

**Characteristics of S&T Manpower Engaged in R&D Activities in the
Public/ Joint Sector Undertakings under the Socio – economic Ministries of
Central Government**

**Part 1
(Main Report)**

**Sponsored by
Department of Science & technology
Government of India**

Techno Economic Services, New Delhi

December, 1999

Contents

Part 1 (Main Report)

Foreword
Executive Summary

| | | Page |
|------------|--|------|
| Chapter 1 | Introduction | 1 |
| Chapter 2 | Methodolgy And Coverage | 6 |
| Chapter 3 | Demographic Profile | 12 |
| Chapter 4 | Revenue And Expenditure | 26 |
| Chapter 5 | Employment Profile | 33 |
| Chapter 6 | Research Projects Handled | 38 |
| Chapter 7 | Research Output | 41 |
| Chapter 8 | Details of R&D Activities at National Level | 45 |
| Chapter 9 | Constraints Influencing R&D of Undertakings | 47 |
| Chapter 10 | Work Culture, Job Satisfaction, Problems & Prospects | 50 |

Part 2 (Annex)

Annex 1.1 to Annex 10.4

Foreword

The National Science and Technology Management Information System (NSTMIS) Division under the Department of Science and Technology has been doing pioneering work in providing R&D related Statistics. The present study also undertaken at the behest of NSTMIS is expected to provide reliable information on the Characteristics of S&T Manpower engaged in R&D activities in the Institutions and Public Sector/ Joint Sector Undertakings under the ambit of Central Socio- economic Ministries/ Departments. This information is of vital importance to plan scientific research by the Socio- economic Ministries/ Departments, as there has been virtual void in the availability of reliable data in this segment of R&D activities.

Vital data were collected on the demographic profiles of the scientists, their employment records, allocation of their time for various research activities, problems faced by them in carrying out research as well on some qualitative indicators of their scientific work .A large number of scientists responded to the TES's information seeking exercise.

The data were collected to provide detailed analysis of R&D manpower in relation to the utilization patterns, availability of professional and innovative skill, qualifications, specialization and matching of skills warranted for the jobs. Other parameters such as R&D output in terms of patents obtained/ filed, publications of scientists, expenditure and funding of research and development activities in the institutions and undertakings under the purview of the Central Socio- economic Ministries were also covered by the study.

The first to be acknowledged is Dr.Rakesh Chetal, Director, NSTMIS, for the concept, initiation of the project and expert advice. We sincerely thank him for his contribution to the project. Thanks are also due to Dr. G. J. Samathanam, Mr. Parveen Arora and Dr. A. N. Rai for their cooperation and help.

This study was possible only through massive support from various Central Socio – economic Ministries/ Departments and research centres of their Public/Joint Sector Undertakings under operation within the country. Our sincere thanks are also to all those coordinators from different Ministries/Departments who participated in this project.

We express our gratitude to all the Undertakings and scientists who extended their wholehearted support through provision of information solicited in the filled – in questionnaires.

We thank our field staff who was never disheartened whenever they were faced with a non- cooperative attitude either at the institutional or individual scientist's level. We thank our colleagues at TES for their constant help and advice. Their suggestions have been of great help in successful completion of this project.

We appreciate the endeavour of NSTMIS division of DST for commissioning this study and related investigators for the successful completion of the project work. We hope that

the project report would be useful to academicians, planners, policy makers, scientists and technologists and other interested individuals and institutions.

The project report is submitted in two portions – one dedicated exclusively to the coverage of INSTITUTIONS and the other to PUBLIC / JOINT SECTOR UNDERTAKINGS

(G.D.Kalra)

Director

Techno Economic Services ,

New Delhi

December , 1999

Executive Summary

The undertakings under the Central Socio-economic Ministries have in-house R&D centres equipped with the latest infrastructure for carrying out R&D activities. These R&D centres are manned by highly qualified manpower and have carved their niche in the national R&D output.

The Techno Economic Services (TES) undertook this study on the behest of Department of Science & Technology to fabricate a systematic DATABASE on the scientific manpower engaged in R&D activities in the undertakings under study. Through an appropriately framed DATABASE, it is easier to answer various questions relating to:

- Utilization pattern of R&D personnel ,
- Professional and innovative skills available ,
- Problems of qualitative mismatch in specific discipline(s) ,
- Quality of motivation etc.

The DATABASE can also help to solve the problems of existing anomalies through proper planning of future intake of S&T manpower.

The data analyzed and processed in the report are based on the extensive fieldwork conducted by TES. This covered 74 institutions and 2,146 R&D personnel of category B responded. The response rate to this massive data seeking exercise through three sets of questionnaires viz. Listing Sheets, Questionnaire for Scientists of category B and above, Institutional Questionnaire is summarized below:

Response from the Public/Joint Sector Undertakings under the Central Socio- economic Ministries/ Departments

| Number of Public/Joint Sector Undertakings* | Number of the Undertakings Covered | Number of Scientists Listed | Number of Scientists covered |
|---|------------------------------------|-----------------------------|------------------------------|
| 100 | 74 | 2700 | 2146 |
| Percentage Coverage | | | |
| | 74 % | | 79.48 % |

* Institutions as listed in Directory of R&D Institutions, 1994, DST

Because of the commendable response, the data received through the Institution Questionnaires and Scientists Schedules constitute the core of analysis presented in the report. The data available from the filled-in listing sheets have been used as a crosscheck.

Demographic Profile:

The overall picture that emerges from the above analysis in respect of in-house R&D centres of public sector enterprises is as painted below:

1. The female R&D manpower of category B and above was 7.25 per cent.
2. In auxiliary and technical staff the females presence increased to 10.65 per cent and
3. In the research-linked administration, the females bagged 15 per cent of the posts.

The overall composition of S&T manpower comprised of:

| | Per cent |
|--------------------------------------|----------|
| R&D manpower of category B and above | 50.00 |
| Auxiliary & Technical Staff | 38.00 |
| Research- linked Administration | 12.00 |

Age-wise and sex-wise configuration of the responding scientists:

The responding R&D manpower of Category B and above (2,146) could be grouped under 3 broad bands of age:

| Years | Per cent |
|------------|----------|
| Up to 40 | 45 |
| + 40 to 52 | 40 |
| + 52 to 58 | 15 |

It was also noteworthy that 12 scientists were actively engaged in research even after the age of superannuation i.e. 58 years (applicable during the period of the study)

Of the responding scientists, 93.24 per cent were males and 6.76 per cent females. The sex-wise response was more or less in line with the gender distribution of scientists listed in the Institution Questionnaire. The females constituted 7.25 per cent of R&D manpower of category B and above as mentioned above.

Fifteen per cent of R&D manpower was within an age band with imminent retirement and needed replacement over a period of 6 years at an average rate of 55 personnel per year

Qualification –wise Dispersion of the Responding Scientists:

Research activities in the enterprises had technical orientation. More than 55 per cent of R&D manpower had engineering qualification (38.6 per cent had B.E/B.Tech. certificate and 16.5 per cent M.E/M.Tech. qualification). More than one –fifth of R&D personnel had M.A/ M.Sc.

High qualifications undoubtedly helped the scientists in direct recruitment to entry grade of category B of the enterprises:

Qualification & Direct Recruitment to category B and above

| Qualification | No. of R&D personnel directly recruited to category B | Per cent |
|---------------|---|----------|
| B. A/B.Sc. | 15 | 25.8 |
| M.A/M.Sc. | 251 | 56.0 |
| M.Ph | 26 | 74.3 |
| Ph.D./D.Sc. | 186 | 63.5 |
| B.E/B.Tech. | 602 | 72.6 |
| M.E/M.Tech. | 276 | 78.0 |

The percentage of direct recruitment to category B and above increased with the qualification.

While the period of 5 years or more needed for reaching category B and above was applicable to the cases with lower qualifications.

Grade- wise Dispersion of Scientists:

56.7 per cent of scientists were placed at first 4 grades while placing of the scientists were of the same order at grade 5 and grade 6.

Grade-wise placement of scientists of category B and above

| | No. of Scientists | Per cent |
|----------|-------------------|----------|
| Grade 1 | 275 | 12.8 |
| Grade 2 | 370 | 17.2 |
| Grade 3 | 294 | 13.7 |
| Grade 4 | 278 | 13.0 |
| Grade 5 | 352 | 16.4 |
| Grade 6 | 344 | 16.0 |
| Grade 7 | 187 | 8.7 |
| Grade 8 | 43 | 2.2 |
| Grade 9 | 2 | Neg. |
| Grade 10 | 1 | Neg. |

Activity-wise Time Allocation by the Scientists:

The scientists in the research outfits of the Central Government enterprises were actively engaged in result- oriented R&D actively; their time allocation was dedicated to mostly applied and experimental types of research. This is supported by the data furnished as under:

Number of Scientists with Zero Involvement in Types of Research

| Type of Research | No. of scientists | Per cent |
|-------------------------|-------------------|----------|
| Basic | 1,728 | 79.65 |
| Applied | 499 | 23.25 |
| Experimental | 714 | 33.25 |
| Other Allied Research | 758 | 35.35 |
| Non-research Activities | 675 | 31.25 |

The data manifest that nearly 80 per cent of R&D manpower had no involvement in Basic Research while maximum involvement of the scientists (76.75 %) was in applied research. While involvement of scientists in experimental, other allied research and non-research activities was practically of the same scale ranging from 64.65 per cent to 68.75 per cent.

It is also discernible that 68.75 per cent of scientific manpower was involved in non-research activities in some way or the other. This is the R&D manpower under whose control and guidance the research-linked administrative set up operates in the enterprises. The main responsibility of involvement in non-research activity was shared by the R&D manpower of upper grades:

Involvement in non-research activity by R&D manpower of category B and above

| Grade | >1 & ≤3 months | >3 & ≤6 months |
|---------|----------------------------------|--------------------------|
| Grade 5 | 112 Scientists 31.82 per cent | 53 scientists 15.06 % |
| Grade 6 | 131 Scientists 38.08 per cent | 52 Scientists 15.12 % |
| Grade 7 | 68 Scientists 36.36 per cent | 42 Scientists 22.46 % |

The involvement of R&D manpower in both Applied and Experimental Research was most intense from grade 3 onward. This is amply manifested by the field data presented below:

| Grade | Applied Research | | Experimental Research | |
|---------|---------------------------|--------------------------|---------------------------|--------------------------|
| | >1 & ≤3 months | >3 & ≤6 months | >1 & ≤3 months | >3 & ≤6 months |
| Grade 3 | 100 Scientists 34.01 % | 66 Scientists 22.45 % | 90 Scientists 30.69 % | 69 Scientists 23.47 % |
| Grade 4 | 77 Scientists 27.70 % | 64 Scientists 23.02 % | 86 Scientists 30.94 % | 65 Scientists 23.38 % |
| Grade 5 | 114 Scientists 32.39 % | 88 Scientists 25.0 % | 132 Scientists 37.50 % | 86 Scientists 24.43 % |
| Grade 6 | 121 Scientists 35.17 % | 70 Scientists 20.35 % | 119 Scientists 34.59 % | 74 Scientists 21.59 % |
| Grade 7 | 78 Scientists 41.71 % | 34 Scientists 18.18 % | 57 Scientists 30.48 % | 33 Scientists 17.65 % |
| Grade 8 | 18 41.86 % | 9 20.35 % | 15 Scientists 34.88 % | 8 Scientists 18.60 % |

Note: The figures in brackets indicate per cent of the scientists in that grade

The area-wise configuration of the responding scientists was as under:

| Area of specialization | Number of Scientists | Per cent |
|------------------------------|----------------------|----------|
| Natural Sciences | 592 | 27.6 |
| Engineering & Technology | 1417 | 66.0 |
| Medical Sciences | 4 | 0.2 |
| Agricultural Sciences | 7 | 0.3 |
| Social Sciences & Humanities | 127 | 5.9 |

In in-house R&D centres of undertakings, scientists with engineering and technology dominated scientific manpower followed by scientists with natural sciences as background

Revenue Expenditure:

The data show that 69 per cent of the projects were self-sponsored by the government undertakings. The projects sponsored by the controlling ministry and public sector were more or less equal and both clubbed together accounted for 21 per cent of projects. All the three government sources put together sponsored 90 per cent of the projects made available to enterprises.

Share of Research Projects Sponsored by Various Agencies

| Agency | Per cent |
|---|----------|
| Controlling Ministry/ Department Other Ministry/Department | 10.7 |
| Public Sector | 10.4 |
| Private Sector | 10.4 |
| International Agencies | 5.6 |
| Self-sponsored | 69.0 |
| Others | 2.2 |

A team headed by a leader who was a senior researcher also handled the projects in the government undertakings. He is supposed to inspire and guide the members through the mechanism of day to day monitoring.

87.3 per cent of R&D manpower was engaged in self-sponsored projects:

Sources of Projects and Involvement of Manpower

| Sponsor of Study | Number of Scientists involved | Per cent |
|--|-------------------------------|----------|
| Controlling Ministry/Deptt. & Other ministries/deptt. | 110 | 5.1 |
| Public Sector | 125 | 5.8 |
| Private Sector | 18 | 0.8 |
| International Agencies | 21 | 0.9 |
| Self-sponsored | 1868 | 87.3 |
| Others | 4 | 0.1 |
| | 2146 | 100 |

Sixty nine per cent of research studies were self-sponsored and that involved 87 per cent of R&D manpower of category B and above.

Flow of Funds from Various Donors for R&D Activities Conducted by Public/ Joint Sector under the Socio- economic Ministries (average of the years 1995-96 and 1996-97)

(Rs. Lakh)

| Agency | Amount | Per cent |
|-------------------------------|--------|----------|
| Controlling Ministry / Deptt. | 44, 13 | 12.78 |
| Other Ministries/Departments | 555 | 1.6 |
| Self- generated Funds | 94 ,87 | 27.48 |
| International Agencies | 499 | 1.44 |
| Private Sector | 24 | 0.1 |
| Others | 195,40 | 56.6 |
| Total | 345,18 | |

It is discernible that more than 50 per cent of funds came from other sources, which included the sale of outputs of R&D .It, is creditable that 27.48 per cent of the funds for R&D activities were self- generated. Both these sources together funded about 84 per cent of requirements of research conducted by the Public/ Joint Sector Undertakings of the Socio- economic Ministries/ Departments. While the controlling ministries met about one- eighth of the requirements of the funds. This scenario represents the true picture of the reforms that have taken place in Public Sector Enterprises in words and spirit.

Expenditure on R&D and its Relevance:

The expenditure on R&D and its proportion to total expenditure of an organization casts its shadow on quality and quantum of out put of R&D activities. Within the R&D expenditure, the investment on development and maintenance of research infrastructure is of great significance in sustaining proper S&T atmosphere in an organization. Equally important is the number and quality of auxiliary and technical staff needed to provide support to the R&D personnel in research pursuits. All these inputs vary with different public/ joint sector enterprises. The responding enterprises under the same ministry/ department have been clubbed together to capture a composite representative average figure.

Percentage Allocation of Funds

| Item of Expenditure | Per cent |
|---|----------|
| S & A of R&D Manpower of Category B and above | 41.6 |
| S& A of Auxiliary & Technical Staff | 14.0 |
| S&A of Administration | 16.4 |
| Other Recurring Expenses | 12.0 |
| Sub- total of Recurring Expenses | 84.0 |
| Non- recurring Expenses | 16.0 |
| Total | 100 |

The share of non-recurring expenditure is low at 16 per cent; normally it is desirable at a level of 30 per cent of total expenditure on research.

Research out put

The development of new products/new designs and their subsequent commercialization was the main objective of R&D centres attached with the public sector undertakings.

Research output of enterprises

| Output | Number | Pre cent |
|---------------------|-------------|------------|
| New Product | 550 | 37.6 |
| New Process | 162 | 11.0 |
| New Design | 111 | 7.6 |
| Modifications | 255 | 17.5 |
| Consultancy | 124 | 8.7 |
| Import Substitution | 172 | 11.6 |
| Others | 88 | 6.0 |
| Total | 1462 | 100 |

It is obvious that the maximum of sponsored projects (37.6 per cent) were related with the development of new products followed by the projects having bearing on various modifications (17.5 %). Import substitution had only 11.6 per cent of significance in research activity of the government enterprises.

| | <u>Assignments</u> | <u>Per cent</u> |
|-----------------------|--------------------|-----------------|
| A. Completed | 698 | 48 |
| B. In progress | 463 | 32 |
| C. Transferred | 301 | 20 |

Nearly 50 per cent of the projects were completed and one- fifth were transferred for commercialization.

Patents Obtained and Patents Applied for:

There was not much to mention about patent obtained and patents applied for. Patents had been obtained by the enterprises under the Ministry of Mines, Ministry of Petroleum and Natural Gas and Ministry of Steel.

Patents Obtained and Patents Applied for

| Ministry/Deptt. | Stage | Patents Obtained | | Patents Applied for | |
|-------------------------------------|-------|------------------|---|---------------------|---|
| Ministry of Mines | A | 1 | 1 | 1 | - |
| | B | - | | - | |
| | C | | | | |
| Ministry of Petroleum & N. Gas | A | 2 | - | 16 | - |
| | B | - | | - | |
| | C | | | | |
| Ministry of Steel | A | 4 | 1 | 1 | 1 |
| | B | - | | - | |
| | C | | | | |
| Ministry of Chemicals & Fertilizers | A | | | 6 | - |
| | B | | | - | |
| | C | | | | |
| Deptt. of Defence Prodn & Supplies | A | | | 1 | - |
| | B | | | - | |
| | C | | | | |
| Deptt. of Heavy Industry | A | | | 1 | - |
| | B | | | - | |
| | C | | | | |

The number related with patents was very insignificant as compared with the number of other out puts. As it comes out, a few enterprises had the distinction of having obtained the patents while other had applied for this distinction.

Scientist-wise Research Output:

The information is derived from the response from available from 2,146 scientists representing 74 enterprises under the ambit of Socio-economic ministries.

Research Output by R&D Personnel of category B and above

| Out put | Out put per scientist reporting the specified out put (in number) in his/her response |
|---------------------------------------|---|
| Product/process developed | 1.4 (0.4 7) |
| Patent obtained | 2.0 (0.06) |
| Patent applied | 1.6 (0,12) |
| Awards/merits earned | 1.22 (0.075) |
| Articles published in Indian journal | 2.33 (0.48) |
| Articles published in Foreign journal | 2.25 (0.24) |
| Booked published | 1.56 (0.011) |

Note: The figures in parentheses represent the average of overall response of 2146. These are the average figures irrespective of gender.

CHAPTER 1

INTRODUCTION

Science and Technology Institutions under the Central Government are grouped as:

- R&D organizations under Major Scientific Agencies i.e. organizations which have R&D or promotion of S&T as their predominant activity.
- R&D organizations under the Central Socio-Economic Ministries/Departments which undertake R&D work occasionally in connection with their day-to-day problems or have one or more than one departments dedicated to R&D work on regular basis.
- In-house R&D units of Public/Joint Sector Undertakings under the Central Socio-Economic Ministries.

The present study is related with the last two components of government intervention in R&D

The role of the Government in the context of present economic liberalization:

The reduction of the discretionary role of the government is an important component of the public policy-making in economies across the world both developed and the developing. The more explicit articulation of this policy is to be seen in the policy with respect to privatization and de-regulation. A less virulent but nevertheless important part of this policy package is the conspicuous reduction of government intervention in all matters of economic activities. However there are some areas where such interventions or such support can not be wished away or even is *sine quo non*. Even the more virulent supporters of economic liberalization, such as the World Bank, have no hesitation in agreeing that certain activities like education and health can not be left entirely with the market as these are typically the areas where known market failures are significantly greater than government failures. To this list (which seems to be ever burgeoning) is added the area of Industrial R&D.

In the past 50 years among the handful of economies that have come long way towards closing the knowledge gap with global technological leaders, government was active in several including Japan, Korea and Taiwan. Korea which followed interventionist and nationalist route keeping Foreign Direct Investment (FDI) to a minimum and relying on other modes of technology transfer and concerted domestic technological efforts.

The government has, therefore, to play an important role in terms of increasing investment in R&D. This role has to be interpreted as initiating a set of policy instrument and institutions which will aid the private sector to overcome the problem of appropriability of research output and consequent possibilities of under-investment and it will be different for basic research, applied research and development research. As far as basic research is concerned recent event and discussions have clearly shown that that

there is no other alternative but for the government to shoulder this in its entirety. The investment in basic research is comparatively riskier.

Table 1.1

**R&D EXPENDIDURE BY TYPE OF WORK BY THE GOVERNMENT
(Central &State) –Rs Crore**

| Year | Basic Research | Applied Research | Experiment al Research | Other Related S&T Activities | Total |
|----------------|-----------------------|-------------------------|-------------------------------|---|----------------|
| 1992-93 | 755.30 | 1635.80 | 1263.31 | 615.79 | 4270.20 |
| 1993-94 | 932.89 | 2014.46 | 1600.32 | 615.20 | 5162.87 |
| 1994-95 | 1028.88 | 2210.56 | 1776.68 | 676.58 | 5692.70 |

As far as applied and development research are concerned, government can put in place a variety of instruments through which its actual conduct in the private sector is strengthened, These instrument consist of tax incentive to private sector to do more R&D, provision of adequate quantities of venture capital, financial aid in the organization and maintenance of technical standards, administration of sharply focussed partnership programme in areas of high – technology and strengthening of higher education sector.

Given the recent growth performance and growth potential, it is no longer meaningful to treat all developing countries as a homogenous bunch. The countries of East Asia, India and China and some of the Latin American countries have relatively more advanced national system of innovation. However even in this select group, with the exception of Korea and Taiwan, most of the countries do not have very clearly articulated instruments and institutions embodying their respective governments’ forays into technology policies. A classic example is that of India where more than one half of the civilian industrial R&D is done by the private sector.

Table 1.2

INDUSTRIAL R&D EXPENDITURE- Rs crore

| Year | Expenditure | | R&D Expenditure as % of Sales Turnover | |
|----------------|----------------------|-----------------------|---|-----------------------|
| | Public Sector | Private Sector | Public Sector | Private Sector |
| 1992-93 | 513.95 | 651.32 | 0.44 | 0.67 |
| 1993-94 | 542.81 | 794.32 | 0.44 | 0.71 |
| 1994-95 | 685.33 | 902.53 | 0.50 | 0.70 |

Source: DST, Research and Development Statistics

But whether the Indian government has a technology policy worth the name (notwithstanding the existence of so-called Technology Policy Standards) is a moot point. Singapore is usually regarded as a free market economy, but from 1991 onwards, the government of that country has been busy putting in place a very sharply focused technology policy. It is not that easy to wish away a role for the government with respect to the organization and conduct of Industrial R&D.

Need for the Study:

S&T Plan Outlays under Socio- Economic Ministries/ Departments increased more than two folds during the 7 th Plan and 8 th Plan Periods:

S & T Plan Outlays under Socio-Economic Ministries
(Rs. Crores)

| 7 th Plan (1985-90) | | 8 th Plan (1992-97) | |
|--------------------------------|---------|--------------------------------|---------|
| Outlays | Actuals | Outlays | Actuals |
| 1953.49 | 2408.14 | 5080.97 | 5501.16 |

Availability of comprehensive data in respect of demographic profile of current manpower engaged in R&D activities in the S&T institutions under the socio economic ministries / departments and an in-depth analysis of their productivity is of importance for planning of research activities in the short term and long term in this sector. It enables identification of the trends, gaps and possible upgradations that may be warranted. Unfortunately, such manpower -related data are still grossly inadequate. The present work is an attempt in the direction of bridging this gap. In order to realize this goal, the present project was formulated with the following objectives.

Objectives of the Study:

The project lays emphasis on providing a unified information on research activities of socio- economic ministries / departments. The study accordingly focuses on the following aspects of S&T activities:

- Manpower
- Academic
- Research
- Finance

The data collected under manpower presents a systematic record of all R&D personnel (category B or equivalent with pre-revised pay scale 2200-4000 and above) employed in research units under the socio-economic ministries/departments with respect to characteristics such as:

- Age
- Sex
- Qualifications
- Year of entry, Year of reaching the category B, Present pay scale, basic salary and gross salary
- Nature of work : basic , applied and experimental research and percentage yearly distribution of involvement at the individual scientist levels
- Field of specialization
- Stage of present research work: Stage 1- just begun, stage 11- half way, Stage 111- Final
- Research output in terms of process developed , patent applied/obtained, award received , papers/ book published etc

The study also collected data on the total strength of auxiliary and administrative staff, expenditure on R&D, sources of funds along with some qualitative information on the specific problems faced by the institutions/ R&D personnel.

The data on career profiles of R&D personnel have been mainly derived from the records of the concerned institution as well as personal contact with the scientists during the field investigations.

Utility of the Study:

The data presented in the study were obtained from 74 enterprises under the Central Socio-Economic Ministries. Departments. The study provides information on the above mentioned activities of 74 enterprises which is useful for R&D statistics and growth indicators needed for scientific R&D statistics in general and planning of in-house R&D capability of enterprises under the jurisdiction of socio-economic ministries.

The resources deployed in R&D activities in these undertakings have direct impact on the technical upgradation of the overall operational activities of the enterprises. The S&T activities in the government enterprises under the socio-economic ministries constitute the fourth largest network of scientific manpower that are directly involved in the transfer of innovations and development in the entire gamut of science and technology. Thus this database will be useful in identifying the organizational resources vis-à-vis the scientific achievements.

Some pragmatic uses and applications of the database are:

- Preparation of a comprehensive information directory on R&D activities of the Central Socio- economic Ministries.
- Identification of needs in terms of academic and research activities.
- Activities related to the specific R&D needs of the Ministry/ Department.
- Resource allocation to various activities and their comparative shares.
- Relative comparison of different Central Ministries/Departments and also the different enterprises within a Ministry in terms of the availability of various resources.

- Manpower planning.
- Women participation in R&D activities and their relative status in scientific hierarchy of the in-house R&D centre of the enterprise.
- Placement information.

The project provides a unified information system to all the Central Ministries/Departments. The information is multi-faceted and was obtained as brief as possible in self-coded formats to facilitate computerization. The detailed data on manpower, academic, R&D activities and financial allocations of Central socio-economic Ministries / Departments are presented in the chapters to follow.

Basic Definitions :

In the presentation of analysis of data in the report , certain concepts and terms have been used . These are furnished in Annex 1.1. Most of the definitions have been standardized , used and published by OECD and UNESCO .

CHAPTER 2

METHODOLOGY AND COVERAGE

METHODOLOGY

The methodology for the systematic execution of the study warranted sequencing of a number of steps, which were dovetailed. The details are as follows:

Step 1:

A list of all the major Central Socio- economic Ministries/Departments and their subordinate offices was prepared from The Directory of R&D Institutions, 1994, assembled by the Department of Science and Technology (DST). There are 100 enterprises under the ambit of the Central Socio-Economic Ministries/Departments reportedly engaged in S&T activities.

Step 2:

Constitution of the Project Advisory Committee (PAC)

Step 3:

Identification of data needs of the project, design of questionnaires and their finalization in consultation with PAC and officers of NSTMIS Division of DST, testing and printing of Schedules.

Step 4:

Approaching the Central Socio-Economic Ministries at Delhi for their co-operation in such a massive information seeking exercise from their undertakings spread throughout the length and breadth of the country.

Step 5:

Mailing of questionnaires to the subordinate offices as and when the letters from the respective controlling ministries were received authorizing the enterprise under their ambit to part with the information sought from them in the pre-designed set of questionnaires.

Step 6:

Orientation training to the field staff and supervisory officers who were to canvass the questionnaires through personal contact with enterprise and scientific manpower of categories B and above.

Step 7:

Collection of data from the enterprises head office through questionnaires and personal data from the individual scientist of category B and above through questionnaires.

Step 8:

Data editing, codification, entry, verification for internal consistency and analysis.

Step 9:

Formulation of tabulation programme and preparation of dummy tables.

Step 10

Software development for tabulation programme and taking out the tables.

Step 11

Analysis and preparation of report

Project Advisory Committee (PAC)

A Project Advisory Committee (PAC) was constituted as per DST guidelines. During the constitution of the committee, enough care was taken so as to include different specialists keeping in view the need and objectives of the study. The list of PAC members is furnished in Annex 2.1

The first meeting of PAC members was held on 17.2.1997. A set of issues was prepared based on the main objectives of the study and they were presented in the meeting for discussion.

The set of draft questionnaires was also put up for approval.

Minutes of the PAC members meeting are enclosed as Annex 2.2

Soliciting Collaboration of Central Socio-Economic Ministries and their Subordinate Offices:

All the Central Socio-Economic Ministry stationed in New Delhi were approached individually on the strength of a general introductory letter issued by the Director, NSTMIS, DST dated 23.4.1997. The copy of the letter is enclosed as Annex 2.3.

Letter was sent to the ministries by TES incorporating the rationale, objectives, scope and need for undertaking the study. The letter was accompanied with the copy of the above mentioned introductory letter of DST and a set of questionnaires designed for canvassing with their subordinate offices. A copy of the letter addressed to the ministries is enclosed as Annex 2.4.

Preparation of questionnaires:

Three sets of questionnaires were designed, one for each of the levels:

- At the institutional level: The schedule sought information on manpower employed, research activities, outputs, financial data etc.
- At the R&D scientist's level: The R&D Personnel Schedule and the Listing Sheet for R&D Scientists were designed. Both these schedules incorporated personal and professional information relating to the respondents , including the particulars of their career , job status , etc

The copies of the questionnaires are appended as Annex 2. 5, Annex 2. 6 and Annex 2.7.

Pre-testing of questionnaires:

Before finalizing the questionnaires, the pre- testing of three schedules was carried out among sample of scientists drawn at random from two different heterogeneous institutions in and around Delhi. The specific problems encountered by the survey teams of TES during pre- testing were accorded due weightage before the questionnaires were passed on for printing.

Mailing of questionnaires:

As a prelude to the initiation of the fieldwork, questionnaires were mailed to the heads of all the 100 public/joint sector undertakings under the jurisdiction of all the Socio-Economic Ministries. The letter from the concerned ministry, introductory letter from the DST referred to above and a set of questionnaires fortified the TES request for co-operation.

Field Work

Field staff and supervisory officers were carefully selected. Most of them had scientific or economic background. They were trained and briefed about questionnaires both at Delhi and state capitals depending upon the location convenience.

During the initial stages of fieldwork, officers of TES accompanied the field investigators to enterprises for introductory discussion with the heads of the institutions. A number of follow-up visits to the individual institutions and the scientists therein were made to collect the information from the scientists of category B and above and the concerned enterprises.

Problems faced in the fieldwork

Fabrication of database of dimension achieved during the fieldwork was not easy. The number and variety of persons involved were so large that a great deal of extra efforts was needed to achieve the present level of response. Some of the problems faced while gathering information from institutions and individual scientists are of great relevance as a background to the study:

- Procurement of letter from the controlling ministry instructing their undertakings to part with the information in pre- designed questionnaires, proved to be a Herculean task resulting in great time loss and needing repeated efforts and visits to the ministries. This can be judged from the time that elapsed between the receipt of the first letter available from the Ministry of Food Processing dated 16.6.1997 and the last letter received from the Ministry of Fertilizers dated 16.9.1998. Copies of both letters under reference are enclosed as Annex 2.8 and Annex 2.9. While the enterprises of the ministries refused to allow the field staff to pass reception in the absence any communication from their controlling ministries.
- Some of the ministries declined to issue the needed instructions despite our persistent requests. These ministries are:
 - Ministry of Railways,
 - Ministry of Textiles,
 - Department of Animal Husbandry & Dairying,
 - Geological Survey of India,
 - Department of Defence Production & Supplies.

Some of the enterprises refused to part with the information despite their having received the instructions from their controlling Ministry and copy of the same having been made available by the field staff of TES on the spot.

- Thirteen Central Socio–Economic Ministries/Departments are supposed to be not having in-house S&T facilities. They were also investigated whether they have, over the years, developed any captive R&D facilities. These Ministries/ Departments were also approached through correspondence (copy of the circular letter is attached as Annex 2.10) accompanied by personal

contacts concurrently. This needed extra manpower and time. Nearly three months were spent in getting response from these Ministries /Departments having no research institutions under their purview.

- Some of the enterprises declined to provide data in the Institution Questionnaire but allowed the field officers of TES to contact their scientists individually. In such cases the response from the scientists was received but the filled-in institution questionnaire was never obtained.
- There were some institutions and scientists who were reluctant to respond to the questionnaires because of repeated requests from multiplicity of agencies and did not do so ultimately. Since the scientists had been approached earlier in connection with other studies by different agencies, they gave the reason of repeated efforts spent in giving their responses and their perception, and efforts having been futile (since they could not see any results of these studies) as justification for not cooperating with TES field staff. Since they are usually not the users of such data their lack of interest is perhaps understandable.
- Another major problem in conducting the field survey, was the difficulty in getting information about the scientists from the enterprises having split locations in the country. Out of 100 undertakings investigated, 50% have more than one setup. Only in very few cases did the mother office furnish the relevant information about the scientists posted in split locations but the scientist questionnaire for the individual scientists had to be obtained from the scientists posted in other locations either by the field staff of TES on the authority of the mother enterprise or the mother enterprise accepted the responsibility. This proved to be efforts and time consuming exercise in either cases

Time Sanctioned for Conducting the Survey of Characteristics of S&T Manpower engaged in R&D Activities in Public/Joint Sector Enterprises:

The time of 6 months sanctioned for conducting the parallel study in respect of Public /Joint Sector undertakings proved to be too inadequate for completion of the survey in the stipulated time. Both the enterprises and the scientists engaged therein were found to be resistant in entertaining the questionnaires from the field officers of TES. More than revealing the facts they appeared more concerned in concealing the details solicited in the questionnaires. This needed repeated sessions of convincing them about the utility of the study. These enterprises were first to show reluctance in parting with the information despite the instructions from the controlling ministries/ department to do so. Their resistance was far deeper as compared with that of the institutions.

Moreover in the enterprises, it was difficult to segregate R&D manpower from the non-R&D personnel because of the interchangeability of their functions. The technical personnel in production and maintenance lines in the enterprises are transferred to in-house research cell depending upon the skill needed for a specific research. It was, therefore, difficult to delineate the scientists to respond to the questionnaire. This entire search proved to be efforts and time-consuming exercise.

Coverage:

In spite of all these difficulties, overall response to this massive information seeking exercise has been quite encouraging.

Table 2.1

Response from the Public/Joint Sector Undertakings under the Central Socio-Economic Ministries/Departments

| Number of Public/Joint Sector Undertakings* | Number of the Undertakings Covered | Number of Scientists Listed | Number of Scientists covered |
|---|------------------------------------|-----------------------------|------------------------------|
| 100 | 74 | 2700 | 2146 |
| Percentage Coverage | | | |
| | 74 % | | 79.48 % |

* Institutions as listed in Directory of R&D Institutions, 1994, DST

The details of response received from the scientists of category B and above from 74 enterprises as stated above, are furnished in Annex 2.11

Chapter 3

Demographic Profile

The demographic profile of the research manpower is skewed in favour of male in the public sector enterprises. This may be attributed to the fact that research manpower for the in-house S&T set-up is in most of cases drawn from production line and maintenance lines. The presence of female personnel in these two lines is reportedly deficient in practically all the undertakings. This aspect is brought out through the analysis of the data as under:

Department of Chemicals & Petro-chemicals (3 units):

The department has highly male dominated R&D set up. In all the three research establishments, there were only 4 female scientists and out of that 3 were at the entry grade 1.

R&D Manpower of category B and above

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | 14 | 3 | 17 |
| Grade 2 | 6 | - | 6 |
| Grade 3 | 3 | - | 3 |
| Grade 4 | 1 | 1 | 2 |
| Grade 5 | - | - | - |
| Grade 6 | 3 | - | 3 |
| Grade 7 | 1 | - | 1 |
| Grade 8 | 1 | - | 1 |
| Total | 29 | 4 | 33 |

| | Male | Female | Total |
|--------------------------------|------|--------|-------|
| Auxiliary & Technical Staff | 33 | 4 | 37 |
| Research Linked Administration | 16 | 4 | 20 |

The overall distribution in research set up in all three units covered works out as under:

| | Percent |
|--------------------------------|---------|
| R & D Manpower of Category B | 36.7 |
| Auxiliary & Technical Staff | 41.1 |
| Research Linked Administration | 22.2 |

The female presence in the set up was nearly 18 per cent.

The non-R&D establishment in all three enterprises comprised of:

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | 7 | 1 | 8 |
| Grade 2 | 1 | - | 1 |
| Total | 8 | 1 | 9 |
| Staff | 7 | - | 7 |

Department of Chemicals & Fertilizers (8 units):

As in the previous enterprises of above department of the Ministry, the research wings of all the 8 enterprises covered under the study had in all 2 female scientists –one at the top grade and the other at the lowest grade1.

One thing that is noteworthy in the research set up of the fertilizer enterprises is that there was a heavy concentration of middle rank scientists in S&T. The scientists of grade 4 and grade 5 constituted more than 55 per cent of manpower.

R&D manpower of category B and above

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | 23 | 1 | 24 |
| Grade 2 | 45 | - | 45 |
| Grade 3 | 7 | - | 7 |
| Grade 4 | 43 | - | 43 |
| Grade 5 | 70 | - | 70 |
| Grade 6 | 10 | - | 10 |
| Grade 7 | 4 | - | 4 |
| Grade 8 | - | 1 | 1 |
| Total | 202 | 2 | 204 |

The other major concentration was at the first two grades; the manpower at these two grades accounted for one-third of the total R&D manpower.

All the 8 enterprises had an adequate support of auxiliary and technical staff and research linked administration:

| | Male | Female | Total |
|--------------------------------|------|--------|-------|
| Auxiliary & Technical Staff | 123 | 9 | 132 |
| Research Linked Administration | 77 | 8 | 85 |

The overall composition of research set up was in the favour of R&D manpower of category B and above:

| | Percent |
|--------------------------------------|---------|
| R&D manpower of category B and above | 48.6 |
| Auxiliary & Technical Staff | 31.4 |
| Research Linked Administration | 20.0 |

The overall presence of female scientists in research set up was only 4.5 per cent

All the 8 enterprises had a very strong presence of non-R&D manpower of category B and above supported by heavy concentration of staff at the lower rungs:

Non-R&D Manpower of Category B and above

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | 3 | - | 3 |
| Grade 2 | 23 | - | 23 |
| Grade 3 | 86 | - | 86 |
| Grade 5 | 43 | - | 43 |
| Grade 6 | 47 | - | 47 |
| Grade 7 | 19 | - | 19 |
| Grade 8 | 6 | - | 6 |
| Total | 227 | - | 227 |

| | Male | Female | Total |
|------------------|------|--------|-------|
| Supporting Staff | 587 | 15 | 602 |

Department of Telecommunication (4units):

All the four units favoured the presence of female scientists in their research set up. The share of female scientists in R&D manpower of category B and above was about 13 per cent. Since opting for electronics by the female students is a recent phenomenon, their entry in the research related with electronics is also a recent happening. This explains the major concentration of female scientific manpower in first two entry grades of the undertakings.

R&D Manpower of Category B and above

| | Male | Female | Total |
|---------|------|----------|-------|
| Grade 1 | 204 | 27 | 231 |
| Grade 2 | 248 | 44 | 292 |
| Grade 3 | 118 | 21 | 139 |
| Grade 4 | 73 | 4 | 77 |
| Grade 5 | 5 | - | 5 |
| Grade 6 | 8 | 1 | 9 |
| Grade 7 | 5 | - | 5 |
| Grade 8 | 1 | - | 1 |
| Total | 662 | 97 | 759 |
| | | (12.78%) | |

The male scientists had 86 per cent of their concentration at the first three grades.

The auxiliary and technical staff had not much role to play and that was also applicable to research- linked administration.

| | Male | Female | Total |
|--------------------------------|------|--------|-------|
| Auxiliary & Technical Staff | 26 | 1 | 27 |
| Research Linked Administration | 5 | 1 | 6 |

The overall composition of S&T manpower in Telecom undertakings was represented by the following ratios:

| | Percent |
|--------------------------------------|---------|
| R&D manpower of category B and above | 96.7 |
| Auxiliary & Technical Staff | 3.4 |
| Research Linked Administration | 0.9 |

Department of Defence Production & Supplies (3 units):

This is the department wherein the presence of female scientists was also conspicuous in the in-house research activities of the constituent undertakings .The female R&D manpower of category B and above formed nearly 12 per cent of the total strength.

R&D Manpower of Category Band above

| | Male | Female | Total |
|---------|------|----------------|-------|
| Grade 1 | 260 | 42 | 302 |
| Grade 2 | 189 | 33 | 222 |
| Grade 3 | 25 | 1 | 26 |
| Grade 4 | 146 | 24 | 170 |
| Grade 5 | 93 | 2 | 95 |
| Grade 6 | 53 | 2 | 55 |
| Grade 7 | 7 | - | 7 |
| Grade 8 | 1 | - | 1 |
| Total | 774 | 104 (11.8%) | 878 |

More than 72 per cent of female scientists were concentrated at the initial two grades while the concentration of male scientists in this slot was only 58 per cent.

The need of auxiliary and technical staff was persistent in the research pursuits of the undertakings under the department and so was the research-linked administration.

| | Male | Female | Total |
|--------------------------------|------|--------|-------|
| Auxiliary & Technical Staff | 513 | 97 | 610 |
| | | 15.9% | |
| Research Linked Administration | 81 | 24 | 105 |
| | | 22.8% | |

The overall proportion of all categories of S&T manpower works out as under:

| | Percent |
|--------------------------------------|---------|
| R&D manpower of category B and above | 55.1 |
| Auxiliary & Technical Staff | 38.3 |
| Research Linked Administration | 6.6 |

The non- R&D manpower had grade-wise pre-dominance in the overall set up of all the three undertakings:

Non- R&D manpower of category B and above

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | 690 | 110 | 800 |
| Grade 2 | 305 | 38 | 343 |
| Grade 3 | 4 | - | 4 |
| Grade 4 | 513 | 37 | 550 |
| Grade 5 | 307 | 10 | 317 |
| Grade 6 | 144 | - | 144 |
| Grade 7 | 59 | - | 59 |
| Grade 8 | 20 | - | 20 |
| Total | 2042 | 195 | 2237 |
| | | 8.72% | |

Department of Family Welfare (one unit):

The research activity was of low key in the only enterprise of the department, which responded. Consequently, the R&D manpower engaged in research was limited in number:

| | Male | Female | Total |
|-----------------|------|--------|-------|
| Grade 1 | 4 | 3 | 7 |
| Grade 2 | - | 1 | 1 |
| Grade 3 | 2 | - | 2 |
| Grade 4 | 2 | - | 2 |
| Grade 8 | 1 | - | 1 |
| Total | 9 | 4 | 13 |
| Auxiliary Staff | 8 | 2 | 10 |
| Administration | 2 | - | 2 |

Department of Heavy Industry (21 units):

All the 21 units, which responded, had well manned research cell for conducting in-house R&D programme. As stated, the S&T personnel are drawn from the production line and the incidence of female in the line is limited. The presence of female scientists is only 5.4 per cent:

R&D Manpower of Category B and above

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | 94 | 5 | 99 |
| Grade 2 | 67 | 10 | 77 |
| Grade 3 | 66 | 7 | 73 |
| Grade 4 | 118 | 3 | 121 |
| Grade 5 | 130 | 8 | 38 |
| Grade 6 | 131 | 2 | 133 |
| Grade 7 | 46 | 1 | 47 |
| Grade 8 | 10 | 2 | 12 |
| Total | 662 | 38 | 700 |
| | | 5.4% | |

| | Male | Female | Total |
|--------------------------------|------|--------|-------|
| Auxiliary & Technical Staff | 477 | 41 | 518 |
| | | 8.0% | |
| Research Linked Administration | 118 | 19 | 137 |
| | | 13.8% | |

The overall proportion of S&T manpower of the department works out in favour of R&D manpower, which was more than 50 per cent:

| | Percent |
|--------------------------------------|---------|
| R&D manpower of category B and above | 51.6 |
| Auxiliary & Technical Staff | 38.2 |
| Research Linked Administration | 10.2 |

The non-R&D manpower was conspicuous through their presence in all the constituents of the sample base:

Non-R&D manpower of category B and above

| | Male | Female | Total |
|-------------|------|--------|-------|
| Grade 1 | 75 | 3 | 78 |
| Grade 2 | 48 | 5 | 53 |
| Grade 3 | 57 | 4 | 61 |
| Grade 4 | 65 | - | 65 |
| Grade 5 | 38 | - | 38 |
| Grade 6 | 23 | - | 23 |
| Grade 7 | 7 | - | 7 |
| Grade 8 | 1 | - | 1 |
| Total | 314 | 12 | 326 |
| | | 3.7% | |
| Lower Staff | 4000 | 153 | 4153 |
| | | 3.7% | |

The percentage of female manpower was the same both at the category B and lower staffs levels.

Department of Industrial Development (2 units)

More than 50 per cent of scientists were concentrated at grade1 whereas first two grades accounted for 78 per cent of R&D manpower of category B and above:

R&D manpower of category B and above

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | 107 | 5 | 112 |
| Grade 2 | 60 | - | 60 |
| Grade 3 | - | - | - |
| Grade 4 | 29 | - | 29 |
| Grade5 | 16 | 1 | 17 |
| Grade 6 | 2 | - | 2 |
| Grade 7 | 1 | - | 1 |
| Grade 8 | - | - | - |
| Total | 215 | 6 | 221 |
| | | 2.7% | |

| | Male | Female | Total |
|--------------------------------|------|--------|-------|
| Auxiliary & Technical Staff | 164 | 60 | 224 |
| | | 27% | |
| Research Linked Administration | 79 | 11 | 90 |
| | | 12% | |

The overall ratio of presence of manpower in all three segments of S&T works out as:

| | Percent |
|--------------------------------------|---------|
| R&D manpower of category B and above | 41.3 |
| Auxiliary & Technical Staff | 41.8 |
| Research Linked Administration | 16.9 |

The presence of non-R&D manpower of category B was noticed to be of limited extent but was adequately supported with staff of lower rank;

Non-R&D manpower of category B and above

| | Male | Female | Total |
|-------------|------|--------|-------|
| Grade 1 | 10 | - | 10 |
| Grade 2 | 3 | - | 3 |
| Grade 3 | 6 | - | 6 |
| Total | 19 | - | 19 |
| Lower Ranks | 184 | 30 | 214 |
| | | (14%) | |

There was no female officer in total non-R&D set up but female gender constituted 14 per cent of staff of lower rank.

Ministry of Mines(3 units):

The three units of the Ministry of Mines were manned by high-ranking R&D manpower at the top. There were 28 scientists of grade 8 and 4 scientists of grade 7 while the scientific manpower at first initial grades was limited at lower number 30 only. All three research set up are research establishments with high ranking researchers at the helm of affairs.

R&D manpower of category B and above

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | 1 | 1 | 2 |
| Grade 2 | 11 | 1 | 12 |
| Grade 3 | 10 | - | 10 |
| Grade 4 | 8 | - | 8 |
| Grade 5 | 11 | - | 11 |
| Grade 6 | 2 | - | 2 |
| Grade 7 | 4 | - | 4 |
| Grade 8 | 28 | - | 28 |
| Total | 75 | 2 | 77 |

| | Male | Female | Total |
|--------------------------------|------|--------|-------|
| Auxiliary & Technical Staff | 65 | 1 | 66 |
| Research Linked Administration | 25 | 1 | 26 |

The presence of female scientists is practically negligible since:

1. mining is the subject which is not permitted to be opted by female students and
2. the research establishments are situated away from urban habitation; these do not attract female researchers even in other disciplines of research activities.

Ministry of Petroleum & Natural Gas (6 units):

More than 50 per cent of R&D manpower was confined to first three grades and 35 per cent at middle rungs of scientific manpower. The 8 scientists at grade 7 and 5 scientists at grade 8 make the research establishments headed by high-ranking scientists:

R&D manpower of category B and above

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | 25 | 1 | 26 |
| Grade 2 | 35 | 3 | 38 |
| Grade 3 | 25 | 2 | 27 |
| Grade 4 | 26 | 3 | 29 |
| Grade 5 | 24 | - | 24 |
| Grade 6 | 12 | - | 12 |
| Grade 7 | 7 | - | 7 |
| Grade 8 | 5 | - | 5 |
| Total | 160 | 9 | 169 |

| | Male | Female | Total |
|--------------------------------|------|--------|-------|
| Auxiliary & Technical Staff | 136 | 10 | 146 |
| Research Linked Administration | 5 | 6 | 11 |

The overall composition of S&T manpower was dominated by R&D manpower of category B and above:

| | Percent |
|--------------------------------------|---------|
| R&D manpower of category B and above | 51.85 |
| Auxiliary & Technical Staff | 44.78 |
| Research Linked Administration | 3.37 |

The non-R&D manpower of category was omnipresent in the entire research establishment, but their presence and influence was on a limited scale:

R&D manpower of category B and above

| | Male | Female | Total |
|-------------|------|--------|-------|
| Grade 1 | 15 | - | 15 |
| Grade 2 | 11 | - | 11 |
| Grade 3 | 15 | - | 15 |
| Grade 4 | 12 | - | 12 |
| Grade 5 | 2 | - | 2 |
| Grade 6 | - | - | - |
| Grade 7 | 2 | - | 2 |
| Total | 57 | - | 57 |
| Lower Ranks | 70 | 10 | 80 |

The presence of female manpower though low in research set up and nil in non-R&D establishment, was marked in the lower ranks of non-R&D. The female therein constituted 12.5 per cent of these personnel.

Ministry of Steel (8 units):

The R&D manpower of grade 6 constituted more than 25 per cent of strength of researchers of category B and above. Since metallurgy and allied disciplines are rarely the subjects of choice by the girl students, the presence of female researchers in the R&D activities of Ministry of Steel was less than 5 per cent in all the establishments.

R&D manpower of category B and above

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | 14 | - | 14 |
| Grade 2 | 18 | 1 | 19 |
| Grade 3 | 12 | 1 | 13 |
| Grade 4 | 20 | 2 | 22 |
| Grade 5 | 10 | - | 10 |
| Grade 6 | 30 | 1 | 31 |
| Grade 7 | 8 | - | 8 |
| Total | 112 | 5 | 117 |

| | Male | Female | Total |
|--------------------------------|------|--------|-------|
| Auxiliary & Technical Staff | 87 | 2 | 89 |
| Research Linked Administration | 31 | 4 | 35 |

The complexion of the overall S&T establishment was as follows:

| | Percent |
|--------------------------------------|---------|
| R&D manpower of category B and above | 48.55 |
| Auxiliary & Technical Staff | 36.92 |
| Research Linked Administration | 14.53 |

The non- R&D manpower was found to have over dominance of personnel of lower rank.

Non-R&D manpower of category B and above

| | Male | Female | Total |
|-------------|------|--------|-------|
| Grade 1 | 21 | 2 | 23 |
| Grade 2 | 8 | - | 8 |
| Grade 3 | 11 | 1 | 12 |
| Grade 4 | 6 | - | 6 |
| Grade 5 | 5 | - | 5 |
| Grade 6 | 1 | - | 1 |
| Total | 52 | 3 | 55 |
| Lower Ranks | 744 | 82 | 826 |

It is only at the lower rungs of non-R&D manpower that the presence of female personnel was noteworthy. Their number was 10 per cent.

Ministry of Power (one unit):

The research in power sector had an even distribution of manpower at grades 2, 3, 4 & 5 and had only one female scientist and that too at the entry grade1.

R&D manpower of category B and above

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | 3 | 1 | 4 |
| Grade 2 | 11 | - | 11 |
| Grade 3 | 8 | - | 8 |
| Grade 4 | 9 | - | 9 |
| Grade 5 | 8 | - | 8 |
| Grade 6 | 3 | - | 3 |
| Grade 7 | 1 | - | 1 |
| Total | 43 | 1 | 44 |

| | Male | Female | Total |
|--------------------------------|------|--------|-------|
| Auxiliart & Technical Staff | 17 | 1 | 18 |
| Research Linked Administration | 14 | 3 | 17 |

The composition of the S&T manpower is evenly distributed among the auxiliary and technical staff and research linked administration:

| | Percent |
|--------------------------------------|---------|
| R&D manpower of category B and above | 55.7 |
| Auxiliary & Technical Staff | 22.8 |
| Research Linked Administration | 21.5 |

Ministry of Textiles (one unit):

The in-house research units of the National Textiles Corporation (NTC) has a very low level of research base. Consequently these were very sparsely manned. This is obvious from the data furnished below:

R&D manpower of category B and above

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | - | - | - |
| Grade 2 | 1 | - | 1 |
| Grade 3 | 1 | - | 1 |

| | Male | Female | Total |
|--------------------------------|------|--------|-------|
| Auxiliary & Technical Staff | 2 | - | 2 |
| Research Linked Administration | 5 | - | 5 |

The set up had a 4-member non- R&D team with no support from the lower staff.

Ministry of Urban Development:

Hindustan Prefab is the only undertaking under the Ministry. It had an in-house research unit catering to its day-to-day design needs and quality control at site of work execution. Limited researchers therefore, manned the research establishment.

R&D manpower of category B and above

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | 5 | - | 5 |
| Grade 2 | - | - | - |
| Grade 3 | - | - | - |
| Grade 4 | 1 | - | 1 |
| Grade 5 | 2 | - | 2 |
| Grade 6 | - | - | - |
| Grade 7 | 1 | - | 1 |
| Total | 9 | - | 9 |

| | Male | Female | Total |
|--------------------------------|------|--------|-------|
| Auxiliary & Technical Staff | 15 | - | 15 |
| Research Linked Administration | 3 | - | 3 |

The organization is basically a non-R&D enterprise and had an overwhelming presence of such manpower:

Non-R&D manpower of category B and above

| | Male | Female | Total |
|-------------|------|--------|-------|
| Grade 1 | 24 | - | 24 |
| Grade 2 | 13 | - | 13 |
| Grade 3 | 10 | - | 10 |
| Grade 4 | 3 | - | 3 |
| Total | 50 | - | 50 |
| Lower Ranks | 483 | - | 483 |

Ministry of Coal (3 units):

The Central Mine Planning & Design Institute Ltd (CMPDI) is a premier institute engaged in R&D activities in coal industry. Its efforts are supplemented by the research conducted by the Singreni Collieries Company Ltd and Neyveli Lignite Corporation Ltd.

The research in all three enterprises is conducted at the level of R&D manpower of category B and above. No auxiliary & technical staff is employed for research activities:

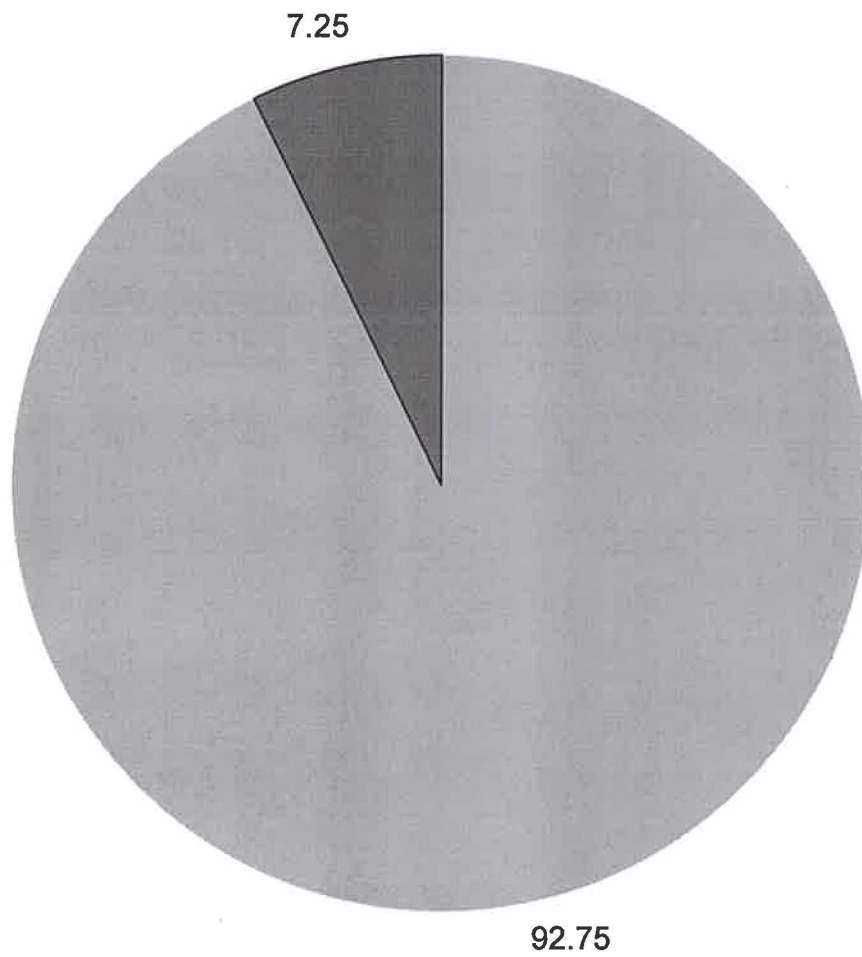
R&D manpower of category B and above

| | Male | Female | Total |
|---------|------|--------|-------|
| Grade 1 | 3 | - | 3 |
| Grade 2 | 6 | 1 | 7 |
| Grade 3 | 9 | 2 | 11 |
| Grade 4 | 4 | - | 4 |
| Grade 5 | 9 | 1 | 10 |
| Grade 6 | 13 | 1 | 14 |
| Grade 7 | 13 | - | 13 |
| Grade 8 | 3 | - | 3 |
| Total | 60 | 5 | 65 |

Nearly 50 per cent of R&D manpower engaged in research activities in coal were at the grades 6, 7 and 8 while the balance 50 per cent the personnel were at the first 5 grades. The research in coalmines was conducted at the level of high-ranking officers.

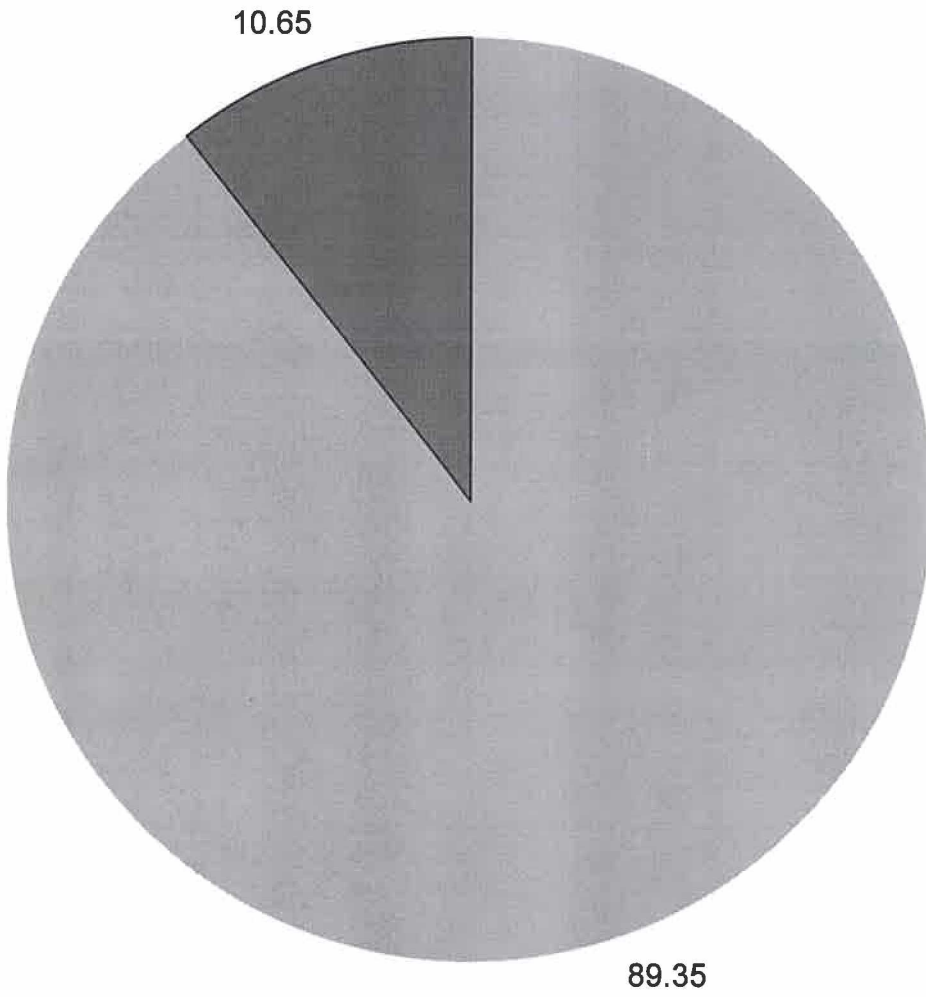
Since most of the scientists involved in research were mining engineers, a discipline girl students are not allowed to opt for, the 92 per cent of scientists were male.

R & D Manpower of Category B and above



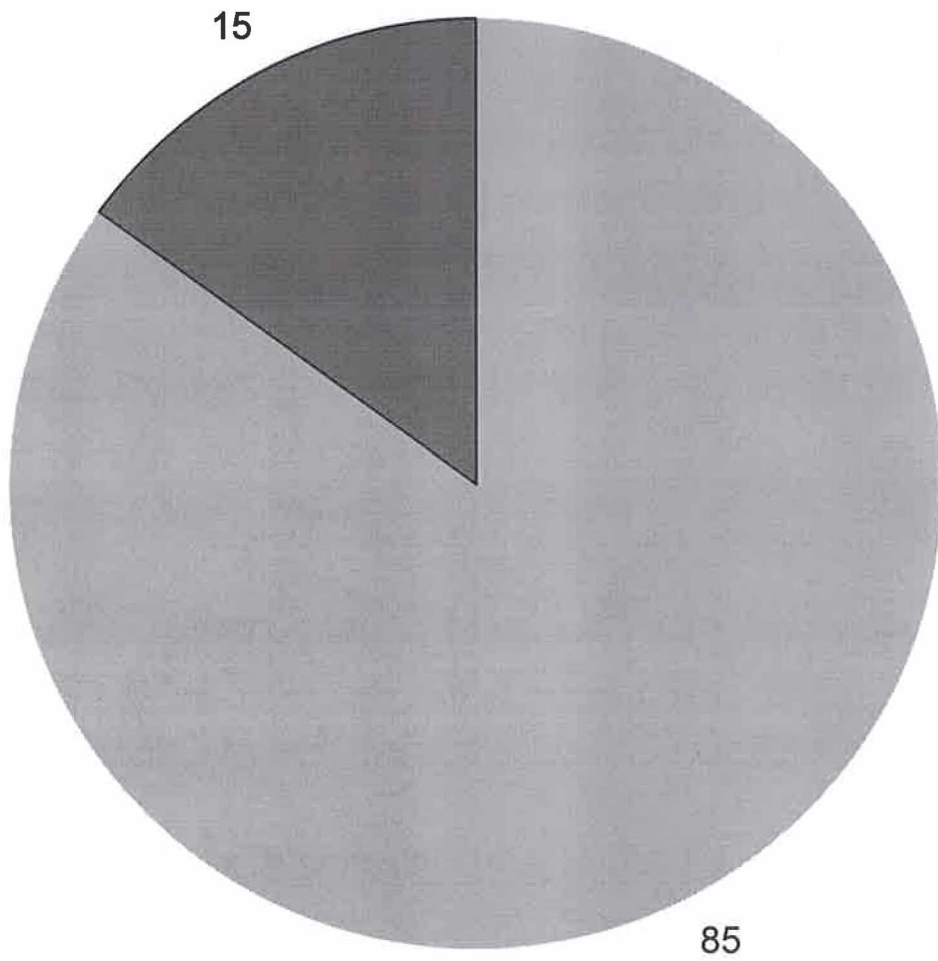
■ Male ■ Female

Auxiliary & Technical Staff



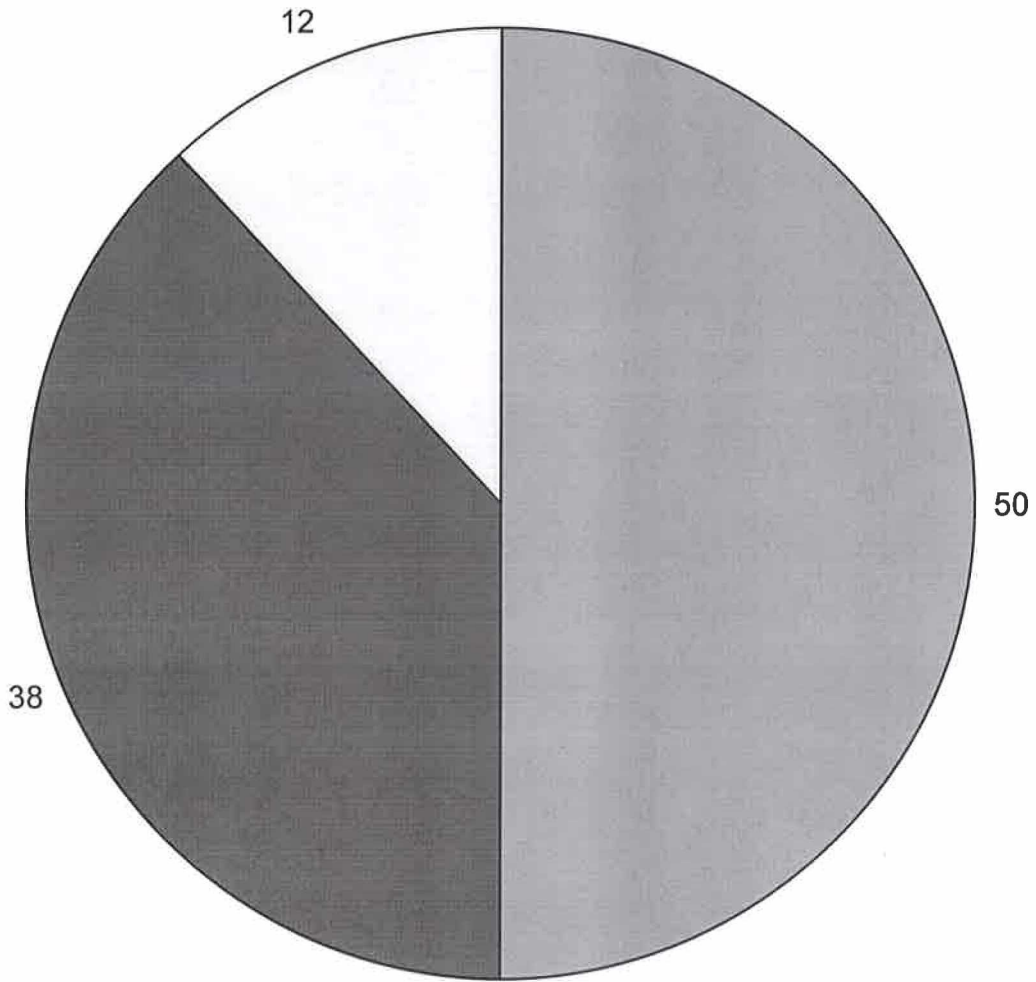
■ Male ■ Female

Research Linked Administration



■ Male ■ Female

Composition of S & T Manpower



- R&D Personnel of Category B and above
- Auxiliary & Technical Staff
- Research Linked Administration

There were no personnel of category B and above in non-R&D set up in all three undertakings, but this aspect was taken care of by the staff at the lower ranks:

| | Male | female | Total |
|-----------------------------|------|--------|-------|
| Non-R&D staff of lower rank | 26 | 3 | 29 |

Ministry of Food Processing (one unit)

The Modern Food Industries (India) Ltd is the only enterprise under the purview of Ministry of Food Processing. It was having a small R&D centre manned by a team of 3 scientists (one male and two females) and four members of auxiliary and technical staff (two males and two females) and 3 research linked administrative staff (one male and two females)

The overall picture that emerges from the above analysis in respect of in-house R&D centres of public sector enterprises is as painted below:

1. The female R&D manpower of category B and above was 7.25 per cent.
2. In auxiliary and technical staff the females presence increased to 10.65 per cent and
3. In the research-linked administration , the females bagged 15 per cent of the posts.

The overall composition of S&T manpower comprised of :

| | Percent |
|--------------------------------------|---------|
| R&D manpower of category B and above | 50.00 |
| Auxiliary & Technical Staff | 38.00 |
| Research Linked Administration | 12.00 |

Chapter 4

Revenue And Expenditure (AVERAGE OF THE YEARS 1995-96 AND 1996-97)

The sources of revenue for carrying out research activities in the public/ joint sector undertakings depended upon the pace and intensity of reform process that set in 1991. The reform process in this area is of recent origin though following the worldwide trend there have been feeble attempts at improving especially the interface between government and enterprises through essentially the medium of the memorandum of understanding (MoUs) . There started a series of attempt to divest government's equity holdings in number of its enterprises. The primary objectives were to:

- raise the resources for the budget which were essentially non-inflationary in nature, and
- broad base the ownership of the enterprises which would eventually allow the enterprises to raise resources from the capital market and thereby lower their dependence on budgetary support.

However to increase efficiency, productivity and competitiveness of the sector a number of measures were introduced. These were policies, which focused on:

1. creating internal competition by eliminating entry barriers , subsidies, price distortions and preferential access to budget and bank resources,
2. improving the management of public enterprises by increasing autonomy and the mandate to become profit - oriented centres, and
3. introducing restructuring policies and establishing a social safety net programme .

The progress in these areas as applicable to the public sector enterprises till 1997- the period of fieldwork related with the study - are mapped out in Table 4.1.

Table 4.1

**Content and Progress of Public Sector Enterprises Reform Programme
(1991 -97)**

| Status in 1991 | Progress through 1997 |
|---|--|
| Competition Policies | |
| The number of industries reserved exclusively for public sector was reduced to 18. | The number of industries reserved for the public sector was reduced to 6. Private participation in some of the segments of the industries was also permitted on a case by case basis. The question of withdrawing the public sector from non-core and non-strategic areas also considered for examination. |
| The direct budgetary support to public enterprises worked out to 1.5 percent of GDP and they received, in addition, a variety of subsidies and subsidized credit. | The budgetary support was curtailed to 0.8 percent of GDP, financing in domestic capital market was increased, preferential access to bank credit was eliminated. |
| | The PSUs which were operating in commercial areas were expected to pay a minimum dividend of 20 percent. |
| Management Policies | |
| There was direct supervision of public enterprises by the government. | The managerial autonomy marginally improved through MoUs signed in 1994-95 |
| The MoU system was introduced in 1988-89 and revised in 1989-90 to improve the performance of PSUs by bringing about a proper balance between accountability and autonomy. | The financial performance of these enterprises was better than what had been targeted for in the MoUs by about 8 percent. |
| Restructuring Policies | |
| The Provisions of the Sick Industrial Companies (Special Provisions), 1985 was amended in December, 1991 to extend it to government companies. Fort seven Central PSUs were registered with the BIFR (as on 31.3.1991). | Up to the end of March, 1995, fifty three cases of Central PSUs were registered with BIFR. A National Renewal Fund was established but the total amount under this fund was not known. |
| There was no social safety net of any sort for employment | Participation of workers in management of profit making and efficient companies was to be encouraged. |

The progress of these various reform measures had an impact on the magnitude, frequency and intensity of flow of funds for research from different sources. This is manifested through data presented in Table 4.2.

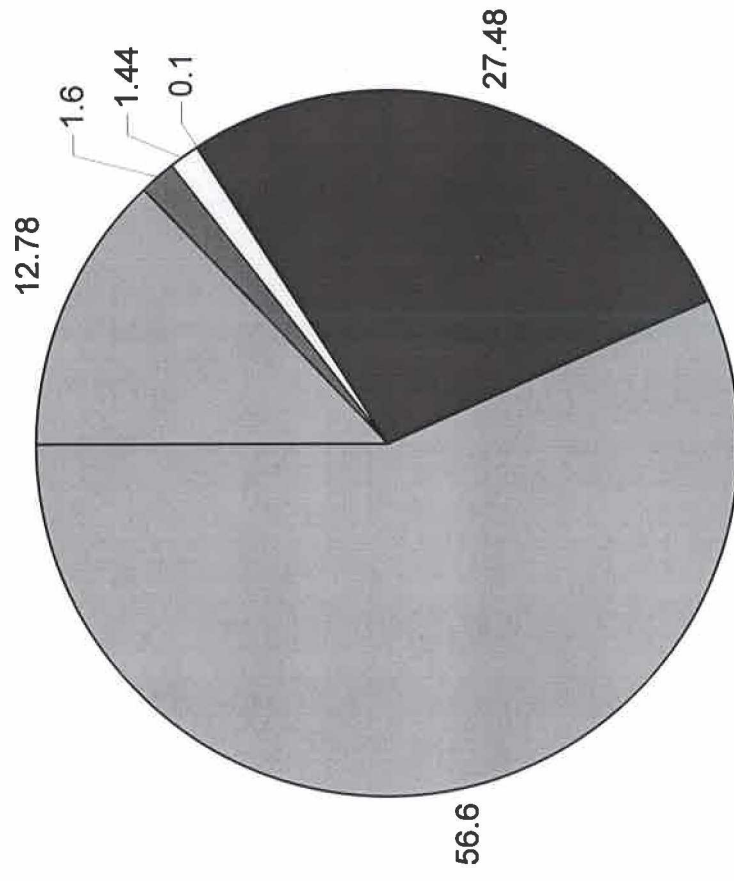
The variations in the flow of funds to different undertakings depended on the marketability of outputs of research conducted and their linkages with the priorities fixed and pursued by the various controlling Socio-Economic Ministries/Departments.

Table 4.2

Sources of Funds for Research Activity (In Rs. Lakh)

| Deptt. Controlling PSUs | Control ling Deptt. | Other Deptt./ Ministries | Own Sources | Internatio nal Agencies | Private Sector | Others | Total |
|---|---------------------|--------------------------|-------------|-------------------------|----------------|--------|-------|
| Deptt. Of Chemicals & Petrochemicals | 353 | 242 | 545 | - | - | 341 | 1481 |
| 3 units | | | | | | | |
| Deptt. Of Chemicals & Fertilizers | 400 | - | - | - | - | 1278 | 1678 |
| 8 units | | | | | | | |
| Deptt. Of Telecommunication (DOT) | 2124 | - | 122 | - | - | 22 | 2270 |
| 4 units | | | | | | | |
| Deptt. Of Defence Production & Supplies | - | - | - | - | - | 6763 | 6763 |
| 3 units | | | | | | | |
| Deptt of Welfare | - | - | - | - | 17 | 1 | 18 |
| 1 unit | | | | | | | |
| Deptt of Heavy Industry | 886 | 136 | 3763 | - | - | 4842 | 9627 |
| 21 units | | | | | | | |
| Deptt of Industrial Development | 319 | - | 469 | 55 | 2 | 886 | 1731 |
| 2 units | | | | | | | |
| Ministry of Mines | 40 | 60 | 46 | - | - | 53 | 199 |
| 3 units | | | | | | | |

Share of Funds Available from Different Sources



■ Controlling Ministry ■ Other Ministries □ International Agencies □ Private Sector ■ Self Generated ■ Others

| | | | | | | | |
|-------------------------------------|------|-----|------|-----|----|-------|-------|
| Ministry of Petroleum & Natural Gas | - | 97 | 294 | - | - | 4231 | 4522 |
| 6 units | | | | | | | |
| Ministry of Power | - | 7 | - | - | - | 119 | 126 |
| 1 unit | | | | | | | |
| Ministry of Steel | - | 13 | 4248 | - | - | 1037 | 5298 |
| 8 units | | | | | | | |
| Ministry of Textiles | 5 | - | - | - | - | - | 5 |
| 1 unit | | | | | | | |
| Ministry of Urban Development | - | - | - | - | 5 | 3 | 8 |
| 1 unit | | | | | | | |
| Ministry of Coal | 286 | - | - | 444 | - | 37 | 767 |
| 3 units | | | | | | | |
| Ministry of Food Processing | - | - | - | - | - | 25 | 25 |
| 1 unit | | | | | | | |
| Total | 4413 | 555 | 9487 | 499 | 24 | 19540 | 34518 |

The average of the funds received per annum for carrying out R&D activities by the units covered above (who responded to the information solicited through institutional questionnaire during field investigations conducted in connection with the study) aggregated to Rs.345.18 Crore. The break up of contribution made by the various agencies listed above is furnished in Table 4.3.

Table 4.3

**Flow of Funds from Various Donors for R&D Activities Conducted by
Public/Joint Sector under the Socio-Economic Ministries
(average of the years 1995-96 and 1996-97)
(Rs. Lakh)**

| Agency | Amount | Percent |
|-----------------------------|--------|---------|
| Controlling Ministry/Deptt. | 44.13 | 12.78 |
| Other Ministries/Deptts. | 555.00 | 1.60 |
| Self Generated Funds | 94.78 | 27.48 |
| International Agencies | 499.00 | 1.44 |
| Private Sector | 24.00 | 0.10 |
| Others | 195.40 | 56.60 |
| Total | 345.18 | |

It is discernible that more than 50 per cent of funds came from other sources, which included the sale of outputs of R&D .It, is creditable that 27.48 per cent of the funds for R&D activities were self- generated. Both these sources together funded about 84 per cent of requirements of research conducted by the Public/ Joint Sector Undertakings of the Socio-Economic Ministries/ Departments. While the controlling ministries met about one- eighth of the requirements of the funds. This scenario represents the true picture of the reforms that have taken place in Public Sector Enterprises in words and spirit .

Expenditure on R&D and its Relevance:

The expenditure on R&D and its proportion to total expenditure of an organization, casts its shadow on quality and quantum of out put of R&D activities. Within the R&D expenditure , the investment on development and maintenace of research infrastructure is of great significance in sustaining proper S&T atmosphere in an organization . Equally important is the number and quality of auxiliary and technical staff needed to provide support to the R&D personnel in research pursuits. All these inputs vary with different public/ joint sector enterprises. The responding enterprises under the same ministry/ department have been clubbed together to capture a composite representative average figure. The information as received in filled-in questionnaires from the enterprises is presented in Annex 4.2 and condensed in Table 4.3.

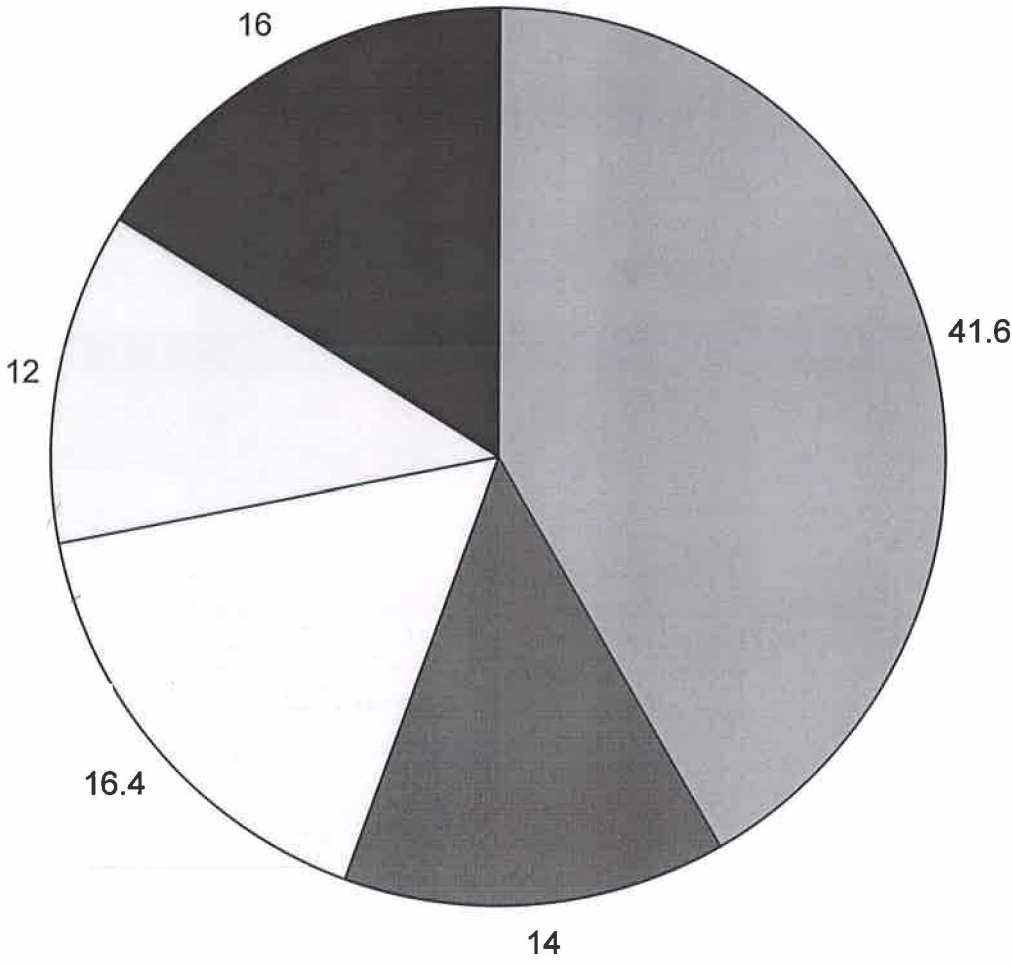
Table 4.3

**Break of Expenditure and Inter-relationship of its Constituents
(average of 1995-96 and 1996-97)**

(Rs. Lakh)

| Recurring Expenses | | | | | Non-Recurring Expenses | Total Expenses |
|--------------------------------------|--|------------------------------------|---------------------------------------|----------------|------------------------|----------------|
| Name of the Department | S&A of R&D Personnel of Category B and above | S&A of Auxiliary & Technical Staff | S&A of Research Linked Administration | Other Expenses | | |
| Deptt. Of Chemicals & Petrochemicals | 45 | 384 | 122 | 820 | 113 | 1484 |
| 3 units | 3.0% | 25.9% | 8.2% | 55.3% | 7.6% | |
| Deptt. Of Chemicals & Fertilizers | 545 | 202 | 719 | 128 | 306 | 1900 |
| 8 units | 28.7% | 10.6% | 37.8% | 6.7% | 16.2% | |

Allocation of Expenditure on Recurring & Non-Recurring Items



- Salary & Allowances of R&D Personnel
- Salary & Allowances of Aux. & Tech. Staff
- Salary & Allowances of Research Linked Admn.
- Other Expenses
- Non-Recurring Expenses

| | | | | | | |
|-------------------------------------|-------|-------|-------|-------|-------|-------|
| Deptt. Of Telecommunication (DOT) | 1161 | 33 | 1033 | 15 | 28 | 2270 |
| 4 units | 51.1% | 1.4% | 45.5% | 1.2% | 0.8% | |
| Deptt. Of Defence Prodn. & Supplies | 2820 | 1383 | 862 | 345 | 494 | 5904 |
| 3 units | 47.8% | 23.4% | 14.6% | 5.8% | 8.4% | |
| Deptt. Of Welfare | 8 | 10 | - | - | - | 18 |
| 1 unit | 44.4% | 55.6% | | | | |
| Deptt of Heavy Industry | 5149 | 368 | 1292 | 1637 | 448 | 8894 |
| 21 units | 57.9% | 4.1% | 14.5% | 18.4% | 5.1% | |
| Deptt of Inds. Development | 328 | 53 | 185 | 41 | 136 | 743 |
| 2 units | 44.2% | 7.1% | 24.9% | 5.5% | 18.3% | |
| Ministry of Mines | 21 | 96 | 70 | 62 | 27 | 276 |
| 3 units | 7.6% | 34.8% | 25.5% | 6.4% | 9.7% | |
| Ministry of Petroleum & Natural Gas | 999 | 966 | 104 | 26 | 2327 | 4422 |
| 6 units | 22.6% | 21.8% | 2.3% | 0.6% | 52.7% | |
| Ministry of Power | 40 | 39 | 20 | - | 27 | 126 |
| 1 unit | 31.7% | 31.0% | 15.8% | | 21.5% | |
| Ministry of Steel | 176 | 75 | 66 | 141 | 179 | 687 |
| 8 units | 25.6% | 10.9% | 9.6% | 27.8% | 26.1% | |
| Ministry of Textiles | 3 | 2 | - | - | - | 5 |
| 1 unit | 60.0% | 40.0% | | | | |
| Ministry of Urban Dev. | 5 | 7 | 5 | - | 10 | 27 |
| 1 unit | 18.5% | 26.0% | 18.5% | | 37.0% | |
| Ministry of Coal | 110 | 199 | 15 | - | 214 | 538 |
| 3 units | 20.4% | 37.0% | 2.6% | | 40.0% | |
| Ministry of Food Processing | 3 | 4 | 1 | - | 17 | 25 |
| 1 unit | 12.0% | 16.0% | 4.0% | | 68.0% | |
| Total | 11413 | 3821 | 4494 | 3265 | 4326 | 27319 |
| | 41.6% | 14.0% | 16.4% | 12.0% | 16.0% | |

Note: S&A stands for salary and allowances

As is apparent from the Table 4.3, there are wide variations in ratios of expenditure apportioned to different specified heads by the 65 enterprises who responded to the question The share of expenses of R&D manpower of category B and above fluctuated within very wide bands amongst the enterprises of various socio-economic ministries:

| Range of the share of salary and allowances of R&D personnel of category B and above | Number of units and their percentage |
|--|--------------------------------------|
| +50 percent | 27 (41.5%) |
| +40 to 50 percent | 06 (09.2%) |
| Below 40 percent | 32(49.3%) |

Near about 50 per cent of units spent less than 40 per cent of funds earmarked for research activities on the salaries and allowances of R&D personnel of category B and above. The average of all the units works out to 41.6 per cent whereas the share should have been above 50 per cent.

In some of the units, the auxiliary and technical staff has significant role to play and this is reflected through their shares in investable funds available for research activities:

| Ministry/Department | Share of Salary & allowances of auxiliary & technical staff |
|--------------------------|---|
| Deptt. Of Family Welfare | 55.6 percent |
| Ministry of Mines | 34.8 percent |
| Ministry of Coal | 37.0 percent |
| Ministry of Textiles | 40.0 percent |

Otherwise 14 per cent which is the average share of salary and allowances is a reasonably acceptable percentage.

But the share of non-recurring expenditure is low at 16 per cent ; normally it is desirable at a level of 30 per cent of the total expenditure on research.

Chapter 5

Employment Profile

The employment of scientists in in-house research center of an undertaking is usually drawn from the technical manpower employed in production/maintenance lines of the organization. The research conducted is usually related with resolving the problems connected with production activities of the unit. As seen in chapter 4, a big share (27.48 %) of the revenue needed for financing the research projects, therefore, come from self-sponsored studies.

The employment record of scientists in research pursuits is thus a mixed one because of interchangeability of tenure of service. This also has its impact on involvement of scientists in different types of research - basic, applied and experimental and duration thereof. The employment profile of S&T manpower engaged in R&D activities in public/joint sector undertakings is summarized in the paragraphs to follow.

Age-wise and sex-wise configuration of the responding scientists:

The responding R&D manpower of Category B and above (2,146) could be grouped under 3 broad bands of age:

| Years | Percent |
|-----------|---------|
| Up to 40 | 45.0 |
| +40 to 52 | 40.0 |
| +52 to 58 | 15.0 |

It was also noteworthy that 12 scientists were actively engaged in research even after the age of superannuation i.e. 58 years (applicable during the period of the study)

Of the responding scientists, 93.24 per cent were males and 6.76 per cent females. The sex-wise response was more or less in line with the gender distribution of scientists listed in Chapter 3. The females constituted 7.25 per cent of R&D manpower of category B and above.

Qualification-wise Dispersion of the Responding Scientists:

Research activities in the enterprises had technical orientation. More than 55 per cent of R&D manpower had engineering qualification (38.6 per cent had B.E/B.Tech. certificate and 16.5 per cent M.E/M.Tech. qualification). More than one-fifth of R&D personnel had M.A/M.Sc.

The chapter is based on the response of 2, 146 R&D manpower of category B and above engaged in S&T activities in 74 public/joint undertakings. The information was obtained through filled-in scientist questionnaires. For every scientist interviewed at personnel level, there was a corresponding schedule dealing with professional and academic details.

High qualifications undoubtedly helped the scientists in direct recruitment to entry to category B of the enterprises:

Qualification & Direct Recruitment to category B and above

| Qualification | No. of R&D personnel directly recruited | Per cent |
|---------------|---|----------|
| B.A/B.Sc. | 15 | 25.8 |
| M.A/M.Sc. | 251 | 56.0 |
| M.Phil. | 26 | 74.3 |
| Ph.D./D.Sc. | 186 | 63.5 |
| B.E/B.Tech. | 602 | 72.6 |
| M.E/M.Tech. | 276 | 78.0 |

The percentage of direct recruit to category B and above increased with the qualification.

While the period of 5 years or more needed for reaching category B and above was applicable to the cases with lower qualifications. Details are furnished in Annex 5.3.

Grade-wise Dispersion of Scientists:

56.7 per cent of scientists were placed at first 4 grades while placement of the scientists were of the same order at grade 5 and grade 6.

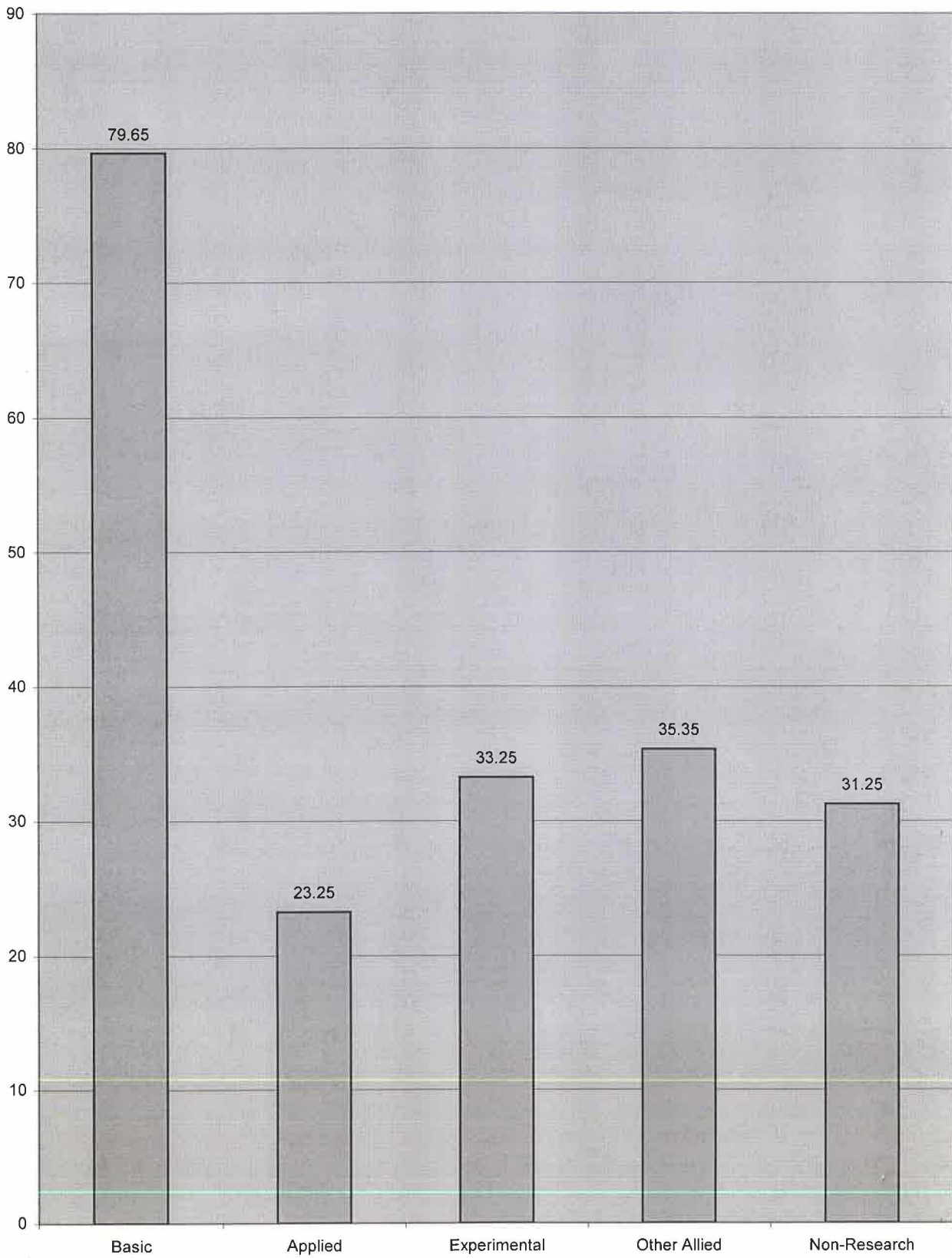
Grade-wise placement of scientists of category B and above

| | No. of Scientists | Per cent |
|----------|-------------------|----------|
| Grade 1 | 275 | 12.8 |
| Grade 2 | 370 | 17.2 |
| Grade 3 | 294 | 13.7 |
| Grade 4 | 278 | 13.0 |
| Grade 5 | 352 | 16.4 |
| Grade 6 | 344 | 16.0 |
| Grade 7 | 187 | 8.7 |
| Grade 8 | 43 | 2.2 |
| Grade 9 | 2 | Neg. |
| Grade 10 | 1 | Neg. |

Age-wise/qualification-wise Distribution of R&D Manpower:

The detailed matrix of age and qualification is furnished in Annex 5.5. It is discernible that the concentration of scientists with Ph.D./D.Sc. was at the older vintage group and since in respect of other higher qualifications, the incumbent had taken advantage of at the time of entry in the undertakings, scientific personnel with these qualifications were more or less evenly distributed.

Percentage of Scientists with zero involvement in Different Types of Research



Time taken to Reach Present Pay scale from the level of category B.

Variations were invariably observed in the time taken to reach the present grade of pay from the level of category B .On an average more than 50 per cent of the researchers took more than 10 years to reach the present scale.

Time Taken to reach the Present Scale from category B
(In years)

| Time Range | Male | Female | Total | Per cent |
|------------|------|--------|-------|----------|
| < 2 yrs | 123 | 14 | 137 | 6.3 |
| 2-4 yrs | 330 | 28 | 358 | 16.7 |
| 5-7 yrs | 308 | 30 | 338 | 15.8 |
| 8-10 | 221 | 16 | 237 | 11.0 |
| >10 yrs | 1019 | 57 | 1076 | 50.2 |
| | 2001 | 145 | 2146 | 100.0 |

Deployment of scientific manpower vis-à-vis their areas of specialization.

As stated earlier, most of the scientists engaged in R&D activities were specifically employed with reference a particular research projects, there were no instance of mismatch between the disciplines of employment and areas of specialization of the researchers. Details of information on this subject are furnished in Annex 5.7.

Activity- wise time allocation by the scientists:

The scientists in the research outfits of the Central Government enterprises were actively engaged in result oriented R&D actively; their time allocation was mostly in applied and experimental types of research. This is supported by the data furnished as under:

Number of Scientists with Zero Involvement in Types of research

| Type of Research | No. of scientists | Per cent |
|-------------------------|-------------------|----------|
| Basic | 1,728 | 79.65 |
| Applied | 499 | 23.25 |
| Experimental | 714 | 33.25 |
| Other Allied Research | 758 | 35.35 |
| Non-research Activities | 675 | 31.25 |

The data manifest that nearly 80 per cent of R&D manpower had no involvement in Basic Research while maximum involvement of the scientists (76.75%) was in applied research whereas involvement of scientists in experimental, other allied research and non-research activities was practically of the same scale ranging from 64.65 per cent to 68.75 per cent.

It is also discernible that 68.75 per cent of scientific manpower was involved in non-research activities in some way or the other. This is the R&D manpower under whose control and guidance the research-linked administrative set up operates in the enterprises. The main responsibility of involvement in non-research activity was shared by the R&D manpower of upper grades:

Involvement in non-research activity by R&D manpower of category B and above

| Grade | >1 & ≤3 months | >3 & ≤6 months |
|---------|----------------|----------------|
| Grade 5 | 112 Scientists | 53 scientists |
| | 31.82 per cent | 15.06 % |
| Grade 6 | 131 Scientists | 52 Scientists |
| | 38.08 per cent | 15.12 % |
| Grade 7 | 68 Scientists | 42 Scientists |
| | 36.36 per cent | 22.46 % |

The involvement of R&D manpower in both Applied and Experimental Research was most intense from grade 3 onward. This is amply manifested by the field data presented below:

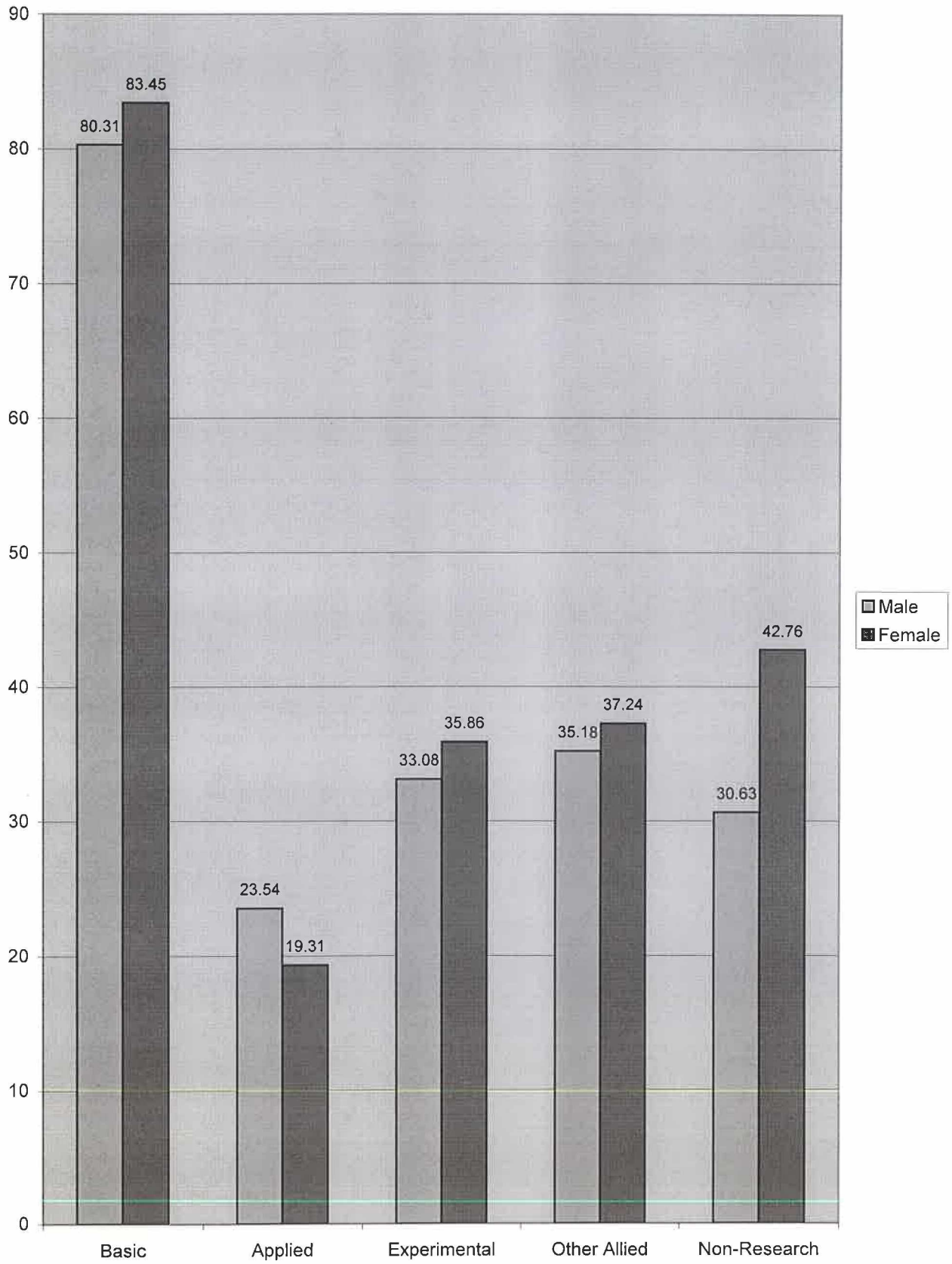
| Grade | Applied Research | | Experimental Research | |
|---------|------------------|----------------|-----------------------|----------------|
| | >1 & ≤3 months | >3 & ≤6 months | >1 & ≤3 months | >3 & ≤6 months |
| Grade 3 | 100 Scientists | 66 Scientists | 90 Scientists | 69 Scientists |
| | 34.01 % | 22.45% | 30.69% | 23.47% |
| Grade 4 | 77 Scientists | 64 Scientists | 86 Scientists | 65 Scientists |
| | 27.70 % | 23.02% | 30.94% | 23.38% |
| Grade 5 | 114 Scientists | 88 Scientists | 132 Scientists | 86 Scientists |
| | 32.39 % | 25.0% | 37.50% | 24.43% |
| Grade 6 | 121 Scientists | 70 Scientists | 119 Scientists | 74 Scientists |
| | 35.17 % | 20.35% | 34.59% | 21.59% |
| Grade 7 | 78 Scientists | 34 Scientists | 57 Scientists | 33 Scientists |
| | 41.71 % | 18.18% | 30.48% | 17.65% |
| Grade 8 | 18 Scientists | 9 Scientists | 15 Scientists | 8 Scientists |
| | 41.86 % | 20.35% | 34.88% | 18.60% |

Note: The figures in brackets indicate per cent of the scientists in that grade

Gender-wise Involvement in R&D Activity:

Non-involvement in different types of research activities is not gender specific but is practically of equal relevance to both the genders.

Non-involvement of R&D Personnel in Various Types of R&D



Gender-wise Non- involvement of Researchers in Different Types of Research Activities

| Gender | Basic Research | Applied Research | Experimental Research | Allied Research | Non-research |
|--------|----------------|------------------|-----------------------|-----------------|--------------|
| Male | 80.31 % | 23.54 % | 33.08 % | 35.18 % | 30.63 % |
| Female | 83.45 % | 19.31 % | 35.86 % | 37.24 % | 42.76 % |

The percentages of non-involvement of both the genders run practically parallel.¹²

¹ The detailed parameter-wise segregated information related with this chapter is furnished in Annex 5.1 to Annex 5.11.

² Non-research activities usually encompass S&T management, planning and coordination, services like information and documentation, quality assurance/control involving testing, analysis of research outputs testing etc., besides administration-cum-management.

Chapter 6

Research Projects Handled

The composition of flow of funds for research activities of public/sector undertakings is a function of number of projects sponsored by various donor agencies. The intensity of research demanded and consequently duration of research input warranted and overall the number of projects sponsored determines quantum of funds available to research centres of the government enterprises. The data on the number of projects sponsored by the various specified agencies are available in Annex 6.1 to Annex 6.7. The details are summarized in Table 6.1

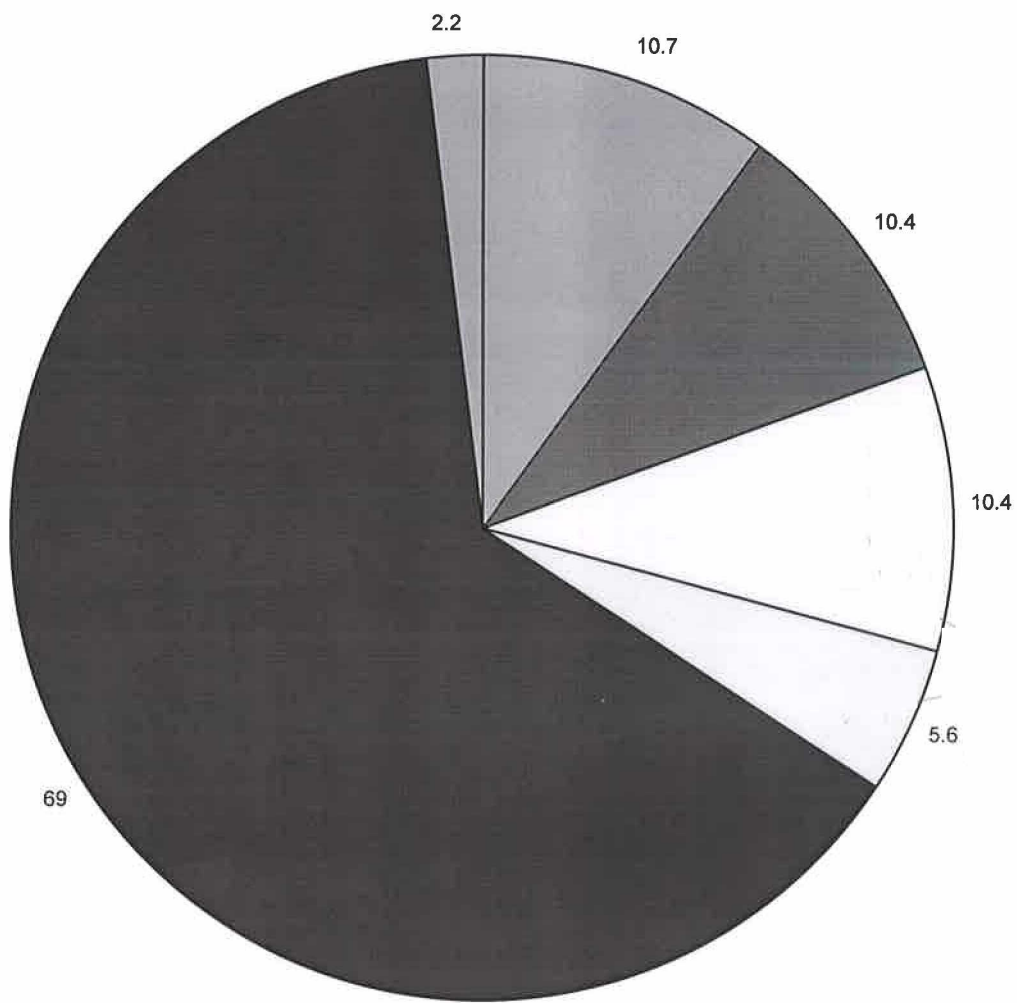
Table 6.1

Details of Projects Sponsored by Various Agencies to Government Enterprises
(Average of 1996-96 and 1996-9)

(In number)

| Ministry/Dept. | Govt | Public Sector | Private Sector | Internati-onal Agency | Self-sponsore-d | Others | Total |
|--|------|---------------|----------------|-----------------------|-----------------|--------|-------|
| Deptt. of Chemicals & Petro-chemicals(3 units) | - | - | - | - | 17 | - | 17 |
| Deptt.of Chemicals & Fertilizers (8 units) | 41 | - | - | - | 31 | - | 72 |
| DOT (4 units) | - | 11 | - | - | 82 | 2 | 95 |
| Deptt.of Defence Prodn 7 Supplies(3 units) | 3 | - | - | - | 46 | - | 49 |
| Deptt. of Family Welfare (one unit) | - | 1 | - | - | - | - | 1 |
| Deptt. of Heavy Industry(21 units) | 7 | 25 | 13 | 33 | 184 | - | 262 |

Share of Research Projects Sponsored by Various Agencies



■ Controlling Ministry ■ Public Sector □ Private Sector □ International Agencies ■ Self-sponsored ■ Others

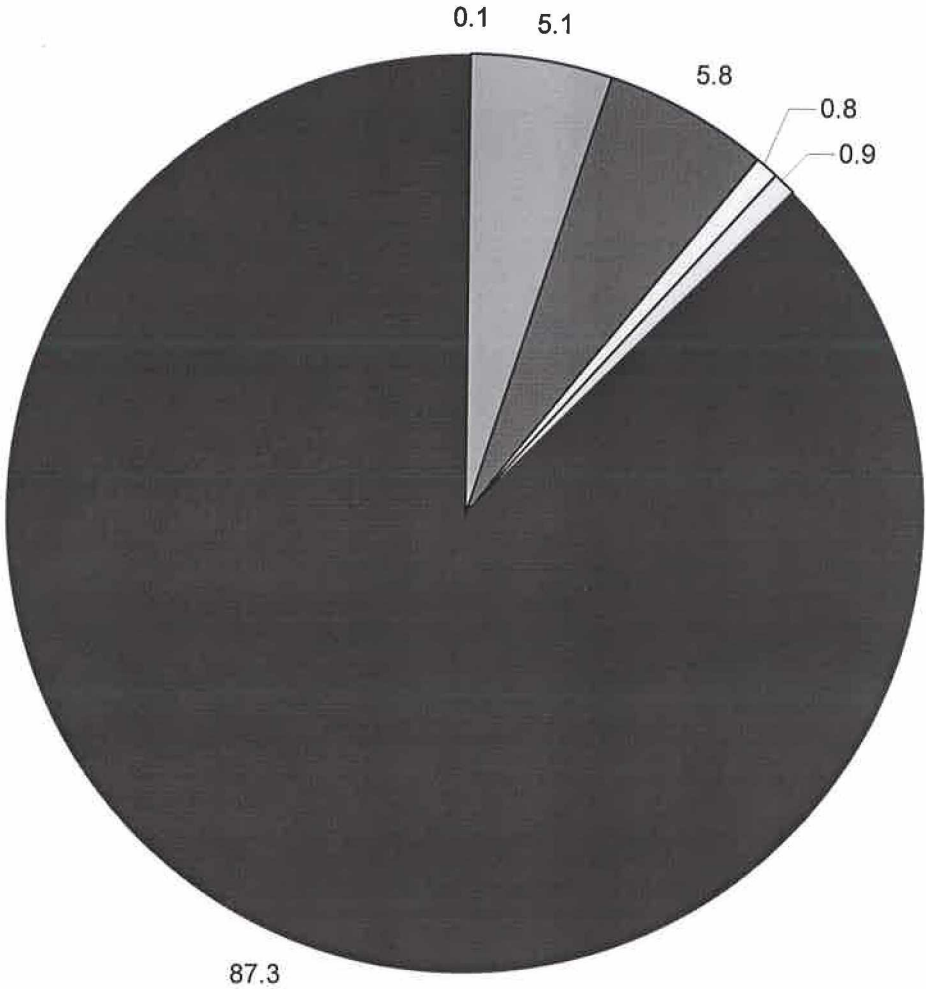
| | | | | | | | |
|---|----|----|----|----|-----|----|-----|
| Deptt.of Industrial Development (2 units) | 8 | 32 | 1 | 2 | 3 | 10 | 56 |
| Ministry of Mines (3 units) | 2 | - | - | - | 31 | - | 33 |
| Ministry of Petroleum & N.Gas(6 units) | - | - | - | 2 | 9 | - | 11 |
| Ministry of Power(one unit) | - | - | - | - | 25 | 3 | 28 |
| Ministry of Steel (8 units) | - | 1 | - | - | 25 | - | 26 |
| Ministry of Textiles (one unit) | - | - | - | - | - | - | - |
| Ministry of Urban Development(one unit) | - | - | - | - | 3 | - | 3 |
| Ministry of Coal (3 units) | 11 | - | - | 1 | 4 | - | 16 |
| Ministry of Food Processing(one unit) | - | - | - | - | 5 | - | 5 |
| Total | 72 | 70 | 14 | 38 | 465 | 15 | 674 |

As expected 69 per cent of the projects were self-sponsored by the government undertakings. The projects sponsored by the controlling ministry and public sector were more or less equal and both clubbed together accounted for 21 per cent of projects. All the three sources put together sponsored 90 per cent of the projects made available to enterprises.

Share of Research Projects Sponsored by Various Agencies

| Agency | Per cent |
|----------------------------------|----------|
| Controlling Ministry/ Department | 10.7 |
| Other Ministry/Department | |
| Public Sector | 10.4 |
| Private Sector | 10.4 |
| International Agencies | 5.6 |
| Self-sponsored | 69.0 |
| Others | 2.2 |

Sources of Projects and Involvement of Manpower



- | | | |
|--------------------------|------------------|------------------|
| ■ Controlling Ministry | ■ Public Sector | □ Private Sector |
| □ International Agencies | ■ Self-sponsored | ■ Others |

The projects in the government undertakings are also handled by a team headed by a leader who is a senior researcher. He is supposed to inspire and guide the members through the mechanism of day to day monitoring.

Annex 6.8 furnishes the details of involvement of scientists in research projects sponsored by various agencies. The information is based on the receipt of filled-in questionnaires from 2,146 R&D personnel of category B and above. The details are summarized as under:

Sources of Projects and Involvement of Manpower

| Sponsor of Study | Number of Scientists involved | Per cent |
|---|-------------------------------|----------|
| Controlling Ministry/Deptt. & Other ministries/deptt. | 110 | 5.1 |
| Public Sector | 125 | 5.8 |
| Private Sector | 18 | 0.8 |
| International Agencies | 21 | 0.9 |
| Self-sponsored | 1868 | 87.3 |
| Others | 4 | 0.1 |
| | 2146 | 100 |

Sixty nine per cent of research studies were self-sponsored and that involved 87 per cent of R&D manpower of category B and above.

Annexure 6.8 furnishes the details of information of the time spent on research projects under execution and the status of their implementation.

Chapter 7

Research output

As mentioned in chapter 4 and chapter 6, 84 per cent of funds needed for research conducted by the government enterprises came from the two sources:

| | Per cent |
|----------------------|----------|
| Self-generated funds | 27.48 |
| Others | 56.60 |

That means that the research operations undertaken by the enterprises had market orientation. The income from 'others' which is basically obtained from marketing of research outputs, contributed more than 50 per cent of revenue needed for sustainability of research activity of the central government enterprises.

With this income the enterprises could themselves sponsor 69 per cent of research studies and deploy 87.3 per cent of R&D manpower of category B and above. This could be done purely on the strength of their research output.

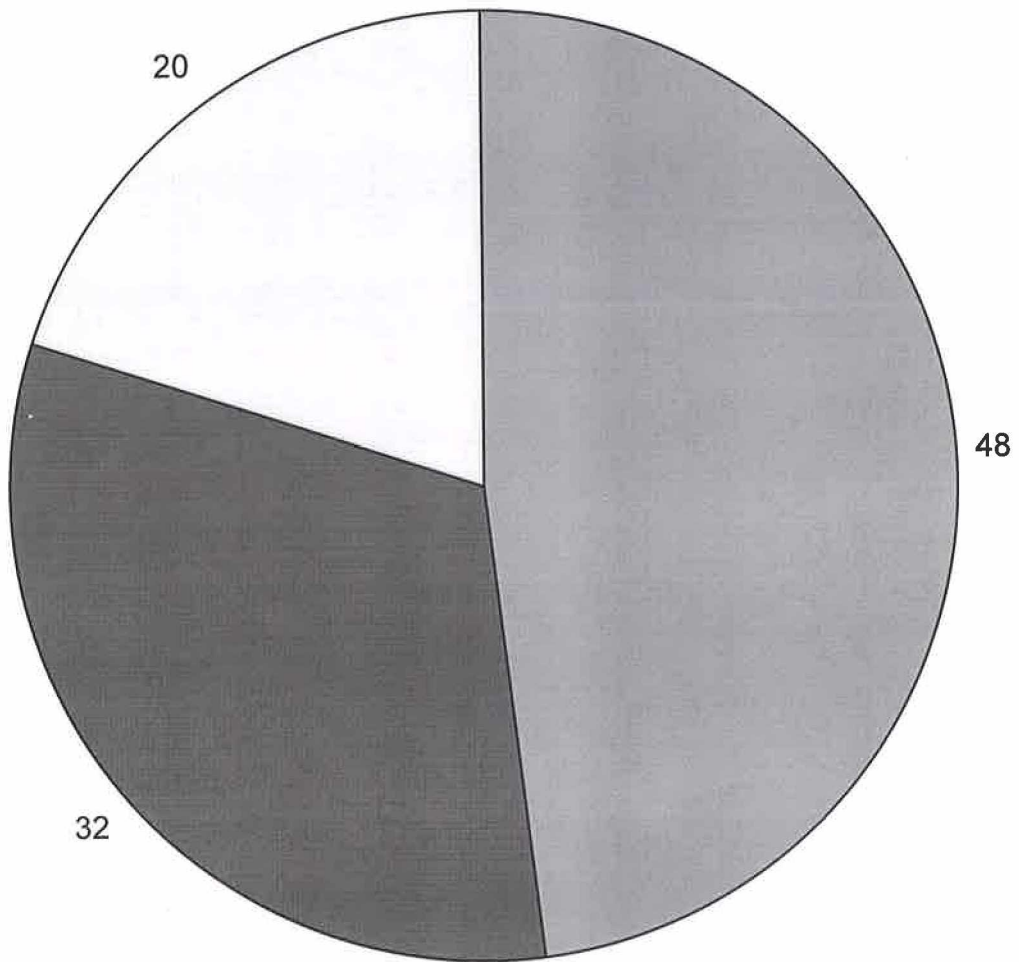
Research output Ministry/Department-wise:

The analysis presented here is based on response received from the enterprises under various ministries/department through filled-in Institution Schedules. The data received have been clubbed together to represent the research output of the controlling Ministry/Deptt. In the interest of better understanding of the research output, the data have been segregated under the following heads:

Research Output of Enterprises under the Socio-economic Ministries/Deptt

| Enterprise | Stage | New Product | New Process | New Design | Modification of P.P.D | Consultancy Service | Import Substitution | Others |
|---|-------|-------------|-------------|------------|-----------------------|---------------------|---------------------|--------|
| Deptt of Chemicals & Petro-Chemicals(3 units) | A | 12 | 2 | - | - | - | - | - |
| | B | 5 | 3 | - | - | - | - | - |
| | C | 4 | - | - | - | - | - | - |
| Deptt. of Chemicals & Fertilizers (8 units) | A | 7 | 22 | 2 | 4 | - | - | - |
| | B | 2 | 18 | 1 | - | - | - | - |
| | C | 8 | 4 | - | - | 7 | - | - |
| Deptt. of Telecommunications (4 units) | A | 7 | - | - | - | - | 10 | - |
| | B | - | - | - | - | - | 1 | - |
| | C | - | - | - | - | - | - | - |
| Deptt of Defence Prodn & Supplies (3 units) | A | 89 | 2 | 1 | - | - | 51 | 12 |
| | B | 102 | - | 45 | 33 | - | 30 | 5 |
| | C | 87 | 2 | - | - | - | 50 | - |

Status of Assignments in hand



■ Completed ■ In progress □ Transferred

| | | | | | | | | |
|--|---|------|------|-----|------|-----|------|-----|
| Deptt. of Family Welfare(one unit) | A | 1 | - | - | - | 1 | - | - |
| | B | - | - | - | 2 | - | - | - |
| | C | - | - | - | - | - | - | - |
| Deptt. of Heavy Industry (21 units) | A | 44 | 37 | 27 | 79 | - | 9 | 31 |
| | B | 27 | 25 | 4 | 69 | - | 12 | 7 |
| | C | 25 | 2 | 21 | 17 | - | 5 | 6 |
| Deptt. of Industrial Development (2 units) | A | - | - | - | 1 | 53 | - | - |
| | B | - | - | - | 2 | - | - | - |
| | C | - | - | - | 0 | 53 | - | - |
| Ministry of Mines (3 units) | A | 6 | 4 | 1 | 5 | - | - | - |
| | B | 3 | 3 | 1 | 3 | - | - | - |
| | C | 2 | 1 | - | 2 | - | - | - |
| Ministry of Petroleum & N.Gas (3 units) | A | 56 | 2 | - | 3 | 1 | - | - |
| | B | 4 | 1 | - | 1 | - | - | - |
| | C | 2 | - | - | - | - | - | - |
| Ministry of Power (one unit) | A | - | 1 | - | 3 | - | 1 | 22 |
| | B | - | - | - | - | - | - | 2 |
| | C | - | - | - | - | - | - | - |
| Ministry of Steel (8 units) | A | 16 | 1 | 3 | 1 | 7 | 3 | - |
| | B | 24 | 10 | 3 | - | - | - | - |
| | C | 1 | - | - | - | - | - | - |
| Ministry of Textiles (one unit) | A | 2 | 1 | 1 | - | - | - | - |
| | B | 2 | 1 | - | - | - | - | - |
| | C | - | 1 | - | - | - | - | - |
| Ministry of Urban Development (one unit) | A | 2 | 1 | 1 | 1 | 1 | - | - |
| | B | 1 | 1 | - | 1 | 1 | - | - |
| | C | - | 1 | - | - | - | - | - |
| Ministry of Coal (3 units) | A | 7 | 9 | - | 1 | - | - | 1 |
| | B | 2 | 4 | - | - | - | - | 2 |
| | C | - | - | - | - | - | - | - |
| Ministry of Food Processing (one unit) | A | 5 | 5 | - | - | - | - | - |
| | B | - | - | - | - | - | - | - |
| | C | 1 | - | - | - | - | - | - |
| Total | A | 249 | 85 | 36 | 125 | 63 | 74 | 66 |
| | B | 172 | 66 | 54 | 111 | 1 | 43 | 16 |
| | C | 129 | 11 | 21 | 19 | 60 | 55 | 6 |
| | | 550 | 162 | 111 | 255 | 124 | 172 | 88 |
| Percent | | 37.6 | 11.0 | 7.6 | 17.5 | 8.7 | 11.6 | 6.0 |

Note: A= Completed B= In progress C= Transferred

P.P.D = Products , Processes and Designs

| | Assignments | Per cent |
|----------------|-------------|----------|
| A. Completed | 698 | 48 |
| B. In progress | 463 | 32 |
| C. Transferred | 301 | 20 |

It is obvious that the maximum of sponsored projects (37.6 per cent) were related with the development of new products followed by the projects having bearing on various modifications (17.5 %). Import substitution had only 11.6 per cent of significance in research activity of the government enterprises.

Nearly 50 per cent of the projects were completed and one- fifth were transferred for commercialization.

Patents Obtained and Patents Applied for:

There was not much to mention about patents obtained and patents applied for. Patents have been obtained by the enterprises under the Ministry of Mines, Ministry of Petroleum and Natural Gas and Ministry of Steel.

Patents Obtained and Patents Applied for

| Ministry/Deptt. | Stage | Patents Obtained | Patents Applied for |
|-------------------------------------|-------|------------------|---------------------|
| Ministry of Mines | A | 1 | 1 |
| | B | 1 | - |
| | C | - | - |
| Ministry of Petroleum & N. Gas | A | 2 | 16 |
| | B | - | - |
| | C | - | - |
| Ministry of Steel | A | 4 | 1 |
| | B | 1 | 1 |
| | C | - | - |
| Ministry of Chemicals & Fertilizers | A | | 6 |
| | B | | - |
| | C | | - |
| Deptt. of Defence Prodn & Supplies | A | | 1 |
| | B | | - |
| | C | | - |
| Deptt. of Heavy Industry | A | | 1 |
| | B | | - |
| | C | | - |

The number related with patents was very insignificant as compared with the number of other out puts. As it comes out, a few enterprises had the distinction of having obtained the patents and some enterprises had applied for patents.

Scientist-wise Research Output:

The information is derived from the response from available from 2,146 scientists representing 74 enterprises under the ambit of Socio-economic ministries. The details of the information are furnished in Annex 7.5 and summarized in Table 7.1.

Table 7.1

Research Output by R&D Personnel of category B and above

| Out put | Out put per scientist reporting the specified out put (in number) in his/her response |
|---------------------------------------|---|
| Product/process developed | 1.4 (0.4 7) |
| Patent obtained | 2.0 (0.06) |
| Patent applied | 1.6 (0,12) |
| Awards/merits earned | 1.22 (0.075) |
| Articles published in Indian journal | 2.33 (0.48) |
| Articles published in Foreign journal | 2.25 (0.24) |
| Booked published | 1.56 (0.011) |

Note: The figures in parentheses represent the average of overall response of 2146. These are the average figures irrespective of gender¹.

¹ The detailed information related with this chapter is furnished in Annex 7.1 to 7.5.

Chapter 8

Details of R&D Related Activities at National Levels (Average of the years 1995-96 and 1996-97)

Organization of seminars, training, conference, award of fellowship etc. have beneficial impact on the incumbent scientists because these provide them the opportunities to project their potential and the outputs of the enterprise that they belong to. The scientists come in direct contact with the scientists from other enterprises and research institutions. Such events provide the training platform as well for in-house scientists.

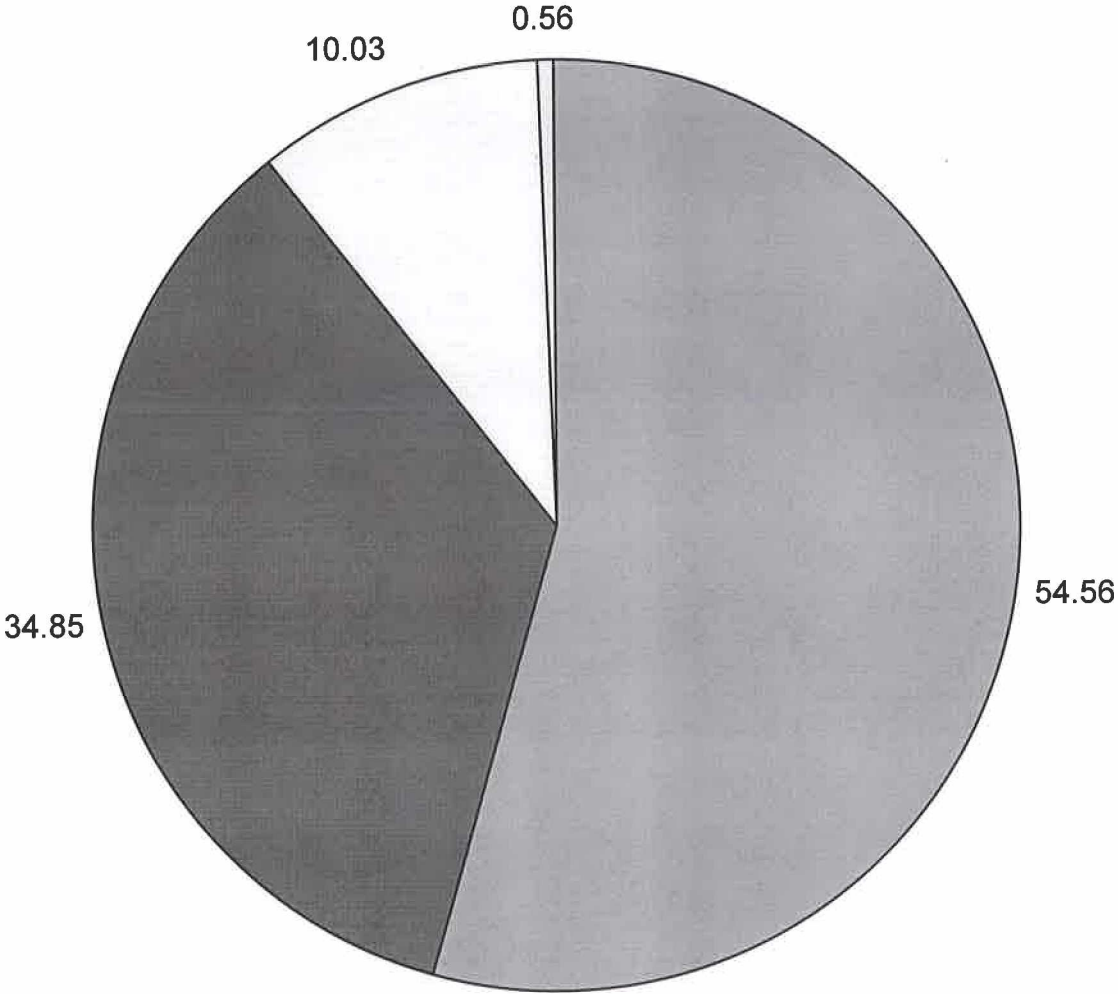
Such programmes serve as a part of obligations that the research enterprises have towards the nation in furtherance of cause of science and technology and overall perception of science. The details of such promotional activities linked with R&D conducted by the government undertakings surveyed are furnished in Annex 8.1 and Annex 8.2 and summarized in Table 8.1

Table 8.1

Seminars and Training Programmes Organized by Enterprises

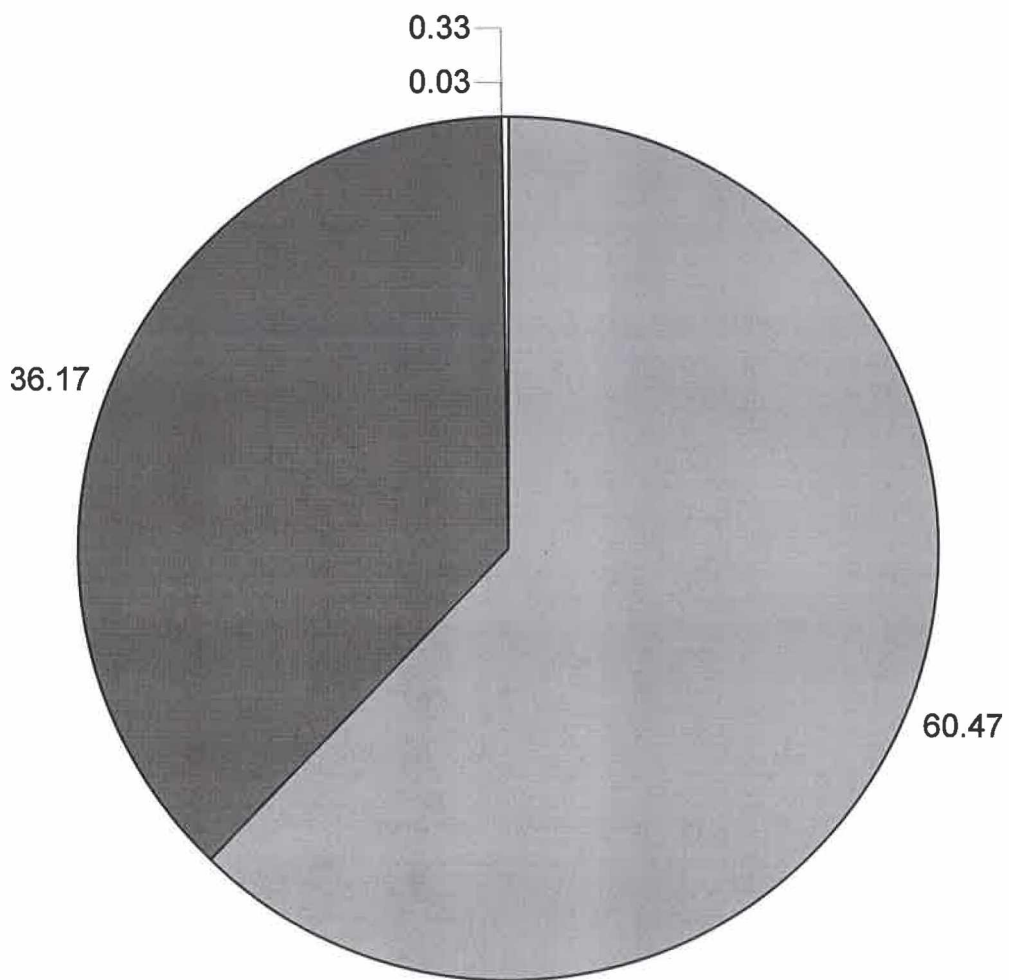
| Department | Status | Seminars | Conferences | Trainings | Fellowships | Exhibitions | Others |
|--|--------|----------|-------------|-----------|-------------|-------------|--------|
| Deptt. Of Chemicals & Petro-chemicals (3 units) | A | 3 | 1 | 1 | - | - | - |
| | B | 7 | 2 | 1 | - | - | - |
| | C | - | - | - | - | - | - |
| Deptt. Of Chemicals & Fertilizers (8 units) | A | 11 | 15 | 16 | - | - | - |
| | B | 15 | 65 | 144 | - | - | - |
| | C | - | - | 8 | - | - | - |
| Deptt. Of Telecommunication (4 units) | A | 40 | 4 | 7 | - | - | - |
| | B | 74 | 5 | 52 | - | - | - |
| | C | 5 | 1 | 1 | - | - | - |
| Deptt. Of Defence Prodn. & Supplies (3 units) | A | 34 | 21 | 74 | 3 | - | - |
| | B | 88 | 29 | 189 | 3 | - | - |
| | C | 6 | 4 | 4 | 1 | - | - |
| Deptt. Of Family Welfare (one unit) | A | - | - | - | - | - | - |
| | B | - | - | - | - | - | - |
| | C | - | - | - | - | - | - |
| Deptt. Of Heavy Industry (21 units) | A | 8 | - | 66 | - | - | - |
| | B | 116 | - | 1396 | - | - | - |
| | C | 3 | - | 28 | - | - | - |
| Deptt. Of Industrial Development (2 units) | A | 58 | 10 | 99 | - | - | - |
| | B | 660 | 50 | 999 | - | - | - |
| | C | 60 | 30 | 180 | - | - | - |

Percentage of Research Activities at National Level



| | |
|---------------|------------|
| ■ Trainings | ■ Seminars |
| □ Conferences | □ Others |

Percentage share of Participants in Research Activities



■ Trainings ■ Seminars □ Conferences □ Others

| | | | | | | | |
|--|---|------|-----|------|---|---|---|
| Ministry of Mines (3 units) | A | 9 | 2 | 2 | - | - | - |
| | B | 16 | 3 | 3 | - | - | - |
| | C | 1 | 1 | 1 | - | - | - |
| Ministry of Petroleum & Natural Gas (6 units) | A | 16 | 1 | 30 | - | - | - |
| | B | 710 | 4 | 60 | - | - | - |
| | C | 7 | - | 10 | - | - | - |
| Ministry of Power (one unit) | A | - | - | - | - | - | - |
| | B | - | - | - | - | - | - |
| | C | - | - | - | - | - | - |
| Ministry of Steel (8 units) | A | 4 | - | 2 | - | - | - |
| | B | 9 | - | 3 | - | - | - |
| | C | - | - | - | - | - | - |
| Ministry of Textiles (one unit) | A | - | - | - | - | - | - |
| | B | - | - | - | - | - | - |
| | C | - | - | - | - | - | - |
| Ministry of Urban Development (one unit) | A | - | - | - | - | - | - |
| | B | - | - | - | - | - | - |
| | C | - | - | - | - | - | - |
| Ministry of Coal (3 units) | A | 5 | 1 | 2 | - | - | - |
| | B | 6 | 1 | 2 | - | - | - |
| | C | - | - | - | - | - | - |
| Ministry of Food Processing (one unit) | A | 3 | - | - | - | - | - |
| | B | 3 | - | - | - | - | - |
| | C | - | - | - | - | - | - |
| Total | A | 191 | 55 | 299 | 3 | - | - |
| | B | 1704 | 155 | 2849 | 3 | - | - |
| | C | 82 | 36 | 304 | 1 | - | - |

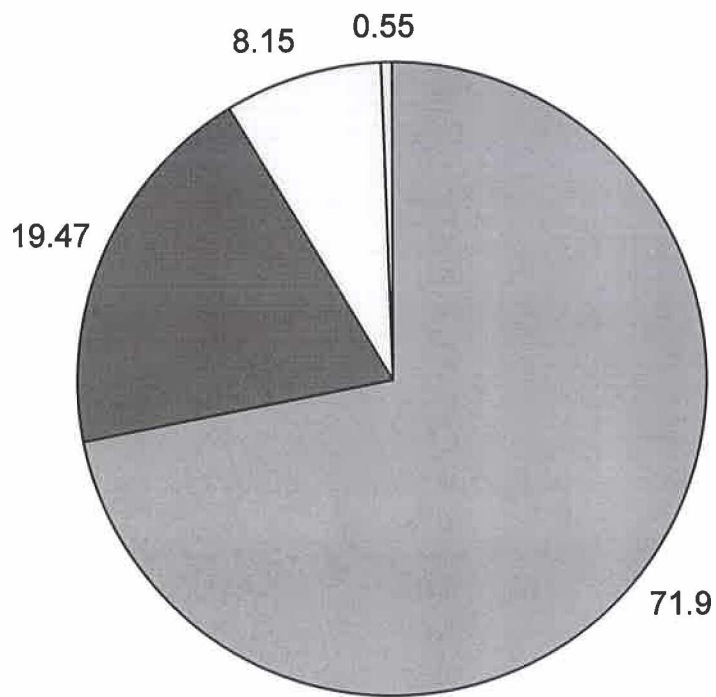
Note: A= No of events , B= No of participants, C = Expenditure incurred in Rs. Lakh

The main thrust of all the enterprises had been on the three main activities:

| | No of events | No of Participants | (In percentage) Expenditure incurred |
|--------------------|--------------|--------------------|---|
| Seminars/Workshops | 34.85 | 36.17 | 19.4 |
| Conferences | 10.03 | 0.03 | 8.15 |
| Trainings | 54.56 | 60.47 | 71.9 |
| Others | 0.56 | 0.33 | 0.55 |

It can be observed that training got the maximum attention and accounted for about 72 per cent of expenditure and also got 60 per cent of participants also.

Share of Expenditure Incurred



■ Trainings ■ Seminars □ Conferences □ Others

Chapter 9

Constraints influencing R&D Activities of Enterprises

Constraints whether physical and or financial cast their shadow on the efficiency and output of R&D activities of a research centre. The qualitative statements as listed in Annex 9.1 and summarized in Table 9.1 were made by the heads of the enterprises which were surveyed. These qualitative opinions constituted a section of the Institution Questionnaire.

Table 9.1

Constraints against Achievements of Full Research Potentials of Government Enterprises

| Deptt | Status | Inadequate Funds | Late receipt of Funds | Less R&D Staff | Less Supporting Staff | Poor Quality of R&D Personnel | Exodus of R&D Personnel | Non-Congenial Work atmosphere | Administrative Problems | Others |
|--|--------|------------------|-----------------------|----------------|-----------------------|-------------------------------|-------------------------|-------------------------------|-------------------------|--------|
| Deptt. of Chemicals & Petrochemicals (3 units) | Yes | 1 | 1 | - | 1 | - | - | - | - | - |
| | No | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| Deptt. of Chemicals & Fertilizers (8 units) | Yes | 1 | - | 3 | 1 | - | 2 | - | - | 1 |
| | No | 7 | 8 | 5 | 7 | 8 | 6 | 8 | 8 | 7 |
| Deptt. of Telecom (4 units) | Yes | 2 | 2 | 2 | - | 1 | 3 | - | - | - |
| | No | 2 | 2 | 2 | 4 | 3 | 1 | 4 | 4 | 4 |
| Deptt. of Defence Prodn and Supplies (3 units) | Yes | - | 1 | 2 | 2 | 1 | 3 | - | 1 | - |
| | No | 3 | 2 | 1 | 1 | 2 | - | 3 | 2 | 3 |
| Deptt. of Family Welfare (one unit) | Yes | 1 | 1 | - | - | - | - | - | - | - |
| | No | - | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Deptt. of Heavy Industry (21 units) | Yes | 10 | 7 | 6 | 6 | 1 | 6 | 1 | 5 | 1 |
| | No | 11 | 14 | 15 | 15 | 20 | 15 | 20 | 16 | 20 |

| | | | | | | | | | | |
|--|-----------|----------|----------|----------|----------|---------|----------|---------|---------|---------|
| Deptt. of Industrial Development (2 units) | Yes No | 1 1 | 1 1 | - 2 | - 2 | - 2 | - 2 | - 2 | - 2 | - 2 |
| Ministry of Mines (3 units) | Yes No | 1 2 | - 3 | 1 2 | 1 2 | - 3 | 1 2 | - 3 | - 3 | 1 2 |
| Ministry of Petroleum & N.Gas (6 units) | Yes No | 1 5 | - 6 | 3 3 | 3 3 | 1 5 | 2 4 | - 6 | 1 5 | 1 5 |
| Ministry of Power (one unit) | Yes No | - 1 | - 1 | 1 - | 1 - | - 1 | - 1 | - 1 | - 1 | - 1 |
| Ministry of Steel (8 units) | Yes No | 3 5 | 2 6 | 3 5 | 2 6 | - 8 | 2 6 | - 8 | - 8 | - 8 |
| Ministry of Textiles (one unit) | Yes No | 1 - | 1 - | 1 - | - 1 | - 1 | - 1 | - 1 | - 1 | - 1 |
| Ministry of Urban Development (one unit) | Yes No | 1 - | 1 - | 1 - | 1 - | 1 - | 1 - | - 1 | - 1 | - 1 |
| Ministry of Coal (3 units) | Yes No | 2 1 | - 3 | 2 1 | 2 1 | - 3 | - 3 | 2 1 | 2 1 | 2 1 |
| Ministry of Food processing (one unit) | Yes No | - 1 | - 1 | - 1 | - 1 | - 1 | - 1 | - 1 | - 1 | - 1 |
| Total | Yes No | 25 41 | 20 46 | 25 41 | 20 46 | 5 61 | 20 46 | 3 63 | 9 57 | 6 60 |

The qualitative information had a mixed reaction. The proportion of positive to negative reactions was 1: 3.5.

Existence of Vacant Posts:

Existence of vacant posts in the research centers of undertakings exerts a negative pull on the research potential of an organization. If the vacant posts happen to be at higher grades, these deprive the research activities of the organization the much needed research leadership and guidance. Annex 9.2 lists the existence of vacant research posts in the research wings of the enterprises. The vacancies are very conspicuous in respect of a few undertakings:

- The Department of Chemicals & Petro-chemicals had in total 28 vacant posts; of which Hindustan Antibiotics Ltd at Pimpri accounted for 19 posts (inclusive of 12 posts of grade 3).
- Within the Department of Heavy Industry, Praga Tools Ltd, Hyderabad had 20 vacant posts that too at grade 5.
- The R&D Centre of Indian Oil Corporation at Faridabad had 26 vacant posts but it had at the same time 15 excess posts well distributed at higher ranks.
- The Research wing of NTPC at NOIDA had 15 vacant posts, which included higher grades also.
- Hindustan Prefab India Ltd under the Ministry of Urban Development had in position 9 R&D personnel but also had 7 vacant posts, which constituted 44 per cent of the total sanctioned strength.

Chapter 10

Work Culture , Job Satisfaction , Problem & Prospects

The chapter is based on response to the scientist schedule by scientists of category B and above related with public/joint sector undertakings under the Central Socio-economic Ministries. As stated earlier, 2,146 R&D personnel responded to this information-seeking attempt. The percentage of scientists who reported satisfactory response to work culture (as defined by a cumulative impact of a set of parameters) prevailing in their enterprises varied within a narrow band of 10 per cent (77 to 87 per cent). These variations have been captured in Table 10.1

Table 10.1

Satisfaction of Work Culture in the Research Centres of Government Undertakings

(In percentages)

| Item | Satisfactory | Not- satisfactory | No response |
|----------------------------|--------------|-------------------|-------------|
| Area of Work | 86.77 | 3.12 | 10.11 |
| Present Project | 76.79 | 3.40 | 19.81 |
| Work atmosphere | 81.22 | 4.29 | 14.49 |
| Support from lower staff | 82.95 | 4.61 | 12.44 |
| Encouragement from Seniors | 81.50 | 5.13 | 13.37 |

Note: The details are furnished in Annex 10.1

Job Satisfaction:

81.36 per cent of R&D manpower of category B and above reported that they were satisfied with their job while 4.19 per cent of scientists stated that they did not have it. About 14.5 per cent did not respond to the question at all.

The job satisfaction was in no way related with the grade: the level of satisfaction at different grades varied within a close margin at the different grades.

Table 10.2**Job Satisfaction – Grade wise**

(In percentage response)

| Pay scale | Satisfied | Not satisfied | Non-response |
|-----------|-----------|---------------|--------------|
| Grade 1 | 82.55 | 3.64 | 13.81 |
| Grade 2 | 79.46 | 5.14 | 15.40 |
| Grade 3 | 80.95 | 5.78 | 13.27 |
| Grade 4 | 77.34 | 7.91 | 14.75 |
| Grade 5 | 77.27 | 3.13 | 19.60 |
| Grade 6 | 82.27 | 2.03 | 15.70 |
| Grade 7 | 92.51 | 2.14 | 5.35 |
| Grade 8 | 95.35 | 0.00 | 4.65 |
| Grade 9 | 100 | - | - |
| Grade 10 | 100 | - | - |
| Over all | 81.36 | 4.19 | 14.45 |

Suggestions at the Undertaking's Levels:

The problems encountered by the scientists in research activities have their origin in their respective enterprises. These problems and their solutions have been categorized into 9 segments. Some of the problems are of severe as well as moderate nature. During the survey, it was quite evident that in almost every undertaking the problems related with infrastructure, lack of funds and shortage of technical manpower were severe. Other problems varied across the undertaking and the ministry/department

The heads of the undertakings were requested to give some suggestions to improve the research worthiness of the in-house R&D centres of undertakings. But unfortunately, the response to this suggestions-seeking exercise was not very encouraging. Only 12 heads of the undertakings opted to furnish suggestions. Their reactions are summarized as under:

| Suggestions | No. of Responding Units |
|---|-------------------------|
| Placement of full sanctioned strength of R&D scientists and supporting staff of different cadres should be ensured. The R&D centre of the undertaking should not be left headless for a very long time. The staff should be recruited after full scrutiny of their caliber. | 4 |
| The various infrastructures available in the research centre should be updated every year and there should not be any paucity of funds to purchase the equipment needed for R&D. | 8 |
| The undertaking should identify the areas of research well before the beginning of every financial year. Duplication of research conducted by the institution elsewhere in the country should be avoided to the extent | 4 |

| | |
|---|---|
| possible. A close liaison between the research institutions and other undertakings should be maintained. The objective of close liaison in the overlapping areas of R&D activities should be encouraged and maintained. | |
| Development of expertise in the specific areas of R&D activities of the undertaking should be attempted as far as possible. This can be achieved through the exposure of scientists to various skills and knowledge up-gradation programmes such as training in India and abroad, active participation in seminars and workshops, availability of latest literature in the library on various areas of research etc. | 2 |
| Pay scales of scientists should be at par with those of other National Research Organizations for the comparable ranks. This will facilitate attracting the talented scientists and retaining them in the research centres of the enterprises. | 2 |
| If the research centre of the enterprise is located in remote areas, the basic facilities such as educational infrastructure for the children, medical and transport facilities etc should be adequately maintained to peg the talented scientists with the institute. | 1 |
| The enterprise should have a strong Personnel Policy in respect of promotion and rewards. Merit should be the only consideration at the time of recruitment of scientists and research accomplishments and flair for R&D should be the criteria for recognition and reward and assessment should be unbiased by the seniors. | 2 |
| The researchers should have an upper hand in the day to day working of the enterprise and this will provide to them the feelings of recognition. The administrative division should be treated as supporting wing of the research centre and provide the necessary inputs needed for R&D activities without much of the time consuming administrative formalities. | 2 |
| Cent percent self-generation of revenue and capital expenditure needed for R&D activities is expected from the R&D activities of the undertakings against 3 decades of standing with full financial support hitherto from the government. This target is considered difficult to be achieved. At best this may be restricted to 50% of the revenue expenditure incurred annually by the undertaking on R&D activities. There should be adequate financial support for R & D activities. | 3 |

Suggestions of Scientists for Improvement of Research Competence of Institutions and R&D Manpower:

Similarly suggestions were solicited from the R&D personnel in the Scientist Schedules for betterment of research output of the individual scientists and ultimately the productivity of the R&D centre of the undertaking:

Number of scientists reported problems faced by them in carrying out research work in their respective enterprises. For the purpose of analysis, these problems and their solutions are grouped into 9 broad categories. The most common problems faced by the scientists are caused by inadequate infrastructure facilities such as ill-equipped laboratory facilities, insufficient space, interrupted supply of power etc.

Financial constraints within the undertakings were reported the most. Besides causing stagnation in promotional avenues, these constraints prevented the scientists from attending international seminars, symposia and training programmes. This restricted their exposures to the latest developments in fields of science and technology. There were also reports of shortages of auxiliary and technical staff in carrying out research activities followed by the scientists who complained about not receiving timely delivery of chemicals, raw materials and other inputs needed for continuance of research work.

Only 1481 scientists (69 %) furnished their comments/suggestions. These suggestions are multiple in nature.

The response is summarized as under:

| Comments/Suggestions | Response |
|--|-----------------|
| The project for research should be related with demand. There should a close interaction with the industry, academic institutions, research and other undertakings conducting research in similar areas to explore the possibilities of collaborative work. This will lead to optimal utilization of infrastructural facilities available in the country. Proper accountability and time frame be prepared for the various projects assigned to avoid time over runs. Research should preferably be handled by a team headed by a competent project leader. Besides development of high-tech products based on orders from customers; some products may be first developed in-house and marketed commercially. Potential fields for diversification should be constantly explored. | 253 |
| Proper training in specified fields of research activities should be arranged in India and abroad. Scientists should be encouraged to participate in seminars/ workshops and collaborative scientific activities in India and abroad to update their scientific skills. The library should be adequately equipped with the latest literature on all the subjects of research normally dealt by the institution. There should normally be no resource constrains for updating library. | 339 |
| A congenial atmosphere to encourage research in the undertaking should prevail and this should be authenticated by the availability of resources and adequate incentives and improvement of pay scales and related benefits. There should be recognition of genuine research talent without any bias through institution of awards. Besides recognition, project allotment should be done based on previous experience and area(s) of expertise. | 259 |
| Administrative procedures should be simplified and revamped. Rules should be framed and interpreted in the best interest of research work. The administration should be treated as a supporting infrastructure of the institute and it should not waste time in avoidable paper work which in certain cases leads to time over in procurement of the essential inputs. | 82 |
| There should be involvement of all the related scientists of the team at the planning stage of the new project. There should be an active involvement of high-ranking scientists at all the stages of the project who should inspire all round indigenous development of technology and products. | 165 |
| There should be adequate availability of supporting staff of various cadres for smooth conduct of research assignments. New scientists should be made | 117 |

| | |
|---|-----|
| aware of function of all the supporting staff and the other divisions and should be encouraged to avail of their help in their research activities. At the selection stage, the R&D personnel should be scrutinized for their high qualifications and inclination for research work. The staff in research centres of the undertakings should be non-transferable to ensure continuity and local maturing of expertise. | |
| All scientists involved in R&D projects should be encouraged to present brief account of their research activities and findings periodically for a healthy over view of their work and appreciation. The senior should listen to their difficulties sympathetically and try to solve their problems within the framework of various constraints. | 96 |
| Infrastructure facilities like computer network, laboratory, library facilities with the latest relevant literature, gadgets/ implements, adequate qualified support staff etc should be available and updated. Adequate funds should be set apart every year to improve the infrastructure as the need arises. | 279 |
| R&D activities of an institute should be separate from its production functions and should have higher level of autonomy. There has to be higher element of flexibility in the functioning of R&D cell of a production unit Revenue generation be detached to extent of 50% of the total funds needed for R&D or R&D units are allowed to have 80% production oriented activities. But allotment of R&D projects should be independent of sales objectives. | 111 |

1641

