG. Some of these groups will be making presentations during the meeting.

65.2 **Presentations of the Working Groups Constituted during the last SAC Meeting:**

65.2.1 **"Hydrogen" by ED IOC (R&D):**

65.2.1.1 Hydrogen being the clean fuel and the fuel of the future, working group was constituted to study various aspects of hydrogen for undertaking research studies.

65.2.1.2 Dr.R.K.Malhotra gave brief background on hydrogen, initiatives taken by Planning Commission, preparation of Roadmap by National Hydrogen Energy Board (NHEB) and creation of Rs.100 Crores Hydrogen Corpus Fund (HCF) by MOP&NG besides three-layer approval procedure for hydrogen project proposals. Four areas viz. hydrogen production, distribution, application, storage / handling and safety were identified by the Planning Commission.

He also shared the status of five projects on hydrogen, which have either been approved by the Steering Committee (2 Nos.) or are under approval (3 Nos.). Another project on 'Hydrogen production by dissociation of water / H_2S has been cleared by the Technical Committee on hydrogen.

65.2.1.3 NHEB Hydrogen roadmap considers an ambitious plan of running one million vehicles on hydrogen based IC engines and fuel cells by 2020. It also considers 1000 MW power generation through fuel cells. These vehicles would require about 7000 MT / day of hydrogen. Investment for the whole programme has been estimated to be Rs.25,000 Crores.

65.2.1.4 It was mentioned that IOC (R&D) in association with International Association of Hydrogen Energy (IAHE), IIT Delhi and IT-BHU is organising 'World Hydrogen Technology Convention' in August 2009 at New Delhi.

65.2.1.5 'Hydrogen Roadmap' prepared by the Working Group was presented for deliberations.

65.4.1.4.1 Today hydrogen is mostly produced through steam reforming of Naphtha. It was mentioned that steam reforming of CNG with established technology could be economically exploited. Delhi could have 4-5 reformers

with pipeline distribution network with short pipeline of 5-10 km.

65.4.1.4.2 Other options viz. water splitting at high temperature or through electrolysis or biologically splitting can be considered.

65.4.1.4.3 Catalytic partial oxidation of CNG with nano carbon production can be another route for H_2. M/s Shell and Hythane are working aggressively on it. HPCL-IIT Delhi project proposal on it is under approval.

65.4.1.4.4 Hydrogen can be sourced from chlor-alkali units since hydrogen along-with caustic soda is produced directly or indirectly at the negative electrode (cathode).

65.4.1.4.5 Hydrogen production from nuclear waste heat or from biomass gasification or liquid hydrogen from hydrides can be other potential routes.

65.2.1.6 As far as hydrogen storage is considered, metal hydrides and carbon nano tubes are the good options.

65.2.1.7 Various short and long-term projects identified for production, storage and application of hydrogen and international linkages were also discussed.

65.2.1.8 Project proposal on Hydrogen production by dissociation of water/ H_2S (a renewable source) utilising solar energy of BHU and IOC (R&D) is under approval.

65.2.1.9 Production cost, flexible H_2 production options, socio-economics, environmental cost & benefit and public acceptance are some of the challenges for hydrogen production.

65.2.1.10 Cost, weight and volume, boil-off losses (3-4% per day), slow release of hydrogen from Hydrides, re-fuelling time, durability and life-cycle and efficiency analyses are the areas to be addressed for storage.

65.2.1.11 Building a national hydrogen transportation & delivery infrastructure, trade-offs between hydrogen production options and hydrogen delivery options, minimising hydrogen leakage and reducing transportation & delivery cost are the challenges of transportation and delivery

65.2.1.12 Cost, system size, air, thermal & water management, improved heat recovery systems, durability & reliability, onboard hydrogen storage, cold weather operation, competition with other technologies and public acceptance are the challenges for fuel cell technology, which need to be tackled.

65.2.1.13 Initiating the discussions on the approach paper on hydrogen, Shri R.K.Singh Director (R) BPCL suggested to zero down on those hydrogen activities, which can help India both in short and long term viz. decentralised production and transportation through mobile van. It was mentioned that Lurgi, Air Products etc are aggressively working in the area of hydrogen. Fuel cell being more efficient, IC engines may be replaced with it. However, cost of fuel cell needs to be brought down.

65.2.1.14 Shri M.B.Lal Chairman SAC opined that while taking up hydrogen projects for research work, credit and debit to all the projects be given based on the merit and cost of each option. Hydrogen Corpus Fund kitty of Rs.100 Crores is very small and should be increased.

One of the suggestions was that international safety norms should be compiled and discussed as a safety drill. Known bottlenecks be identified, plus and minuses of all the routes be known and then course of action decided. One of the members suggested that due diligence of all the hydrogen production routes be done to come to some logical conclusion.

65.2.1.15 The Group will submit an approach paper with specific recommendations for submission to MOP&NG. Members of the working group felt that 1-2 more meetings would be required for finalising the approach paper on hydrogen.

65.2.2 **"Monitoring of Projects" by Director (T), EIL:**

65.2.2.1 Objective of this group was to develop a methodology to monitor the progress of projects while ensuring focus on specific targets and expenses.

65.2.2.2 The Committee was of the opinion that appropriate weightage needs be assigned to specific activities depending on the importance.

65.2.2.3 The project proposal should inter-alia clearly indicate the objective, cost estimate and phasing of expenditure, timeframe with milestones, likely partners and list of facilities to be installed along with likely suppliers of equipment etc.

65.2.2.4 To overcome the issue of Proven Track Record (PTR), demonstration units on semi commercial level should be set up for establishing the performance.

65.2.2.5 Major milestones suggested for project monitoring were preparation of enquiry for new hardware, bid evaluation, commercial evaluation and order placement, setting up of support facilities, interim report based on in-house collated data, installation of new facilities, experimental work, model validation, development of design methodologies and final report.

65.2.2.6 Project review should be done on monthly basis by the monitoring committee and on quarterly basis by the steering committee.

65.2.2.7 Initiating the debate, Dr.M.O.Garg, Director IIP said that we don't have laid-down procedure for project monitoring. R&D projects need mid course corrections based on the progress. Three issues need to be addressed viz. preparation of MOU, monitoring w.r.t. Milestones and change in scope.

65.2.2.8 The Group will submit the approach paper with firm recommendations, which can then be submitted to MOP&NG.

65.2.3 "Energy Efficiency Improvement in Refineries" by CGM, EIL (R&D):

65.2.3.1 Shri M.B.Lal, Chairman SAC placed on record the services of Dr.S.Banik, CGM EIL (R&D) and his contribution to EIL in general and to the SAC in particular.

65.2.3.2 Energy being the major chunk of operating expenses, working group on Energy efficiency improvement was constituted.

65.2.3.3 Dr. Banik said that typical opportunities for energy conservation in refineries may be in the areas of heat exchanger train, column internals, air preheat, outboard steam generator, air coolers, optimisation of vacuum pump and ejector for vacuum generation, pressure recovery turbines etc.

65.2.3.4 EIL had already undertaken energy conservation study at Saudi Aramco's Ras Tanura Refinery and identified potential for energy conservation.

65.2.3.5 Working Group identified some of the novel areas (not applied before) for energy conservation. These are progressive / successive distillation of crude / secondary conversion of products, vacuum flashing for maximisation of vacuum gas oil recovery, divided wall column technology, use of side re-boiler in Naphtha stabiliser, energy recovery from overhead vapour etc.

65.2.3.6 Progressive distillation (sequencing of column) requires less high-level heat while column pressure is optimised. It, however, may not be suitable in case of frequent crude change over.

65.2.3.7 Heat integration through thermally coupled divided wall column can save 30% both on energy and capital cost. Typically it can be used in naphtha splitter, for benzene reduction in gasoline and separation of 1-butene from C_4 mix feed.

65.2.3.8 Working group felt that some of the above ideas could be taken up for development and commercialisation.

65.2.3.9 Shri R.K.Singh, Director (R) BPCL initiating the debate said that internationally 45% of the total cost in the refining sector is for

energy, whereas in India it is 60-65%. Therefore scope is there for energy conservation.

65.2.3.10 Chairman SAC suggested that if members agree, an expert group with experienced members from EIL and CHT could be constituted to visit refineries for identifying areas for improvements. It was felt that part of the energy savings say 15% or so in line with Shell GSI can be paid to the team for their services.

65.2.3.11 The Group will submit a final report with specific proposals for considerations of SAC / MOP&NG.

65.3 **Presentation on on-going Projects:**

65.3.1 "Catalyst development for Isomerisation of C7+ hydrocarbons in industrial feedstock" by IIP:

65.3.1.1 IIP used 0.6% Pt on Isomerisation catalyst. However, in view of production of light products and not getting fully isomerised as well as low RON (70), some more work is required. IIP requested for extension of the project by six months i.e. up-to September 2009, which was agreed by the SAC.

65.3.1.2 Shri D.K.Tuli, GM IOC (R&D) suggested to consider C_{15}-C_{16} feed for Isomerisation studies, for which no catalyst is available in the market. IIP agreed with the suggestion.

65.3.2 "Solid acid catalyst for alkylation of isobutene with alkenes to form alkylates as gasoline blends" by IIP:

65.3.2.1 In view of some problems and very high cost and time in getting isobutene, IIP requested for extension of the project by one year, which was agreed by the SAC.

65.3.3 "Add-on facilities for development of trickle bed reactor technology: Part-III: large scale hydrodynamics studies for distributor and re-distributor / quench system" by EIL:

65.3.3.1 Part-I and Part-II studies were done on 6" column. Part-II will be done on 1.2 m dia column.

65.3.3.2 In view of non-availability of vendors for fabricating the equipment, EIL requested for another extension of the project schedule up-to September 2010, which was agreed by the SAC. It may be mentioned that the project has already been extended from March 2006 to March 2009. EIL confirmed that after global economy meltdown, vendors are now available for fabricating the equipment.

Day-2 deliberations:

65.4 **Opening of the Session:**

65.4.1 In the 2nd day of the SAC meeting, Shri R.K.Singh, Director (R), BPCL welcomed Chairman SAC, Shri M.B.Lal and Joint Secretary (R), Shri L.N.Gupta, IAS at the 'Oceanic' Hall BPCL Mumbai Refinery.

Shri Singh thanked Mr Lal, who spent maximum time in this refinery as well as Shri L.N.Gupta for making it to the SAC. He touched upon the deliberations of y'day.

65.4.2 Dr.K.S.Balaraman, Executive Director CHT welcomed the Chairman SAC, Joint Secretary (R), members of the SAC, executives of oil companies, Scientists, invitees and participants to the meeting.

65.4.3 Shri M.B.Lal Chairman SAC welcomed Shri L.N.Gupta, JS (R). He said that it was indeed a great moral booster for the SAC today to have dignitaries like Prof. J.P Gupta, S.Sivasanker, B.Viswanathan, Pal Ratnasamy, M.O.Garg, R.K.Singh, B.N.Bankapur, Anand Kumar etc. Presence of Shri L.N.Gupta will go a long way.

He said that one of the SAC supported project on 'Synthetic Aviation Lubricant' is expected to be completed by June 2009. The project will give strategic advantage to India in aviation lubricants. He said that of the seven working groups constituted for preparing approach paper on research activities during the last SAC meeting, three of them have made presentations y'day. These were on 'Hydrogen', 'Project monitoring' and 'Energy efficiency in refineries'. Today,

presentation will be by the working group on 'Acceptance of technology'. He also briefed about the agenda for the day.

65.4.4 Dr. Paul Ratnasamy suggested that tobacco seed in India is thrown away. Technology can be suitably developed to convert it to produce bio diesel, yield of which will be about 40-45%.

65.5 **Presentation by working group on 'Acceptance of Indigenous Technologies by oil companies' by Director (R), IOC:**

65.5.1 This subject was taken as an area of study because it was widely felt by many that several R&D efforts in India don't find commercial application and remains in lab scale, and deserve better acceptance by the refining industry.

65.5.2 Shri B.N.Bankapur, Director (R) gave brief background about constitution of the Working Group. He said that PSU oil companies in general supported adoption of indigenous technologies having manageable risk and cost. These included 11 from EIL, 7 from BPCL, 2 from HPCL, 6 from IIP and 7 from IOC (R&D). He said that high risk is involved if indigenous technologies do not work.

Lack of proven-ness, confidence and competitiveness w.r.t. capex, Opex; pilot plants / demonstration units, scale-up and engineering capabilities, support services etc are some of the reasons in poor acceptability of indigenous technologies.

65.5.3 It was suggested that focus should be on novel technologies viz. CTL, 2nd generation bio fuels etc. R&D organisations should join hands with engineering companies to synergise the knowledge, have pilot / demonstration plants, and make vigorous marketing efforts.

65.5.4 Suitable mechanism should be developed for adequate incentive to first user of the technology. Funding of pilot plants / demonstration units can be with grants from CHT / OIDB.

65.5.5 Up-gradation of indigenous technologies should be a continual activity. Attrition of manpower should be addressed for longer continuity of human resources.

65.5.6 Major recommendations of the working group were development of novel technologies, vigorous marketing strategy, road shows, targeting of private oil companies, nano science and catalyst development, continual up-dation / up-gradation, joining hands with engineering companies, suitable mechanism by CHT / OIDB for incentives for implementation of technology and for funding pilot plants / demonstration units.

65.5.7 JS (R) suggested that compendium of indigenous technologies including their implementation, time lag in development and implementation if any, improvements made to the technologies subsequent to their first adoption etc should be prepared for submission to MOP&NG. The compendium should also include the technologies to be developed / demonstrated in future and comparison of the same capturing the edge over other available technologies.

He said that system of adequate reward and incentive for R&D personnel should be there. There should be a separate budget for R&D activities in OIDB budget and MOP&NG will support it.

65.5.8 Shri M.B.Lal, Chairman SAC advised CHT to organise a conference / workshop on R&D after 3-4 months. An integrated scientific journal (6 monthly) on R&D activities may be published by IOC (R&D). It was also suggested to open a website for getting comments on presentations made.

65.5.9 Shri Anand Kumar Director IOC (R&D) said that some changes are required in the working group report on 'Acceptance of indigenous technologies', which they will be doing shortly.

65.6 **Presentation on "Cauvery Basin Refinery (CBR) of CPCL for demonstrating Indigenous Technologies" by IOC (R&D):**

65.6.1 A need was felt to have smaller capacity operating demonstration units, which can establish the proven-ness of Indian R&D work.

One of the options was to use CBR Refinery as a demonstration site for developing new processes arising from indigenous R&D efforts.

65.6.2 Shri Anand Kumar, Director IOC (R&D) gave an overview of the proposal under consideration for using CBR refinery for demonstrating the indigenous technologies. CBR Refinery with initial capacity of 0.5 MMTPA was revamped to 1.0 MMTPA. It is processing low sulfur KG basin, PY-3 and NM crude oils and producing diesel meeting BS-II specification. The refinery is having only CDU without any secondary or treatment units.

65.6.3 IOC (R&D) is considering the option of modernising the refinery using Indianoil developed technologies and meeting BS-III specification for diesel and gasoline on one hand, and demonstrating the technologies and their capabilities on the other.

65.6.4 IOC (R&D) considered four technologies viz. INDMAX (already commercialised) for RCO up-gradation, INDAdeptD (ready for commercialisation) for LCO desulphurisation, INDAdeptG for gasoline desulphurisation and INDTreat for LCN and LPG treating.

65.6.5 Total investment is expected to be Rs.601 Crores. In case funding for the project is arranged at concessional rate from OIDB, IRR would be 42%. IOC (R&D) has already discussed the subject matter with CPCL.

65.6.6 Shri B.N.Bankapur Director IOC (R) said that one of the options with CBR is to shutdown the refinery, as it cannot meet BS-III specification. Alternatively, CBR can be used for demonstrating IOC (R&D) technologies on one hand and meeting BS-III product quality on the other while earning the profit.

65.6.7 Initiating the discussions, Chairman SAC said that the indigenous technologies taken up for demonstration in CBR should be capable for handling streams from high sulfur crude oils since global competition for technologies will be largely based on such crude, and also for making the Euro-III or Euro-IV grades of MS and HSD.

Shri K.Murali, Director (R) HPCL also stressed to make it high sulfur based demo unit.

65.6.8 IOC (R&D) also desired for a suitable mechanism for funding the project through OIDB, which can be in the form of grant-in-aid.

65.7 **Presentation on "Second Generation Bio Fuels" by Dr.D.K.Tuli, GM IOC (R&D):**

65.7.1 Second generation bio fuels are bio-ethanol from lingo cellulose, sun-fuel from biomass or algae and bio-hydrogen.

65.7.2 Pre-treatment, hydrolysis, fermentation and separation are the route for ethanol production from lingo cellulose.

Cost reduction for pre-treatment, overcoming the recalcitrance of cellulosic biomass and use of less expensive enzymes are some of the challenges.

65.7.3 Currently, hydrogen is mostly produced from fossil fuel through reforming. Biomass and bio-assisted approaches offer good options. Different routes can be direct bio-photolysis, indirect bio-photolysis and dark fermentation.

In direct bio-photolysis, water can be split in presence of sunlight to hydrogen and oxygen. But major challenges are low conversion efficiency and oxygen sensitivity of hydrogenase enzyme.

The concept of indirect-photolysis involves aerobic dark fermentation yielding four moles of H_2 / mole of glucose in algae cell.

65.7.4 In dark fermentation, anaerobic bacteria as well as micro algae on carbohydrate rich biomass substrates is used to produce H_2. Bio-fuel yield from algae is higher at about 30%. This process can produce hydrogen throughout the day without sunlight.

65.7.5 Bio-diesel from algae is limited because of high concentration of polyunsaturated fatty acids, harvesting, extraction and conversion

and water quality. Economics of algal bio-diesel need to be improved to make it competitive.

65.7.6 It was mentioned that Texaco is having a 10 MT / day pilot plant for production of bio-diesel from sunlight, wherein CO_2 is the raw material for bio-diesel. This process will take care of GHG as well. SAC can look into it.

65.7.7 The presentation was only for information. However, it was felt that IOC should develop firm proposal for production of 2nd generation bio fuels for putting up to the SAC.

65.8 **Presentation on 'Coal-to-liquid' by EIL:**

65.8.1 EIL made a brief presentation on CTL as well as their approved project. SAC requested both EIL and BPCL to expedite the progress of the approved CTL project as only MOU was signed so far.

65.9 **Presentation on "FT catalyst / process development" by Prof. S.Sivasanker, IIT Madras:**

65.9.1 NCCR at IIT Madras was set up by DST, 2 years ago. NCCR along with CPCL proposed to put up a proposal to develop cobalt based Fischer Tropsch catalyst that combines high activity, selectivity and life for low temperature operation as well as development of catalytic reactors.

65.9.2 FT diesel is better than petro-diesel w.r.t. Cetane Index and density. FT process is highly exothermic. CPCL is interested to convert petcoke to syngas.

65.9.3 Total cost of the project is Rs.377 Lakhs of which Rs.227 Lakhs is sought from CHT / OIDB. Completion schedule of the project is 3 years.

65.9.4 The proposal will be sent to SAC members for obtaining their viewpoints for discussions in the next SAC meeting.

65.10 **Presentation on "Process Intensification" by RGIPT:**

65.10.1 Prof. J.P.Gupta made a presentation on Process Intensification of Rajiv Gandhi Institute of Petroleum Technology (RGIPT). RGIPT was set up by an act of Parliament in December 2007 at Jais, Rae Bareli.

Process Intensification (PI) is basically to make the plants smaller, safer, faster, cheaper, environment friendly, product specific, energy efficient, smaller footprint etc. He said that NCL, IISc, IIT Kanpur and Madras, UICT etc are working on PI.

65.10.2 Some of the PI application can be in the field of steam reforming of natural gas, reforming of naphtha to gasoline, dehydrogenation of alkanes and ethyl benzene, ethylene polymerisation methyl and ethyl acetate production, ethanol / propanol distillation, ethanol from bio-ethanol, polyolefins production, solvent extraction etc.

65.10.3 PI can also be used in offshore activities for making platform smaller, enhanced oil recovery, gas stripping, NG conditioning, bio-diesel production etc.

65.10.4 RGIPT wants to set up a laboratory for fundamental research to develop scientific basis for PI. Their proposal envisages investment of Rs.1040 Lakhs and requested for grant-in-aid from OIDB through SAC.

65.10.5 SAC in principle agreed to the RGIPT proposal on process intensification. However, for pursuing further in the matter, specific proposal need to be developed for carrying out PI studies and submitted to the SAC for funding.

65.11 **Concluding Remarks by Shri L.N.Gupta, JS (R):**

65.11.1 Shri L.N.Gupta in his concluding remarks said that SAC is working extensively for the last 27 years to improve the research activities in the field of hydrocarbon. He was happy to note that most of the actions that were suggested during the 64th meeting by the Secretary, P&NG have been covered in this meeting.

65.11.2 He expressed concern on volatile crude oil price and touched upon areas like GHG emission, bio-fuels should be the priority of the SAC. Bio-fuel can trigger rural employment, algae have the great possibility, conversion of CBR is important and concept of PI was very interesting. He said that Nano is the result of entrepreneur efforts through process intensification. Centre of excellence should be supported.

65.11.3 JS (R) suggested that perspective plan for R&D should be made. Focussed areas and projects should be identified. Funds are never the problem.

65.11.4 It was suggested that RGIPT could work in the area of PI whereas IOC (R&D) can work for bio-fuels.

65.12 Shri B.D.Ghosh, Director CHT, presented vote of thanks.

Annexure

Participants to the 65th Meeting of the Scientific Advisory Committee on Hydrocarbons of MOP&NG held on 23rd March 2009 at BPCL, Corporate Office and on 24th March 2009 at Mumbai Refinery

S. No.	Organisation	Name, S/Shri	Designation
1.	SAC	M.B.Lal	Chairman
2.	IIP, Dehradun	Dr.M.O.Garg, Director	Member
3.	-do-	Dr.V.V.D.N. Prasad, Scientist	---
4.	IOC HQ	B.N.Bankapur, Director (R)	Member
5.	-do-	Govind Ram, GM (T)	---
6.	BPCL	R.K.Singh, Director (R)	Member
7.	-do-	P.S.Bhargava, ED Mumbai Refinery	---
8.	EIL	M.K.Joshi, Director (T)	Member
9.	-do-	Dr.S.Banik, CGM EIL (R&D)	Permanent Invitee
10.	CHT	Dr.K.S.Balaraman, ED	Member Secretary
11.	MOP&NG	L.N.Gupta, Joint Secretary (R)	Permanent Invitee
12.	HPCL	K.Murali, Director (R)	Permanent Invitee
13.	HPCL	Dr. R.P.Verma	Consultant
14.	IOC(R&D)	Anand Kumar, Director (R&D)	Permanent Invitee
15.	-do-	Dr. R.K. Malhotra, ED	---
16.	-do-	Dr. D.K. Tuli, GM (PC&AE) & CEO, IT	---
17.	-do-	Brijesh Kumar, DGM (HD)	---
18.	BPCL (R&D)	Dr.M.A.Siddiqui, ED (R&D)	Permanent Invitee
19.	-do-	N.V.Choudary, CM	---
20.	-do-	Dr.Ravi Kumar	---
21.	CPCL		Special Invitee
22.	NCL	P. Ratnasamy	---
23.	IIT-Madras	S. Sivasanker	---
24.	- do -	B. Vishwanathan	---
25.	RGIPT	Prof. J.P. Gupta	---
26.	CHT	B.D.Ghosh, Director	---
27.	-do-	A.K.Agarwal, Director	---
28.	- do -	S.Bose, Jt. Director (Admn.)	---

1.	M.B.Lal Member Technical (PNG), Appellate Tribunal for Electricity, Core-5, 6th Floor, SCOPE Complex, Lodhi Road, **New Delhi**-110 003	Chairman
2.	Dr.M.O.Garg, Director, Indian Institute of Petroleum, P.O.IIP, Mohkampur, **Dehradun**-248 005 (Uttrakhand)	Member
3.	Professor S.K.Biswas, Department of Mechanical Engineering, Indian Institute of Science, C.V.Raman Avenue, **Banglore**-560 012	Member
4.	Professor D.N.Saraf, University of Petroleum and Energy Studies, Village Bitholi, Via Prem Nagar, **Dehradun-248 007** (Uttrakhand)	Member
5.	Dr. S.Pushpavanam, Professor, Chemical Engineering Department, Indian Institute of Technology-Madras, P.O. IIT, **Chennai**-600 036	Member
6.	Shri B.N.Bankapur, Director (Refineries), Indian Oil Corporation Ltd., SCOPE Complex, 5th Floor, Core-2, Lodhi Road, **New Delhi-110 003**	Member
7.	Shri R.K.Singh, Director (Refineries), Bharat Petroleum Corporation Ltd., Bharat Bhawan, 4&5 Currimbhoy Road, Ballard Estate, P.B. No. 688, **Mumbai**-400 001	Member

8.	Shri M.K.Joshi, Director (Tech.), Engineers India Limited, EI Bhawan, 1, Bhikaiji Cama Place, **New Delhi**-110 066	Member
9.	Dr. D.M.Kale, Director General, ONGC Energy Centre, 10th Floor, Core-4, SCOPE Minar Complex, Luxmi Nagar, **New Delhi**-110 092	Member
10.	Shri Arun Kumar, Oil Industry Development Board, 301, World Trade Centre, Babar Road, **New Delhi**-110 001	Member
11.	Dr.K.S.Balaraman, Executive Director, Centre for High Technology, SCOPE Complex, Lodhi Road, **New Delhi**-110 003	Member- Secretary
12.	Shri R.S.Pandey, Secretary, Ministry of Petroleum & Natural Gas, Shastri Bhawan, **New Delhi**-110 001	Permanent Invitee
13.	Shri L.N.Gupta, Joint Secretary (Refineries), Ministry Of Petroleum & Natural Gas, Shastri Bhawan, **New Delhi**-110 001	Permanent Invitee
14.	Shri D.Pathak, Director (R&A), Ministry Of Petroleum & Natural Gas, Shastri Bhawan, **New Delhi**-110 001	Permanent Invitee
15.	Shri K.Murali, Director (Refineries), Hindustan Petroleum Corporation Ltd., 17, Jamshedji Tata Road, P.O. Box No. 11041, **Mumbai**-400 020	Permanent Invitee

16. Shri Anand Kumar,
Director,
Indian Oil Corporation Ltd.,
R&D Centre,
Sector-13,
Faridabad-121 007

Permanent
Invitee

17. Dr. M.A.Siddiqui,
Executive Director (R&D),
Bharat Petroleum Corporation Ltd.,
Corporate R&D Centre,
Plot No. 2A,
Udyog Kendra,
Greater Noida (U.P.)

Permanent
Invitee

18. Shri G.Sri Ganesh,
General Manager (R&D),
Hindustan Petroleum Corporation Ltd.,
Mumbai Refinery,
Corridor Road, Mahul,
Mumbai-400 074

Permanent
Invitee

19. Dr.Ajay Deshpandey,
Deputy General Manager (R&D)
Engineers India Limited,
Sector-16,
Gurgaon-122 001

Permanent
Invitee