उच्च प्रौद्योगिकी केन्द्र
(पेट्रोलियम एवं प्राकृतिक गैस मंत्रालय)

सीएचटी

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

CHT/ASP/ 2398

Date: 03rd January 2011

To,

Scientific Advisory Committee (SAC) on Hydrocarbons of MoP&NG:

- Chairman & Members of SAC and Permanent & Special Invitees (as per list attached)

Dear Sir,

Sub: **Minutes of the 68th Meeting of the Scientific Advisory Committee (SAC) on Hydrocarbons of Ministry of Petroleum & Natural Gas**

Wish You A Very Happy & Prosperous New Year 2011.

Enclosed please find a copy of the Minutes of 68th Meeting of the Scientific Advisory Committee (SAC) on Hydrocarbons of Ministry of Petroleum & Natural Gas held on 1st December 2010 at Hotel Janpath, New Delhi, for your kind information and necessary action.

Thanking you,

Yours faithfully,

3/1/2011

(B.D.Ghosh)
Executive Director

Enci. As above

ED

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Chairman, Members, Permanent Invitees and Special Invitees to the Scientific Advisory Committee

1.	Shri Arun Balakrishnan A – 25, Little Gibbs Road, Malabar Hill, **Mumbai** – 400 006	Chairman
2.	Dr. J. P. Gupta, Director, Rajiv Gandhi Institute of Petroleum Technology, Ratapur Chowk, **Rae Bareli** – 229 316 (U.P.)	Member
3.	Dr. M.O.Garg, Director, Indian Institute of Petroleum, P.O.IIP, Mohkampur, **Dehradun** – 248 005 (Uttarakhand)	Member
4.	Dr. R. Kumar, Professor Emeritus, Department of Chemical Engineering, Indian Institute of Science, Bangalore, **Bengaluru** – 560 012 (Karnataka)	Member
5.	Prof. Shantanu Roy, Department of Chemical Engineering, Indian Institute of Technology-Delhi, Hauz Khas, **New Delhi** – 110 016	Member
6.	Prof. G. D. Yadav, Director, Institute of Chemical Technology, Nathalal Parekh Marg, Matunga (East), **Mumbai** – 400 019	Member
7.	Shri G. D. Goyal, Director (Commercial), EI Bhawan, Engineers India Limited, 1, Bhikaiji Cama Place, **New Delhi** – 110 066	Member
8.	Shri S. K. Srivastava, Director General, Director General of Hydrocarbons, C – 139, Sector 63, **NOIDA** – 201 301 (U.P.)	Member
9.	Shri B. N. Bankapur, Director (Refineries), Indian Oil Corporation Ltd., SCOPE Complex, 5th Floor, Core-2, Lodhi Road, **New Delhi** – 110 003	Member

10.	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
11.	Shri K. Murali, Director (Refineries), Hindustan Petroleum Corporation Ltd., 17, Jamshedji Tata Road, P.O. Box No. 11041, **Mumbai** – 400 020	Member
12.	Dr. R. K. Malhotra, Director (R&D), Indian Oil Corporation Ltd., R&D Centre, Sector-13, **Faridabad** – 121 007	Member
13.	Shri Arun Kumar, Secretary, Oil Industry Development Board, OIDB Bhawan, Plot No. 2, Sector – 73, **NOIDA** – 201 301 (U.P.)	Member
14.	Shri B. D. Ghosh, Executive Director, Centre for High Technology, SCOPE Complex, Lodhi Road, **New Delhi** – 110 003	Member- Secretary
15.	Shri S. Sundareshan, Secretary, Ministry of Petroleum & Natural Gas, Shastri Bhawan, **New Delhi** – 110 001	Permanent Invitee
16.	Shri Sudhir Bhargava, Additional Secretary, Ministry of Petroleum & Natural Gas, Shastri Bhawan, **New Delhi** – 110 001	Permanent Invitee
17.	Shri L. N. Gupta, Joint Secretary (Refineries), Ministry Of Petroleum & Natural Gas, Shastri Bhawan, **New Delhi** – 110 001	Permanent Invitee
18.	Shri P. K. Singh, Director (R&A), Ministry Of Petroleum & Natural Gas, Shastri Bhawan, **New Delhi** – 110 001	Permanent Invitee

19.	Shri K. V. Seshadri, Executive Director (Mumbai Refinery and R&D), Bharat Petroleum Corporation Ltd., Mahul, Chembur **Mumbai** – 400 074	Permanent Invitee
20.	Shri G. Sri Ganesh, General Manager (R&D), Hindustan Petroleum Corporation Ltd., 17, Jamshedji Tata Road, P.O. Box No. 11041, **Mumbai** – 400 020	Permanent Invitee
21.	Shri Ajay Deshpande, General Manager (R&D), Engineers India Limited, Sector-16, **Gurgaon** – 122 001	Permanent Invitee
22.	Shri K. Balachandran, Managing Director, Chennai Petroleum Corporation Limited, 536, Anna Salai, Teynampet, **Chennai** – 600 018	Special Invitee
23.	Shri M. R. Hingnikar, Executive Director (R&D), GAIL (India) Limited, PARC Building, Plot no. 24, Sector – 16 A, **NOIDA** – 201 301 (U.P.)	Special Invitee

Date: 03rd January 2011

Minutes of the 68th Meeting of Scientific Advisory Committee (SAC) on Hydrocarbons of MOP&NG held on 1st December 2010 at Hotel Janpath, New Delhi – 110001:

68.1 Opening of the Session

68.1.1 **Shri B.D.Ghosh, ED, CHT** welcomed Shri. Arun Balakrishnan, Chairman SAC; Shri L.N.Gupta, Joint Secretary (R), MOP&NG; members of the newly constituted SAC, senior officials from MOP&NG, invitees, academia and scientists to the 68th SAC meeting. He gave an overview of SAC in his opening remarks.

68.1.2 In his address, **Chairman SAC** welcomed the members of the newly constituted committee and hoped for meaningful contribution from the members. Considering the fact that only about 10% projects could be commercialised, he stressed upon peer review of projects as well as commercialisation efforts.

68.1.3 **Shri L.N. Gupta, JS (R)** welcomed all and said that he is pleased to be here with the scientists and technocrats, without whom there could not have been much progress.

He stressed upon areas of concern and said that the existing projects are taking considerable time for completion thereby resulting in less commercialisation. He hoped that the peer review as suggested by Chairman SAC would be more fruitful to address this concern. He said that commercialisation should be the main agenda for the Committee.

JS (R) highlighted the uniqueness of SAC and observed that SAC is quite mature with 67 meetings to-date over a period spanning nearly 29 years without interruption. He remarked that though the primary mandate to the SAC is for development of indigenous capability and technical competence, the body needs to address issues pertaining to marketing and production as well. Besides development of cost effective research, optimisation and improvement, the future need may call for enlarging the focus and reducing the external vulnerability. Some of the new areas which could be targeted are nano-technology, CTL / GTL, energy, difficult feed processing along with fruitful utlisation of Hydrogen Corpus Fund (HCF).

JS (R) also requested SAC to deliberate on future fuel requirements and scrapping of old non-compliant vehicles. He wished meaningful contribution from the newly constituted committee members to the hydrocarbon sector.

68.1.4 **Shri A.K. Agarwal, Director CHT** gave a brief presentation about the role of CHT and its contribution to SAC. He also informed the members about the recently constituted Committee of MOP&NG to suggest modalities for commercialisation of the completed and potential research projects.

68.1.5 **Chairman SAC** invited members from the academia to give their views on R&D projects.

68.1.6 **Dr. R. Kumar** stressed on the need for orientation of research towards industrial application. He opined that with indigenisation alone we may be out of sync and hence should focus towards internationalisation. He said that we need to look on the projects in an integrated way including the user for the developed technology. Test or challenge today is not to develop the technology but to sell / export the same. He also felt that much more contribution can be made by Corporate Research Laboratories (CRLs) as they are the best judge to decide on analysing and competing processes. He suggested that SAC should spend / deliberate more on high scientific content and futuristic technologies.

68.1.7 **Prof. Shantanu Roy** expressed that there is considerable dis-connect between the Industry and Academia and there is urgent need to correct it and address the issue. The possible remedy to this, suggested by JS (R), was having an active MOU for transferring industry issues to academia and vice-versa. He said that CHT is known to very few in academia, its presence felt should be increased. For any research activity, global picture of work is required to be known.

68.1.8 **Prof. G.D.Yadav** said that technology should be developed for recovery of stranded oil. He said that methyl formate going to be main source of petrochemicals. As most of the processes are catalyst based, there is considerable engineering challenges involved which need to be addressed.

68.1.9 **Shri S.K.Srivastava, DG, DGH** while expressing his views spoke about upstream oil sector and stressed on increasing / improving the recovery of oil from oil reservoirs. While it is 25% in India, in countries like Norway it is nearly 60%.

68.1.10 **Shri B.N.Bankapur, Director (R), IOCL** said that instead of doing research and looking for commercialisation, one should look and then do the research and only niche technologies should be developed. He also agreed with Prof. R.Kumar that we should focus on internationalisation and not indigenisation.

Coke and coal are surplus, but no technology is available except with SASOL and Shell. Technology for FO desulphurisation is very cost prohibitive and needs to be looked into. Cost of hydrogen production is very high, one should look how to make it economical.

68.2 **Presentations:**

ED (R&D), GAIL gave brief background about the three hydrogen project proposals submitted by GAIL. Of these two proposals were on storage of Hydrogen while the third one was application oriented on demonstration of PEM Fuel Cell using hydrogen.

68.2.1 **"Development of Light weight Composite Cylinders for Storage of Hydrogen gas using fibre reinforced plastic materials" by GAIL:**

68.2.1.1 **Dr.S.Sarkar** briefed about the highlights of the project which was proposed to be taken up in collaboration with M/s Shriram Institute of Industrial Research, New Delhi. The proposal aims at indigenous design and development of lightweight and safe metal-plastic composite cylinders for storage of compressed

gas for vehicular application in India. The project was proposed to be addressed in three phases involving different cylinder capacities over a period of three years.

68.2.1.2 **Dr. R.Kumar** suggested involving the users, in this case is automobile manufacturer, who would be keen in joining the project. He also opined that the initial activities on the material development and testing for all the three cases be taken up in parallel due to common-ness which will help in reducing the overall project schedule.

Moreover, he expressed that the project should set target for storage of hydrogen on the basis of unit volume as well as unit mass against pre-defined benchmarked value. In view of uniform / linear pressure, only cylinders should be considered for development. He also opined that the developed material should first be tried with CNG instead of hydrogen.

68.2.1.3 **Dr.R.K.Malhotra, Director (R&D) IOC** said that because of cylinder weight, automobile manufacturers would like to have composite cylinders for storage. GAIL confirmed that Maruti, Ashok Leyland and Hero Honda have shown interest in this project.

He suggested exploring IPR issues for freedom of proceeding. CSIR organisation URDIP, Pune may help in this regard.

68.2.1.4 **Prof. G.D.Yadav** suggested considering the tropical temperature for the project.

68.2.1.5 ***Chairman advised GAIL to address all the above issues, deliberate with experts, compare the project with the best technologies that are available today and submit the modified proposal.***

Chairman also suggested to submit the list of people and credential of Shriram Institute who will be working on the project to CHT.

68.2.2 **"Development of Novel Nano-composite Hydrogen Storage materials" by GAIL:**

68.2.2.1 The project is proposed to be taken up with Alternative Energy and Nanotechnology Laboratory (AENL) of IIT Madras, Chennai as partner. It is a fundamental research project with an objective to develop nano-composite system for hydrogen storage and evaluation of its performance.

68.2.2.2 Zeolite based structures are proposed to be used for developing / testing the nano-composite materials.

68.2.2.3 Nano-composite material should be looked not from adsorbing point of view of hydrogen but also from releasing point of view.

68.2.2.4 Since this is an important area of research, SAC suggested GAIL organising a workshop on nano-particle for knowledge

and sharing. Discussions on characteristics we desire, ability to store at room temperature, adsorption, rate of release, defining materials etc could be included to identify potential target materials for hydrogen storage.

68.2.2.5 **Dr.R.K.Malhotra, Director (R&D) IOC** suggested involving Prof. P.N.Srivastava of BHU in this regard. Prof.G.D.Yadav may also be involved.

68.2.2.6 ***Chairman advised to compare the project with the best technologies that are available today and requested GAIL to review the project proposal, address the issues and revert with modified proposal for review by SAC.***

68.2.3 **"Development & demonstration of a 25 KW PEM Fuel Cell System (scaled up from 10kW)" by GAIL:**

68.2.3.1 **Dr.S.Sarkar** said that this is a collaborative project with Centre for Fuel Cell Technology (CFCT) under Department of Science & Technology and aims at development of capability for design of 25 KW Proton Exchange Membrane (PEM) Fuel Cell, which will be tested in an industrial environment for its reliability and robustness. The know-how generated is proposed to be extended for clean power generation and captive power.

68.2.3.2 **Prof. R.Kumar** said that 25 KW fuel cells are already available, why we want to develop them. Improvement is important rather than developing.

68.2.3.3 **Dr.S.Banik** suggested involving engineering company such as EIL at developing stage itself as it calls for considerable engineering expertise.

68.2.3.4 **Dr.R.K.Malhotra** enquired about efforts so far made by either CFCT or GAIL for commercialisation of 10 KW PEM FC, as these also have an extensive market with cell tower companies. CH SAC said that 5% of diesel sold in India used by cell towers.

68.2.3.5 ***Chairman suggested GAIL to review the project with Dr.R.Kumar, Prof. G.D.Yadav and other experts and put up the fresh proposal. Also submit the list of people who will be working on the project.***

68.2.4 **"Desulfurization of FO using Solvent Extraction route" by CPCL & IIP, Dehradun:**

68.2.4.1 The project proposal was briefed by Dr. S.M.Nanoti of IIP. CPCL had approached IIP for developing a process for desulfurization of fuel oil considering future specification. The proposal is for Phase-1 only, which shall be followed by Phase-2 involving test run in Pilot plant at CPCL using internal resources.

68.2.4.2 Although specifications for RFO depend on the end user, the desired sulphur content should be < 1%. Estimated cost of the

project was Rs.37.67 Lakh, whereas IIP presented a revised cost of Rs.133.6 Lakh. The increase in cost was due to modified scope of work requiring equipments for ultra-sonic and microwaves.

68.2.4.3 Dr. R. Kumar suggested that all element of the project be reviewed and specified. He also opined that microwave approach may be more fruitful as compared to ultrasound and advised IIP to focus studies with microwaves. He also suggested using non conventional solvents. He expressed that this would be a do-able project.

68.2.4.4 ***Since IIP has revised the cost estimate of the project from the earlier submission, IIP was requested to submit the revised project proposal covering the views expressed by the members.***

68.2.5 **"Studies on Suitability of Indian Petroleum Feed Stocks for Needle Coke and Carbon Fibre through Mesophase formation" by IIP, Dehradun:**

68.2.5.1 SAC during 67th meeting observed that needle coke technology is already available with IOC who has US patent and therefore suggested considering production of carbon fibre and expanding the scope to have more value addition.

68.2.5.2 The revised project proposal aims to make pitch fibres from molten mesophase pitch besides meeting the earlier objective.

68.2.5.3 The revised project cost is Rs.126.50 Lakh with a time schedule of 30 months, primarily due to requirement of Spinneret for making the fibres. Initial cost of the project was, however, Rs.75 Lakh with completion schedule of 18 months.

68.2.4.5 ***SAC advised to have a discussion between smaller group consisting of IOC (R&D), IIP, CHT and Dr.R.Kumar either at IIP or CHT on existing and the proposed technology. Chairman also suggested addressing the issue of correlation between quality of feed and carbon fibre. The decision on approving the project shall be taken up subsequently.***

68.2.6 **"Review of Coal to Liquid (CTL) Fuels Technology Project" by EIL R&D / BPCL R&D:**

68.2.6.1 Shri Ajay Deshpande, GM (R&D) EIL briefed about the present status of the project which is being done along with BPCL (R&D). The progress of the project was summarized by Dr. R.N.Maiti, EIL.

68.2.6.2 EIL informed about the difficulties encountered in procurement of gasifier and consequent need to source gasifier on development term basis. As per the SAC suggestion in its previous meeting, concerted efforts were made by EIL and BPCL to arrive at feasible tie-up with L&T for getting the

gasifier. However, in the absence of any committed proposal from L&T, the arrangement could not materialise.

68.2.6.3 In this regard, M/s Thermax was also approached by EIL who have shown interest to associate in the project as a development partner for gasifier only.

68.2.6.4 EIL informed that the patent rights or royalty generated in commercialisation of "gasification technology" only will be shared with M/s Thermax to the extent of 25% and balance 75% between EIL / BPCL / CHT in line with MOU already signed with CHT. This was necessitated since M/s Thermax would be sharing the 25% cost of the gasifier development project.

68.2.6.5 The Committee members agreed with the EILs proposal for associating M/s Thermax as development partner only for gasifier. EIL and BPCL will sign a separate MOU with Thermax for gasifier.

68.2.6.6 EIL also informed members that 63rd Meeting of SAC had recommended initial sanctioning of 20% of Rs.16.5 Crores for this project i.e. Rs.3.3 Crores, of the total approved funding (Rs.33 Crores to be shared on 50:50 basis). The remaining funding was to be reviewed based on the progress of the project.

68.2.6.7 A proposal for funding beyond the initial sanction of 20% was submitted by EIL for consideration and sanctioning of balance 80% of funds.

68.2.6.8 SAC reviewed the progress of the project in detail and suggested EIL to explore end-users, willing to implement the technology so developed. EIL agreed to explore the same parallelly.

68.2.6.9 ***SAC gave the go-ahead to the proposal of EIL for association with Thermax for gasifier procurement and also approved releasing the remaining 80% funds for the project.***

68.3 **Presentations on Completed Projects:**

68.3.1 "Catalyst development for Isomerisation of C7+ hydrocarbons with Industrial feed stock" by IIP, Dehradun:

68.3.1.1 Dr. Nautiyal said that the objective of the project was to develop a zeolite based catalyst for Isomerisation of C7+ paraffin hydrocarbons in the industrial pre-treated feedstock to have suitable product for gasoline pool.

68.3.1.2 IIP informed that the project has been successfully completed with the development of catalyst which has been tested on n-heptane, n-octane and naphtha isomerisation.

68.3.1.3 The Zeolite based catalyst developed has high surface area, optimum acidity and high dispersion of noble metal. The novel preparation method has facilitated optimising the catalyst activity to produce less cracking products and more isomers. Isomer yield of 65% wt and 55-58% wt have been obtained from individual paraffins and naphtha respectively.

68.3.1.4 Chairman opined that the present project may be considered completed as the stated objectives have been met. He also remarked that for commercialisation purposes, light kerosene cut may be tested.

68.3.1.5 ***SAC also opined that any completed project before it comes to SAC for appraisal should be put up to a Committee, who should submit a one page report on achievement of the project vis-à-vis its objective.***

68.3.2 "Development of Solid Acid Catalyst for the Alkylation of Iso-butane with alkenes to form Alkylates as Gasoline blend" by IIP, Dehradun:

68.3.2.1 Objective of the project was to develop catalyst for Alkylation of Iso-butane with alkenes to form alkylates as gasoline blends, said Dr. Nautiyal.

68.3.2.2 IIP informed that conversion of butenes with 74% alkylate yield was achieved with the developed catalyst and has exhibited much better performance when compared with standard set of catalysts.

68.3.2.3 The research work has resulted in successful development of catalyst having properties such as high strong Bronsted acidity; higher alkylate yields compared to the standard catalysts, higher TMP and lower DMH, longer sustained performance, reproducibility and regenerability.

68.3.2.4 On a query from Dr. R. Kumar, it was informed that the catalyst life did not show any decline in activity when studied over a period of 14 hours against 7 hours for standard ones.

68.3.2.5 Shri. K.Murali, Director (R) HPCL indicated that HPCL is ready to take the lead in testing the catalyst on a commercial scale.

68.3.2.6 ***Chairman opined that the present project may be considered completed as the stated objectives have been met. He also expressed that the catalyst can be exploited for commercial applications.***

68.3.3 "Add-on facilities development for Trickle Bed Reactor Technology: Part-1: Large Scale hydrodynamic studies for distributor and re-distributor / quench systems" by EIL:

68.3.3.1 The presentation was made by Dr. R.N.Maiti, EIL.

68.3.3.2 The objective of the project was to carry out research work and study hydrodynamics in large diameter columns for

development of Trickle Bed Reactor (TBR) technology for addressing various aspects of hardware design.

68.3.3.3 EIL informed that the project has been completed in September 2010 without any cost implication. Main reason for the delay, it was informed, was due to non-availability of vendors for fabrication of experimental facility, essential to carry out the data collection and testing of various distributors / re-distributors in 1.2M diameter column.

68.3.3.4 The research work has resulted in successful design of a new distributor system with other internals like inlet diffuser, catalyst support grid, outlet collector box.

68.3.3.5 As a part this project, Residence Time Distribution (RTD) studies were undertaken with BARC. CFD model for TBR was developed partnering with IIT Delhi. The evaluation of distributor performance using gamma-ray tomography was undertaken by IOC (R&D). The hydrodynamic models based on fundamental principles have been used successfully to validate the experimental data.

68.3.3.6 The design of distributor and other internals has been implemented in commercial reactor offered to IOCL-BGR (DHDT unit) and FGH unit of HMEL (GGSR).

68.3.3.7 ***Chairman and other members opined that the present project may be considered completed as the stated objective has been met and commercial applications have also been achieved.***

68.4 **Concluding Remarks:**

68.4.1 Chairman in his concluding remarks appreciated the excellent views expressed by members of the newly constituted SAC and other participants to the meeting.

68.4.2 ***Chairman suggested that the Project proponents be advised to give a PERT Chart and details of the persons working on the project.***

68.4.3 ***Chairman agreed that CHT will organise a brain storming session as part of the next SAC meeting to be held shortly.***

68.4.4 Shri B.D.Ghosh, ED (CHT), thanked Chairman and other participants for a very fruitful meeting. He thanked Chairman for steering the SAC effectively for smooth functioning of SAC and valuable advice on future R&D projects.

68.4.5 List of participants is enclosed as **Annexure**.

Annexure

Participants to the 68th Meeting of the Scientific Advisory Committee (SAC) on Hydrocarbons of MOP&NG held on 1st December 2010 at Hotel Janpath, New Delhi

S. No.	Organisation	Name, S/Shri	Designation
1.	SAC	Arun Balakrishnan	Chairman
2.	MoPN&G	L.N. Gupta, JS (R)	Permanent Invitee
3.	MoPN&G	P.K. Singh, Dir (R&A)	Permanent Invitee
4.	MoPN&G	B.K. Datta, US	Permanent Invitee
5.	MoP&NG	A. Goswami, US	Permanent Invitee
6.	OIDB	Arun Kumar, Secretary	Member
7.	IOC	B.N. Bankapur, Director (Refineries)	Member
8.	- do -	Dr. R.K. Malhotra, Director (R&D)	Member
9.	- do -	Dr. K.P. Naithani, ED (R&D)	---
10.	- do -	S. Rajagopal, GM (R&D)	---
11.	- do -	Anup Kacker, GM (R&D)	---
12.	- do -	S.K. Ganguli, DGM (R)	---
13.	CPCL	K. Balachandran, MD	Special Invitee
14.	DGH	S.K. Srivastava, DG	Member
15.	- do -	R.K. Sinha, Advisor (P)	---
16.	BPCL	K.V. Seshadri, ED (MR / R&D)	Permanent Invitee
17.	BPCL (R&D)	Dr. N.V. Choudary, CM	Member
18.	- do -	Dr. V. Ravikumar, SM	---
19.	EIL (R&D)	Ajay Deshpande GM (R&D)	Permanent Invitee
20.	- do -	Dr. R.N. Maiti, SM	---
21.	- do -	Dr. S. Banik, Advisor	---
22.	HPCL	K. Murali, Director (Refineries)	Member
23.	- do -	G. Sri Ganesh, GM (R&D)	Permanent Invitee
24.	- do -	Dr. R.P.Verma, Consultant	---
25.	- do -	R.N. Mathur, CM	---
26.	IIP, Dehradun	Dr. M.O. Garg, Director	Member
27.	- do -	Dr. S.M. Nanoti	---
28.	- do -	Dr. N. Viswanadham	---
29.	- do -	Dr. B.R. Nautiyal	---
30.	- do -	Dr. Manoj Srivastava	---
31.	- do -	Dr. U.C. Agrawal	---
32.	GAIL	S.Venkatraman, Director (BD)	Special Invitee

S. No.	Organisation	Name, S/Shri	Designation
33.	GAIL	M.R. Hingnikar, ED (R&D)	Special Invitee
34.	- do -	Dr. S.Sen, GM (R&D)	---
35.	- do -	Dr.S. Sarkar, DGM	---
36.	- do -	T. Nandakumar, Mgr.	---
37.	IISc., Bangalore	Prof. R. Kumar	Member
38.	IIT Delhi	Dr. Shantanu Roy, Assoc. Prof.	Member
39.	ICT, Mumbai	Prof. G.D. Yadav, Director	Member
40.	CHT	Shri B.D.Ghosh, ED	Member Secretary
41.	-do-	A.K.Agarwal, Director	---
42.	-do-	R. Krishnamurthy, Director	---
43.	-do-	O.P. Raghav, Director	---
44.	-do-	S.C. Das, Addl. Director	---
45.	-do-	S.K. Shukla, Addl. Director	---
46.	-do-	J. Singh, Addl. Director	---
47.	-do-	A.S.Pathak, Addl. Director	---
48.	-do-	Sunil Chaudhary, Jt. Director	---
49.	-do-	V.K. Suri, Jt. Director (F)	---