

REPORT OF THE WORKING GROUP ON RESEARCH AND DEVELOPMENT
IN PUBLIC SECTOR ENTERPRISES

DECEMBER 1977

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INTRODUCTION

Pursuant to a recommendation made by the National Committee on Science and Technology, a Working Group to suggest measures for organising and promoting R&D in the Public Sector Enterprises (PSEs) in Heavy Engineering, Heavy Electricals, Chemicals, Oil and Metallurgy was constituted in June 1974 vide Department of Science and Technology Notification constituting the Working Group. The composition of the Working Group was amended by the Department of Science and Technology by a Notification in July 1974. The revised composition of the Group was as follows:

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|----|---|--------------|
| 1. | Dr S. Varadarajan,
Chairman & Managing Director,
Indian Petrochemicals Corporation,
PO Petrochemicals,
Baroda 391 346 | ... Chairman |
| 2. | Shri P.J. Fernandes,
Director General, BPE and
Additional Secretary,
Ministry of Finance,
New Delhi | ... Member |
| 3. | Shri Mohammad Fazal,
Chairman,
Standing Conference on Public
Enterprises,
Chandralok,
36 Janpath,
New Delhi | ... Member |
| 4. | Dr Y. Nayudamma,
Director General,
Council of Scientific & Industrial
Research, Rafi Marg,
New Delhi
Or
His nominee | ... Member |

- | | | | |
|----|--|-----|-----------|
| 5. | Dr S. Ramachandran,
General Manager (R&D),
Hindustan Steel Limited,
Ranchi - 2 | ... | Member |
| 6. | Shri M.M. Suri,
Member, National Committee
on Science & Technology,
New Delhi | ... | Member |
| 7. | Dr B.D. Tilak, Member, NCST
and Director, National
Chemical Laboratory,
Poona | ... | Member |
| 8. | Shri K.N. Ramaswamy,
Deputy Director General (Engg)
DGTG, Udyog Bhavan,
New Delhi | ... | Member |
| 9. | Shri M.K. Modwel,
Deputy Adviser,
Bureau of Public Enterprises,
Ministry of Finance,
Mayur Bhavan,
Connaught Circus,
New Delhi | ... | Secretary |

Dr. Nayudamma, Director General, CSIR nominated Shri Baldev Singh, Chief, Technology Utilisation, CSIR to assist the Working Group and his participation in the Working Group was available in all the deliberations. The valuable suggestions and directions given by Dr A Ramachandran, Secretary, Department of Science and Technology were available to the Working Group from time to time and later in July 1977 when he took over additional charge as Director General, CSIR also, he participated in the meeting of the Working Group on 27th August, 1977.

Shri G.C. Baveja took over as Director General of Bureau of Public Enterprises in February 1977 and in his official capacity as Additional Secretary and Director General, Bureau of Public Enterprises took the place of Shri P.J. Fernandes as Member of the Working Group. Shri M.K. Modwel, Secretary of the Working Group

left the Bureau of Public Enterprises in September, 1975 and in the later deliberations of Working Group and in the preparation of the Report, the services of Sri S. Kasy Aiyar, Deputy Adviser, Bureau of Public Enterprises were placed at the disposal of the Working Group as the Secretary.

Dr K.V. Swaminathan, Director, Department of Science and Technology assisted the Working Group in its deliberations and in the compilation of data regarding Research & Development work in public enterprises.

2. Terms of Reference

The terms of reference of the Group were as follows:-

(1) The Group will review the recommendations made by the Working Group on Organisation of R&D within the Public Sector and relationship with National Laboratories appointed by the Action Committee on Public Enterprises in May 1972 and in the light of such review, will suggest any modifications, changes, additions, etc., therein as it may consider necessary for the purpose of establishing R&D on a sound basis in relation to public sector units in Heavy Engineering, Heavy Electricals, Chemicals, Oil and Metallurgy.

(2) The Group will, on the basis of the analysis of information received and certain broad conclusions reached by the Working Group of the Action Committee on Public Enterprises or otherwise, undertake further study of the specific R&D problems in the above units and make specific recommendations for the solution thereof.

(3) The Group will evolve technological standards of performance at each point in the total manufacturing processes and will identify long and short term goals such as improvement of quality, productivity, financial returns, areas of obsolescence and sophistication, change in pattern and rate of growth of demand, international competition, etc.

(4) The Group will suggest measures for establishing meaningful cooperation in a substantial way between the Public Sector Enterprises and the National Laboratories in the five areas mentioned in (1) above so that the National Laboratories are in a position to make an impact on altering or improving products or manufacturing processes.

(5) In the light of the programmes indicated in the Draft Science & Technology Plan (1974-79) prepared by the NCST, the Group will discuss with the management of public sector units in the above five areas and help them in identifying the gaps and suggest action plans along with financial requirements.

(6) The Group may suggest measures to ensure that the public sector undertakings play a positive role in extending technological assistance to the small entrepreneurs.

3. The first meeting of the Working Group was held on the 19th August 1974. It was decided in that meeting that the Chairman be authorised to collect upto date information regarding the existing status and scope of R&D organisations in the five selected industries, viz., Coal Mines Authority, Steel Authority of India Limited, Indian Telephone Industries Limited, Bharat Electronics Limited and Bharat Heavy Electricals Limited. This information was accordingly collected. It was also decided in the first meeting of the Working Group that the Group should seek an opportunity to visit some public enterprises and discuss the matter of promotion of Research, Design and Development (RDD) with the Chief Executives. In accordance with this decision, in a meeting of the Chief Executives of the light and medium engineering group of public enterprises held at Bangalore on 27th and 28th August 1974, the Chairman of the Group, Dr Varadarajan addressed the Chief Executives on the subject of RDD activities. This was followed by a lively discussion amongst the Chief Executives wherein the Chief Executives expressed a firm opinion that they should set up their own RDD facilities.

4. Prior to the formation of the Working Group by the NCST, Dr Varadarajan had submitted a report on R&D as a Chairman of the Working Group constituted by the Action Committee on Public Enterprises. This report was submitted in 1973 and recommended certain lines of action for promotion of various aspects of R&D in the PSEs. The Action Committee on Public Enterprises had submitted a report to Government based on the report of the Working Group. In constituting this NCST Working Group the NCST had included the members of the earlier Working Group of the Action Committee and in addition included Director General, Bureau of Public Enterprises, Chairman, SCOPE and DGTD. Discussions in the first meeting and in the meeting of the light and medium engineering group of Public Enterprises revealed that there was not much additional work that could be performed by the NCST Working Group at that stage.

5. The NCST Plan on Science and Technology had just been drawn up and the PSEs were still in the preliminary stage of exercise on the implementation of this plan. The Action Committee had just submitted their report which had gone into the depth of the various aspects of the RDD. These factors further confirmed the view that the present Working Group could not undertake any substantial additional work at that stage.

6. In March 1977 the Chairman of the Working Group Dr Varadarajan had a meeting with Dr A Ramachandran, Secretary, Department of Science and Technology. The work already done by the Working Group and the further plan of action was discussed. It was felt that the time was now opportune to review the recommendations of the Action Committee on RDD in PSEs and the progress made so far in implementing the NCST Plan.

7. Accordingly, the Working Group met on three occasions - 18th July 1977, 27th August 1977 and 20th September 1977 and discussed the various terms of reference and formulated its recommendations. The status of implementation of the Plan on Science and Technology 1974-79 in respect of the five groups of Enterprises was also ascertained in July/August 1977. The observations and recommendations of the Working Group based on the discussions and data collected follow.

ROLE OF RESEARCH AND DEVELOPMENT

8. Public Enterprises in India play a key role in the economic development of the country. Investments in public enterprises stood at Rs.8973 crores as on 31st March 1976 and are estimated to have gone up by another about Rs.1500 crores by 31st March 1977. Most public enterprises are large and have plans for further growth and diversification. The large size, technological complexity and potential growth of public enterprises offer exceptional opportunities for profitable RDD inputs of a high order. Such RDD inputs are essential not only for improving the performance of the units to international standards in quality, cost, diversity and relevance in the markets but more importantly to ensure in the long term, reduction in the need for importing know-how repeatedly to update technology.

9. The Indian public sector enterprises have lately entered the export market in a substantial way. Several large orders are on hand or are expected to be received by BHEL, Engineering Projects (India) Limited, Hindustan Machine Tools, etc. There is very keen competition in technology and costs in the international market. To be able to compete and survive in international markets, RDD is an essential input. Unless our designs are comparable with the best in the world and competitive in price and unless the enterprises are supported by RDD back up to adopt technology as required for the export market, survival would be impossible. Even in the internal

market the role of RDD in adaptation and assimilation of technology cannot be overstressed.

10. Industrial Research Design and Development can most efficiently be carried out within the enterprise, provided a suitable environment can be created in the enterprise for promoting RDD.

11. The factors favouring 'in house' RDD are many. The enterprise has an intimate knowledge of its own strengths and weaknesses and can readily direct available RDD resources to the most relevant areas. The RDD personnel will have full knowledge and participation in the successes and failures and this will provide strong motivation for RDD. All information concerning the detailed operational parameters of the enterprise will be readily available to RDD personnel along with the objectives of the enterprises.

12. 'In house' RDD is vital also for meaningful cooperation between National Laboratories and the enterprises. This is because, it would be necessary to clearly identify the specific areas and problems and their priorities before they can be tackled by National Laboratories. Further, once laboratory solutions are obtained for problems it would be necessary to transplant them into the industrial environment. Both these activities would require effective RDD set up in the enterprises themselves.

ESTABLISHMENT OF RDD ON A SOUND BASIS IN PUBLIC SECTOR UNITS

13. The NCST Working Group reviewed the recommendations made by the Action Committee's Working Group on organisation of RDD within the public sector and relationship with national laboratories. In the light of this review, the amended recommendations of the Group are being made. Most of these recommendations relating to the establishment of RDD on a sound basis in public enterprises would be applicable not only to the public sector units in heavy engineering,

heavy electricals, chemicals, oil and metallurgy but to public enterprises in the other sectors as well.

14. Information Systems for Short Term RDD Goals

For identification of RDD problems in the short term, it is necessary to have precise information about the current technological performance and the best practicable performance for each manufacturing operation. A Technical Performance Standards Department should be created in each unit headed by personnel with appropriate status and authority and reporting to the Chief of the unit or other appropriately high level in the unit, depending upon the size and complexity of operations. The Technical Performance Standards Departments will have the responsibility of evolving and implementing qualitative and quantitative production standards in each department.

15. Financial Management Information System

A Financial Management Information System should also be evolved which will be able to produce accurate statistical information, within two to three weeks of immediate value covering costs, margins and profits of each product in each section of manufacture.

16. The technical performance standards information and the financial management information will form the primary sources for identification of short term RDD.

17. Corporate Planning and Long Term RDD Goals

A rolling corporate plan, covering five to ten years and revised every year, is essential for identifying long term RDD problems. Each enterprise should establish a Corporate Planning Department functioning in close coordination with all operating departments. The Corporate Planning Department should report

at an adequately high level in the enterprise. Long term RDD will require building up of infrastructure resources and human talent which can be done only if a perspective vision over a sufficiently long period is available.

18. Organisation of RDD in the PSEs

Each manufacturing enterprise regardless of its size, should appoint a full time RDD Director or Manager on its Board or its Executive Management Committee charged with corporate responsibility for overall RDD input and performance including commissioning RDD outside the enterprise. If suitable personnel of high calibre are not immediately available, a part time Director/Consultant may be appointed.

Major enterprises should create their own RDD laboratories suited to their needs; the Head of the Laboratory may, if found suitable, also be the Corporate RDD Director/Manager. Smaller enterprises, which also will have an RDD Director/Consultant, may use the services of other laboratories.

Although it is necessary that major enterprises create their own RDD laboratories, research work need not wait for the creation of their laboratories or be confined to their own laboratories only. The use of National laboratories as also the laboratories in other public sector enterprises should be encouraged to the maximum extent possible so that facilities created in the country can be used to the maximum advantage.

The RDD laboratories attached to PSEs may, apart from undertaking their own research, also act as coordinating agencies for RDD purchased from abroad or to be farmed out to other laboratories in the country.

19. Coordination of RDD in related Industries

Where there is only one dominant public enterprise in one sector of industry (e.g. steel, coal, heavy electricals, etc.), the RDD Director of the dominant enterprise will become the focal point for coordination of research activities in the public sector industries in that area.

Where a number of public enterprises (and private enterprises too in some cases) are engaged in one sector of industry (e.g. heavy engineering, chemicals, pharmaceuticals, etc.), it is recommended that a Research Coordinator for RDD be appointed in the concerned Ministry. The Research Coordinator should be a respected member of the scientific or technological community and should be able to command respect of the public sector enterprises and establish a useful dialogue with the Chief Executives of the PSEs. It is, therefore, recommended that he should have an appropriately high status reporting directly to the Secretary in the Ministry and should be responsible for review of performance and coordination of RDD activities in enterprises within the purview of that Ministry. It may be desirable to have a panel of nationally known personnel whose advice could be sought by the Research Coordinator in case of specific problems concerning their speciality.

20. Research Council for the Public Sector

RDD management experience is scarce in India and recruitment of personnel will have to be made by unorthodox and intensive search, and part and full time personnel will have to be obtained for senior positions with unusual work schedules and remuneration patterns. The culture of RDD personnel is different from others and a radical change in the personnel recruitment, development, training and transfer and motivation policies is necessary if RDD is to be developed as an effective input. Efficient use of RDD also requires a rational motivation for its use at the highest

levels. Special training and education of senior management including Chief Executives in RDD, through courses, visits and seminars is necessary.

To encourage unorthodox imaginative solutions to the problems of recruitment, development, training, transfer and motivation of RDD personnel and to promote a rational understanding of RDD amongst the senior executives, a Research Council for the Public Sector may be established with a Chairman of the rank of Secretary to the Government. The Research Council will review the critical support required for achieving goals of self reliance in technology periodically. The Coordinators on RDD in the Ministries and Directors RDD in the major companies will be members of the Council. It is recommended that the Council have a full time Member for personnel recruitment, training and development and a commercial Member for evolving systems for the efficient organisation of RDD.

21. RDD and Export

In many industries, an effective RDD organisation cannot be supported if its output is solely directed towards application in India. This is because, often, the volume and value of goods and improvements arising within the country from such technology would not be commensurate with the expenditure on RDD and technology development. Adequate volume can be obtained by sale of product or of technology outside the country.

Import of technology should be confined as far as possible to such organisations that have the necessary absorptive capacity. In the case of major enterprises this will mean that a viable RDD system should be available in the enterprise. In the case of small scale enterprises cooperative RDD institutions will need to be evolved in order to create the necessary absorptive capacities.

There is inadequate appreciation in general of RDD achievements in the country. This arises due to inadequate communication between technology development agencies and the educated public. It is necessary to give continuing information on the scope and limitation of RDD and a great deal of effort has to be put in to give balanced appreciation.

22. RDD and Lead Companies

In each sector, lead companies should be identified wherever possible, which would spearhead the RDD effort. For example, in the field of power equipment, petrochemicals and fertilizers, Bharat Heavy Electricals Limited, Indian Petrochemicals Corporation Limited and Fertilizer Corporation of India Limited could be nominated as lead agencies. Similar public sector enterprises could be identified for other areas as well. Identification of fruitful areas of research, coordination of conduct of such research and application in the spectrum of enterprises in that field and screening of requirements of import of technology could be appropriate functions of such lead companies.

23. Capital Equipment for RDD

When a technology is developed in national interest and the costs of such development expenditure cannot easily be met from the PSE's resources, such development should not be delayed for want of capital. Capital for equipment for RDD in public sector enterprises should be provided in the form of outright grant or interest free or very low interest loans repayable over a very long period.

IDENTIFICATION OF SPECIFIC RDD PROBLEMS

24. The Working Group considers that the identification of specific RDD problems in public sector enterprises is dependent on the organisational set up and other inputs referred to in the earlier

paragraphs with reference to item(1) of the Terms of Reference. A study of specific problems of RDD in specific enterprises would require detailed knowledge of the commercial and technical operations, competitive market conditions, high level of expertise in the specific industry and would require a long period of time and continuous updating. It is important to recognise that priorities of RDD problems change with time and the process of identification and of solving RDD problems is a continuous one and does not submit itself to a one time exercise. The NCST Working Group would, therefore, refrain from a detailed study of specific RDD problems of specific enterprises.

25. However, the Working Group would like to suggest some effective institutional arrangements regarding identification of specific RDD problems on a continued basis. The RDD activity should receive attention right from the project formation stage. In the project report itself appropriate financial and other provisions should be made for the necessary RDD inputs so that repetitive import of technology for upgraded designs does not become necessary. After the project goes into production, periodical reviews of performance of RDD in each PSE should be conducted by the parent Ministry. The review of RDD could form an integral part of the performance review meeting conducted quarterly by the Ministries with the PSEs under their administrative control. In any case, annual review should be conducted by the Ministry in detail and the performance in RDD should form a part of the Annual Report of the Ministry. The Department of Science and Technology could provide the necessary assistance for coordinating such reviews and should be represented in the review meetings.

TECHNOLOGICAL STANDARDS

26. The evolution of technological performance standards at each point in the total manufacturing processes would require long and detailed technical study of each process and would require to be

updated on a continuous basis. The recommendations have already been made in paras 13 to 25 for the evolution of effective institutional arrangements for identification of specific RDD problems. The evolution of technological standards for improvement of quality, productivity, etc. may have to be done at the industry level and be reviewed periodically by means of arrangements therein. The Working Group recommends, therefore, that these standards be evolved and administered on the basis of the recommendations contained earlier and would refrain from laying down any specific standards of technological performance.

COOPERATION WITH NATIONAL LABORATORIES

27. There is scope for much greater cooperation with National Laboratories than exists at present. Improvement in the general environment in RDD in public enterprises, for which suggestions have been made earlier, will contribute generally to greater cooperation. In addition, new organisational and institutional forms will be required. Some recommended forms are :

- (a) Creation of Cells within the National Laboratories composed of a small group of scientific staff from among the laboratory staff, which will devote themselves wholly to the needs of a specific public sector enterprise. The expenses incurred on the Cell can be met by the PSEs on long term contract.
- (b) Nomination of a Senior Scientist in the Laboratory as a contact scientist for a PSE.
- (c) Nomination of individual RDD scientists in laboratories on Boards of PSEs.

- (d) Nomination of a RDD scientist in the PSE as a contact scientist for the laboratory.
- (e) Appointment of a laboratory as an institutional consultant for the PSE.
- (f) Formation of Cooperative Research Institutes (such as those established for silk, cotton, jute, etc.). These cooperative institutes will be jointly administered by a group of public sector enterprises and a National Laboratory (or a group of National Laboratories).

IMPLEMENTATION OF S & T PLAN 1974-79 OF NCST

28. A number of PSEs and Administrative Ministries were addressed to provide the Working Group with the current status of implementation of the various projects included in the S & T Plan. The replies received have been summarised and included as Annexure I to the Report which also indicates the parties addressed. It would be seen from the Annexure that substantial progress has been made in implementing these plans in the various areas.

29. In the recommendations for establishment of RDD on sound basis in the public enterprises, the Group has suggested the creation of certain institutional arrangements for identification of short and long term RDD problems in public enterprises and for the coordination of RDD problems. It may be mentioned that the problem of identifying gaps is a continuing one and requires an intimate knowledge and long association with the specific industry, its technology, financial standards, performance, etc. The Working Group feels that it may not be possible for the Group to identify the gaps in the RDD plans of numerous public sector enterprises. Once the necessary institutional arrangements mentioned in the earlier paragraphs are set up, the identifying of

gaps and action plans to overcome the deficiencies could be implemented as a continuing work of the set up suggested.

EXTENDING TECHNOLOGICAL ASSISTANCE TO SMALL SCALE ENTREPRENEURS

30. At present major public enterprises are providing technological assistance to ancillary industries associated with the public enterprises and 479 ancillary units had been set up (up to 31st March 1976). For these units, the public sector enterprises are providing technical know-how, managerial guidance, production process/method, etc., apart from other assistance in the form of purchase contracts, etc. There is already a focal point for coordination of all types of assistance to ancillary industries, in the Bureau of Public Enterprises.

Apart from this it was felt that there were three areas in which public enterprises can play a role in assisting small scale entrepreneurs. Firstly, there are entrepreneurs supplying raw materials, components and assemblies to public sector enterprises particularly in the engineering group of industries. The RDD Group in the public enterprises through the medium of the Purchases Department can actively assist the various small scale entrepreneurs in improving designs, developing norms and improving quality, etc.

The second area is where the small scale entrepreneurs may be users of products like intermediate chemicals, plastics, etc., supplied by public enterprises. This is the case in many chemical industries. The Marketing Department of these public enterprises, with the help of the RDD Group in the public enterprises can assist the small scale entrepreneurs in identifying new products and applications, upgrading the existing quality and improving the performance standards in various areas.

The third category of small entrepreneurs are those totally unconnected with the public sector enterprises, located in the neighbourhood of the public sector enterprise. There may be no analytical and testing facilities on RDD institutions in the neighbourhood. In such cases the public sector enterprises can actively assist the small scale entrepreneurs in the neighbourhood for providing various testing and analytical facilities and also assisting them in small research and development projects as long as such work does not become a substantial burden on the public enterprises and does not detract the public sector enterprise from its normal course of activities.

Assistance to small scale entrepreneurs will be a continuing effort and will be a natural outcome of establishing an appropriate RDD effort within the public enterprises. A senior scientist from the RDD laboratory attached to the Public Sector Enterprises could be nominated as a contact scientist for a small scale industry in a manner similar to what has been suggested in the earlier paragraphs relating to Cooperation with National Laboratories.

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STATUS OF PROJECTS IDENTIFIED IN THE DRAFT S&T PLAN
1974-79 OF NCST IN THE CHEMICALS SECTOR

S U M M A R Y

The status of the projects as detailed in the pages below is based on the information received from the major Public Sector Undertakings in the area of chemicals in which the R&D programmes were identified, namely, (i) Indian Petrochemicals Corporation Ltd., (ii) Fertilizer Corporation of India Ltd., (iii) Hindustan Organic Chemicals Ltd., (iv) Hindustan Insecticides Ltd. and (v) Engineers India Ltd.

50 projects specifically identified from the draft S&T Plan 1974-79 of NCST have been included in this list. Of these, 25 projects were taken up by Fertilizer Corporation of India Ltd., 11 projects by Indian Petrochemicals Corporation Ltd., 11 projects by Indian Drugs & Pharmaceuticals Ltd., and 2 projects by Hindustan Organic Chemicals Ltd. and 1 project by Hindustan Antibiotics Ltd.

Public Sector Enterprises have mentioned that in addition to the projects identified by the NCST, certain other gaps have been identified by them in their day-to-day working and, therefore, have taken up 50 additional projects in addition to the 50 referred to above. In this category, 14 projects have been taken up by Indian Drugs & Pharmaceuticals Ltd., 14 projects by Hindustan Organic Chemicals Ltd., 11 projects by Engineers India Ltd., 6 projects by Indian Petrochemicals Corporation Ltd. and 5 projects by Hindustan Insecticides Ltd. A list of these 50 projects is also given in the following pages.

The Fertilizer Corporation of India Ltd. is having an "In-house" R & D of its own. A brief resume of "In-house" R & D efforts of Fertilizer Corporation of India Ltd. is also enclosed.

Status of projects identified in the Draft S&T plan 1974-79
of NCST in the Chemicals Sector taken up by PSEs

NCST Project Index No.	Project title	Remarks
1.	2.	3.
<u>G₁-Bulk Organic Chemicals/Petro-chemicals polymers</u>		
S ₅ G ₁ P ₁ (i)	Oxidation of p-xylene	IPCL has taken up this project. Preliminary studies to incorporate manganese as co-catalyst in para-xylene oxidation was carried out in the R&D Laboratory and has been found to be promising. Extensive study will be taken up when the gas-liquid oxidation reactors become available as a result of EIL-IPCL joint R&D programme on para-xylene oxidation which is being taken up shortly.
S ₅ G ₁ P ₃	Disproportionation of toluene to benzene and xylenes.	IPCL is shortly going to take up this project at the IPCL Research Centre in collaboration with EIL.
S ₅ G ₁ P ₁₇	High analysis nitrogenous organic compounds based on urea etc.	FCI has taken up the project.
S ₅ G ₁ P ₃₀	Aniline	The project is taken up by HOCL in collaboration with NCL, Poona. A number of catalysts suitable for Aniline manufacture have been prepared and tested.
S ₅ G ₁ P ₃₅	Ethylene oxide	Work in progress in NCL with IPCL sponsorship.
S ₅ G ₁ P ₃₆	Ethylene glycol	Work in progress in NCL with IPCL sponsorship.
S ₅ G ₁ P ₄₃	Block copolymers of Styrene and butadiene.	IPCL propose to take up this project shortly.
S ₅ G ₁ P ₄₄	Terpolymers of ethylene, propylene and butylene.	IPCL has started this project but could not continue owing to non-availability of polymer grade ethylene and propylene. This project will be continued as soon as the raw materials become available.

1.	2.	3.
S ₅ G ₁ P ₄₅	Butyl rubber	IPCL wanted to take up this project but could not do so because of the non-availability of polymer grade Isobutylene. It will be taken up as soon as the raw materials become available.
S ₅ G ₁ P ₄₈	Ethylene-vinyl acetate copolymer.	IPCL has taken up this project. Preliminary studies to establish the feasibility of copolymerising ethylene and vinyl acetate using Ziegler-Natta catalyst are in progress in the R&D Laboratory. Results show that using metal (acetyl acetonates) and trialkyl aluminiums as catalyst, vinyl acetate can be copolymerised with olefins and vinyl and monomers . Further studies are in progress.
S ₅ G ₁ P ₄₉	Moulding grade polyesters based on butylene ethylene glycol and terephthalic acid.	IPCL has just initiated work on this project.
S ₅ G ₁ P ₅₁	Copolymers of styrene with acrylonitrile, methyl methacrylate, methyl styrene and terpolymer with acrylonitrile and butadiene.	IPCL has taken up this project. The process for the manufacture of SAN has been standardised on laboratory scale and pilot plant trials are under way. The properties of SAN obtained in the laboratory is comparable to commercial samples. This process will be tested in the multi-purpose semi-commercial pilot plant as soon as it is ready.
S ₅ G ₁ P ₅₇	R & D Centre at IPCL	IPCL has taken action on setting up the R&D Centre.

G₂- Fertilizers and other Nutrients

S ₅ G ₂ P ₁	Reuse of by-product phosphogypsum for recovery of sulphuric acid and cement.	FCI has taken up the project.
S ₅ G ₂ P ₂	Recovery of sulphur from by-product phosphogypsum.	FCI has taken up the project.
S ₅ G ₂ P ₃	Utilisation of Fly ash.	FCI has taken up the project. Only preliminary work undertaken.

1	2.	3.
S ₅ G ₂ P ₄	High pressure gassification of solid fuels for direct manufacture of ammonia/methanol/oxo-synthesis gas.	Initiation of this depends on collaboration terms with foreign firms which are yet to be finalised. Hence kept in abeyance by FCI.
S ₅ G ₂ P ₅	High pressure hydrogasi-fication of coals for production of methane rich gas and high pressure hydrogen.	Initiation of this depends on collaboration terms with foreign firms which are yet to be finalised. Hence kept in abeyance by FCI.
S ₅ G ₂ P ₆	Development of an alternative reduction oxidation of iron oxide with producer gas and steam in fluid bed system and under pressure.	FCI has taken up this project. Substantial progress made.
S ₅ G ₂ P ₇	Application of anhydrous ammonia as a fertilizer.	FCI has taken up the project.
S ₅ G ₂ P ₈	Beneficiation of low grade rock phosphates.	FCI has taken up the project.
S ₅ G ₂ P ₉	Suitability of different types of rock phosphates resources in India for production of phosphatic fertilizers.	Project was taken up by FCI.
S ₅ G ₂ P ₁₀	Utilisation of pyrite cin-der obtained as by-product from pyrite based sulphuric acid plants.	Project taken up by FCI.
S ₅ G ₂ P ₁₂	Hydrazine cracking catalyst.	FCI has taken up the project.
S ₅ G ₂ P ₁₃	Substitute for platinum catalyst for oxidation of ammonia to nitric acid.	Substantial work is going on various catalysts in FCI.
S ₅ G ₂ P ₁₄	Hydrorefining catalyst based on indigenous raw materials.	FCI has taken up the project.

1.	2.	3.
S ₅ G ₂ P ₁₅	Deoxo catalyst based on indigenous raw materials.	Taken up by FCI. Substantial progress made.
S ₅ G ₂ P ₁₆	Pre-reforming catalyst.	Taken up by FCI. Substantial progress made.
S ₅ G ₂ P ₁₈	Development of advanced non-destructive testing techniques for evaluation of engineering materials and plant equipment related to fertilizer and heavy chemical industries.	Project taken up by FCI.
S ₅ G ₂ P ₁₉	Pressure vessels evaluation by experimental stress analysis under simulated loading.	FCI has taken up the project.
S ₅ G ₂ P ₂₀	Evaluation of service defects on a few specific equipment of fertilizer/chemical plants by specially developed NDT techniques.	FCI has taken up the project.
S ₅ G ₂ P ₂₁	Studies on vibration levels association with service deterioration of high speed rotary machines and related equipment used in fertilizer/heavy chemical industry.	Taken up by FCI.
S ₅ G ₂ P ₂₂	Design and fabrication of an instrument for rapid non-destructive estimation of ferrite in austenitic stainless steel.	FCI has taken up the project.
S ₅ G ₂ P ₂₃	Extraction of phosphoric acid from rock phosphate using ammonium sulphate in a cycle.	Initiation of this scheme depends on collaboration terms with foreign firms which are yet to be finalised. Hence kept in abeyance by FCI.
S ₅ G ₂ P ₂₄	Development of comprehensive process for the production of different types of alumina and aluminium compounds required for industrial uses.	FCI has taken up the project.

1.	2.	3.
S ₅ G ₂ P ₃₀	Nitrification inhibitors for soil application.	FCI has taken up the project. Work in progress.
S ₅ G ₂ P ₃₁	Development of pilot plant for the mass culture of blue green algae (Bio-technology of algal culture).	FCI has taken up the project.
G ₄ - <u>Organic Fine Chemicals, Drugs and Pharmaceuticals</u>		
S ₅ G ₄ P ₄	Vitamin B ₆	NCL is to get in touch with IDPL as possible user. The bench scale process for this drug was purchased from NCL, Poona. The process was considerably improved and further developmental work was taken up in the pilot plant. The process has been successfully developed. However, the raw materials cost per kg. of vitamin B ₆ is on the very high side which is primarily due to the high cost of both indigenous and imported raw materials involved in the process.
S ₅ G ₄ P ₅	Methyldopa	Development of a laboratory scale process is under progress in IDPL.
S ₅ G ₄ P ₇	Indomethacin	Process details obtained by IDPL from CDRI and demonstration work at pilot plant in progress.
S ₅ G ₄ P ₉	Fursemide	Process has been developed and is ready for implementation.
S ₅ G ₄ P ₁₀	Metronidazole	IDPL has taken up this project.
S ₅ G ₄ P ₁₁	Chloroquin and Amodiaquin	A laboratory scale process from the basic stage has been completed for chloroquin by IDPL. Work on amodiaquin has been suspended due to low priority.
S ₅ G ₄ P ₁₂	Caffeine, Theophylline and Aminophylline.	IDPL has yet to initiate action to implement the project.
S ₅ G ₄ P ₁₄	p-Aminobenzoic acid and benzocaine.	Some work was taken up by NCL. The trial production at the main plant has been carried out successfully.

1.	2.	3.
S ₅ G ₄ P ₁₇	Novaldiamine	Process for the production of Novaldiamine has been developed at the pilot plant by IDPL.
S ₅ G ₄ P ₁₈	Diethylethoxymethylenemalonate	IDPL has taken up the project. A laboratory scale process has been developed.
S ₅ G ₄ P ₁₉	Butyl and propylamines.	The work on the project has been suspended due to low priority.
S ₅ G ₄ P ₂₇	Fermentation Technology and Enzyme Research Centre.	HAL submitted proposals but a further detailed probe was undertaken by a Study Group constituted by CSIR. Report under consideration of the Ministry.

G₅ - Dyes, Intermediates for Dyes and Pharmaceuticals

S ₅ G ₅ P ₂₆	Infrastructure facilities for R&D at HOC.	HOC has developed certain infrastructure facilities for R&D.
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Additional Projects taken up by various public sector undertakings which do not figure in the Draft S&T Plan 1974-79

I. Additional Projects taken up by Indian Drugs & Pharmaceuticals Ltd. not identified in the Draft S&T Plan 1974-79 of NCST.

-	Pethidine Hydrochloride.	Process for the preparation of Pethidine hydrochloride by alternative route has been completed at the laboratory scale.
-	Allopurinol.	The technology at the Pilot Plant scale has been developed and is ready for implementation at the main plant.
-	Secobarbital	Laboratory scale process has been completed.
-	Trimethoprim	Laboratory scale process has been developed from the basic stage of gallic acid.
-	Sulphamethoxazole.	Laboratory scale process has been developed and Pilot Plant trials are awaited.

1.	2.	3.
-	Sulphadiazine	Laboratory scale process has been developed.
-	Procaine Hydrochloride	A process for the manufacture of Procaine Hcl was developed from the basic stages and the trial production at Pilot Plant started.
-	Sulphadimethoxine	A bench scale process has been developed.
-	Allobarbitol	A laboratory scale process has been completed.
-	Glibenclamide	A process at the laboratory scale has been developed from the basic stages.
-	Diazepam	Technology has been developed in the laboratory scale and Pilot Plant work is in progress.
-	Pantothenic Acid	Work on the development for a laboratory scale process for this drug is under progress.
-	Neomycin	Technology and strain has been developed successfully in the laboratory. Fermentation technology at the pilot plant level has been standardised. Recovery and purification technology at pilot plant is being finalised.
-	6-APA	One batch for 1 kg production has successfully been completed.

II. Projects taken up by Hindustan Organic Chemicals Ltd.
not identified in the Draft S&T Plan 1974-79 of NCST.

- Development of Fixed Bed Catalyst for Aniline
- Process Development of Diphenylamine
- Development of Technology for meta-Nitrochlorobenzene.
- Process development for Resorcinol.

1.	2.	3.
-	Development of Technology for Effluent Treatment	
-	Pilot Plant for Aniline Fluidised Bed Reactor.	
-	Process development for Cyclohexylamine	
-	Development of Technology for ortho-Nitrophenol-para-Nitrophenol/p-Aminophenol.	
-	meta-chloroaniline	
-	3-4 Dichloroaniline	
-	ortho-Nitroaniline	
-	ortho-Phenylenediamine	
-	4-4 Diamine Diphenyl methane (first step in the manufacture of MDI)	
-	Flame retardants based on Formaldehyde.	
III. <u>Projects taken up by Hindustan Insecticides Ltd. not identified in the draft S&T Plan 1974-79 of NCST.</u>		
-	Technology development of important intermediates of the pesticides like Anisole, para-nitro-metacresol; Alfa Chloro N-Methyl Acetamide; Thio-phosphoric acid; Chlorothiophonates etc.	
-	Formulation of important pesticides like Endosulfan, Malathion, Dicofol, Methoxychlor etc.	
-	Development of technologies for composite OP group of compounds like Dimethoate; Fenitrothion; Metasystox; Dipterax; DDVP etc.	
-	Methoxychlor	
-	Melthane	

1.	2.	3.
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IV. Projects taken up by Engineers India Ltd., not identified in the draft S&T Plan 1974-79 of NCST

- Development of process Design Methods
- Benzene Extraction
- Naphtha Cracking
- Surfactant Manufacture
- Thermal Conversion Processes
- Production of paraffin wax by solvent dewaxing
- Heat Transfer on low finned tube surface
- Regular Packing
- Steam Jet ejector
- Development of trays, column internals etc.
- Burner development

V. Projects taken up by Indian Petrochemicals Corporation Ltd., not identified in the Draft S&T Plan 1974-79 of NCST

- Testing of catalysts under Reforming Conditions.
- Effect of high temperature on the physico-chemical properties of Ammoxidation catalyst.
- Investigations on Molecular Sieves as Catalysts.
- Vapor and Liquid Phase Oxidation of C9 Stream.
- Development of strapping Grade Polypropylene.
- Electroplating of Polypropylene.

A BRIEF RESUME OF IN-HOUSE R&D EFFORTS OF
FERTILIZER CORPORATION OF INDIA LIMITED

The R&D Division of Fertilizer Corporation of India Ltd. came into existence in the year 1961. Functionally the R&D Unit comprises of the following separate groups:-

1. Chemical Research Wing
2. Physical Research Wing
3. Agricultural Research Wing
4. Catalyst Research and Development Wing
5. Pilot Plant Wing

In the Chemical Research Wing, there are 40 projects now in hand under the following 7 sub-groups:-

- i) Characterisation of Raw Materials and Feedstocks for Fertilizer Plants;
- ii) Material evaluation and corrosion control;
- iii) Product Development (Diversification) and Utilisation of Waste materials/by-products;
- iv) Water Treatment;
- v) Pollution Control;
- vi) Keeping Quality, granulation and drying of multinutrient fertilizers; and
- vii) Development of modern analytical techniques.

In the Physical Research Wing, there are now 65 projects in hand under the following 9 sub-groups :-

- i) Mineralogical evaluation and physical characterisation of fertilizer raw materials and feedstock;
- ii) Physical evaluation of plant materials;
- iii) Structural investigations of fertilizer materials by physical methods;
- iv) Development of Physico-chemical methods and related facilities for research;
- v) Technical aid to industry and consultancy services;
- vi) Instrument development for research and industry;
- vii) Development in non-destructive testing techniques;
- viii) Catalyst Research and Development; and
- ix) Studies and physical and chemical processes related to fertilizer technology.

In the Agricultural Research Wing, there are at present the following 12 projects under implementation :-

- i) Introduction of Anhydrous Ammonia in Indian Agriculture;
- ii) Use of organic manure for improving soil productivity and increasing fertilizer use efficiency;
- iii) Studies on controlled release of nitrogen for increasing the efficiency of nitrogenous fertilizer;
- iv) Evaluation of different high analysis complex fertilizers with special reference to different water soluble phosphates (Nitro-phosphate-Suphala);
- v) Soil Test Crop response correlation study for finding out norms of major crops under varied agro-climatic conditions;
- vi) Micronutrient need of crops and the possibility of manufacturing fertilizers containing micronutrients;
- vii) Direct application of rock phosphate and basic slag under acidic soil conditions;
- viii) Utilisation of NPK Fertilizers under waterlogged paddy;
- ix) Nutrition need of high fertilizer consuming vegetables and quick growing fruit trees;
- x) Studies on compatibility and field evaluation of fertilizer pesticide mixtures in crop production;
- xi) Innovation of agronomic practices with reference to intensive cropping system and crop rotation; and
- xii) Fertility status of Bihar Soils.

In the Catalyst Research and Development Wing, there are at present 48 projects under implementation under 14 sub-groups, e.g. (i) Reformation Catalyst; (ii) H.T. Co-conversion Catalyst; (iii) Dehydrogenation Catalyst; (iv) Ammonia Synthesis Catalyst; (v) L.T. Shift Catalyst; (vi) Methanation Catalyst; (vii) Sulphuric Acid Catalyst; (viii) Hydrofining Catalyst; (ix) Phthalic Anhydride Catalyst; (x) Aniline Catalyst; (xi) Cyclohexane Catalyst; (xii) Deoxo Catalyst; (xiii) Physico-Chemical Studies; and (xiv) Miscellaneous.

In the Pilot Plant Wing also, there are 24 projects under implementation under the following 6 sub-heads :-

- i) New processes;
- ii) Design Data generation;
- iii) Standardisation of processes;
- iv) Pilot Plant trials on processes developed by Research Departments;
- v) Exploratory investigations of miscellaneous schemes; and
- vi) Development of process and equipment for catalyst manufacture and pilot scale evaluation of catalyst.

STATUS OF PROJECTS IDENTIFIED IN THE DRAFT S&T
PLAN 1974-79 OF NCST IN THE OIL SECTOR

S U M M A R Y

The status of the projects as detailed in the pages below is based on the information received from the major Public S_ector Undertakings in the area of oil, in which the R & D programmes were identified, namely, (i) Oil & Natural Gas Commission, and (ii) Indian Oil Corporation.

44 projects specifically identified from the S & T Plan 1974-79 of NCST which have been taken up by Oil & Natural Gas Commission have been included in this list. In addition to these 44 projects mentioned above, the Oil and Natural Gas Commission have taken up 6 more additional projects to cover certain gaps identified by them in their day-to-day working. A list of these 6 projects is given in the following pages. The Indian Oil Corporation have taken up 11 projects at their R & D Centre. A list of these projects is also given in the following pages.

Status of Projects identified in the Draft S&T Plan 1974-79
of NCST in the Oil Sector taken up by PSEs

Sl. No.	NCST Project Index No.	Title of the Project	Remarks by O.N.G.C.
1.	2.	3.	4.
A-1 : <u>ORIGIN, MIGRATION AND ACCUMULATION OF PETROLEUM</u>			
1.	S ₂ G ₂ A ₁ P ₂	Geochemistry of dispersed sedimentary organic matters of Tertiary and pretertiary sequences of poorly explored sedimentary basins of India for evaluating petroleum generating conditions and petroleum source-quality (Punjab, Ganga, Rajasthan, Sanchor, Vin-dhyun, Godavari-Krishna, Palar, Andman Nicobar Basin and Gondwana Grabens).	The project has been taken up as priority project No.8 in collaboration with IIT, Madras. Supply orders for purchase of the required imported/indigenous equipment, chemicals and glass-ware have been placed. Available samples from the Baratang formation of Andamans have been collected.
2.	S ₂ G ₂ A ₁ P ₃	Study of relations between chemical composition of crude oils in the Cambay and Upper Assam Basins with geology as clue to their origins.	The project has been taken up as priority project No. 9. Action for procurement of imported/indigenous equipment, chemicals and glass-ware is in hand. Literature survey on the relations between geology and chemical composition of oils from different countries has been carried out.
3.	S ₂ G ₂ A ₁ P ₅	Hydrogeological and hydrochemical studies of all Indian Sedimentary basins in relation to hydrocarbon migration and entrapment conditions and preservation of oil, gas accumulation.	The project has been taken up as priority project No.11. Requirements of the indigenous equipment, chemicals and glasswares were processed. Some of the materials have been received. Literature survey in respect of organic matters in waters has been carried out.
4.	S ₂ G ₂ A ₁ P ₉	Development of computer softwares to study processes of origin, migration and accumulation of petroleum in Indian Sedimentary basins.	The project has been taken up as priority project No. 12. A programme for storage and retrieval of geochemical data for sedimentary organic matter has been prepared. Literature survey on the kinetics of hydrocarbon generation under different geothermal conditions has been made.

1.	2.	3.	4.
5.	S ₂ G ₂ A ₁ P ₁₁	Study of biological markers in petroleum and sediments in the Cambay and Upper-Assam basins and evaluation of their applications to the solution of problems of identification of sources and genetic correlation and migration of crudes.	The project has been taken up as priority project No. 10. Requirement for the imported/indigenous equipment, chemicals and glasswares have been processed. Some of the indigenous materials have been received. Literature survey in respect of n-alkanes and porphyrins has been carried out.
6.	S ₂ G ₂ A ₁ P ₁₂	Direct geochemical & geophysical methods for evaluation of petroleum resources of moderately & poorly explored sedimentary basins of India.	The project has been taken up as priority project No. 16. A field party has been organised for undertaking geophysical and geochemical field work at Anklesvar, in collaboration with CEIG Osmania University, 337 high precision gravity stations with 157 repeat stations DES at 2 points has been completed and 152 geochemical samples have been collected. In collaboration with Roorkee University, mathematical modelling for studying the DC electrical response and the magnetotelluric response of hydrocarbon bearing structures is under progress.

A-2 : PRODUCTION, RESERVOIR STUDIES & TRANSPORTATION

7.	S ₂ G ₂ A ₂ P ₃	Demulsification/effluent disposal and allied problems	The project has been taken up as priority project No. 46. Requirement of imported/indigenous equipment and stores has been processed. Some literature survey has been done on the effluent disposal.
8.	S ₂ G ₂ A ₂ P ₄	Sand control in oil and/or gas wells	The project has been taken up as priority project No. 49. Studies on the conditions leading to incursion of sand are going on at present.

1.	2.	3.	4.
9.	S ₂ G ₂ A ₂ P ₅	Well Stimulation	This project has been taken up as priority project No. 47. Requirement of the imported/indigenous equipment and stores has been processed. Laboratory studies on various viscosifiers polymers and cellulose etc. have been carried out to formulate a suitable hydraulic fracturing fluid. Identification of indigenous additives has been completed.
10.	S ₂ G ₂ A ₂ P ₆	Modern secondary recovery methods	The project has been taken up as priority project No. 43. Requirement of imported indigenous equipment and stores has been processed. Literature survey of surfactant and low interfacial tension flooding has been done.
11.	S ₂ G ₂ A ₂ P ₇	Mathematical Modelling	The project has been taken up as priority project No. 44. Study of the literature for development of two dimensional black oil model has been carried out. Some work in formulation of the problem has also been started.
12.	S ₂ G ₂ A ₂ P ₁₀	Design and development of artificial lift equipment for oil fields.	The project has been taken up as priority project No. 45. Requirement for the imported/indigenous equipment and stores have been processed. Literature surveys of plunger lift and other gas lift methods for artificial lift have been completed.

A-3 : BIOSTRATIGRAPHY

13.	S ₂ G ₂ A ₂ P ₄	Meso-Cenozoic biostratigraphy of the south Shillong front comparative study with that of Bangla Desh and Palaeogeographic reconstruction of the area.	The project has been taken up as priority project No. 2. Requirements of imported/indigenous equipment and stores have been processed. It is proposed to carry out the studies in collaboration with Calcutta University and Chandigarh University for palaeontological and palynological analysis relating to this project.
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1.	2.	3.	4.
14. S ₂ G ₂ A ₃ P ₅	Palaeogene biostratigraphy of the Andaman/Nicobar islands and its inter-relationship with the Sumatran arc to the south-east.		Both these projects have been taken up as one priority project No. 1. Requirements of imported/indigenous equipment and stores have been processed. The project envisages collaboration with Banaras Hindu University and Punjab University.
15. S ₂ G ₂ A ₃ P ₆	Neogene biostratigraphy of the Andaman/Nicobar islands and its inter-relationship with the Sumatran arc to the southeast.		

A-4 : DRILLING TECHNIQUES AND PROCESSES

16. S ₂ G ₂ A ₄ P ₁₅	Development of drilling techniques for abnormal wells		The project has been taken up as priority project No. 35. Both indigenous and imported equipment and stores are under procurement.
17. S ₂ G ₂ A ₄ P ₁₆	Development of subsea completion techniques		The project has been taken up as priority project No. 38. Literature survey on the available literature has been conducted, and a brief report has been issued.
18. S ₂ G ₂ A ₄ P ₁₇	Study of Drilling Economics		The project has been taken up as priority project No. 39. Literature survey on minimum cost drilling has been carried out and is to be continued. Some computer programmes have also been made for processing of field drilling data.
19. S ₂ G ₂ A ₄ P ₁₈	Development of directional drilling.		The project has been taken up as priority project No. 40. Literature survey on high angle directional drilling was conducted and a brief report has been issued.
20. S ₂ G ₂ A ₄ P ₁₉	Development of cementing techniques		The project has been taken up as priority project No. 37. Both indigenous and imported equipment and stores are under procurement. Literature survey on the cementation techniques is being carried out. Literature survey is also being carried out for secondary cementation and plug back job.

1.	2.	3.	4.
21. S ₂ G ₂ A ₄ P ₂₁	Methods of forecasting high pressure and prevention on blow-outs.		The project has been taken up as priority project No. 36. Both the indigenous and imported equipment and stores are under procurement. Literature survey on the subject and collection of field data have been done on which a preliminary report is under preparation.
22. S ₂ G ₂ A ₄ P ₂₂	Research programme for pollution control.		The project has been taken up as priority project No. 41. Literature survey on oil-spill on sea, its prevention and control has been carried out and a brief report has been issued. It includes oil spill damage, clearing equipment and techniques and methods of prevention of oil spills on sea.

A-5 : SEDIMENTARY PROCESSES AND FORMATION OF DELTAS

23. S ₂ G ₂ A ₅ P ₂	Godavari Krishna deltas Complex		The project has been taken up as priority project No. 3. This project is taken up in collaboration with Andhra University which will study the surface and near surface samples collected by Research Scholars. The required imported and indigenous equipment and stores are under procurement.
24. S ₂ G ₂ A ₅ P ₅	Tertiary sediments of South Cambay basin.		The project has been taken up as priority project No. 4. All available information on the Cambay basin has been collected and documented sectorwise. The proposed analytical work will be taken up when scientific manpower required for the project becomes available.

A-6 : DRILLING MUD AND OIL WELL CEMENT

25. S ₂ G ₂ A ₆ P ₁	Studies on problems connected with instability of mud systems at high temperature and development of thermostable additives/drilling fluids.		The project has been taken up as priority project No. 28. Requirements of the imported and indigenous equipment and stores have been processed.
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1.	2.	3.	4.
26. S ₂ G ₂ A ₆ P ₄	Preparation and maintenance of mud of high specific gravity (Sp.gr. of 2.0 and above) to balance high formation pressures.	The project has been taken up as priority project No. 29. Requirements for the imported and indigenous equipment and stores have been processed.	
27. S ₂ G ₂ A ₆ P ₅	Synthesis of mud chemicals and additives.	The project has been taken up as priority project No. 26. Requirements for indigenous equipment, stores have been processed. The project envisages collaboration with AITRA, Ahmedabad.	
28. S ₂ G ₂ A ₆ P ₇	Studies on corrosion problems associated with the use of salt water workover fluids.	The project has been taken up as priority project No. 30. Requirement for the imported and indigenous equipment and stores have been processed.	
29. S ₂ G ₂ A ₆ P ₁₁	Manufacture of oil well cements	The project has been taken up as priority project No. 31. Requirements for imported and indigenous equipment and stores are under process of procurement.	
30. S ₂ G ₂ A ₆ P ₁₄	Synthesis of chemicals for improvement of the properties of cement slurries e.g. fluid loss, viscosity, setting time and strength retrogression.	The project has been taken up as priority project No. 32. The required imported and indigenous equipment and stores are under process of procurement. The project envisages collaboration with Regional Research Laboratory, Jorhat. The work plan and other terms and conditions have been finalised with the collaborators.	
31. S ₂ G ₂ A ₆ P ₁₅	Studies on bond strength vis-a-vis expending characteristics of cement.	The project has been taken up as priority project No. 34. Action for providing the required material and staff for the project is in hand.	
32. S ₂ G ₂ A ₆ P ₂₀	Development of software for solving mud problems	The project has been taken up as priority project No. 27.	
33. S ₂ G ₂ A ₆ P ₂₅	Studies on strength retrogression and its prevention	The project has been taken up as priority project No. 33. The required imported and indigenous equipment and stores are under process of procurement.	

1.	2.	3.	4.
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A-7 : EXPLORATION GEOPHYSICS INCLUDING WELL-LOGGING

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| 34. S ₂ G ₂ A ₇ P ₁ | Design and development of digital seismic field system. | The project has been taken up as priority project No. 17. The required imported and indigenous equipment and stores are under process of procurement. The project envisages collaboration with ECIL. |
| 35. S ₂ G ₂ A ₇ P ₃ | Development of digital grade geophones. | The project has been taken up as priority project No. 19. Required imported and indigenous equipment and stores are under process of procurement. Collection and study of literature connected with the design and formulation of basic specifications have been done. Drawings of the various components for development of digital grade geophones have been prepared. |
| 36. S ₂ G ₂ A ₇ P ₄ | Development of modern well logging system. | The project has been taken up as priority project No. 21. The ONGC is collaborating with Bhaba Atomic Research Centre in designing a prototype multiparameters resistivity device. Negotiations for the manufacture of modern well logging systems have upto now not been successful. Further talks with different agencies are still going on. |
| 37. S ₂ G ₂ A ₇ P ₅ | Data processing software generation. | The project has been taken up as priority project No. 20. The requirements for imported equipment and stores are under process of procurement. |
| 38. S ₂ G ₂ A ₇ P ₆ | Design and development of expendable and semi expendable jet perforators. | The project has been taken up as priority project No. 48. 50 Nos. shaped charges manufactured by IEL, Calcutta, have been field tested. A performance report with the suggested improvements, has been sent to IEL for doing the needful. Now manufacturing of MK-85 type gun will be taken up with the concerned ordnance factories. |

1.	2.	3.	4.
39. S ₂ G ₂ A ₇ P ₈	Development of seismic field techniques in folded areas.		The project has been taken up as priority project No. 14. The required imported and indigenous equipment and stores are under process of procurement.
40. S ₂ G ₂ A ₇ P ₉	Delineation and identification of subtle traps for hydrocarbons (lithology oriented interpretation of geophysical data).		The project has been taken up as priority project No. 15. Three seismic lines, which were shot across Unauwa Well No. 1, were analysed with the specific objective of delineating the Unauwa sands on the seismic sections.
41. S ₂ G ₂ A ₇ P ₁₁	Development of well log evaluation techniques for heterogenous shally sands containing fresh water.		The project has been taken up as priority project No. 23. Procurement action for the import equipment required for the project is in hand.
42. S ₂ G ₂ A ₇ P ₁₂	Design and development of production logging equipment.		The project has been taken up as priority project No. 42. Requirement of imported and indigenous equipment and stores is under process of procurement.
43. S ₂ G ₂ A ₇ P ₁₇	Mathematical modelling in exploration geophysics (including non-homogenous, non-isotropic and dissipative media).		<p>The project has been taken up as priority project No. 13. In collaboration with University of Roorkee, the following major topics of investigation are under progress:-</p> <ul style="list-style-type: none"> i) Stochastic modelling of stratigraphic sequences. ii) Design and development of filters for enhancing bright spots. iii) Possibility of the application of Kalman filter to geophysical data processing.
44. S ₂ G ₂ A ₇ P ₁₉	Study of physical properties and evaluation of logging parameters on core samples under simulated formation conditions.		The project has been taken up as priority project No. 22. Discussions have been held with NGRI, Hyderabad, regarding their collaboration in fabrication of pressure cells and associated pressure-temperature generating and measuring systems. The NGRI are yet to submit their terms and conditions for the collaboration. Literature survey and theoretical studies on the expected behaviour of rock properties with pressure and temperature has been attempted.

ADDITIONAL PROJECTS TAKEN UP BY ONGC WHICH DO NOT
FIGURE IN THE DRAFT S&T PLAN 1974-79 OF NCST

Sl.No.	Title of the Project	Remarks
1.	Geophysical survey instrument (Marine/Design and development of marine streamer.)	The project has been taken up as priority project No. 18. The required indigenous/imported equipment and stores are under process of procurement.
2.	Basement mapping and deep seismic sounding (DSS) Arabian Sea, Ganga Valley, Cambay Basin and part of Himalayas.	The project has been taken up as priority project No. 25. Deep seismic sounding field work along the first profile of approximate length of 200 kms. from Mehamadbad to Billimora in the Cambay Basin has been completed in collaboration with NGRI. The DSS field work along the second profile Navibandar to Amreli of approximate length of 160 kms. in Saurashtra has been completed.
3.	Regional aeromagnetic survey over the continental shelf and across the continental margins off West Coast of India.	The project has been taken up as priority project No. 24. The project envisages collaboration with NGRI for carrying out the survey. The land bases for position location systems ANA have been fixed by 2 survey parties at suitable points along the West Coast of India. The computation of their precise coordinates is in progress.
4.	Geomorphological evaluation of the India Coast.	The project has been taken up as priority project No. 5. This project is being carried out in collaboration with Poma University and Andhra University.
5.	Sedimentological, geochemical and microbiofacies study in the continental shelf between Bombay High and offshore of Kutch.	The project has been taken up as priority project No. 6. The required imported and indigenous equipment and stores are under process of procurement. Detailed discussions with the scientists of NIO, Goa on sampling surveys in the area of study, alignment of survey cruises, sampling sites etc. were held. The NIO agreed to collaborate and to share half of the cost of the proposed surveys and studies.
6.	Remote Sensing using ERTS Imageries.	The project has been taken up as priority project No. 7. The required imported and indigenous equipment and stores are under process of procurement.

List of Projects taken up by Indian Oil Corporation Ltd.,
at their R & D Centre which are not identifiable with
Projects listed in draft S & T Plan 1974-79 of NCST.

Sl.No. Title of the Project		Remarks
1.	2.	3.
1.	Product Development	11 special oils are under development for various applications. Some other important products under development are Fire resistant hydraulic fluids, improved metal working oils, improved antiwear hydraulic oils, improved greases and some specialities for rubber/leather industries etc.
2.	Product Application Studies.	<p>(a) A kerosene wick stove with a higher thermal efficiency (60% +) was developed and is being produced under IOC licence by M/s Oriental Metal Industries, Calcutta.</p> <p>(b) Tracks were laid in various parts of India for the scientific choice of bitumen for durable and economic pavements in various climates with different grades of bitumens produced by Madras Refineries and HPC. These tracks are under periodical observation for assessing their performance.</p> <p>(c) Various commercial fuel saving devices marketed were evaluated in IOC test cars.</p>
3.	Technical Service to Customers.	IOC is providing technical back-up service to their customers to solve various problems of application. This has given them an opportunity to develop/improve some products for specific applications.
4.	Assistance to Refineries & Pipelines Division	IOC is providing assistance to various refineries in quality control of various products. Examples are ATF production at Barauni, improved methods for evaluation of cold flow properties of Diesel fuels from Koyali and Barauni.
5.	Improvement of Standards of Lubes & Fuels.	IOC is doing this through introduction of high quality products and by assisting in formulating improved ISI standards for lubes and fuels incorporating performance tests wherever feasible.
6.	Development of Oils, particularly those used in marine service and metal working operations.	IOC has entered into an agreement with Castrol U.K. for this purpose after field trials in various ships for 6 to 12 months. IOC has already obtained provisional approval of four important engine builders for their marine oils. The results will be evaluated by engine manufacturers with a view to give final approval.

1.	2.	3.
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Petroleum Process Development Group Projects

- | | |
|---------------------------------------|--|
| 7. Visbreaking/Thermal Cracking. | Pilot scale visbreaking unit has been fully commissioned upto the distillate accumulator stage and has been fully tested for flow, temperature, pressure and control measurements. |
| 8. Delayed Coking Studies. | After the completion of visbreaking studies, thermal cracking studies will be conducted in the same unit and thereafter the same will be converted for delayed coking studies with minor modifications. |
| 9. Wax Deciling Unit | IIP has completed laboratory scale studies on Barauni and Madras Refineries slack waxes. IIP and EIL have also sent their recommendations to solve problem of debottlenecking of MRL solvent dewaxing plant. |
| 10. Reforming Catalyst proving plant. | IIP has already got a 100-400 ML volume reactor for catalyst proving plant. They have developed catalysts for reforming hydrodesulfurisation and have found them as good as commercially available ones. |
| 11. Coal to Oil Project | IOC in collaboration with NRDC has sponsored this project at the Central Fuel Research Institute, Dhanbad. |

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STATUS OF PROJECTS IDENTIFIED IN THE DRAFT S&T
PLAN 1974-79 OF NCST IN THE METALLURGICAL SECTOR

S U M M A R Y

The status of the projects as detailed in the pages below is based on the information received from the major Public Sector Undertakings in the area of metallurgy in which R & D programmes were identified, namely, (i) Steel Authority of India Ltd. (SAIL), (ii) Hindustan Copper Ltd. (HCL), (iii) Hindustan Zinc Ltd. (HZL), and (iv) Bharat Aluminium Company Ltd. (BALCO).

26 projects, specially identified from the draft S&T plan 1974-79 of NCST have been included in this list. Of these 26 projects identified, 20 projects were taken up by SAIL, 4 projects by HCL, 3 projects by HZL, 1 project by BALCO and 1 by Mishra Dhatu Nigam Ltd. (It may be mentioned here that in the case of projects like "Augmentation of Facilities for Ore Dressing and Agglomeration", SAIL, BALCO, HZL and HCL have taken up the projects individually as far as their problems in this field are concerned and thus, the number of projects of individual companies adds upto more than 26.

Public Enterprises have mentioned that in addition to the projects identified by the NCST, certain other gaps have been identified by them in their day-to-day working and, therefore, have taken up 36 additional projects in addition to the 26 projects referred to above. In this category, 21 projects were taken up by SAIL, 13 projects were taken up by HZL, and 2 projects were taken up by BALCO. A list of these 36 projects is also given in the following pages.

STATUS OF PROJECTS IDENTIFIED IN THE DRAFT NCST PLAN
1974-79 IN METALLURGY SECTOR

NCST Project Index Number	Title of the Project	Remarks
1.	2.	3.

G-1 : Ores and Minerals

S.G.P.₁

Augmentation of facilities
for ore dressing and
agglomeration

SAIL has taken up this project under the title "Iron ore Beneficiation" under the project No. 120101 and also "Optimisation of process parameters" with project No. 120201 in respect of iron ore beneficiation with particular reference to improvement of Al_2O_3/Fe and for sintering process respectively.

Bharat Aluminium Co. have a project for "Bench Scale Testing and Pilot Plant Testing of Bauxite". The principal operation relates to the determination of grinding characteristics, digestion condition, accepted settling rate, amount of red mud found and its settling characteristics, effect of impurities, etc.

Hindustan Zinc Ltd. have nine projects in this category i) Beneficiation of Moore Cake for the recovery of Zinc; ii) Establishment of flowsheet for Sikkim ROM ore and upgradation of Sikkim Zinc concentrate; iii) Lead copper separation from complex lead-copper bulk concentrate from Rajpura-Dariba Mines; iv) Recovery of metals from old mine dumps and slag; v) Recovery of Lead, Zinc and Magnetite from a complex Magnetite-Lead Zinc ore like that of Gorubathan deposit, Darjeeling Distt.; vi) Separation of pyrite from low grade lead concentrate; vii) Beneficiation (Flotation) tests for magnesite recovery from Magnesite ore with high silicon content; viii) Lead and copper separation from Sargipalli Pb-Cu ore; and ix) Flotation studies of Rajpura-Dariba Polymetallic Ore.

Hindustan Copper have formulated a project "Mineral Beneficiation Pilot Plant" which is yet to be approved.

1.	2.	3.
<u>G-2 Coal and Coke</u>		
S ₇ G ₂ P ₁	Production of formed coke from non-coking coals.	SAIL has taken up this project under the title "Formed coke as alternative metallurgical fuel" with project No. 110201 in collaboration with CFRI, CMPDI, MECON, TISCO, etc.
S ₇ G ₂ P ₂	Production of formed coke by hot briquetting.	SAIL has taken up this project under the title "Formed coke as alternative metallurgical fuel" with Project No. 110201 in collaboration with CFRI and others.
S ₇ G ₂ P ₃ (a)	Renovation of pilot coke oven battery for testing of coal blends.	SAIL has taken up this project under the title "Pilot Coke Oven Battery" with their Project No. 110103 in collaboration with CIL, CMPDI and CFRI.
S ₇ G ₂ P ₃ (b)	Selective preparation of coal for coking.	SAIL has taken up this project under the titles (i) "Selective preparation of coal" with their project No. 110101 and (ii) "Pre-heating and Pipeline charging of coal" with their project No. 110102.
S ₇ G ₂ P ₃ (c)	Selective extraction and selective agglomeration of coal to produce low ash product.	SAIL has taken up this project under the title "Deashing of Coal" with their project No. 110202 in collaboration with CFRI.
<u>G-3 : Iron and Steel</u>		
S ₇ G ₃ P ₂	Computer Control for processes in steel industry.	SAIL has taken up the following three projects with their project No. indicated therein:- i) "Process control computerisation at BSL" - 310101. ii) "Controller unit for billet cutting" - 310102. iii) "Indigenisation of computer control" - 310103.
S ₇ G ₃ P ₃	Improvements in Blast Furnace productivity and reduction of coke rate.	SAIL has taken up the following five projects with their project No. indicated therein:-

1.	2.	3.
		i) "Performance evaluation of Indian blast furnace" - 130101. ii) "Conversion of existing blast furnace into experimental blast furnace" - 130102. iii) "Determination of optimum slag regime in Indian blast furnace" - 130103. iv) "Lime injection through tuyeres of Indian blast furnace" - 130104. v) "Coal dust injection" - 130105.
S ₇ G ₃ P ₄	Trials with OBM and SIP processes for steel making.	SAIL has taken up the following two projects with their project No. indicated therein:- i) "Evaluation of twin hearth practice" - 140201. ii) "Evaluation of bottom blown oxygen steel making" - 140202.
S ₇ G ₃ P ₅	Development of continuous casting technology with particular reference to LD operation, quality and productivity.	SAIL has taken up the following two projects with their project No. indicated therein:- i) "Continuous casting technology" - 160101. ii) "Direct casting thin section" - 160102.
S ₇ G ₃ P ₆	External desulphurisation of hot metal	SAIL has taken up this project under the title "Desulphurisation/desiliconisation of hot metal outside blast furnace" with their project No. 130107.
S ₇ G ₃ P ₇	Direct reduction by gaseous reductant with the gassification of locally available high volatile non-coking coal.	SAIL has taken up this project under the title "Pilot Plant for sponge iron based on coal gassification" with their project No. 130201. SAIL R&D has been associated with the demonstration plant for sponge iron under APIDC with UNIDO assistance.
S ₇ G ₃ P ₈	Development of instrumentation for steel plant.	SAIL has taken up the following two projects with their project No. indicated therein:-

1.	2.	3.
		i) "Modern Analytical techniques for steel plants (XRF quanto-meter)" - 220101. ii) "Use of solid-electric oxygen probe" - 170104.
S ₇ G ₃ P ₉ (*)	Studies on utilisation of steel plant wastes.	SAIL has taken up the following two projects with their project No. indicated therein:- i) "Development of coal bonded pellets technology" - 120204. ii) "Pyridine recovery from cokeoven gas" - 110104.
<u>G-4 : Special Steels</u>		
S ₇ G ₄ P ₁	Development of electroslag refining technology for various grades of alloys.	SAIL has taken up the following two projects with their project No. indicated therein :- i) "Roll Lubrication" - 160201. ii) "Electro-slag refining of special steels" - 160202.
S ₇ G ₄ P ₂	Development of basic oxygen processes for making high alloy steels by BOF process.	SAIL has taken up the following four projects with their project No. indicated therein :- i) "Alloy Steels by BOF process" - 140401. ii) "Non-silicon electrical steel"- 210301. iii) "Flux practices in LD steel making" - 140101. iv) "Design and operation of oxygen and lance in LD" - 140102.
S ₇ G ₄ P ₃	Development of suitable stainless steel for Phosphoric Acid Service.	SAIL has taken up this project under the title "Suitable stainless steel for phosphoric service" with their project No. 210201.
S ₇ G ₄ P ₆	Development of creep resistant steels.	SAIL has taken up this project under the title "Creep Resistant Steels with their project No. 210104.

*Project transferred to Recycling of Wastes panel and hence funds not include here.

1.	2.	3.
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G5 : Common Non-Ferrous Metals

S ₇ G ₅ P ₁	Setting up of facilities for hydrometallurgy and electro-metallurgy with special reference to Ni, Cu, Zn, & Cr.	Remarks against S ₇ G ₅ P ₁ on augmentation of facilities for ore dressing include activities by Hindustan Copper & Hindustan Zinc in this area.
S ₇ G ₅ P ₅ (a)	Improvement in copper refining process by use of high current density.	Hindustan Copper has taken up this project and process designs and equipment specifications were completed in 1976. The project is expected to be commissioned in October, 1978.
S ₇ G ₅ P ₅ (b)	Improvement in copper refining process by use of periodic reverse current.	
S ₇ G ₅ P ₈	Recovery of zinc from moore cake	The status against this has been indicated in the remarks against S ₇ G ₅ P ₁ .
S ₇ G ₅ P ₉	Development of high purity zinc for die-casting.	Two projects, one for recovery of high purity zinc & cadmium and another for high purity zinc using vortexial cell, have been proposed by Hindustan Zinc.

G8 : High Purity Metals & Super Alloys

S ₇ G ₈ P ₁	Setting up of Special Metals & super alloys Plant.	A new public sector undertaking "Mishra-dhatu Nigam Ltd." has been set up in Hyderabad for production of super alloys with iron base, nickel base & cobalt base.
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G₁₁ : Refractori

S ₇ G ₁₁ P ₁	Development of basic refractories for LD Converters and improved lining life.	SAIL has taken up the following two projects with their project No. indicated therein:- i) "Basic refractories for LD Converters" - 150101. ii) "Beneficiation of magnesite"-120102.
S ₇ G ₁₁ P ₂	Development of better quality pouring refractories.	SAIL has taken up the following two projects with their project No. indicated therein:- i) "Introduction of slide gate wall system to replace conventional stopper rod system in teeming steel" - 150102. ii) "Investigation on sleeves for 270 T ladles" - 150103.

LIST OF ADDITIONAL PROJECTS TAKEN UP BY PUBLIC SECTOR UNDERTAKINGS IN
METALLURGICAL AREA WHICH ARE NOT IDENTIFIABLE WITH PROJECTS LISTED IN
THE DRAFT S&T PLAN OF NCST 1974-79

Hindustan Steel Limited

Sl. No.	Project Title	Project No. of HSL
1.	2.	3.
<u>Coal & Coke</u>		
1.	Improvement in Performance of coke ovens in steel plants.	110301
<u>Steel Making</u>		
2.	Coated Graphite Electrode in Electric AVC Furnace.	140301
3.	Low Carbon Steel	140302
<u>Mechanical Working and Casting</u>		
4.	Roll Lubrications	160301
<u>Fuel & Energy</u>		
5.	Energy Model for Integrated Models	170101
6.	Combustion efficiency of Soaking Pits, Reheating Furnace.	170102
<u>Raw Materials and Iron making Division</u>		
7.	Development of Ferro-alloys in India.	130109
8.	Utilisation of basic steel plant slag for soil amendment purpose.	-
<u>Steel making and processing Division</u>		
9.	Improving the yield of Wheels and Axles at DSP.	160501
10.	Improving the yield in Primary Mills.	160502
11.	Operating Committee on Rolling Mills.	160900
12.	Reduction of width variation in skelps from DSP.	180101
13.	Reduction in Incidence of Roll Breakage in Skelp Mill (DSP).	180102

1.	2.	3.
14.	Task Force on Tribology in Steel Plant	180401
	<u>Product Development Division</u>	
15.	Adaptation of CRGO Steels	-
16.	Development of High-speed steel with optimized composition	160201/ 210203
17.	To develop rimming quality non-aging deep drawing steels.	210105/ 140401
	<u>Process Control & Scientific Services</u>	
18.	Process Control Hardware Laboratory	-
19.	Installation of Line Printer for IBM 1620	-
20.	Technical information and documentation system for Iron & Steel Industry (TIDSTS)	-
	<u>SOC and OR Group</u>	
21.	Training and promotional work in SOC & OR for R&D Engineers	

HINDUSTAN ZINC LIMITED

Research Projects in Metal Extraction Etc.

1. Recovery of Zinc from Screw Conveyor Product.
2. Recovery of Zinc as zinc dust from zinc dross.
3. Recovery of Antimony from Antimony Dross of Lead Smelter.
4. Recovery of Zinc from Moore Coke.
5. Recovery of Copper from Copper Cement.
6. Recovery of Cobalt from Cobalt Cake.
7. Recovery of Zinc from Retort Slags.
8. Process for zinc sulphate from zinc dross.
9. Recovery of zinc from Smelter Effluents.
10. Fast Dissolution of Cadmium Sponage.
11. Recovery of Zinc from hard zinc.
12. Standardisation and Development of Analytical Techniques for elements in various products.
13. Design of aluminium cathode.

1.	2.	3.
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BHARAT ALUMINIUM COMPANY LIMITED.

1. Hydraulic transportation of bauxite.
2. Mineralogical and Petrological evaluation of bauxite.

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STATUS OF PROJECTS IDENTIFIED IN THE DRAFT S & T PLAN
1974-79 OF THE NCST OF THE HEAVY ELECTRICALS SECTOR

SUMMARY

The status of the projects as detailed in the pages below is based on the information received from Bharat Heavy Electricals Limited in the area of Heavy Electricals in which the R & D programmes were identified.

Thirty Eight projects specially identified from the draft S & T Plan 1974-79 of NCST have been included in this list. All these projects were taken up by Bharat Heavy Electricals Limited for implementation. The present status of these projects as indicated by Bharat Heavy Electricals Limited is given in the following pages.

STATUS OF PROJECTS IDENTIFIED IN THE DRAFT S & T PLAN
1974-79 OF NCST IN HEAVY ELECTRICALS SECTOR (POWER)

NCST No	Title of the Project	Remarks by BHEL
1.	2.	3.
<u>G₁ - R & D Task Force</u>		
S ₃ G ₁ P ₁	500 MW Prototype	BHEL has a time bound programme to manufacture a 500 MW Unit. In the area of steam turbines and turbo-generators for large size sets, a collaboration has been entered into with KWU. In some areas such as Boilers and Heat Exchanger the development work is being done in-house. A Programme has also been drawn up for the absorption of technology from KWU.
S ₃ G ₁ P _{2(a)}	R & Projects - Power Systems - 400 Kv line and equipment	BHEL is in a position to design and manufacture major equipment like switchgear, power/instrument transformers for 400 KV Systems.
S ₃ G ₁ P _{2(b)}	R & D Projects - Power Systems - HVDC line and equipment	Studies have already been taken up for the HVDC line and equipment.
S ₃ G ₁ P _{3(a)}	R & D Facilities - Expansion - New Ultra HV Synthetic testing, training of power system and maintenance engineers.	BHEL has plans for development of equipment for UHV transmission. In order to design and test the equipment such as transformers and switchgears a UHV laboratory is being set up at Bhopal.
S ₃ G ₁ P _{3(b)}	R & D Facilities - Expansion - New - Steam Turbine development centre, superconducting Dev. Centre for small and medium scale industries; on the line computation/automation, direct energy conversion.	BHEL has a developmental centre for steam turbines, large and medium utility turbines and industrial turbines. R & D programmes like twin shell castings for 210 MW turbines, development of turbovisory instrumentation, etc. are in progress.
S ₃ G ₁ P ₄	Product Development Projects - Large transformers, super conducting motors, Bulb turbines.	R & D Projects are in progress for transformers such as spray resin encapsulated 33 KV current transformer, 20 MVA Al, wound Transformer, Development of 5200 KVA Traction Transformer, etc. A bulb turbine prototype as a test model is under manufacture. Designs for a 7.5 MW bulb turbine for the Western Yamuna Canal Project is ready.

1.	2.	3.
S ₃ G ₁ P ₅	Materials Development programme - Creepresist steels, non-ferrous insulations, special alloys, ceramics, new materials.	<ul style="list-style-type: none"> - R&D projects are under progress to study the creep characteristics and fatigue crack growth rates in different materials used in BHEL equipment. - Projects to develop erosion resistant materials for use in fans, mills, etc. have been undertaken. - Development of electrical contact material. - Development of capacitor impregnates. - Development of epoxy resin for Class F insulation.
S ₃ G ₁ P ₆	Power and Industrial Electronics - Process control, automation, instrumentation, computers.	<ul style="list-style-type: none"> - A project is under progress for extracting mono-crystalline silicon by FZ process. - BHEL also has a programme for the development of power thyristors.

G₂ - MHD

S ₃ G ₂ P ₁	MHD 2-5 MW Laboratory Scale experiments.	A joint project between DST, BHEL and BARC is under progress for the development of a 5 MW MHD demonstration power plant based on coal gas. BHEL's responsibility in this project is mainly for the development of hardware required for the project.
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G₃ - Fuel Efficiency

S ₃ G ₃ P ₂	Efficient fuel oil burning equipment	<ul style="list-style-type: none"> - BHEL has established a liquid fuel burning test rig to develop efficient combustion equipment, ignitors and flame sensing and monitoring systems. - To improve fuel efficiency BHEL has other projects such as fluidized combustion boiler which is presently in an advanced stage of testing and conversion from oil to coal fired boilers.
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1.	2.	3.
S ₃ G ₃ P ₃	Antipollution equipment	A fully instrumented experimental electrostatic precipitator has been set up in the Ennore Power Station to study the behaviour and control of particulate emission under varying conditions.
S ₃ G ₃ P ₄	Waste Heat Boilers (Fuel Efficiency)	A nation-wide survey was carried out in the area of waste heat boilers. BHEL has in the past designed and manufactured waste heat boilers. It has recently completed a feasibility study on the Namrup Station for which a clearance to undertake the project has been received.

G₅ - Solar Energy

S ₃ G ₅ P ₁	Laboratory for Solar Energy	R&D activities in the area of solar energy based on solar thermal energy and on converting solar thermal energy into mechanical/electrical energy are in progress. In the first group projects on heating and cooling such as domestic solar water heater, space heating are being carried out and in the second projects such as solar pumps and mini-power plants.
" "	2 Solar Cells	
" "	3 Solar Distillation	
" "	4 Solar Drying	
" "	5 Solar Cookers	
" "	6 Solar Water Heaters	
" "	7 Solar Space Heating, Cooling, Refrigeration and Ice making machine	

BHEL has also been nominated by DST as the Coordinator for all national projects in the area of solar collector development.

G₇ - Wind Power

S ₃ G ₇ P ₁	Wind Mill for Power Generation.	Windmill for Power generation.
2	O&M Services	Design data is being collected from the 1 KW vertical Axis Wind Mill being tested at our R & D Unit Hyderabad. The data will be utilised for the design of a (proposed) 5 MW machine.
3	Wind Mill for Pumping Water	
4	Collection of Wind Data from IMD on Computer	
5	Report on 5-10 KW Wind Generator (Consultant)	
6	Steering Committee on Wind Mills	

1.	2.	3.
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G_9 - Chemical Energy Sources

$S_3 G_9 P_1$	Battery Powered Vehicle	BHEL has provided electrics for a battery powered vehicle which has been tested at Ahmednagar. Also BHEL has designed and manufactured an Electrically operated trolley bus which has undergone successful trials in Calcutta.
2	Long Term R & D Projects	
	1. Lithium Cells	
	2. Sodium Sulphur Cells	
	3. Metal Air Cells	
	4. H_2O_2 Cells	

G_{10} - Gas Turbine

$S_3 G_{10} P_1$	10 MW Peak Load Project	BHEL is setting up a prototype combined cycle demonstration plant based on gasified coal and a gas turbine.
2	10 MW Base Load Project	
3	Waste Heat Boiler (for Gas Turbine)	BHEL has also examined the feasibility of converting the Namrup Station into a combined cycle station and has got clearance to go ahead with the project.
4	R & D on Use of Coal Gasification for Gas Turbine.	
5	Preliminary 150 MW Dual Cycle	- A project for the development of a coal gasifier is in progress. - BHEL has a joint programme in the area of coal gasification with RRL, Hyderabad - Also BHEL is the convenor of the Steering Committee set up by the Ministry of Energy to examine conversion of the Avon Engine for power generation.

G_{12} - Better Utilisation of Existing Thermal Stations

$S_3 G_{12} P_1$	R & D to improve utilisation of existing Thermal Stations - visits, diagnosis, 'workshop' meeting.	BHEL has Research and Product Development Centres for all its products. At each of these centres studies are being made to improve the product and thereby increase the availability of thermal power stations. Also BHEL has set up a system for monitoring BHEL equipment in thermal power stations and initially the performance of 6 power stations is being measured.
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1.	2.	3.
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G₁₆ Drilling Rigs

S ₄ G ₁₆ P ₁	RDD in Oil & Water Drilling Rigs.	BHEL is manufacturing oil rigs. For this BHEL has entered into collaboration with an American concern, BHEL is also having plans to progressively manufacture the rigs indigenously. Also BHEL has set up an Engineering Centre for oil rig equipment at Hyderabad.
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G₂ Heavy Pressure Vessels, Boilers, Heat Exchangers, Dryers, etc.

S ₄ G ₂ P ₁	National Boiler Institute, Trichy.	The proposed activities of this Institute are already being carried out by the Boiler Plant at Trichy.
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G₃ Equipment for Fertilizer Plants, Petroleum Refineries and Petrochemical plants, Heavy Duty Pumps, Compressors and Special Pumps for Chemical Industries

S ₄ G ₃ P ₁	Combined Research Institute for Heat and Mass Transfer	A DPR was prepared for a combined Institute for Boiler, Heat and Mass Transfer Studies as desired by NCST. This project has substantially been dropped as the activities are being carried on by the Boiler Plant at Trichy.
S ₄ G ₃ P ₂	Research, Design and Development Institute for Chemical Equipment	

Additional Projects

No.1	15 MW Turbo-generator for fast breeder test reactor being developed by Reactor Research Centre, Kalapakkam, Madras	BHEL's primary involvement in the FBTR project has been in the development, detailed design and manufacture of the steam turbine required for the project. In addition, it is manufacturing several additional components for the FBTR system, such as the steam generator, the intermediate heat exchanger, block pile components and piping.
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STATUS OF PROJECTS IDENTIFIED IN THE DRAFT S & T
PLAN 1974-79 OF NCST IN HEAVY ENGINEERING SECTOR

SUMMARY

The status of the projects as detailed in the pages below is based on the information received from the Department of Heavy Industry in the Heavy Engineering Sector.

Eighty projects specially identified from the draft S & T Plan 1974-79 of NCST have been included in this list. Most of these projects were identified against various public sector undertakings in the field of heavy engineering. Four other projects which have been taken up have also been included.

STATUS OF PROJECTS IDENTIFIED IN THE DRAFT S&T PLAN 1974-79
OF NCST IN HEAVY ENGINEERING SECTOR

NCST Project Index No	Title of the Project	Remarks as indicated by the Min. of Heavy Industry
1.	2.	3.

G₁ - Heavy Electric Equipment for Power House, Transmission,
Sub-Station, Mill Drives, Traction Equipment, Steam and
Water Turbines

S ₄ G ₁ P ₁	Constitution of Research Group & Team (Hydrosets)	Included in the opera- tional Plan of BHEL
S ₄ G ₁ P ₂	Constitution of Design & Development Group & Teams (AC & DC Machines)	-do-
S ₄ G ₁ P ₃	Development work relating to Power and Instrumentation Transformers, Recti- fiers and Capacitors.	-do-
S ₄ G ₁ P ₄	Manufacture, Research & Development of Circuit Breakers, Isolators & Lighting Arrestors.	-do-
S ₄ G ₁ P ₅	Development work relating to Hydro-dynamic equipment including pumps and turbines.	-do-
S ₄ G ₁ P ₆	Systems & Application engineering for Industrial Projects (Included in G ₄ P ₈)	-do-

G₂ Heavy Pressure Vessels, Boilers, Heat Exchangers,
Dryers, etc.

S ₄ G ₂ P ₁	National Boiler Institute, Trichy.	As the activities in the proposed DPR are being carried out by the Boiler Plant of BHEL, Trichy, the scheme has been deferred.
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G₃ Equipment for Fertilizer Plants, Petroleum Refineries,
Petrochemical Plants, Heavy Duty Pumps, Compressors and
Special Pumps for Chemical Industries

S ₄ G ₃ P ₁	Combined Research Institute for Heat and Mass Transfer.	As the activities pro- posed in the DPR are being carried out by the Boiler Plant of BHEL, Trichy, the scheme has been defe- rred.
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1.	2.	3.
S ₄ G ₃ P ₂	Research, Design and Development Institute for Chemical Equipment	The setting up of this Institute has been deferred for the time being. But the Chemical Equipment Research Scheme has been included in the modest R&D scheme of BHPV included in the S&T Plan.
<u>G₄</u>	<u>Heavy Machine Tools</u>	
S ₄ G ₄ P ₁	RDD Centre for Heavy Machine Tools	Scheme approved by Board of Directors of HEC in principle. DPRs are awaited in the Ministry.
<u>G₅</u>	<u>Steel Plant & Metallurgical Plant Equipment</u>	
S ₄ G ₅ P ₁	Equipment Design Organisation for Steel plants	-do-
S ₄ G ₅ P ₂	RDD Centre for Aluminium Industry	-do-
S ₄ G ₅ P ₃	Equipment Design Organisation for Aluminium Plant	-do-
S ₄ G ₅ P ₄	Central Mine Design & Construction Cell for Mining of non-ferrous metals covering copper, zinc, lead nickel.	MAMC has prepared detailed project report for development of certain mining machinery. Project Report under examination.
S ₄ G ₅ P ₅	Non-ferrous Research Centre (included in panel on Mining Steel and Metallurgical Industry)	HEC Design Institute mentioned at S4G4P1 will cover this also.
S ₄ G ₅ P ₇	Control Systems Design Organisation	Development work is being taken up by BHEL as part of their operational plan.
<u>G₆</u>	<u>Mining Machinery Ore Beneficiation Equipment and Heavy Earth Moving Eqpt</u>	
S ₄ G ₆ P ₁	Central Mining Equipment Design Cell	) Detailed project report has been received by the Department of Heavy Industry and has been circulated to Screening agencies for comments.
S ₄ G ₆ P ₂	Design and Consultancy Cell for Beneficiation of Coal and Coal Washeries.	
S ₄ G ₆ P ₃	Development of double drum ranging arm shearer.	

1.	2.	3.
S ₄ G ₆ P ₄	Development of long well coal cutting machine with curved jib.	) Detailed project report has
S ₄ G ₆ P ₅	Development of flame proof diesel locomotive.	) been received by the De-
S ₄ G ₆ P ₆	Development of shuttle car	) partment of Heavy Industry
S ₄ G ₆ P ₇	Development of low pressure axial flow main mine fan.) and has been circulated to
) Screening agencies for
) comments.
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G ₇ -	<u>Port and Harbour Machinery</u>	
S ₄ G ₇ P ₁	Establishment of development cells in plant engineering (ports) for the development of port and bulk handling equipment	HEC Design Institute mentioned at S4G4P1 cover this also.
G ₈ -	<u>Special Requirements of Defence</u>	
	Included in the Panel on Machine Tools	
G ₁₀ -	<u>Process Control Instrumentation</u>	
S ₄ G ₁₀ P ₁	Funding of RDD at manufacturing organisation.	) Rs.130 lakhs provided by
S ₄ G ₁₀ P ₂	Funding of RDD at national laboratories	) Ministry of Heavy Industry
		) in the Addl. Revenue
		) Budget for funding RDD
		) in manufacturing Organisations.
G ₁₁	<u>Special Machinery Printing, Packing, Bottling, etc.</u>	
S ₄ G ₁₁ P ₁	Printing Machinery & Graphic Technology Research Design & Development Institute	) A detailed project report on Graphic Art Research, Machine Development and Training
S ₄ G ₁₁ P ₂	Design & production of matrices for Indian languages compositions	) Institute has been
S ₄ G ₁₁ P ₃	Development of typewriter Key Boards and computing units.	) prepared and approval is
		) expected shortly.
)
S ₄ G ₁₁ P ₄	Development of photo setting units)
S ₄ G ₁₁ P ₅	Development of plate making machinery)

1.	2.	3.
S ₄ G ₁₁ P ₆	Development of the dark room type of camera and process enlarger.	A Detailed Project Report on Graphic Art Research, Machine Development and Training Institute has been prepared and approval is expected shortly.
S ₄ G ₁₁ P ₇	Development of the Dark film processing equipment.	
S ₄ G ₁₁ P ₈	Development of colour scanners	
S ₄ G ₁₁ P ₉	Development of powderless etching machines.	
S ₄ G ₁₁ P ₁₀	Development of litho printing of down frames and lithoplate coating machines	
S ₄ G ₁₁ P ₁₁	Development of automatic platen machine RA 3 size.	
S ₄ G ₁₁ P ₁₂	Development of Letter Press Proof Press	
S ₄ G ₁₁ P ₁₃	Development of single colour sheet fed machine RA 3 and RA 4 size	
S ₄ G ₁₁ P ₁₄	Development of off-set Proof Press	
S ₄ G ₁₁ P ₁₅	Development of folding machine	
S ₄ G ₁₁ P ₁₆	Development of perfect binding machines	
S ₄ G ₁₁ P ₁₇	Development of case making machinery	
S ₄ G ₁₁ P ₁₈	Development of gathering machine	
S ₄ G ₁₁ P ₁₉	Development of wire stitching machine	
S ₄ G ₁₁ P ₂₀	Development of envelope making machine	
S ₄ G ₁₁ P ₂₁	Development of rotary cutting and creasing machines	
S ₄ G ₁₁ P ₂₂	Development of photo-sensitive materials for graphic art.	
S ₄ G ₁₁ P ₂₃	Development of following items: Development of mounting bases, blocks, locking devices, plate registering devices, electronic sheet counting equipment, measuring and testing devices, anodisation of printing plates, polymer plates, photopolymer plates, presensitized plates, paper master, light sources including Xenon lamps.	
S ₄ G ₁₁ P ₂₄	Development of packaging machinery	

1.	2.	3.
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G₁₂ Equipment for the manufacture of Fabrics,
Felts, Filters, etc.

S₄G₁₂P₁ Setting up engineering divisions in the Not included in Heavy
textile laboratories for RDD activities Engineering.

G₁₃ Equipment for Wires & Cables, Wire
Ropes & Plastics Extrusion

S₄G₁₃P₁ Telecommunication and Power Cables and)
Equipment for RDD Institute) A Central Cables and
S₄G₁₃P₂ Development of extruders) Wires Research Insti-
S₄G₁₃P₃ Development of*4 machines by CMERI,) tute was to be set up
Durgapur) for this. Position
S₄G₁₃P₄ Augmentation of RDD at TRC) not known.
S₄G₁₃P₅ Funds to manufacturers for RDD

G₁₄ Information Census Survey in
Heavy Engineering

S₄G₁₄P₁ Establishment of Data Bank in Heavy Included in the National
Engineering Information System.

G₁₆ Drilling Rigs

S₄G₁₆P₁ RDD in Oil and Water Drilling Rigs BHEL Operational Plan
includes this item.

Additional Projects

- | | | |
|----|--|--|
| 1. | 15 MW Turbo-generator for fast breeder test reactor being developed by Reactor Research Centre, Kalapakkam, Madras | Included in Status Report on Heavy Electricals. |
| 2. | Pump Design & Development Institute | The scheme has not come upto the Govt. so far. |
| 3. | Establishment of Aluminium Application Centre | BPCL are at present concentrating on their indigenisation programme and RDD facilities are being established to take up development work also. |

1.	2.	3.
4.	Development of oil Drilling Rigs	Included in BHEL operation plan.
5.	6000 T press Forging	Work is being done in HEC.
6.	RDD in automotives Ancillaries, Diesel Engines Transport Vehicles.	Under the Automotive Research Association of India, Poona some work has been started and funds released by the Department of Heavy Industry.

* The four machines to be developed are:-

- (i) High Speed paper Insulating Machine
- (ii) High Speed Twining Machine for paper and plastic insulator cables.
- (iii) Trunk Cable Insulating Machine
- (iv) Trunk Cable Quadding Machine

In addition to the list of RDD Projects identified under Sector 4 - Heavy Engineering, a number of projects identified in other sectors falling under the purview of the Department of Heavy Industry have also been reported as having been taken up. These are cited below:

NCST Project Number	Name of the Project	Remarks
1.	2.	3.
S ₆ G ₄ P ₁	Welding Equipment and Consumables RDD Institute	A National Welding Research Institute is being set up. Over 60 per cent investment has been made and a number of development projects have already been taken up.
S ₆ G ₁₃ P ₁ to S ₆ G ₁₃ P ₆	Metal Cutting Tools Institute, IMTRA and extension Centres, Forming Tools Institute	<p>1. A detailed project report for a Central Metal Forming Institute has been prepared and is being considered by the Govt. This is likely to be approved shortly.</p> <p>2. Phase I for establishing facilities for Metal Cutting Tool research facilities within the CMTI is being taken up.</p> <p>3. Machining Data Bank is being proposed for inclusion as part of CMTI activities.</p>
S ₉ G ₂ A ₅ P ₁ to S ₉ G ₂ A ₅ P ₆	Aerial & other Ropeways, Design Organisations.	The development is included in the operational plan of Jessop and Company.
S ₆ G ₃ P ₁	National Plan for Machine Tools	A. <u>HMT</u>
Also additional Projects under S ₆	<p>i) Electro Discharge Machine</p> <p>ii) Front Automatic Chucking Lathe</p>	<p>i) Design of Electro-Discharge Machine is completed. Prototype is in progress.</p>

1.	2.	3.
iii) Vertical Machining Centre, Auto Tool Exchanger and Precision Index Table	ii) A front Auto Chucking Lathes has been developed and exhibited in IMTEX-75. Won an Award. Further modifications are being carried out.	
	iii) Development of Vertical Machining Centre is in progress.	
	iv) Prototype for a Numerically Controlled Lathe developed. Orders for 15 NC machines received from UK.	
	v) Light Duty Copying Lathe developed.	
	B. <u>C.M.T.I.</u>	
	i) Development of Die Sinking Machine is in progress.	
	ii) Manufacture of prototype for Universal Thread Grinding Machine is in progress.	
	iii) Design for Coordinate Measuring Machine completed and manufacture started.	
	iv) Scheme for a light unit heads approved by Govt.	
	v) Prototype for printed circuit Board drilling machine completed and is under test.	
	vi) Detailed Project Reports are under preparation for -	
	a) Slant bed NC Lathe	
	b) Slideway grinding machine	
	c) N.C. System	

The other programmes taken up include the following :

Sl No.	Name of the scheme	Implementing Agency	Remarks of the Heavy Industry Ministry
1.	Precision Engineering Centre		The Scheme is yet to be approved by Government
2.	Ultra High Voltage Laboratory	BHEL	Ultra High Voltage Laboratory is being established at Bhopal to meet the customer requirements pertaining to the equipment of 400 KV systems and for development work relating to higher systems.
3.	Corporate R & D Hyderabad	BHEL	An R & D complex is being set up at Hyderabad consisting of different laboratories like aero-dynamics, metallurgy, material sciences, chemicals, electronics, etc.
4.	R & D in various Units	BHEL	Plant level R & D works relates mainly to the product development. A number of experiments and Product Development Projects have been identified for the plant level R & D work and work started on them.

**REPORT OF THE
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DECEMBER