

## 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<br>31.82 per cent | 53 scientists<br>15.06 % |
| Grade 6 | 131 Scientists<br>38.08 per cent | 52 Scientists<br>15.12 % |
| Grade 7 | 68 Scientists<br>36.36 per cent  | 42 Scientists<br>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<br>34.01 % | 66 Scientists<br>22.45 % | 90 Scientists<br>30.69 %  | 69 Scientists<br>23.47 % |
| Grade 4 | 77 Scientists<br>27.70 %  | 64 Scientists<br>23.02 % | 86 Scientists<br>30.94 %  | 65 Scientists<br>23.38 % |
| Grade 5 | 114 Scientists<br>32.39 % | 88 Scientists<br>25.0 %  | 132 Scientists<br>37.50 % | 86 Scientists<br>24.43 % |
| Grade 6 | 121 Scientists<br>35.17 % | 70 Scientists<br>20.35 % | 119 Scientists<br>34.59 % | 74 Scientists<br>21.59 % |
| Grade 7 | 78 Scientists<br>41.71 %  | 34 Scientists<br>18.18 % | 57 Scientists<br>30.48 %  | 33 Scientists<br>17.65 % |
| Grade 8 | 18<br>41.86 %             | 9<br>20.35 %             | 15 Scientists<br>34.88 %  | 8 Scientists<br>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<br>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.<br>& 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> |
|-----------------------|--------------------|-----------------|
| <b>A. Completed</b>   | 698                | 48              |
| <b>B. In progress</b> | 463                | 32              |
| <b>C. Transferred</b> | 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.