CHAPTER VII

Expenditure on Research and Development by CPSEs

7.1 Introduction

Research & Development (R&D) plays an important role in the business processes that result in technology bringing new products and services to the market place. R&D results in high quality jobs, successful enterprises, better goods and services and more efficient and cost effective processes.

As per survey conducted by the National Science and Technology Management Information System (NSTMIS) under the Department of Science and Technology (DST), the status of R&D in the country has shown that the Gross Expenditure on R&D (GERD) has more than tripled from ₹ 24,117 crore to ₹ 85,326 crore in the decade from 2004-05 to 2014-15. The study revealed that GERD was mainly driven by the government sector with central government accounting for 45.1 *per cent*, state governments 7.4 *per cent*, public sector industries 5.5 *per cent* and institutions of higher education 3.9 *per cent*. The private industry accounted for the balance 38.1 *per cent.*

The Government of India has aimed to develop India into a global innovation hub by 2020 on the back of effective government measures to provide an enabling environment for growing research and development in India. R&D activities by CPSEs would result in substantial increase in market share and demonstrable increase in competitiveness. It also allows CPSEs to address the new challenges and opportunities in an increasingly global world.

7.2 Scope of Audit

The Chapter has covered expenditure on R&D activities by 21 selected CPSEs ***(Appendix-XXVI)*** during the period 2013-14 to 2017-18. The sample of 21 CPSEs was selected with expenditure of more than ₹ 15 crore in R&D activities during any of the year from 2014-15 to 2016-17.

7.3 Audit objectives

The objective of audit was to assess whether:

- Due diligence was exercised while framing company's R&D policy/plan and setting out R&D budget?
- R&D plan has been effectively implemented to achieve the envisaged benefits within the budgeted cost?

- Effective procedures and methodologies are in place for monitoring implementation and final results from the R&D projects?

7.4 Audit criteria

The analysis was carried out against the following criteria:

- Guidelines issued (September 2011) by DPE.
- Procedures and modalities for selection of R&D projects and its evaluation mechanism of CPSE.
- Agenda/Minutes of Board Meetings/R&D sub-committee/Monitoring committee.
- Income Tax benefit related to Research and Development expenses.

7.5 Audit Findings

7.5.1 Policy and planning for undertaking R&D activities

Para 3.1 and 3.2 of the Guidelines on Research and Development (R&D Guidelines) for Central Public Sector Enterprises (CPSEs) issued by Department of Public Enterprises (DPE) in September 2011 requires that every CPSE must have Corporate R&D Policy which may be aligned with the Company's Vision and Mission. Based on the Corporate R&D Policy, the company must develop an R&D manual and specific R&D plan.

Audit observed that out of the 21 CPSEs, Bharat Dynamics Limited has a well-structured R&D policy covering strategic planning, development of human resources, R&D corpus fund, development of SOPs, special forum like joint development programmes with Defence Research and Development Organisation or development partners, review, interaction and analysis mechanism and criteria in technology transfer.

However, non-compliance of Guidelines was observed in case of following CPSEs:

- Steel Authority of India Limited has not formulated its R&D policy and specific R&D plans. It is having R&D manual only which has been developed by its R&D Centre (RDCIS).
- Oil and Natural Gas Corporation Limited, NTPC Limited and BEML Limited do not have R&D Policy and manual. NTPC has established NTPC Energy Technology Research Alliance (NETRA) as R&D Centre.
- NMDC Limited is not having R&D Policy and Manual. It has developed (November 2017) IMS Apex Framework document for R&D which mainly address the International Standards (International Organisation for Standardisation, Occupational Health and Safety Assessment Series and Social Accountability norms).
- In absence of R&D policy and Specific R&D plans, ITI Limited is following R&D manual which is a part of Quality Management System Manual of the company

and in Nuclear Power Corporation of India Limited it is a part of Corporate Management System Document.

- GAIL (India) Limited, Oil India Limited, Indian Oil Corporation Limited, Bharat Heavy Electricals Limited and Power Grid Corporation of India Limited have R&D Corporate policy but they do not have specific R&D plans based on the policy and manual.
- The R&D policy of Bharat Electronics Limited was framed in 1983 and it has not been revised since then. The company has R&D Procedural Guide approved in July 2012.
- NALCO and EIL have Board approved Roadmap for 2013-2020/R&D policy in line with the DPE guidelines.

7.5.2 Funding of R&D projects

7.5.2.1 R&D expenditure as a percentage of PAT

Para 3.8 of the R&D Guidelines prescribes that minimum expenditure on R&D as a percentage of Profit after tax (PAT) should be one *per cent* in case of Maharatna/Navaratna CPSEs and 0.5 *per cent* in case of Miniratna – I&II and below category CPSEs. The R&D expenditure as a percentage of PAT by the selected CPSEs during the period 2013-14 to 2017-18 is detailed in Table 7.1 below:

Table 7.1: Actual R&D expenditure by CPSEs as a percentage of PAT during 2013-14 to 2017-18

(₹in crore)

Sl. No.	Name of CPSE	Category of CPSE	2013-14		2014-15		2015-16		2016-17		2017-18	
			Amount	*per cent* of PAT	Amount	*per cent* of PAT	Amount	*per cent* of PAT	Amount	*per cent* of PAT	Amount	*per cent* of PAT
1	SAIL	Maharatna	113.66	6.62	144.26	8.9	124.7	NA*	127.66	NA*	122.9	NA*
2	ONGC	Maharatna	623	2.82	575	3.24	564	3.52	621	3.47	606	3.04
3	GAIL	Maharatna	53.88	1.33	51.61	1.18	76.49	2.35	28.47	1.26	28.87	0.82
4	BHEL	Maharatna	1114	32.19	1019	71.81	893	NA*	794	160.08	753	93.30
5	IOCL	Maharatna	252.72	5.05	262.97	3.75	597.31	11.33	327.10	3.15	316.63	1.66
6	NTPC	Maharatna	134.34	1.06	129.56	1.18	129.68	1.26	162.28	1.59	184.98	1.97
7	NMDC	Navratna	16.74	0.26	18.49	0.29	17.64	0.58	20.3	0.78	22.03	0.58
8	PGCIL	Navratna	2.95	0.07	6.72	0.13	10.85	0.18	9.92	0.13	8.71	0.10
9	BEL	Navratna	467	50.11	549	47.04	704	53.86	777	50.19	988	70.62
10	EIL	Navratna	20.93	3.33	17.68	3.69	16.93	5.49	12.67	4.59	13.23	4.07
11	HPCL	Navratna	100.62	5.8	129.87	4.75	180.32	4.84	276.54	4.45	232.78	3.75
12	OIL	Navratna	38.75	1.3	71.11	2.83	46.76	2.01	63.42	4.1	64.32	2.41
13	NALCO	Navratna	13.87	2.33	7.31	1.13	15.75	1.19	47.52	6.5	27.95	4.17
14	BPCL	Navratna	36.8	0.91	40.7	0.80	59.7	0.85	49.5	0.62	83.2	1.05
15	BDL	Miniratna	19.89	5.76	22.72	5.43	29.43	5.21	37.41	6.62	40.22	7.62
16	BEML	Miniratna	86.23	18.43	82.82	12.25	66.63	10.41	78.08	9.24	102.04	7.88
17	ITI	Other	0.33	NA*	0.05	NA*	17.23	6.76	16.95	5.56	7.76	3.3

18	MDSL	Miniratna	52.66	13.24	66.47	13.52	73.07	12.85	75.09	13.67	75.11	17.07
19	HAL	Navratna	85	3.15	150	6.28	257	12.86	305	11.66	309	14.92
20	ECIL	Other	22.40	47	23.81	47	19.79	27	22.65	40	16.03	30
21	NPCIL	Other	Data not furnished									

**** The CPSEs incurred loss during the year***

It can be seen that the R&D expenditure during the years 2013-14 to 2017-18 did not meet the requirement stipulated in the Guidelines as detailed below:

- Actual expenditure on R&D was below one *per cent* of PAT for all the years during 2013-14 to 2017-18 in case of NMDC Limited and Power Grid Corporation of India Limited.
- During the year 2017-18, actual expenditure on R&D by GAIL (India) Limited was below the prescribed expenditure of one *per cent*.
- Bharat Petroleum Corporation Limited could achieve the prescribed expenditure of one *per cent* of PAT during 2017-18 only and it could not comply with the DPE guidelines during the years 2013-14 to 2016-17.
- Steel Authority of India Limited and Bharat Heavy Electricals Limited, though they suffered losses during the years 2015-16 to 2017-18 and 2015-16 respectively, continued to incur R&D expenditure.
- Bharat Heavy Electricals Limited, Bharat Electronics Limited and Electronics Corporation of India Limited were the top three CPSEs in terms of R&D expenditure as percentage of PAT which ranged from 32-160*per cent*, 47-70 *per cent* and 27-47*per cent* respectively during the years 2013-14 to 2017-18.

The R&D expenditure as percentage of PAT was above 1 *per cent* in 79 company-years[51] during 2013-14 to 2017-18 whereas it was below 1 per cent in 15 company-years out of total 94 company-years (20 CPSEs x 5 years *less* 6 years of loss in SAIL, BHEL and ITI). In case of 14 company-years (BHEL-4 years, BEL-5 years & ECIL-5 years) the R&D expenditure as percentage of PAT ranged from 27-160 per cent, whereas in 27 company-years it ranged above 5 *per cent*. Thus, the prescribed rate of R&D spending as a percentage of PAT needs to be reviewed for further enhancement so that the same could be linked to the best practice of R&D expenditure incurred by government organisations in India.

7.5.2.2 R&D expenditure against R&D budget

Para 3.8 (iii) of the R&D Guidelines provided that R&D budget for the next three years must be clearly indicated, however, the projected annual expenditure for the year under consideration will be taken as the target for the year. Further, para 3.8 (iv) also provided that the lapsed R&D budget will be transferred to R&D fund created by the respective company. However, R&D expenditure of CPSEs if compared with percentage utilization

[51] *One company-year refers to one company for one year.*

of the budget it can be seen that significant number of CPSEs out of the sample size of 21 could not utilize 100 per cent of the budgeted amount as depicted in Table 7.2.

Table 7.2: Percentage of actual R&D expenditure against R&D budget during 2014-15 to 2017-18

(₹ in crore)

Sl. No.	Name of CPSEs	2013-14			2014-15			2015-16			2016-17			2017-18		
		Budgeted	Actual Exp.	*per cent* age over budgeted	Budgeted	Actual Exp.	*per cent* age over budgeted	Budgeted	Actual Exp.	*per cent* age over budgeted	Budgeted	Actual Exp.	*per cent* age over budgeted	Budgeted	Actual	*per cent* age over budgeted
1	SAIL	173	114	66	186	144	77	180	125	69	175	128	73	151	123	81
2	ONGC	391	623	159	543	575	106	774	564	73	608	621	102	650	606	93
3	GAIL	40	54	134	43	52	119	30	76	252	23	28	127	35	29	82
4	BHEL	1114	1114	100	1019	1019	100	893	893	100	794	794	100	753	753	100
5	IOCL	408	253	62	416	263	63	465	597	128	418	327	78	455	317	70
6	NTPC	65	134	205	76	130	170	103	130	126	102	162	160	94	185	197
7	NMDC	22	17	76	22	18	83	88	18	20	29	20	71	87	22	25
8	BEL	651	467	72	664	549	83	814	704	87	955	777	81	1064	988	93
9	EIL	41	21	51	32	18	56	27	17	63	31	13	40	33	13	40
10	HPCL	91	101	111	256	130	51	169	180	106	244	277	113	198	233	118
11	OIL	NA*	39	NA	44	71	163	38	47	123	61	63	104	62	64	104
12	NALCO	NA*	14	NA	NA*	7	NA	15	16	107	38	48	126	38	28	73
13	BPCL	39	37	95	46	41	89	57	60	105	54	50	92	90	83	92
14	BDL	27	20	72	NA	23	NA	NA	29	NA	24	37	159	95	40	42
15	BEML	NA*	86	NA	NA*	83	NA	NA*	67	NA	NA*	78	NA	NA*	102	NA
16	ITI	NA*	0.33	NA	NA*	0.05	NA	NA*	17	NA	NA*	17	NA	NA*	8	NA
17	HAL#	693	1083	156	948	1042	110	982	1191	121	1036	1284	124	1212	1612	133
18	PGCIL	59	3	5	100	7	7	132	11	8	124	10	8	106	9	8
19	MDSL	38	53	140	41	66	161	46	73	159	51	75	147	50	75	150
20	ECIL	NA	22	NA	NA	24	NA	NA	20	NA	NA	23	NA	NA	16	NA
21	NPCIL**	86	36	42	70	24	34	64	24	38	50	18	36	50	19	38

**** Oil India Limited, National Aluminium Company Limited, ITI Limited, BEML Limited and Electronics Corporation of India Limited did not furnish information in respect of year-wise R&D budget for these years.***

***** The data in respect of NPCIL includes the data of its Technical Development Group only. The year wise budget and actual expenditure was not made available for Electronic Systems Group.***

 # The figure includes both internal and external funding.

- The R&D budget for the next three years was not indicated in case of Engineers India Limited, GAIL (India) Limited, Oil and Natural Gas Corporation Limited, Hindustan Petroleum Corporation Limited, Bharat Petroleum Corporation Limited, Electronics Corporation of India Limited, BEML Limited, Bharat Dynamics Limited and Bharat Electronics Limited

- In case of NTPC Limited and Bharat Petroleum Company Limited, the lapsed amount of R&D budget is being transferred to the R&D fund created by the CPSE as per DPE guidelines. However, Power Grid Corporation of India Limited, Bharat Heavy Electricals Limited, Bharat Electronics Limited, Bharat Dynamics Limited, BEML Limited, Engineers India Limited, Oil and Natural Gas Corporation Limited,

GAIL (India) Limited, NMDC Limited, Oil India Limited did not create any R&D fund, hence, the lapsed R&D budget could not be carried forward to next year.

- In the years 2015-16 and 2017-18, NMDC Limited could utilize only 20-25*per cent* of the R&D budget, whereas, during the rest of the years the budget utilization was 71-83 *per cent*.
- Steel Authority of India Limited and Engineers India Limited could utilize only 66-81 *per cent* and 40-63*per cent* respectively of the budget during the years 2013-14 to 2017-18.The data has been considered of its R&D Centre (RDCIS) only in absence of non-availability of data relating to the plants/units.
- Indian Oil Corporation Limited and Bharat Petroleum Corporation Limited utilized only 62-78 *per cent* and 89-95 *per cent* during the last five years except 2015-16.
- The lowest utilization of R&D budget was 5-8 *per cent* by Power Grid Corporation of India Limited during the year 2013-14 to 2017-18.
- Percentage utilization of R&D budget by GAIL (India) Limited was high (252 *per cent*) in the year 2015-16 and the lowest was 82*per cent* in the year 2017-18.
- The CPSEs and the years in which utilization of 100 *per cent* of the R&D budget was achieved is given in ***Appendix-XXVII.***

7.5.3 Implementation of R&D projects

Para 4.3.1 and 4.3.2 of the R&D Guidelines prescribe that mechanism for the implementation of the R&D project shall be constituted in the beginning of the project and the impact made by R&D activities should be quantified to the best possible extent with reference to the baseline data developed before the start of the project.

Audit noted that some CPSEs have well defined mechanism in place for implementation of R&D projects *viz.*

(i) In case of Bharat Electronics Limited, the major activities for development of R&D projects, targeted technical specifications, fund and manpower requirement, collaborative partners and proposed schedule etc. are well set out at the time of Management Sanction Order which is routed through Development &Engineering functional heads, Chief Technology Officers, General Managers, Executive Directors, and finally the Chairman and Managing Director (CMD); an apex R&D committee constituting of CMD, Directors (R&D/Finance) and an external director (designated by GOI) periodically review/analyse miles stones, time extensions, risk areas and recommends to the Board for necessary approval.

(ii) National Aluminium Company Limited Research & Technology Centre (NRTC) is assisted by local board of advisors (Research & Scientific Advisory Committee/Technology Committee) in planning, implementing, periodical review of R&D projects and getting necessary approval of the Board.

(iii) Oil India Limited has a Research Council (RC) as an apex core committee, led by apex Functional Director as Council Head appointed by the Board, the annual plan and budget of the company is prepared by the two members R&D Coordination Team and thereafterit is submitted to RC for necessary approval of Board.

However, the implementation mechanism as mentioned above cannot be said to be effectively adhered to by the CPSEs except NALCO as enumerated below: -

7.5.3.1 In-house R&D projects

The details of In-house R&D projects taken up by CPSEs during 2013-14 to 2017-18 is given in Table 7.3

Table 7.3: Details of in-house R&D projects

Sl. No.	Name of CPSEs	No. of R&D projects taken up in-house	Completed project	No. of delayed projects (completed/re-scheduled and on-going)	No. of re-scheduled/delayed completed projects > one year
1	BDL	7	1	0	0
2	BEL	235	0	49	13
3	BEML	31	26	21	8
4	HAL	85	51	29	19
5	HPCL	55*	23	0	0
6	ITI	2	1	1	1
7	NMDC	32	32	0	0
8	BHEL	484	484	139	18
9	NALCO	16	12	1	1
10	EIL	41	27	10	0
11	OIL	128	128	12	6
12	NPCIL	19	12	6	3
13	SAIL	253	190	56	0
14	MDSL	14	13	1	0
15	NTPC	31	22	9	3
16	PGCIL	7	7	0	0
17	BPCL	31	23	1	1
18	GAIL	0**	-	-	-
19	ONGC	2470	2470	0	0
20	IOCL	105	73	28	7

**** This does not include projects of Navi Mumbai R&D centre as complete details was not furnished***
***** GAIL does not undertake in house projects.***
Note: The details were not furnished in respect of ECIL

- In case of Bharat Dynamics Limited, out of seven projects taken up, one project was short closed, one completed project was not required by the user and rest are expected to be completed in 2018-19 and 2019-20.
- Bharat Electronics Limited has taken up 235 R&D projects during the years 2013-14 to 2017-18 and no projects were completed. Out of 49d elayed/re-scheduled projects, 13 were delayed for a period of more than one year.
- BEML Limited completed 26 projects out of total 31 projects undertaken during 2013-14 to 2017-18. Out of 21 delayed/re-scheduled projects, eight projects were delayed for a period more than one year.
- Hindustan Aeronautics Limited completed 51 projects out of 85 projects undertaken during the year 2013-14 to 2017-18.Out of 29 delayed/re-scheduled projects, 19 were delayed for a period more than one year.
- Bharat Heavy Electricals Limited completed 484 projects during the year 2013-14 to 2017-18 out of which 139 projects (both completed and ongoing) were/are delayed which includes 18 projects delayed by more than one year and three projects with a delay of more than three years. Three delayed projects resulted in cost overrun of more than ₹ 140 lakh.
- ITI Limited completed one out of two projects undertaken during the year 2013-14 to 2017-18 with a delay of more than three years.
- Oil India Limited completed 128 projects undertaken during the year 2013-14 to 2017-18. Out of 12 delayed projects, six projects were delayed for more than one year.
- Nuclear Power Corporation of India Limited completed 12 out of 19 projects undertaken during the year 2013-14 to 2017-18. Three out of six projects were delayed by more than one year.
- Steel Authority of India Limited completed 56 projects with a delay of one to ten months. 20 projects were stage closed whose sanctioned cost was ₹ 926.25 lakh (actual cost incurred was not furnished)
- India Oil Corporation Limited completed 73 out of 105 projects undertaken during the year 2013-14 to 2017-18. Out of 28 completed/re-scheduled delayed projects, seven projects were delayed for more than one year. One delay project could not be completed due to technical reason after 60 *per cent* work progress.

7.5.3.2 R&D projects in collaboration with Universities/Institutes

The details of R&D projects taken up by the CPSEs in collaboration with Universities/Institutes during 2013-14 to 2017-18 are given in Table 7.4.

Table 7.4: Details of R&D projects in collaboration with Universities/Institutions

Sl. No.	Name of CPSEs	No. of university/ Institutions	No. of R&D projects taken up	Sanctioned cost (₹ in Lakh)	Cost incurred (₹ in Lakh)	*per cent* age of actual cost to sanctioned cost	Projects completed		Ongoing projects
							Within schedule	Beyond schedule	
1	BPCL	7	7	5185	5174	100	0	1	6
2	ITI	1	1	14	13	93	1	0	0
3	NALCO	15	33	2773.6	2076.81	75	10	10	13
4	NMDC	6	7	1358	482	35	0	2	5
5	OIL	9	12	1628.50	238.90	15	4	4	4
6	GAIL	12	32	5345.88	4011.41	75	7	14	11
7	EIL	4	4	631.48	342.09	54	2	0	2
8	HAL	7	22	2558	962	38	4	7	11
9	BEML	1	1	5.75	5.75	100	0	1	0
10	BEL	49	127	132846.36	59990.71	45	0	0	127
11	NPCIL	1	2	112.41	112.41	100	2	0	0
12	SAIL	8	14	340.70	237.03	70	10	0	4
13	BHEL	17	44	5551.24	5159.02	93	19	25	0
14	NTPC	23	37	5195.64	4675.56	90	2	10	25
15	PGCIL	5	6	1863	520	28	0	3	3
16	ONGC	17	48	10314.31	4050.79	39	14	7	27
17	HPCL	15	24	4292.42	2555.16	60	11	1	12
18	IOCL	10	12	614.01	204.77	33	0	4	8
19	MDSL	6	6	233.80	380.49	163	1	2	3

Note: No project was taken up in collaboration with universities/institutions by BDL. Details were not furnished in case of ECIL

- Oil India Limited and Power Grid Corporation Limited could utilise only 15 and 28 per cent respectively of the sanctioned cost. Out of the total 18 R&D projects undertaken by them, only four projects were completed in time and 7 projects got delayed
- NMDC Limited incurred 35 per cent of the sanctioned cost and could complete only two out of total seven projects with a delay of more than one year.
- BEML Limited had taken up only one project which was completed after a delay of 21 months.
- Out of 127 projects in Bharat Electronics Limited, 58 projects which were scheduled to be completed before March 2018 were extended. No projects were completed and 45 per cent of sanctioned cost was utilized for these projects.
- Bharat Heavy Electricals Limited could complete 19 projects within schedule and 25 projects with a delay ranging from 1 to 40 months out of total of 44 projects undertaken during the period.
- In case of Hindustan Aeronautics Limited, out of 22 projects 4 projects were completed in time and 7 projects were completed after a delay of 6-43 months.
- NTPC Limited completed only 2 projects within time out of 37 projects taken up and 10 projects were completed with a delay of more than one year.

- Performance in terms of timely completion of projects in collaboration with universities/institutes was satisfactory in case of ITI Limited, Engineers India Limited, Nuclear Power Company of India Limited, Hindustan Petroleum Corporation Limited and Steel Authority of India Limited. Whereas, the performance of GAIL (India) Limited and NALCO was not satisfactory.

7.5.4 Monitoring of R&D projects

Para 5.1 of the Guidelines states that for proper and periodic monitoring of the R&D activities CPSEs may appoint a Sub-committee of the Board or a suitable Apex group. Para 5.2 of the Guidelines further state that the R&D projects undertaken by CPSEs shall be monitored and reviewed at regular intervals (monthly/quarterly/annually) and the project report submitted for review shall contain both physical and financial progress of the project.

The following non-compliances were noticed:

- Steel Authority of India Limited and Mazagon Dock Shipbuilders Limited had not appointed a sub-committee of the Board or apex group for periodic monitoring of R&D activities.
- The project report submitted for review in ITI Limited, Oil India Limited, NMDC Limited, Oil and Natural Gas Corporation Limited, Engineers India Limited, National Aluminium Company Limited(in-house projects), Hindustan Petroleum Corporation Limited, NTPC Limited, Power Grid Corporation of India Limited did not contain financial progress of the project.
- As per the terms of reference of Research Advisory Council (RAC) of Engineers India Limited, the RAC was to meet twice a year but RAC meeting was held only once during the years 2013-14, 2015-16 and 2016-17. No RAC meeting was held during 2017-18.
- The minutes of meetings of DP Review/MECU-Project Management Group of ITI Limited held during 2017-18 and 2018-19 (upto 08.12.2018) did not reveal deliberation in respect of the only on-going in-house R&D project (E1/E3 for MCEU) which was scheduled to be completed by December 2018.

7.5.5 Registration of patents and publication of research papers by CPSEs out of R&D projects

Patent of technology, product or invention enables the right of a company to exclude others from making, using, or selling it. This also helps in recovering the development costs and to obtain a return of investment in the development of the patented technology. Filing of patent helps in limiting the risk that the technology, product or invention developed on the same idea will be obtained by some other company.

Table 7.5 indicates the CPSE wise completed R&D projects vis-à-vis patent filed for registration as well as patent granted during the year 2013-14 to 2017-18:

Table 7.5: Number of patents filed by CPSEs

Sl. No.	Name of CPSEs	Completed R&D projects			No. of patentable invention filed for patent registration		No. of patent granted
		In-house	University/ Institutions	Total	India	Outside India	
1	Steel Authority of India Limited	190	10	200	168	0	0
2	Oil and Natural Gas Corporation Limited	2470	21	2491	29	2	0
3	GAIL (India) Limited	0	21	21	23	1	2
4	Bharat Heavy Electricals Limited	484	44	528	193	5	198
5	NTPC Limited	22	12	34	9	0	0
6	NMDC Limited	32	2	34	3	0	0
7	Bharat Electronics Limited	0	0	0	82*	0	7*
8	Engineers India Limited	27	2	29	21	0	0
9	Oil India Limited	128	8	136	6	4	2
10	National Aluminium Company Limited	12	20	32	20**	0	9**
11	Bharat Petroleum Corporation Limited	23	1	24	16	11	3
12	BEML Limited	26	1	27	12	0	7
13	Hindustan Aeronautics Limited	51	11	62	309	0	15
14	Nuclear Power Corporation of India Limited	12	2	14	0	0	0
15	Power Grid Corporation of India Limited	7	3	10	4	0	0
16	Mazagon Dock Shipbuilders Limited	13	3	16	1	0	0
17	Electronics Corporation of India Limited	Details not furnished			2	0	2
18	Bharat Dynamics Limited	1	0	1	0	0	0
19	Hindustan Petroleum Corporation Limited	23	12	35	79	35	2
20	Indian Oil Corporation Limited	73	4	77	13#	33#	0
21	ITI Limited	1	1	2	0	0	0

This includes seven patents filed during 2018-19. The patents granted pertains to the patents filed during the year 1998-99 to 2009-10.

****This includes nine patents filed prior to 2013-14 but granted during 2013-14 to 2017-18.***

 # This includes data for the year 15-16 to 17-18.

Bharat Heavy Electricals Limited was the outstanding performer among the sampled CPSEs; it was granted 198 patents. In case of 11[52]CPSEs, no patent was granted during the year 2013-14 to 2017-18. It can also be seen that out of 600 projects filed for patent registration by 9[53] CPSEs; only 49 patents were granted during the year 2013-14 to 2017-18. Thus, the performance of CPSEs does not seem encouraging except for Bharat Heavy Electrical Limited.

7.5.6.1 Publication of research papers by CPSEs out of R&D projects

The achievements from R&D are published as research papers which may be useful for future guidance as well as sharing knowledge. This could result in application of research by other entity/organization with the permission of the author and generating royalty from the research output. It was however, noted that despite significant R&D expenditure, the contribution of CPSEs in publication of research papers was not very promising.

Table 7.6 indicates the CPSE wise publication of research paper during the period 2013-14 to 2017-18.

Table 7.6: Number of research publication CPSE wise

Sl. No.	Name of CPSEs	R&D expenditure (2013-14 to 2017-18) (₹ in crore)	No. of publication (2013-14 to 2017-18)
1	Steel Authority of India Limited	633	475
2	Oil and Natural Gas Corporation Limited	2989	447
3	GAIL (India) Limited	239	5
4	Bharat Heavy Electricals Limited	4573	72
5	Indian Oil Corporation Limited	1757	20*
6	NTPC Limited	741	3
7	NMDC Limited	95	5
8	Bharat Electronics Limited	3485	71**
9	Engineers India Limited	81	56
10	Hindustan Petroleum Corporation Limited	920	30
11	Oil India Limited	284	33
12	National Aluminium Company Limited	112	4
13	Bharat Petroleum Corporation Limited	270	12
14	Bharat Dynamics Limited	150	8
15	Hindustan Aeronautics Limited	6212	36
16	Power Grid Corporation of India Limited	40	24
17	Mazagon Dock Shipbuilders Limited	342	5

[52] *SAIL, ONGC, NTPC, NMDC, EIL, NPCIL, PGCIL , MDSL, BDL,IOCL. and ITI*
[53] *GAIL, OIL, NALCO, BPCL, BEML, HAL, ECIL, BEL and HPCL.*

18	Nuclear Power Corporation of India Limited	186	4
19	BEML Limited	416	Nil
20	ITI Limited	42	Nil
21	Electronics Corporation of India Limited	105	4

The data was provided for the year 2013-14 to 2014-15 only.

****** The data was provided for the year 2017-18 only.***

7.5.6.2 Commercialization of technologies developed by R&D projects:

CPSEs are spending considerable resources on R&D activities in an effort to make discoveries that can help develop new products or way of doing things or work towards enhancing pre-existing products or processes. However, it was noted that only five CPSEs could earn meagre revenue during the year 2013-14 to 2017-18 from the technologies developed by R&D projects whereas Nuclear Power Corporation of India Limited and Hindustan Aeronautics Limited earned significant revenue from the new technology as shown in the Table 7.7:

Table 7.7: Commercialisation of new technology developed

Name of CPSEs	No. of Technology Commercialized	Sales generated from the new technology (₹ in crore)
Steel Authority of India Limited	39	Nil
India Oil Corporation Limited	11	6.89
Engineers India Limited	4	0.70
Hindustan Petroleum Corporation Limited	14	Nil
National Aluminium Company Limited	4	0.08
Bharat Petroleum Corporation Limited	2	4.50
Bharat Dynamics Limited	4	26.67
Electronics Corporation of India Limited	15	Nil
Nuclear Power Corporation of India Limited	5	545.17
Hindustan Aeronautics Limited	2*	7017

**** Only Advanced Light Helicopter and Light Combat Aircraft production sales included***

7.6 Conclusion

Some of the leading CPSEs (Maharatna, Navratna or Miniratna) do not have Corporate R&D policy as prescribed by DPE guidelines on R&D activities. Most of the CPSEs are not transferring the lapsed budget to R&D fund. There were substantial delays in completion of projects. There was lack of effective monitoring of R&D projects. The performance of CPSEs in patenting and revenue realization out of the completed projects was not satisfactory. Very few research papers were published by CPSEs except

some of the CPSES. Very little revenue was earned from the commercialization of technologies by most of the CPSEs.

7.7 Recommendations

- CPSEs may put in place R&D Policy, manual and specific plan and create separate R&D fund to prevent lapsing of R&D budget.
- The targets in respect of R&D expenditure may be fixed under the MoUs with CPSEs in view of the actual expenditure in previous years.
- CPSEs may take steps to achieve 100 *per cent* utilization of R&D budget.
- R&D projects needs to be better monitored and completed in time.
- CPSE should make an effort to publish more research papers and increase their earnings from commercialization of technologies developed from R&D project.

DPE in its reply stated (July 2019) that recommendations are noted and also stated that the R&D Guidelines has since been withdrawn. The office memorandum (July 2019) withdrawing the Guidelines stated that the Guidelines were withdrawn as they had become redundant after revision of MoU Guidelines prescribing result-oriented parameters since 2016-17 onwards. The recommendations above shall act as a way forward to ensure the achievement of the spirit envisaged in the DPE guidelines, when the administrative Ministries set targets for R&D expenditure under MoUs for the CPSEs annually in future.