31

DEPARTMENT OF ATOMIC ENERGY

IMPORT OF URANIUM FOR NUCLEAR PLANTS

COMMITTEE ON ESTIMATES
(2018-2019)

THIRTY-FIRST REPORT

(SIXTEENTH LOK SABHA)

सत्यमेव जयते

LOK SABHA SECRETARIAT
NEW DELHI

THIRTY-FIRST REPORT

COMMITTEE ON ESTIMATES
(2018-2019)

(SIXTEENTH LOK SABHA)

DEPARTMENT OF ATOMIC ENERGY

IMPORT OF URANIUM FOR NUCLEAR PLANTS

Presented to Lok Sabha on 13 December, 2018

LOK SABHA SECRETARIAT
NEW DELHI

December, 2018/   Agrahayana, 1940(S)

EC No. ____

Price ₹ ____

Published under Rule 382 of the Rules of Procedure and Conduct of Business in Lok Sabha (Eleventh Edition) and Printed by the Manager, Government of India Press, Minto Road, New Delhi.

CONTENTS PAGE

COMPOSITION OF THE COMMITTEE ON ESTIMATES (2014-15)

Dr. Murli Manohar Joshi - Chairperson

Members

2.	Shri Sultan Ahmed
3.	Shri Kirti Azad
4.	Shri Kalyan Banerjee
5.	*Shri Om Birla
6.	Shri Dileep Singh Bhuria
7.	Shri Ashwini Kumar Choubey
8.	Shri Ashok Chavan
9.	Col. Sonaram Choudhary
10.	Shri Ramen Deka
11.	Shri Kalikesh N. Singh Deo
12.	Shri Sanjay Dhotre
13.	Shri P.C.Gaddigoudar
14.	^Shri Sudheer Gupta
15.	Dr. Sanjay Jaiswal
16.	Smt. Darshana Vikram Jardosh
17.	Smt. Kavitha Kalvakuntla
18.	Shri Nalin Kumar Kateel
19.	Shri Vinod Khanna
20.	Shri P. Kumar
21.	Shri K.H. Muniyappa
22.	Shri Ravindra Kumar Pandey
23.	Shri K N Ramachandran
24.	Shri J.C. Divakar Reddy
25.	Md. Salim
26.	Shri Arvind Sawant
27.	Shri Ganesh Singh
28.	Shri Kirti Vardhan Singh
29.	Shri Rajesh Verma
30.	Shri Jai Prakash Narayan Yadav

***** Elected vide Lok Sabha Bulletin Part-II No. 987 dated 03.012.2014 consequent upon vacancy caused by the appointment of Shri Hari Bhai Chaudhary, Member of Lok Sabha in the Council of Ministers w.e.f. 09.11.2014.

^ Elected vide Lok Sabha Bulletin Part-II No. 987 dated 03.012.2014 consequent upon vacancy caused by the appointment of Shri Ram Kripal Yadav, Member of Lok Sabha in the Council of Ministers w.e.f. 09.11.2014.

COMPOSITION OF THE COMMITTEE ON ESTIMATES (2016-17)

Dr. Murli Manohar Joshi – Chairperson

Members

2. Shri Sultan Ahmed
3. Shri A. Arunmozhithevan
4. Shri George Baker
5. Shri Kalyan Banerjee
6. Shri Dushyant Chautala
7. Shri Ashok Shankarrao Chavan
8. Shri Ashwini Kumar Choubey
9. Shri Ram Tahal Choudhary
10. Col. Sonaram Choudhary
11. Shri Ramen Deka
12. Shri Sanjay Dhotre
13. Shri P.C. Gaddigoudar
14. Shri Sudheer Gupta
15. Smt. Kavitha Kalvakuntla
16. Shri P. Kumar
17. Smt. Poonam Mahajan
18. Shri K.H. Muniyappa
19. Shri Rajesh Pandey
20. Shri Ravindra Kumar Pandey
21. Shri Raosaheb Danve Patil
22. Shri Bhagirath Prasad*
23. Shri Konakalla Narayan Rao
24. Md. Salim
25. Shri Arvind Ganpat Sawant
26. Shri Jugal Kishore Sharma
27. Shri Gajendra Singh Shekhawat
28. Shri Anil Shirole
29. Shri Rajesh Verma
30. Shri Jai Prakash Narayan Yadav

---

*Elected *vide* Lok Sabha Bulletin Part-II No. 3908 dated 28.07.2016 vice Shri Arjun Ram Meghwal appointed as Minister.

COMPOSITION OF THE COMMITTEE ON ESTIMATES (2018-19)

Dr. Murli Manohar Joshi – Chairperson

Members

2. Shri A. Arunmozhithevan
3. Shri George Baker
4. Shri Kalyan Banerjee
5. Shri Ramesh Bidhuri
6. Shri Dushyant Chautala
7. Shri Ram Tahal Choudhary
8. Col. Sonaram Choudhary
9. Shri Ramen Deka
10. Dr. Ratna De (Nag)
11. Shri Sanjay Dhotre
12. Shri Nishikant Dubey
13. Shri P.C. Gaddigoudar
14. Shri Prakash B. Hukkeri
15. Dr. Sanjay Jaiswal
16. Smt. Kavitha Kalvakuntala
17. Smt. Raksha Khadse
18. Shri Nimmala Kristappa
19. Shri Kaushalendra Kumar
20. Shri P. Kumar
21. Shri Rajesh Pandey
22. Shri Ravindra Kumar Pandey
23. Dr. Bhagirath Prasad
24. Smt. Ranjeet Ranjan
25. Shri Rajiv Pratap Rudy
26. Shri Md. Salim
27. Shri Arvind Ganpat Sawant
28. Shri Kalikesh Narayan Singh Deo
29. Shri Jugal Kishore Sharma
30. Shri Jay Prakash Narayan Yadav

SECRETARIAT

1.	Smt. Sudesh Luthra	-	Additional Secretary
2.	Smt. Preeti Shrivastava	-	Joint Secretary
3.	Shri Vipin Kumar	-	Director
4.	Shri Sujay Kumar	-	Under Secretary
5.	Shri L. Shantikumar Singh	-	Committee Assistant

INTRODUCTION

I, the Chairperson of the Committee on Estimates, having been authorized by the Committee to submit the Report on their behalf, do present this Thirty-first Report on the subject 'Import of Uranium for Nuclear Plants' pertaining to the Department of Atomic Energy.

2. Nuclear power provides an important, sustainable, cost-effective and clean energy option for mitigating the energy shortfalls in the Country. Besides generation of electricity, nuclear technology has many applications in the field of healthcare, industry, agriculture and research. In view of our limited uranium resources and in order to ensure long term energy security, India has opted for a three stage nuclear power programme aiming to multiply the domestically available fissile resource through the use of natural uranium in Pressurised Heavy Water Reactors, followed by use of plutonium obtained from the spent fuel of Pressurised Heavy Water Reactors in Fast Breeder Reactors. The present nuclear power capacity in the country comprises 22 nuclear power reactors. The Government has taken several enabling steps to augment nuclear power capacity substantially.

3. Considering the importance of sustained supply of Uranium for nuclear power generation, the Committee on Estimates (2014-15) selected the subject 'Import of Uranium for Nuclear Plants' for in-depth examination and report to the House. The Committee on Estimates (2016-17) and (2018-19) continued with the examination of the subject.

4. The Committee held sittings on 19.05.2016 and 22.05.2018 to take oral evidence of the representatives of the Department of Atomic Energy. The draft Report was considered and adopted by the Committee at the sitting held on 11.10.2018.

5. In this report, the Committee have dealt with various issues like agreements with various countries for supply of uranium, IAEA safeguards, functioning, output and profitability of India's nuclear power plants, domestic exploration efforts and reserves of uranium, safety aspects of India's nuclear plants, radiation hazards in and around nuclear plant sites, proper handling and management of nuclear waste, application of nuclear-related technology in other fields, etc. The Committee have analysed these issues/points in detail and have made observations/ recommendations in the report.

6. The Committee would like to express their thanks to the representatives of the Department of Atomic Energy, who appeared before them and placed their considered views on the subject. The Committee also wish to thank them for furnishing the information required in connection with the examination of the subject.

7. For facility of reference and convenience, the observations/recommendations of the Committee have been printed in bold in Part-II of the Report.

NEW DELHI;	**Dr. MURLI MANOHAR JOSHI,**
<u>10 December, 2018</u>	**CHAIRPERSON,**
19 Agrahayana, 1940 (Saka)	**COMMITTEE ON ESTIMATES.**

ACRONYMS

AEC	Atomic Energy Commission
AG	The Australia Group
AHWR	Advanced Heavy Water Reactor
AMD	Atomic Minerals Directorate for Exploration and Research
BARC	Bhabha Atomic Research Centre
CAMECO	Canadian Mining and Energy Corporation
CGGC	Chhotanagpur Granite Gneiss Complex
CIPHET	Central Institute of Post-Harvest Engineering and Technology
CLND Act	Civil Liability of Nuclear Damage Act
CSR	Corporate Social Responsibility
DAE	Department of Atomic Energy
DSZ	Dharmapuri Shear Zone
EMCCR	En masse Coolant Channel Replacement
EMFR	En masse Feeder Replacement
ESL	Environmental Survey Laboratories
FY	Financial Year
GHAVP	Gorakhpur Anu Vidyut Pariyojana
IAEA	International Atomic Energy Agency
IGAs	Inter-Governmental-Agreements
ILW	intermediate level waste
KAPS	Kakrapar Atomic Power Project
KAPP	Kakrapar Atomic Power Project
KGS	Kaiga Generating Station
KKNPP	Kudankulam Nuclear Power Plant
KKNPS	Kudankulam Nuclear Power Plant
kWh	Kilowatt-hour
MoP	Ministry of Power
LLW	low level waste
LWR	Light Water Reactor
MAPS	Madras Atomic Power Station
MLD	Million litre per day
MTCR	Missile Technology Control Regime
MW	Megawatt
NAPS	Narora Atomic Power Station
NDFB	North Delhi Fold Belt
NMMC	Navoi Mining & Metallurgical Combinat State Company
NPCIL	Nuclear Power Corporation of India Limited
NPT	Nuclear non-Proliferation Treaty
NSDF	near surface disposal facilities
NSG	Nuclear Suppliers' Group

PFBR	Prototype Fast Breeder Reactor
PHWR	Pressurized Heavy Water Reactors
PLF	plant load factor
RAPS	Rajasthan Atomic Power Project
RO	Reverse osmosis
SSP	Secondary Sodium Pumps
SSZ	Singhbhum Shear Zone
TAPS	Tarapur Atomic Power Station
TIFR	Tata Institute of Fundamental Research
UCIL	Uranium Corporation of India Limited
UO_2	Uranium dioxide
U_3O_8	Triuranium octoxide
UOC	Uranium ore concentrate
WA	The Wassenaar Arrangement
WHO	World Health Organisation

Part-I

CHAPTER - I

Introductory

Nuclear research in India started with the establishment of the Tata Institute of Fundamental Research (TIFR) in 1945. In April 1948, the Atomic Energy Act was passed and the Atomic Energy Commission was set up. A hallmark of the nuclear programme, founded under the leadership of Dr. Homi Jehangir Bhabha, the first Chairman of The Atomic Energy Commission (AEC), has been to achieve self-sufficiency in all aspects of applications of nuclear energy in the Country.

In 1954, it was decided by AEC to set up the Atomic Energy Establishment at Trombay, which was formally inaugurated on January 20, 1957. On January 12, 1967, it was renamed as Bhabha Atomic Research Centre (BARC). BARC has been a mother institution involved with the development of technologies related to building nuclear reactors, fuel fabrication, reprocessing of the irradiated fuel, production or up-gradation of heavy water. The research leading to applications of the radiation technology for medical diagnostics and therapeutic purposes, producing high yielding and disease-resistant varieties of rice, jute, pulses, groundnuts and mustard or the preservation of agricultural commodities, sterilization of medical products etc. has been pursued from the beginning. BARC has also initiated and sustained research and development activities in all newly emerging areas of nuclear technology and basic sciences which are of national importance, and has served as the cradle of all DAE's programmes.

During the period 1948-1954 the AEC functioned within the Ministry of Natural Resources and Scientific Research. In August, 1954, the Department of Atomic Energy (DAE) was created under the direct charge of Prime Minister and has since then remained under the charge of successive Prime Ministers. DAE is a multifaceted organization comprising research institutions and closely linked industrial units providing an excellent environment for both scientific enquiry as well as technology development. Over the years, the activities of the DAE have grown in strength and coverage, encompassing a wide spectrum, ranging from basic research in mathematics, physics, chemistry and biology on the one hand, to the construction and operation of nuclear power reactors on the other.

The DAE family now comprises six research centers, three industrial organizations, five public sector undertakings and three service organizations. It has under its aegis two boards for promoting and funding extra-mural research in nuclear and allied fields, mathematics and a national institute.

As per data of the Central Electricity Authority, per capita consumption of power in the Country was 1075 kWh in 2015-16 as compared to 1010 kWh in the previous year. As per data of World Bank for the year 2014, the per capita consumption of power in China was 3927 kWh, in the USA it was 12984 kWh and in the United Kingdom it was 5130 kWh. The Indian power sector is largely thermal based, with 64.3% of installed capacity accounted for by coal, gas and diesel based plants. The percentage of Nuclear source of energy to the total installed capacity is just about 2% of the total installed capacity. Therefore, there is immense scope for expansion and diversification of power generation in the Country.

The Committee held extensive deliberations to analyse the various issues concerning the subject “Import of Uranium for Nuclear Plants”, the details of which have been given in the succeeding paragraphs of the report. The observations/recommendations emerging out of the deliberations have been given in Part II of the Report.

India’s Nuclear Power Programme:

1.2 Thorium reserves in India are among the largest in the world. DAE has a plan to use thorium as part of its long-term nuclear power programme. Due to the absence of fissile isotope in naturally occurring Thorium (unlike that existing in Uranium), commercial utilisation of thorium, on a significant scale, can begin only when abundant supplies of either Uranium or Plutonium resources are available. With this in view, a three-stage nuclear power programme, based on a closed nuclear fuel cycle has been chalked out to use thorium as a viable and sustainable option, right at the inception of India’s nuclear power programme. The three stage nuclear power programme aims to multiply the domestically available fissile resource through the use of natural uranium in Pressurised Heavy Water Reactors, followed by use of plutonium obtained from the spent fuel of Pressurised Heavy Water Reactors in Fast Breeder Reactors. Large scale use of Thorium will subsequently follow making use of Uranium-233 that will be bred in Fast Breeder Reactors, when adequate nuclear installed capacity in the Country has been built. The third stage of Indian nuclear power programme which contemplates making use of this Uranium-233 to fuel Uranium-233 – Thorium based reactors, can provide energy independence to the Country for several centuries.

1.3 With the sustained efforts over years, India has gained experience over the entire thorium fuel cycle – fabrication, irradiation and reprocessing on a semi-industrial scale. Efforts are currently on to enlarge this experience to a bigger scale. Bhabha Atomic Research Centre (BARC) and other research organisations attached to DAE are engaged in various R&D activities to address the issues concerning utilisation of thorium in different types of reactors.

1.4 Nuclear Power Corporation of India Limited (NPCIL), a Public Sector Enterprise under the administrative control of the DAE is responsible for setting-up, designing, constructing, commissioning and operation of nuclear power reactors.

1.5 India's oldest reactor was Apsara which was designed by BARC with the assistance of the United Kingdom which had also provided enriched Uranium for the reactor. The present nuclear power capacity in the Country comprises 22 nuclear power reactors with a total installed capacity of 6780 MW. Of these, one reactor, RAPS-1 [100 MW, owned by the DAE and operated by NPCIL] is under extended shutdown for techno-economic assessment and KAPS-1 (220 MW) is also under long shutdown for Renovation and Modernisation activities - En masse Coolant Channel Replacement (EMCCR) and En masse Feeder Replacement (EMFR). KAPS-2 (220 MW), which was under shutdown for Renovation and Modernisation activities, has restarted after undergoing the EMCCR and EMFR procedures.

1.6 The Government has taken several enabling steps to increase the nuclear power capacity. A ten-fold increase in installed capacity is planned by DAE for the near future by setting up of new projects. As per the replies furnished by the Department, besides 22 nuclear power reactors, 8 reactors of 6200 MW are under construction and for 12 new reactors (9000 MW) administrative approval and financial sanction has been accorded by the Government. This includes India's Prototype Fast Breeder Reactor (PFBR) at Kalpakkam, Tamil Nadu with an installed capacity of 500 MW, which is scheduled to be in operation in the fourth quarter of FY 2018-19. In addition, the Government has approved setting up of 16 indigenous reactors with a total installed capacity of 11000 MW and 28 reactors with foreign technical collaboration for a total installed capacity of 29900 MW. Of these, for 10 PHWRs of 700 MW each, work on pre-project activities at different sites is in progress.

1.7 The Government has also entered into enabling agreements with other countries for nuclear cooperation including supply of fuel. The Atomic Energy Act has been amended recently to enable Joint Ventures of Public Sector Companies to set up nuclear power projects. Indian Nuclear Insurance Pool has been launched to enable various stakeholders obtain insurance for liability arising out of the provisions of the Civil Liability for Nuclear Damage (CLND) Act.

1.8 To enable nuclear power plants to work smoothly, there is a need to ensure unhindered Uranium supply to our reactors. NPCIL expected requirement of fuel during 2018-19 is 354 (tons UO_2) which would increase to 535 (tons UO_2) during 2021-22. Out of 22 nuclear power reactors, 14 reactors are under IAEA safeguards and use imported fuel. The remaining 8 reactors are fuelled by the indigenous fuel. Imported nuclear fuel requirement for IAEA safeguarded power reactors annually for one effective full power year based on tariff norms for fuel consumption for various types of reactors is 795 (tons UO_2).

1.9 Indian nuclear power plants have, for about five decades, demonstrated safe and reliable operation and generated about 598 Billion Units of clean electricity up till FY 2017-18. During the Year 2017-18, NPCIL recorded highest ever power generation of 38336 Million Units. During the previous two years, *i.e.,* 2015-16 and 2016-17, the power generated was 37456 Million Units and 37674 Million Units, respectively.

1.10 As regards the domestic uranium reserves in the Country, the Atomic Minerals Directorate for Exploration and Research (AMD), a constituent unit of the

DAE has established 2,40,174 tonnes of U_3O_8 in the Country in 45 deposits of varying grade and tonnage. Out of 45 deposits, a total of 18 deposits are either currently under production/exploratory mining or planned/future mining centres. The mining and beneficiation (processing) of uranium ore deposits for production of uranium are undertaken by Uranium Corporation of India Limited (UCIL), a Public Sector Undertaking of DAE. At present, the uranium ore deposits at Jaduguda, Narwapahar, Bagjata, Bhatin, Banduhurang, Turamdih and Mohuldih in Jharkhand and Tummalapalle in Andhra Pradesh are under commercial mining by UCIL. UCIL currently operates three processing plants (mills) at Jaduguda and Turamdih in Jharkhand and Tummalapalle in Kadapa (YSR) district, Andhra Pradesh for beneficiation and production of uranium ore.

1.11 Import of uranium for power plants is very much required as the domestic production of uranium is not sufficient for the nuclear power generation programme of the Country. The indigenous uranium also works out to be costlier than the imported uranium. Quality of domestic uranium ore is very poor compared to uranium ore being mined conventionally by major producers. Moreover, uranium has to be extracted from a depth of about 500-800 m below the ground. This makes the extraction and processing cost of uranium in the Country very high as compared to other countries.

1.12 There are formal and informal grouping of nations that control access to sophisticated technologies in both conventional and non-conventional fields. These groupings are :

(i) Nuclear Suppliers Group (NSG) - NSG is a group of nuclear supplier countries that seeks to contribute to the non-proliferation of nuclear weapons through the implementation of two sets of Guidelines for nuclear exports and nuclear-related exports. Although India has not been inducted formally as a member, it has been granted a waiver and as a result it can trade with NSG members.

(ii) Missile Technology Control Regime (MTCR) - It is an informal political understanding among Countries that seeks to limit the proliferation of missiles and missile technology. India is a member to this group.

(iii) The Wassenaar Arrangement (WA) - It was established in order to contribute to regional and international security and stability, by promoting transparency and greater responsibility in transfers of conventional arms and dual-use of goods and technologies. India is a member to this group.

(iv) The Australia Group (AG) - It is an informal forum of countries which, through the harmonisation of export controls, seeks to ensure that exports do not contribute to the development of chemical or biological weapons. India became a member to this group in 2018.

1.13 During the first five decades, the Nuclear programme of the Country developed almost independently of the world. Access to nuclear materials, equipment and technology was tightly controlled by a handful of countries. Because of the provisions of Nuclear non-Proliferation Treaty (NPT), assistance to our Country was not available. This international isolation, in a way, was instrumental in developing an indigenous manpower and knowledge base in the Country which helped to maintain the progress of nuclear programme. This isolation, however, ended with the signing of Indo-US Civil Nuclear Cooperation Agreement, which opened the access to nuclear materials, technology and equipments for the Country. It led to expansion of our nuclear power generation programme. The Committee were informed during the oral evidence by the Chairman, AEC & Secretary, DAE that the percentage of contribution of atomic energy in our country in the overall production of energy is about 2.4 per cent in terms of installed capacity, but in terms of total electricity generation, it is about 3.5 per cent because our plants operate at 80 percent capacity.

1.14 Consequent upon the opening up of civil nuclear cooperation and bilateral civil nuclear agreements, Government of India decided on a separation plan for the Nuclear Power Reactors in the Country, under which some of the Pressurized Heavy Water Reactors (PHWRs) in the Country were placed under International Atomic Energy Agency (IAEA) Safeguards. The safeguarded reactors placed under the IAEA would be eligible for uranium supplies sourced from outside India. Of the 22 reactors with a capacity of 6780 MW in operation, 14 reactors with a capacity of 4380 MW are under IAEA Safeguards and are fuelled by imported uranium. These include 10 PHWRs (2060 MW) which use natural uranium and 4 LWRs which use low enriched uranium. The remaining 8 reactors with a capacity of 2400 MW are fuelled by indigenous natural uranium.

1.15 Four more reactors under construction- KAPP 3&4 (2x700 MW PHWRs) and KKNPP 3&4 (2x1000 MW LWR) with a total capacity of 3400 MW have recently been placed under IAEA safeguards.

1.16 Even though the Nuclear Suppliers Group's (NSG) waiver is on record, India had to undertake several bilateral Inter-Governmental-Agreements (IGAs) to proceed with nuclear trade with each country. Nuclear trade is facilitated only if there exists an IGA between the countries. Even if uranium is mined by private companies in any country, its export is strictly regulated by that country in accordance with its legal requirements to ensure non-proliferation. Nuclear trade with India by a foreign enterprise is possible only based on the assurance of the concerned foreign government in the form of an IGA.

1.17 India has entered into IGA with 15 countries, namely, USA, UK, Russia, South Korea, Japan, Kazakhstan, Australia, Argentina, Canada, Czech Republic, France, Mongolia, Namibia, Vietnam and Bangladesh. Import of uranium, so far, has been sourced from only a few countries, namely, Canada, Kazakhstan, France and Russia. No uranium has been imported from other leading producers such as Uzbekistan and Namibia for a number of reasons. India has also been exploring arrangements with friendly countries for sourcing uranium fuel for the safeguarded reactors in a manner conducive to stability and security of fuel supply in the medium and long terms.

1.18 The Committee have been apprised by the DAE that the Department's aim of procurement/importing uranium is to have 15,000 MT of uranium and that Government's approval has been sought for procurement of Uranium Ore Concentrate (UOC) to the tune of 15,000 MT with the objective of stockpiling of imported uranium to achieve long-term stability in fuel supply for the nuclear power reactors under IAEA safeguards and thereby strengthening the nuclear power programme of the Country.

Financing pattern of Nuclear power plants:

1.19 Nuclear power plants are in the Central Sector. They have been set up with a mix of debt and equity with the equity being met from Government Budgetary Support and NPCIL's internal resources. Power generated by these plants is allocated to beneficiary States and Union Territories by the Ministry of Power (MoP). As per the present norms of MoP, 50% is allocated to the home State (State where the project is located), 35% to the other beneficiary States and Union Territories in the Electricity Region and 15% unallocated power is retained at the disposal of the Government of India, to be allocated to meet the demand of various beneficiaries from time to time.

Financial Allocation for the Department of Atomic Energy:

1.20 Financial Allocation for the DAE for the last three years is as follows:

(₹in crores)

	2016-17	2017-18		2018-19
	Actuals	BE	RE	BE
Financial Allocation	12894.09	12461.20	13209.54	13971.41

1.21 The DAE has been able to spend the money allocated to it in the recent years. The actual expenditure of the DAE in 2016-17 was ₹12,894.09 crore whereas in the year 2017-18 the BE was ₹12,461.20 crore. RE for 2017-18 was higher at ₹13,209.54 crore. Financial Allocation of Rs. 13,971.41 crore at BE 2018-19 stage is 5.76% more than the RE of 2017-18. The Committee have been informed that the Government has made a special provision for ₹3000 crore per year for construction of nuclear power plants and the DAE is also getting ₹1000 crore to ₹2000 crore from the National Clean Energy Fund. The DAE had proposed for a funding of about ₹15000 crore per year from the Government for its requirement relating to uranium import and nuclear power plants. For procurement of uranium, the DAE spent ₹1500 crore in the year 2016. Taking advantage of low prevailing uranium prices, the DAE is able to procure two and a half times more uranium than it had planned for. The

Committee have also been informed that the constraint of funding has now been addressed and the Government has agreed to provide funds on a regular basis for the next 15-20 years

Revenue Generation:

1.22 Regarding generation of revenue from various resources by DAE and plan for growth of revenue in future, following written information was submitted to the Committee:

"Resource-wise details of revenue generated by DAE during last five years:

	Amount (₹ in Crores)				
Head of Accounts	2013-14 ₹	2014-15 ₹	2015-16 ₹	2016-17 ₹	2017-18 ₹
0049 - Interest Receipts	1,197	1,399	1,456	1,521	1,628
0050 - Dividend	949	674	773	692	2,584
0071 - Contributions & Recoveries	16	12	11	7	29
0801 - Power	2,804	2,857	2,909	2,009	1,520
0852 - Industries	1,685	1,920	1,594	1,400	1,330
1401 - Atomic Energy Research	65	49	59	104	84
Total	6,716	6,911	6,802	5,733	7,175

Revenue generation from nuclear power reactors:

1.23 The financial performance of NPCIL, registered by operation of the nuclear power reactors for each of last three years is indicated in Table below:

	2015-16	2016-17	2017-18
Generation (Million Units)	37456	37674	38336
Revenue from Operations (₹ Crore)	9,626	10,003	12,206
Profit Before Tax (₹ Crore)	3,422	3,232	4,622
Total Comprehensive Income net of tax (₹ Crore)	2,697	2,491	3,614

1.25 The Committee were informed that NPCIL's revenue target for the current year 2018-19 is ₹10,660 crore.

CHAPTER - II

Import of Uranium

2.1 The Government has set a target of 14340 MW of nuclear power generation by the year 2024 which is likely to be met on the strength of nuclear power reactors operating on both domestic and imported uranium. Assured supply of uranium is, therefore, of critical importance. In order to protect the stability of uranium Supply for reactors, the Government is embarking on maintaining a stockpile of 15000 metric tonnes of uranium which will be sufficient for next 15-16 years for operation of the existing as well as proposed reactors. In order to undertake import of uranium, DAE enters into contract with entities from uranium producing countries following which the import is concluded. Imported uranium is kept in Hyderabad at Nuclear Fuel Complex, which is an entity under DAE.

Domestic Production

2.2 As per the written submission of DAE, the history of uranium exploration in the Country is as under:

> "The history of uranium exploration in India dates from 1949. The first uranium deposit was established at Jaduguda, East Singhbhum district, Jharkhand in 1951. uranium exploration until the mid-1970s, was mainly confined to Singhbhum Shear Zone (SSZ), Jharkhand and Umra-Udaisagar belt, Rajasthan. Several low-grade and small-medium tonnage deposits were established in SSZ, Jharkhand and Umra, Udaipur district, Rajasthan. Subsequently, investigations were expanded to other favourable geological domains, which resulted in establishing a number of small uranium deposits such as Bodal, Rajnandgaon district and Jajawal, Surguja district, Chhattisgarh and Walkunji, South Kanara district, Karnataka.
>
> During late seventies, exploration was intensified in several potential geological sectors with a focus on sandstone - type deposits. A high - grade, medium - tonnage sandstone – type Uranium deposit was established at Domiasiat (KPM), West Khasi Hills district, Meghalaya.
>
> During mid-eighties, a low-grade, carbonate - related strata bound deposit was established at Tummalapalle, Kadapa distrist, Andhra Pradesh in southern part of Cuddapah Basin. Since the ore was not amenable for beneficiation using conventional leaching procedures which existed at the time, exploration in this sector was discontinued. However, development of an economically viable flow sheet for recovery of uranium from Tummalapalle ore through alkali pressure leaching rejuvenated the exploration activities in the Southern part of Cuddapah basin.

In early 1990s, a near-surface unconformity - related deposit was discovered in the northern part of Cuddapah basin at Lambapur, Nalgonda district, Telangana. By 1996, extensive exploration in the northern parts of Cuddapah basin resulted in establishing unconformity - related deposits at Peddagattu and Chitrial, Nalgonda district, Telangana. Exploration in the adjacent Palnad sub-basin established a small deposit at Koppunuru, Guntur district, Andhra Pradesh.

Recent and on-going uranium exploration in various geological domains of India

2.3 In order to achieve self-sufficiency and speedy augmentation of uranium resources for nuclear power programme of the Country, Atomic Mineral Directorate for Exploration and Research (AMD) made a paradigm shift in the uranium exploration strategy. It includes (a) sustained multi-parametric exploration in the established uranium provinces of the Country for immediate augmentation of uranium resources; and (b) developing the potential geological domains for future. In this direction, during the recent years, exploration activities have been concentrated in the following areas.

1. Cuddapah Basin, Andhra Pradesh;
2. Singhbhum Shear Zone (SSZ), Jharkhand;
3. North Delhi Fold Belt (NDFB), Rajasthan & Haryana;
4. Mahadek basin, Meghalaya;
5. Bhima basin, Karnataka;
6. Dharmapuri Shear Zone (DSZ), Tamil Nadu.
7. Other potential geological domains such as the Kaladgi basin, Karnataka; Satpura Gondwana Basin, Madhya Pradesh and Chhattisgarh; Siwalik basin in Himachal Pradesh: Lesser Himalaya, Uttarakhand; Kotri-Dongargarh belt, Chhattisgarh and Chhotanagpur Granite Gneiss Complex (CGGC), Chhattisgarh, Uttar Pradesh and Madhya Pradesh are also under active exploration"

2.4 Elaborating on the problem of uranium mining in the Country, the representative of the DAE provided following information during the deposition before the Committee:

"... today for extracting uranium from mines in India we have to go 500 metres below the ground. In Jadugoda, we go below 800 metres....We are taking it from different places like Narwapahar, Turamidh, etc. In the last four years, we have increased the output from Jadugoda area. Jadugoda mine is the deepest mine in this country...I will put two-three points for your consideration: (a) In India, uranium mining are carried out at an average grade 0.04%-0.05% U_3O_8. (b) In Canada, mining takes place between 530 m to 640 m below surface. (c) In Australia, mining is carried out upto a depth of 350 m... It is coming down as low as that... if you see comparing it with other countries is that they get it at average one per cent... That is why their prices are very low. Today we are in a position to buy uranium very cheap from abroad. What we are doing is that we are having a policy where we have our own reactors which are running on Indian uranium and whatever is possible we are getting from outside at a very cheap price and running the reactors. So, this is, in fact, only a self-reliance that to the extent possible what is available, make use of that…"

2.5 Regarding utilization of indigenously produced uranium, following written information was submitted to the Committee:

"… Eight reactors with a total installed capacity of 2400 MW are fuelled by indigenous fuel. The Government has made efforts to augment indigenous uranium supply by opening of new mines and processing facilities thus narrowing down the demand-supply gap for reactors using indigenous fuel."

2.6 Data on amount of uranium used for civilian nuclear programme with the break-up of imported sources (country-wise) for the period 2011-12 to 2015-16, based on the dispatches of fuel bundles supplied to the PHWRs and BWRs, as furnished by the DAE is as under:

PHWR Fuel Dispatches -Imported						
SOURCE	MATERIAL	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
FRANCE	Uranium in MT	0	0	0	1.108	0
	UO_2 in MT	0	0	0	1.257	0
RUSSIA	Uranium in MT	15.827	227.389	79.156	0	226.098
	UO_2 in MT	17.959	258.016	89.818	0	256.55
KAZAKHSTAN	Uranium in MT	256.684	30.071	154.046	318.697	66.895
	UO_2 in MT	291.256	34.121	174.793	361.621	75.905

BWR Fuel Dispatches -Imported Source						
SOURCE	MATERIAL	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
RUSSIA	Uranium in MT	16.831	17.942	4.344	0.140	14.589
	UO_2 in MT	19.098	20.358	4.929	0.159	16.554

2.7 During oral deposition, the Committee were apprised of the following in the context of planned use of indigenous and imported uranium :

"**...** हम लोग सोचते हैं कि धीरे-धीरे प्रोडक्शन बढ़ायेंगे, बाहर से यूरेनियम लाना कम हो जाएगा, लेकिन बंद नहीं होगा। क्योंकि जो रिएक्टर्स बाहर से आ रहे हैं, शायद हम लोग उनके लिए यूरेनियम बाहर से ही लेंगे। हमारे यहां जो यूरेनियम बाहर से आ रहा है, वह धीरे-धीरे बंद हो जाना चाहिए। अभी हमने बताया कि मेघालय और आंध्रप्रदेश में जो यूरेनियम सोर्सेस आइडैंटीफाई हुए हैं, जब हम उन्हें एक्सप्लॉयट कर सकेंगे, तब हमारे पास यूरेनियम की कोई समस्या नहीं होगी। कुछ सालों में विदेशों के ऊपर निर्भरता कम हो जाएगी।**...** ”

Import of uranium

2.8 Giving a brief background of uranium import and sources of uranium import in the Country, following written information was submitted to the Committee:

“Nuclear power reactors placed under the IAEA safeguards would be eligible for uranium supplies from outside India. The international market for uranium is a relatively volatile one. Notwithstanding the opening up of international civil nuclear trade in nuclear fuel and technology, our interactions with vendors in various countries in the last few years have revealed that India faces considerable constraints in accessing the world's uranium market. Even though the Nuclear Suppliers Group's (NSG) (the 48 member multinational body which regulates export of nuclear materials and technology with a view to control nuclear proliferation) waiver is on record, India had to undertake several bilateral Inter-Governmental-Agreements (IGAs) to proceed with nuclear trade with each country.

In parallel, with the opening up of the civil nuclear cooperation with foreign partners for supply and erection of nuclear power plants, this Department has also been exploring arrangements with friendly countries for sourcing uranium fuel for the safeguarded reactors in a manner conducive to stability and security of fuel supply in the medium and long term. As part of this activity, Contractual Agreements were entered and the following contracts are currently valid:

Sl. No	Firm/ Country	Contractual	Provision for additional quantity during the contractual period	Procured as on date
1.	M/s. Cameco, Canada	*3000 MT of Uranium Ore Concentrate spread over six years (2015-2020).	2500 MT with mutual agreement	2473.88 (31.03.2018)
2.	M/s. JSC NAC Kazatomprom, Kazakhstan	#5000 MT of Uranium Ore Concentrate spread over five years (in 2015-2019).	2000 MT with mutual agreement	3413.65 (31.03.2018)

*The contract permits procurement of a minimum of 2750 MT and maximum of 5500 MT of natural UOC
The contract permits procurement of a minimum of 3750 MT and maximum of 7000 MT of natural UOC"

2.9. The Committee have further been apprised that during September 2013, DAE had entered into a Contract with M/s. Navoi Mining & Metallurgical Combinat State Company (NMMC), Uzbekistan for import of 2000 MT of Uranium Ore Concentrate, spreading over the years 2014-18. Accordingly, the firm was to supply about 200 MT of Uranium Ore Concentrate (UOC) during the year 2014 and 300 MT of UOC during the year 2015. However, due to issues related to dispatch and transportation of the material, the supplies have not yet commenced. M/s NMMC has shown willingness to supply uranium ore concentrate. A new contract needs to be negotiated.

2.10. A contract has also been signed on 15.04.2015 with M/s. CAMECO Inc., Canada for procurement of 3000 MT of Uranium Ore Concentrate (UOC) spread over a period of 6 years commencing from 2015 to 2020 at an estimated cost of ₹1833 crore (approx). M/s. CAMECO Inc., Canada has supplied 2471.87 MT of Uranium Ore Concentrate during 2015, 2016 and 2017 and shall be supplying 1000 MT of UOC during the year 2018. DAE has an option to increase the annual quantity, over and above 3000 MT, by upto an additional 500 MT of UOC by giving CAMEO a request notice on or before July 1 of the year preceding the applicable delivery year specifying the requested additional quantity. This will bring the maximum off take over the 6 year period to 5500 MT.

2.11. Since the earlier contract signed with M/s. Kazatomprom, Kazakhstan in the year 2009 got concluded in the year 2014, a fresh contract was signed on 08.07.2015 with M/s. Kazatomprom, Kazakhstan for procurement of 5000 MT of Uranium Ore Concentrate (UOC) spread over a period of 5 years commencing from 2015 to 2019 at an estimated cost of ₹3156.23 crore (approx). M/s. JSC NAC Kazatomprom, Kazakhstan has supplied a total of 3413.65 MT in 2015, 2016 and 2017 and shall be supplying 1500 MT of UOC during the year 2018. DAE has an option to increase the annual quantity, over and above 5000 MT, by upto 500 MT by giving Kazatomprom a request notice on or before July 1 of the year preceding the applicable delivery year specifying the requested additional quantity. This will bring the maximum off take over the 5 year period to 7000 MT.

2.12 DAE is also exploring the possibility of entering into Contracts with a few more firms in order to develop new Vendors. After receipt of fuel from foreign sources, all the safeguarded nuclear power plants in the Country are operating to full capacity. It is expected that the Country's Nuclear Power programme shall steadily progress and, therefore, the procurement of uranium from foreign sources is likely to continue.

2.13 Quantity of fuel received and payments made as on 12 May, 2018 are given at **Appendix - I**.

2.14 The Committee were informed that even after the signing of 'Nuclear Deal' between India and the USA, there is requirement of inter-Governmental Agreements with uranium producing countries. Following information was submitted to the Committee:

> "Framework of an IGA includes supply of nuclear and non-nuclear materials specifically included in such an IGA, exchange of training of personnel, organisation of symposia and seminars, technology transfer, provision of relevant technical assistance and services, exchange of scientific and technical information and documentation, joint research and/or development projects and any other forms of cooperation, as may be mutually determined in writing, by the two sides. Such IGAs helps structured cooperation towards development of nuclear power, Research and Development, Radiation and Nuclear Safety, Regulatory exchanges etc. in India.
> It is true that participating Governments (PG) in NSG gave unanimous consent to do nuclear commerce with India that facilitated the uranium supplier countries to enter into IGA as nuclear trade is facilitated only if there exists an IGA between the countries. Even if uranium is mined by private

companies in any country, its export is strictly regulated by that country in accordance with its legal requirements to ensure non-proliferation. Entering into contact directly with a private mining company will be possible only when that country is authorised to do nuclear trade with India. Nuclear trade with India by a foreign enterprise is possible only based on the assurance of the concerned foreign Government in the form of an IGA."

2.15 Regarding import of uranium from multiple sources, a representative of DAE apprised the Committee during the course of deposition:

"... regarding the supply of uranium from Uzbekistan, which could not commence, the reason for it is that it is a landlocked country. उन लोगों ने फाइनल स्टेज में कहा कि आपको पिक-अप करना पड़ेगा और अपने देश में ट्रांसपोर्ट करना पड़ेगा। इसका मतलब हमें वह यूरेनियम लेकर दूसरे देशों से होकर गुजरना पड़ेगा। यह थोड़ा मुश्किल था। जब इस बारे में बातचीत चल रही थी तब दूसरा कांट्रेक्ट आ गया और देखा कि यूरेनियम 10-15 परसेंट सस्ते रेट पर मिल रहा था। इस वजह से हम वहां आगे नहीं बढ़े। That is why we did not continue it further. You are right that there are some uncertainties at some places. So, the idea is to open many sources. आपने देखा कि रशिया, कनाडा, अस्ट्रेलिया, कजाकिस्तान ओपन करने की कोशिश कर रहा है। हम नामीबिया से भी कोशिश कर रहे हैं, उनके पास भी बहुत यूरेनियम है। हम पांच-सात कंट्रीज में ओपन कर रहे हैं।

Today's meeting is regarding procurement of uranium for strategic reserves, I would like to say that हम लोग अगले चार-पाँच सालों में 15 हजार टन यूरेनियम का स्ट्रैटजिक रिज़र्व तो कर ही लेंगे। It will reduce its uncertainty."

2.16 Following information was submitted to the Committee regarding existing storage capacity for stockpiling of uranium in the Country:

"As of now the storage capacity for Uranium is around 10,000 MT U at NFC and arrangements are in progress for increasing the storage capacity for additional 5000 MT..."

2.17 When asked about plans to use extensively, thorium technology to replace the Uranium, the DAE in its written submission to the Committee informed that the three stage nuclear power programme aims to multiply the domestically available fissile resource through the use of natural uranium in Pressurised Heavy Water Reactors, followed by use of plutonium obtained from the spent fuel of Pressurised Heavy Water Reactors in Fast Breeder Reactors. Large scale use of thorium will subsequently follow making use of Uranium-233 that will be bred in Fast Breeder Reactors, when adequate nuclear installed capacity in the country has been built. The third stage of Indian nuclear power programme which contemplates making use of this Uranium-233 to fuel Uranium-233 – Thorium based reactors, can provide energy independence to the Country for several centuries.

2.18 With the sustained efforts over years, India has gained experience over the entire thorium fuel cycle – fabrication, irradiation and reprocessing on a semi-industrial scale. Efforts are currently on to enlarge this experience to a bigger scale. Bhabha Atomic Research Centre (BARC) and other research organisations attached to DAE are engaged in various R&D activities to address the utilisation of thorium in different types of reactors. Some important highlights of these activities are the following:

i) Thorium Oxide (Thoria) pellets contained in bundles have been used in the initial cores of our Pressurised Heavy Water Reactors (PHWRs). Thoria based fuels have also been irradiated in the research reactors CIRUS and DHRUVA. After such irradiations, these fuel elements have been examined in the laboratories at BARC, yielding excellent results.

ii) The irradiated thoria pins of CIRUS have been reprocessed to obtain Uranium-233. The recovered Uranium-233 has been fabricated as fuel for the 30 kW (thermal) KAMINI reactor, which is in operation at Indira Gandhi Centre for Atomic Research (IGCAR) at Kalpakkam.

iii) A 300 MW Advanced Heavy Water Reactor (AHWR) using thorium based fuel has been designed and is being developed. This reactor will serve as a technology demonstrator with the several advanced passive safety features. A Critical Facility was commissioned in 2008 at BARC, and is designed to be used for carrying out experiments to further validate the physics design features of AHWR.

(iv) As a long term plan, the Department is working on technology development for high temperature reactors where thorium will be used as a fuel."

CHAPTER - III

Power Generation from Nuclear Reactors

3.1 The Indian power sector is largely thermal based, with 64.3% of the 221.8 GW of installed capacity accounted for by coal, gas, and diesel-based plants. The percentage of different sources of energy to the total installed capacity of 344.68 GW is shown in the following table:

1.Total Installed Capacity (As on 31.08.2018) - Source : Central Electricity Authority (CEA)

Fuel		MW	% of Total
Total Thermal		2,21,803	64.3%
	Coal	1,96,098	56.9%
	Gas	24,867	7.2%
	Oil	838	0.2%
Hydro (Renewable)		45,457	13.2%
Nuclear		6,780	2.0%
RES* (MNRE)		70,649	20.5%
	Total	**344,689**	

* Installed capacity in respect of RES (MNRE) as on 30.06.2018.

RES (Renewable Energy Sources) include Small Hydro Project, Biomass Gasifier, Biomass Power, Urban & Industrial Waste Power, Solar and Wind Energy.

3.2 When asked about the status of target of nuclear power generation, a representative of the DAE deposed as under before the Committee:

"The first question was about the position with regard to 63GW electricity we have promised by 2032 or 2034 and whether that is happening or not.

In-between, after the present Government came, they gave us a new target that by 2024, we should triple our production which would come to about 14 GW. Today, whatever plans are already under construction, we will take to about that much by 2022 or so. So, we are on this target.

... we are now planning to make 2,500 MW to 3,000 MW electricity addition every year. If you multiply that, in the next 20 years or so, we will reach near about the target. For that, the main constraint was the funding. The present Government has agreed to give us funds on a regular basis for next 15 to 20 years. Now, it is up to our capability to get into agreements with all these organisations, get uranium, get reactors and also make our own reactors.

... AEC has already approved, and we are going to the Cabinet, for construction of ten reactors simultaneously. So, instead of going for two reactors at a time, we are going for ten reactors simultaneously. I find that everybody is enthusiastic about it and I am sure that we will be able to get funds for that. The sites are all identified where we have already got land. So, we will make it. That is the first step we have taken.

Similarly, Kovvada is a site near Srikakulam which is old Andhra Pradesh. We are going to make there six reactors. That is the site which is now in the most advanced stage. May be the Government will announce by the end of the year about some more new constructions coming up. There will be large number of plants coming up."

3.4 The DAE representative also furnished the following information in oral deposition before the Committee:

"… apart from whatever is operating, i.e., 21 reactors, another 10 reactors are under construction at various stages. It includes Koodankulam which is going critical; KAPS 3 and 4, RAPS 7 and 8 reactors, PFBR is another. Two more reactors on which excavation work has started at Koodankulam. Two more reactors are coming up in Haryana which is also sanctioned. So, 10 reactors are under construction."

3.5 When asked about the physical and financial performance of each of the currently functioning nuclear power reactors of the country during each of the last three years, following written information was submitted by the DAE to the Committee:

"Indian nuclear power plants have, for about five decades, demonstrated safe and reliable operation and generated about 598 Billion Units of clean electricity up till FY 2017-18.
Indian nuclear power stations have registered many achievements in reliable, safe and continuous operation at high Availability Factors. The nuclear power

plants have recorded about 478 reactor-years of safe, accident free operation so far.

The present nuclear power capacity in the Country comprises of 22 nuclear power reactors with a total installed capacity of 6780 MW. Of these, one reactor, RAPS-1 [100 MW, owned by the Department of Atomic Energy and operated by Nuclear Power Corporation of India Limited (NPCIL)] is under extended shutdown for techno-economic assessment and KAPS-1&2 (2X220 MW) are under long shutdown for Renovation and Modernisation activities - Enmasse Coolant Channel Replacement (EMCCR) and Enmasse Feeder Replacement (EMFR).

The details of the Output (Generation in Million Units of Electricity) and Physical Performance (Plant Load Factor - PLF) of each of the 21 NPCIL reactors over the last three years are given in the following table

Unit	**Capacity (MW)**	**2015-16**		**2016-17**		**2017-18**	
		Generation (MU)	**PLF (%)**	**Generation (MU)**	**PLF (%)**	**Generation (MU)**	**PLF (%)**
TAPS-1	160	786	55.91	1236	88.18	174	12.44
TAPS-2	160	500	35.58	935	66.71	1001	71.39
TAPS-3	540	4530	95.51	4159	87.92	3680	77.79
TAPS-4	540	4573	96.40	4530	95.77	2013	42.55
RAPS-2	200	1226	69.79	1106	63.13	1555	88.74
RAPS-3	220	1845	95.47	1618	83.98	1877	97.40
RAPS-4	220	1668	86.29	1936	100.46	1656	85.93
RAPS-5	220	1950	100.89	1715	89.01	1974	102.41
RAPS-6	220	1773	91.73	1096	56.89	1543	80.06
MAPS-1	220	1861	96.30	1465	76.04	1194	61.97
MAPS-2	220	1349	69.83	1739	90.25	1781	92.43
NAPS-1	220	1803	93.30	1655	85.90	1836	95.27
NAPS-2	220	1630	84.33	1724	89.43	1800	93.42
KAPS-1	220	1608	83.19	##	-	##	-
KAPS-2	220	421	21.79	##	-	##	-
KGS-1	220	1918	99.28	1742	90.37	1927	99.98
KGS-2	220	1834	94.92	1708	88.65	1885	97.81
KGS-3	220	2078	107.51	1063	55.15	1898	98.47
KGS-4	220	1842	95.32	2021	104.84	1824	94.65
KKNPS-1	1000	2261	25.74	6212	70.92	4437	50.65
KKNPS-2	1000	--	--	12**	97.00	4281	48.87

Notes:

[$] _The generation figures are rounded to nearest integer._
[##] _KAPS-1&2 have been taken in project mode for EMCCR and EMFR activities from August 01, 2016 onwards._
** In addition, KKNPP-2 generated about 2327 MUs of infirm power during the year 2016-17.

3.6 The nuclear power projects under commissioning/construction/sanctioned along with their location and State are tabulated below:

Nuclear Power Project	Location & State	Capacity (MW)	Status
Kudankulam Nuclear Power Plant (KKNPP) Unit – 2	Kudankulam, Tamil Nadu	1x1000	Commissioned.
Kakrapar Atomic Power Project (KAPP) Units – 3&4	Kakrapar, Gujarat	2x700	Under Construction. Expected completion by 2019.
Rajasthan Atomic Power Project (RAPP) Units – 7&8	Rawatbhata, Rajasthan	2x700	
Prototype Fast Breeder Reactor (PFBR)	Kalpakkam, Tamil Nadu	1x500	Expected completion in last quarter of 2018-19
Gorakhpur Anu Vidyut Pariyojana (GHAVP) Units – 1 to 2	Gorakhpur, Haryana	2x700	Project accorded Financial Sanction, Being readied for launch
Kudankulam Nuclear Power Plant (KKNPP) Units – 3 & 4	Kudankulam, Tamil Nadu	2x1000	Project accorded Financial Sanction, Excavation commenced.
Presssurissed Heavy Water Reactor (PHWR)		2x700	Planned
	Total	9100	

3.7 The Government has accorded 'in principle' approval of the following sites for location of nuclear power plants in future:

Location & State	Capacity (MW)
Indigenous Reactors	
Gorakhpur, Haryana (Units 3&4)	2 x 700
Chutka, Madhya Pradesh	2 x 700
Mahi Banswara, Rajasthan	4 x 700
Kaiga, Karnataka	2 x 700
Bhimpur, Madhya Pradesh	4 X 700
Kalpakkam, Tamil Nadu	2 X 600
Reactors with Foreign Technical Cooperation	
Kudankulam , Tamil Nadu (Units 5&6)	2 x 1000
Jaitapur, Maharashtra	6 x 1650
Kovvada, Andhra Pradesh	6 x 1000*
ChhayaMithiVirdi, Gujarat	6 x 1000*
Haripur, West Bengal	6 x 1000*
Total	40900 MW

**Nominal Capacity*

The estimated total nuclear power generation is 55780 MW.

3.8 When asked about the current status of the proposal to construct 10 units of India's indigenous PHWRs, the DAE submitted following written information to the Committee:

"The Government in June 2017 accorded administrative approval and financial sanction for setting up 10 indigenous PHWRs of 700 MW each. The work on pre-project activities at sites like land acquisition at Greenfield sites, obtaining statutory clearances, site investigations etc. are in progress. The manufacturing and supply orders for the special materials required for long delivery items like steam generator forgings, Incoloy tubes etc. have been placed. Tendering of other long delivery equipment for the fleet mode reactors has been initiated…The annual requirement of fuel for operating the 10 PHWRs of 700 MW capacity each will be about 1250 MT of natural Uranium dioxide (UO_2) fuel.

The details of the location and capacity of the 10 PHWR reactors are as follows:

Location & State	Project	Capacity (MW)
Chutka, Madhya Pradesh	Chutka-1&2	2 X 700
Kaiga, Karnataka	Kaiga-5&6	2 X 700

Mahi Banswara, Rajasthan	Mahi Banswara- 1 & 2	2 X 700
Gorakhpur, Haryana	GHAVP– 3 & 4	2 X 700
Mahi Banswara, Rajasthan	Mahi Banswara- 3&4	2 X 700

Fast Breeder Reactors

3.9 When asked about the status of the construction of Prototype Fast Breeder Reactor (PFBR) at Kalpakkam, Tamil Nadu with an installed capacity of 500 MW, the DAE submitted following written information to the Committee:

"All the construction activities of PFBR are completed and the integrated commissioning of all the systems is in progress. As a pre-requisite for filling of the reactor coolant i.e liquid sodium in the Main Vessel (MV), Reactor Assembly along with MV is preheated through Safety Vessel – Main Vessel annular space with Nitrogen to the required temperature.

Towards commissioning of Secondary sodium system, trial runs of Secondary Sodium Pumps (SSP) -1 & 2 were carried out. Meanwhile, SSP -2 was started and the torque value was observed to be higher than expected. The pump was stopped and it is being removed with required precaution for investigation.

Presently after rectification of the SSP-2, the Primary Sodium filling in Main Vessel will be started. On purifying the filled Sodium, commissioning of Primary Sodium Pumps will be done prior to isothermal operations. On completion of isothermal operations, dummy fuel sub- assemblies in the reactor core will be replaced with actual fuel sub-assemblies towards first approach to criticality of the reactor and further power operations.

Although all construction activities, total equipment erection & installation have been completed in PFBR, time schedules for first approach to criticality (FAC) followed by subsequent power operation got shifted. In addition as commissioning is under progress, occasional mismatches and design anomalies in system/ equipment between the prior assessments based on theoretical models and actual observation are being noticed and appropriate rectification actions are undertaken. These anomalies are essentially owing to First-Of-A-Kind (FOAK) design and engineering having no international reporting/ benchmarking.

Accordingly, PFBR is scheduled to be in operation in the fourth quarter of FY 2018-19."

3.10 DAE submitted following written information to the Committee when asked about the cost over-run due to delay in the project:

"The present approved cost of PFBR is ₹5677 crore. Owing to the above reasons, the proposed cost of the PFBR is ₹6100 crore and the breakup of the additional cost is given below.

S.No	Details	Amount (₹ in crore)	Amount (₹ in crore)
1	Net expenditure incurred up to June 2017		5388.54
2	Commitments & Liabilities outstanding as on June 2017		374.69
3	Additional amount required from July 2017 up to commercial operation		336.77
3.1	Manpower cost	133.77	
3.2	CISF deployment cost	19.31	
3.3	Indirect manpower cost	25.11	
3.4	Consumption of Power cost	71.14	
3.5	Other Administrative expenses	34.15	
3.6	Additional requirements including spares & consumables	39.00	
3.7	Bank Guarantee under CLND Act	1.50	
3.8	Contingencies	12.79	
	Total	336.77	**6100.00**
	Amount committed above ₹5677 crore	86.23	
	Total Additional requirement	**423.00**	"

Cost of Nuclear Power plants

3.11 Further, a representative of the DAE submitted the following in an oral deposition before the Committee:

"...Let us divide between Indian reactors and foreign. Indian reactors are not much of a problem. We get the equity either our own funding or Government gives through budgetary support and the rest of the money we take through Indian agencies at higher interest rates. But in the case of foreign reactors, first problem is that they have to give at 70 per cent of the amount which is loan amount, that is debt financing, and that has to come from lower interest rates. Russians have given at four per cent interest for whatever equipment they are supplying. That is why, Russian reactors have been cheaper.

We are in a very advanced stage of discussion with the Westinghouse as of today. Their cost is higher but we are trying to negotiate with them so that the interest burden comes down. If the interest burden comes down again the price will match. In addition to that, Westinghouse sources a lot of equipment from Japan and Korea, which give loan at a very low interest rates. So, our idea is to increase the component which can be taken from Japan and Korea. In that case we would be able to give at a much lower rate."

3.12 On the issue of liability in case of mishaps, the Committee were informed as under:

"The way it is written is, it is the operator's liability. In this case it is the NPCIL who is the operator. First ₹1,500 crore liability will be paid by them through this insurance process. That is, insurance companies will pay... these foreign suppliers will have to take another insurance of ₹1,500 crore through the insurance company. That is why this insurance is very important for us. Our insurance companies will recover the money from those persons..... It is already agreed and we took some time for ratification. Once that ratification is there, from this fund, we will be given the money which goes anything beyond ₹1,500 crore. xxxxx Generally, it is the Government's responsibility."

3.13 When asked about the relative cost of nuclear power in relation to other sources, a representative of the DAE stated the following in an oral deposition before the Committee:

''पहली बात यह है कि जो यूरेनियम बाहर से आता है, वह इंडियन यूरेनियम से सस्ता है। कॉस्ट उसकी वजह से नहीं बढ़ता है। अभी जो इंडिया में न्यूक्लीयर पावर का कॉस्ट है, तारापुर-वन और तारापुर-टू में वह लगभग 90 पैसा प्रति किलोवाट है। We buy that power from the State Electricity Board at almost Rs.7 to Rs.9. There are two more new plants called Tarapur-III and IV, there too we generate power at around Rs.2.70, which is again the cheapest.

राजस्थान में आप देखेंगे, जो भी नये पावर प्लांट होते हैं, उसमें कॉस्टली होता है। These plants are all capital intensive plants where with the passage of time the cost of power comes down.

Second point is that these reactors work for at least 60 years. For example, Tarapur Reactor is almost operating for almost 45 years. It can easily run for another five years. As it goes towards the end of it, power cost comes down drastically. At the beginning, it is high and towards the end it is low.

If you take into consideration solar energy, you will get it cheap around Rs.8 or 9 per kilowatt. But it will provide you power only during particular time of day or season or a particular period. जैसे हमारा एक मानुवुरू में प्लांट है, जो 12 मेगावाट का प्लांट है। Their average output throughout the year is almost two to three megawatt. That means it is less than 20 to 25 per cent. If we add this cost taking into consideration the amount of land, it will not be very cheap. Anybody will establish a plant only if the generation of power through it is comparable to other sources of power other wise the state electricity boards will not buy it. This is the reason why we are doing so much to get loan for these foreign reactors. It is a capital intensive plant. Being a capital intensive plant, you need to get the capital cheap so that the power cost is less.

As of today, whatever power we get, if we are not able to bring down its cost, we will not be able to sell it because we are selling it in the open market with the State Electricity Boards. They will not buy from us. The Central Electricity Authority also says that you cannot sell power at a rate which is more than a particular price. There is an experimental reactor, PFBR. We are doing the costing of that. That will come between Rs. 5 and Rs. 6.5. That is a new technology, but power generated from all other plants will be cheaper."

Import of nuclear reactors

3.14 When asked about the terms and conditions of import of nuclear reactors from different countries, the DAE, in the written information furnished to the Committee, stated as under:

"The fundamental assessment of an imported reactor is cost viability and the soundness and safety of the relevant technology, based on the availability of a reference plant. In addition, assurance of life time supply of uranium is a critical consideration. With regard to the commercial requirement, a viable tariff regime for electricity generated, is an important pre-requisite."

Export of Nuclear reactors

3.15 When asked about collaboration with countries like Canada for joint export of nuclear reactors to other countries like Pressurised Heavy Water Reactors (PHWRs), the DAE submitted following written information to the Committee:

"Currently there is no proposal for joint export of nuclear reactors. However, efforts are being made to do so during bilateral discussions and also through Ministry of External Affairs (MEA) to explore possibilities of such ventures."

3.16 When asked whether the DAE is in a position to export nuclear reactors and the potential markets, the restrictions, if any, applicable in the light of international agreements/covenants, fuel linkages for exported reactors, competitiveness of the price of the reactors, the DAE submitted following written information to the Committee:

"India has full potential to export nuclear reactors of its PHWR design. There have been some exploratory discussion for collaboration with countries like Canada in this regard. India and Canada are the two countries with largest PHWR base and technology. Both sides have held some discussions to pool their expertise for greater mutual advantage and to look for joint export of PHWRs to other countries. Canada could supply the required uranium for such a PHWR plant, while India will supply the heavy water and major reactor components. Moreover, the safety design of Indian PHWRs has been upgraded to the post Fukushima safety requirements. The nuclear operators of both the countries have been requested to further explore this idea and to come up with a programme of action in due course."

3.17 On the same subject, the DAE representative furnished the following information during oral deposition before the Committee:

"Today itself we can supply Pressurized Heavy Water Reactors. Our design is very good. As I said, we are the only heavy water reactor producer in the world. The only issue is fuel...will get the fuel from some foreign country."

CHAPTER- IV

Nuclear Safety and Waste Management

4.1 Nuclear power is a reliable and safe energy option. With newer safety features, constant technological advancements and a more robust regulatory oversight, nuclear power is going to be safer in the future, including in India. Thanks to the diligence of scientists and engineers in the Country, India have a commendable record of operating its nuclear fleet for over 40 years without any serious incident.

Atomic Energy Regulatory Board (AERB)

4.2 Atomic Energy Regulatory Board (AERB) is the nodal agency in the Country which is responsible for ensuring safety of all atomic power plants in the country. The mission of the AERB is to ensure the use of ionising radiation and nuclear energy in India does not cause undue risk to the health of people and the environment. The functions of AERB are as follows:

i. Develop safety policies in nuclear, radiation and industrial safety areas for facilities under its purview.
ii. Develop Safety Codes, Guides and Standards for setting up, design, construction, commissioning, operation and decommissioning of different types of nuclear and radiation facilities.
iii. Grant consents for siting, construction, commissioning, operation and decommissioning, after an appropriate safety review and assessment, for establishment of nuclear and radiation facilities.
iv. Ensure compliance with the regulatory requirements prescribed by AERB during all stages of consenting through a system of review and assessment, regulatory inspection and enforcement.
v. Prescribe the acceptance limits of radiation exposure to occupational workers and members of the public and acceptable limits of environmental releases of radioactive substances.
vi. Review the emergency preparedness plans for nuclear and radiation facilities and during transport of large radioactive sources, irradiated fuel and fissile material.
vii. Review the training program, qualifications and licensing policies for personnel of nuclear and radiation facilities and prescribe the syllabi for training of personnel in safety aspects at all levels.
viii. Take such steps as necessary to keep the public informed on major issues of radiological safety significance.
ix. Maintain liaison with statutory bodies in the country as well as abroad regarding safety matters.

x. Promote research and development efforts in the areas of safety.
xi. Review the nuclear and industrial safety aspects in nuclear facilities under its purview.
xii. Review the safety related nuclear security aspects in nuclear facilities under its purview.
xiii. Notifying to the public, the 'nuclear incident', occurring in the nuclear installations in India, as mandated by the Civil Liability for Nuclear Damage Act, 2010.

4.3 Periodic safety audit of all atomic power plants in India is carried out by the Atomic Energy Regulatory Board (AERB).

4.4 When asked about the safety mechanism put in place in installations under the DAE, following written information was furnished to the Committee by the DAE:

"AERB has established a robust regulatory mechanism for ensuring safe use of the radiation sources at various radiation facilities in the Country. The regulatory mechanism is based on the principle of graded approach in their regulation based on their radiation hazard potential. The Diagnostic and research institutions/bodies/facilities using radioactive materials in the Country are regulated with respect to radiation safety requirements under the Atomic Energy Act, 1962, Atomic Energy Radiation Protection Rules, 2004 and AERB Safety Codes and Standards, Safety Guides and Guidelines and Safety Manuals.

To ensure radiation protection compliance by the facilities which are using radioactive materials for diagnostic or research purposes, inspections are conducted by AERB as per the frequency specified in AERB's regulatory documents "Regulatory Inspection and Enforcement in Radiation Facilities" (AERB/SM/G-3). As per the requirements in the regulatory documents, the diagnostic facilities using radioactive materials are to be inspected once in three years, whereas the research facilities using radioactive materials are to be inspected on a sample basis.

AERB conducts regular awareness programmes on aspects related to radiation safety and regulatory requirements. AERB has also been issuing notices periodically in the leading dailies specifying the requirement of obtaining licence from AERB.

Hospitals, Colleges, Universities and academic institutions desirous of installing and using any equipment with either a radioactive source or which generates ionizing radiation (such as x-rays) are required to obtain the requisite AERB "Licence for Operation".

"Licence for Operation" for the equipment is issued to only those institutions that install equipment whose design has been approved by AERB. AERB verifies the leakage radiation of an equipment/ its prototype along with other requirements and issues a Design Approval/Type Approval, as the case may be.

Before obtaining the Licence for Operation, the utilities are required to appoint AERB approved Radiological Safety Officers (RSOs) whose responsibilities include periodic radiological protection survey around the installation and reporting the radiation safety status to AERB. Further, all the radiation workers involved in operating the equipment are also required to be provided with TLD dosimeters(for monitoring the radiation dose received by them). The dose received by these workers are monitored at a periodicity of once in three months. The results of all these measurements are to be maintained at the institution, for scrutiny during regulatory inspections carried out by AERB.

Radioactive sources are to be kept under strict administrative control and safety and security is to be ensured by the Organisation/Institution holding the sources. BARC has developed radiation detection systems and monitoring methodology to detect the movement of orphan sources in public domain and for search of orphan sources. Detailed radiation monitoring in suspected areas and major cities including buildings are to be carried out by trained teams of Police and National Disaster Response Force (NDRF).

Large number of security agencies including trainers to train the first responders have been provided training by DAE. But for India, having a large area, having additional trained manpower, along with requisite equipment is advisable. This is primarily from considerations of early detection of any inadvertent radiation emergency and taking necessary preventive actions. DAE has 23 emergency response centres (ERCs) established in the country whose emergency response teams will be able to provide expert advice and technical support to the monitoring teams from Police and NDRF."

4.5 On the subject of safety audit of nuclear power plants, the following written information was furnished to the committee by the DAE:

"Periodic safety audit of all atomic power plants in India is carried out by the Atomic Energy Regulatory Board (AERB). All nuclear power projects (NPP) undergo an elaborate in-depth safety review during all stages, viz. setting up, construction, commissioning and operation. After satisfactory review during project stage, AERB issues operating licence to an NPP for a period of up to five years. During the licence period, safety performance of an operational NPP is continuously monitored in compliance with regulatory guidelines. A consolidated safety assessment of the plant is undertaken while renewing the operating licence after every five years. During the project stage of a power plant, quarterly regulatory inspections and during operation of a power plant, six monthly regulatory inspections are carried out by AERB. These inspections are in addition to the periodical safety review of all plants.

AERB also carries out elaborate and comprehensive Periodic Safety Review (PSR) for all operating NPPs at regular intervals. During the PSR, NPPs are subjected to an integrated review to ensure that the safety status of the plant is maintained as per the design intent and degradations affecting safety are attended to for example those due to ageing and/or change in plant/site environment. The PSR also involves comparison of the safety aspects with the current safety requirements/practices. Based on these PSRs, safety up-grades and modification, system/equipment replacement are identified and implemented as necessary. Several safety up-gradations and enhancement have been done in NPPs based on the outcome of periodic safety reviews.

In addition to the regulatory oversight by AERB, Nuclear Power Plants in India are also being reviewed by WANO (World Association of Nuclear Operators) and OSART (Operational Safety Review Team) mission of IAEA.

Further, the safety audits are also undertaken following any major incident relevant to nuclear safety anywhere in the world to examine the need for any strengthening of the safety features. One of the recent example of such reviews was the review done following the Fukushima Accident in 2011 based on which a number of safety enhancements were implemented at all Nuclear Power Plants."

4.6 When asked about the issue of impact of radiation on nearby population and the steps taken to address the concerns of the affected people by the DAE, following information was furnished to the Committee:

"The radiation dose from operation of nuclear power plants at Tarapur is a negligible fraction of the natural background (existing from natural sources like sun, cosmic rays, soil, rocks etc.) and has had no adverse health effects on the people living in the vicinity.
Environmental Survey Laboratories (ESL) are established at each site before the reactor operation which collect baseline radiation data from natural sources like cosmic rays, rocks, soil etc. of the site. After the plant goes into operation, environmental matrices like air, water, soil, crops, fish, milk etc. are monitored for radioactivity in an area upto 30 km around the plant. The data collected over 46 years of operation in India has shown that the increase in radiation level around nuclear power plants has been negligible and within the variations in the natural background.

Epidemiological survey for health assessment in respect of employees working in close proximity of radiation and staying in the nearby residential complex and villages of each of the nuclear power plants in operation have been carried out by reputed local medical colleges and analysis has been carried out by Tata Memorial Hospital (TMH), Mumbai, a premier cancer research centre in the country. In addition, annual medical checkups are carried out for all occupational workers regularly. The examinations/studies have found that the morbidity pattern of all ailments as well as birth defects among newborns is lower than the national average. There has also not been any rise in cancer morbidity, birth defects in the new born as compared to national average. No instances of radiation hazard to public including pregnant women residing around Tarapur Site has been reported.

AERB has laid down various requirements for safe operation of nuclear power plants. These requirements are in line the internationally accepted benchmarks of International Atomic Energy Agency (IAEA) and other regulatory bodies. Adherence to these safety requirements in each stage is ensured by systematic safety review of the reports submitted by utility and periodic regulatory inspections of the plant carried out by AERB.

AERB has also prescribed the requirement of environmental monitoring around each NPP site. In compliance of this requirement, extensive surveys of all environmental matrices as well as dietary products from area around the nuclear power plant sites are done by Environmental Survey Laboratories (ESLs). Radiation dose to members of the public near the operating plants is also estimated based on these surveys. The public dose calculated by ESL at plant boundary for Tarapur Site was 3.04 µSv (2015) as against the AERB specified limit of 1000 µSv/ year, which is applicable to all members of public including pregnant women. The annual dose limit of 1000 µSv is specified in line with the recommendations of the International Commission for Radiation Protection (ICRP) and is followed internationally. The information on the estimated dose to the public is reported in the Annual Reports of AERB regularly, which are available in the AERB website www.aerb.gov.in."

4.7 On the subject of risk of hazardous radiation on the workers in uranium mines and people living around nuclear reactors, following was submitted by the representative of the Department of Atomic Energy during the course of deposition before the Committee:

"question is about mining. जहां पर माइनिंग होती है, वहां अंडरग्राउंड जाते हैं, जिस भी क्षेत्र में हमारे लोग काम करते हैं, सबको एक बैज दिया जाता है। उनको हमेशा वह बैज पहनना होता है। हर हफ्ते, हर महीने और हर साल उनके बैज को आइडेंटिफाई कर के हम देखते हैं कि किसको कितना रैडिएशन मिला है। आज तक अगर आप डैमेज करने वाले आइफिल टॉवर का ऊंचा है, वह रेडिएशन जो लेते हैं, वह ब्रिक लैवल का हाइट है, इतना कम है, हम लोग ऐसा बताते और दिखाते हैं लोगों को, अगर आइफिल टॉवर की हाइट से आदमी को डैमेज होता है, जो रैडिएशन हमारे एंप्लॉइज़ को मिलता है, वह ईंट के बराबर की हाइट का है, इतना कम है। वह एक प्रतिशत से भी कम हम लोगों को मिलता है। इसलिए यूरेनियम से कोई प्रॉब्लम नहीं है। दूसरा है कि यूरेनियम का विस्फोट कहीं नहीं होता है। यह विस्फोट जो आप बोल रहे हैं, It is like a bomb and the bomb was used only in Hiroshima and Nagasaki in Japan. अभी जहां पर भी रीएक्टर्स का काम चलता है, वहां पर विस्फोट कहीं नहीं होता है। उसमें काबू में रखा हुआ है। एक रिएक्शन चलता है, इतनी एनर्जी मिलती है। इसलिए ओज़ोन लेयर तक जाने का कोई भी ऐसा विकल्प नहीं है। इसलिए प्रॉब्लम ही नहीं है। तीसरा है कि इस यूरेनियम से जो रेडिएशन आता है, इसको अल्फा रेडिएशन बोलते हैं। अल्फा रेडिएशन है कि जो हवा में एक सैंटिमीटर डिस्टेंस भी नहीं आता है। इसको छूने से या खाने से लोगों को तकलीफ होती है। अगर इस बिल्डिंग में दस किलो यूरेनियम रखें, एक टन यूरेनियम रखें, तो भी अपने को कोई नुकसान नहीं है। अल्फा तो अपने तक पहुंचता ही नहीं है इसलिए कोई रेडिएशन का सवाल नहीं है। हम अपको बोल सकते हैं कि हम न्युक्लियर फ्युल बनाते है, 40 साल हो गए और हमारी हैल्थ देखिए। I am the best healthy man. I am talking of all the 4000 employees. You see the average health. Every day we handle uranium. Last year, we have made 1500 tonnes."

4.8 When asked about the number and specialised experts required and average time taken for carrying out periodic safety audit of all nuclear power plants of India, following written information was furnished to the Committee:

"During the license period, AERB continuously monitors the safety performance of operating nuclear power plants (NPP) in compliance with the regulatory requirements. Detailed periodic safety reviews are taken up by the licensee which are further reviewed by AERB for license renewal every five years. It takes an average time of 6 months per NPP. AERB primarily utilises its infrastructure and resources & expertise (around 25 Nos.) for conducting safety reviews of operating nuclear power plants. These are additionally supported by specialized experts from among AERB staff, Technical Support Organisations and retired senior experts in various fields, as and when required."

4.9 On the subject of Training of first responder personnel for tackling nuclear disaster, following written submission was made to the Committee:

"Experts from DAE are imparting training to response agencies –

1. National Disaster Response Force (NDRF)
2. Sahshatra Seema Bal (SSB)
3. National Security Guards (NSG) and

Defence forces at their academies of –

4. NBCD School, INS, Shivaji, Lonovla
5. College of Military Engineering CME, Pune
6. AFINBCP, Arjan garh, New Delhi

First Responder courses have been conducted for Response agencies both as short duration courses (3 day module) and as Training of Trainers (TOT) course as 12 day module.

The course content for the module includes – Radiation Safety, Detection, Monitoring Systems, Contamination hazard assessment and control, Potential threat of Radiation Events (terrorism), Flow of information for activating response, Communication to public, National Emergency Response Network, Field exercises and Table top exercises.

In case of defence, course content is additionally structured to include – Nuclear Disaster case studies, effect, Mitigation of consequences by radiation response/counter measures and medical management of victims.

The course content for the response agencies is in sync with the manual on 'Training of First Responder to Radiological Emergency in Public Domain' by International Atomic Energy Agency (IAEA), 2006 and other guidelines available from IAEA.

For training of defence forces, our country specific details are added based on mutual capacity building, knowledge sharing by DAE in the field of radiation safety and emergency preparedness, response based on the participants' requirements."

Nuclear Waste Management

4.10 Radioactive wastes are generated during various operations of the nuclear fuel cycle. Mining, nuclear power generation, and various processes in industry, defence, medicine and scientific research produce by-products that include radioactive wastes. Radioactive waste can be in gas, liquid or solid form, and its level of radioactivity can vary. The waste can remain radioactive for a few hours or several months or even hundreds of thousands of years. Depending on the level and nature of radioactivity, radioactive wastes can be classified as exempt waste, Low & Intermediate level waste and High Level Waste.

4.11 Any activity related to the nuclear fuel cycle, that produces or uses radioactive materials generates radioactive waste. The management of radiation emitting radioactive material is a matter of concern and is what sets nuclear wastes apart. Public acceptance of nuclear energy largely depends on the public assurance for safe management of radioactive wastes. Not all nuclear wastes are particularly hazardous or hard to manage as compared to other toxic industrial wastes. It is also a time of heightened global concern about nuclear energy after the earthquake and the fear of the radioactive releases from the affected damaged reactors in Japan. In accordance with international guidelines, a coherent comprehensive and consistent set of principles and standards are being practiced all over the world for waste management system.

4.12 A representative of DAE made the following oral deposition before the Committee on the subject of nuclear waste:

"I must tell with all the pride that we are the most developed Country in waste management in the world and we have got the best plants...When we get the spent fuel, 99 per cent material in the spent fuel from Indian PHWRs is useful and only one percent is waste. We separate this one per cent waste also. After we get that waste, out of that waste also probably again 90 or 95 per cent is useful."

4.13 When asked about the nuclear waste management in India and our track record in managing nuclear waste *vis-a-vis* other countries, following information was furnished to the Committee:

"The safe management and disposal of radioactive wastes from the Atomic Plants/Nuclear Plants are regulated by the Atomic Energy Regulatory Board (AERB) in accordance with the Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987 and the requirements of AERB Safety Code on 'Management of Radioactive Waste (AERB/SC/RW)'. The waste management aspects are reviewed by AERB throughout the life cycle of the plants viz: siting, construction, commissioning and operation. Based on the satisfactory review of the arrangements made by the plant for safe management of radioactive wastes, AERB issues authorization with respect to the form, quantity and the activity content of the waste that can be discharged. Periodic reports are submitted by the plants to AERB in the prescribed format which are reviewed by AERB. AERB also conducts regular inspections of these plants to verify compliance with the laid down requirements.

The low level solid, liquid and gaseous wastes generated from nuclear power plants are disposed off as per the standard approved method after ensuring compliance with the regulatory requirements. The details are as follows:

1. Solid waste: Solid waste generated from nuclear power plants after suitable conditioning are disposed off in near surface disposal facilities (NSDF) located within the exclusion zone boundary of nuclear power plants. NSDFs are designed and constructed to contain the radionuclides within the disposal system until the decay of radionuclides to negligible activity level. The radioactive solid wastes generated during operation and maintenance of nuclear power plants is segregated and volume reduced prior to its disposal. Disposal of waste is carried out in specially constructed structures such as stone lined trenches, reinforced concrete trenches and tile holes. These disposal structure are located both above and under-ground in access - controlled areas and are designed based on multi barrier principle for ensuring effective containment of the radioactivity. The areas where the disposal structures are located are kept under constant surveillance with the help of bore-wells laid out in a planned manner by routinely monitoring the underground soil and water samples to confirm effective confinement of radioactivity present in the disposed waste.

2. Liquid waste: Low level liquid waste generated from nuclear power plants are discharged to the environment after suitable treatment ensuring

compliance with the regulatory limit. The treatment system essentially comprises chemical treatment, evaporation, ion exchange and filtration. Low and Intermediate Level Liquid waste streams are treated by various techniques, such as filtration, adsorption, chemical treatment, evaporation, ion exchange; reverse osmosis etc. depending upon the nature, volume & radioactivity content. Small concentrate volume contains majority of radioactivity and is immobilized in suitable conditioning matrix and disposed in various engineering modules. These engineered waste disposal modules are co-located with nuclear power plants and other radiological facilities.

3. <u>Gaseous waste:</u> Gaseous waste generated from nuclear power plants are discharged to the environment through high stack after filtration and dilution with continuous monitoring of radionuclides and compliance with the regulatory limits. Gaseous waste is treated at the source of generation. The techniques used are adsorption on activated charcoal and filtration by high efficiency particulate air filter.

The liquid and gaseous radioactive effluents discharged to the environment are only a small fraction of the prescribed limits.

India follows a three stage Nuclear Power Programme, which is based on a closed nuclear fuel cycle. Spent fuel from one stage of the programme is considered as the resource for the subsequent stages.

Safe management of nuclear waste has been accorded high priority right from the inception of our nuclear energy programme. Management of radioactive waste in Indian context includes all types of radioactive wastes generated from entire nuclear fuel cycle and also from installations using radio-nuclides in medicine, industry and research. Management of these wastes covers the entire range of activities right from handling, treatment, conditioning, transport, storage and disposal.

Utmost emphasis is given to separation/recovery of radio-isotopes present in waste for their deployment for societal applications, waste volume minimization, effective containment and isolation of radio-activity followed by near zero discharge of radioactivity to the environment, in selection of processes and methodologies for management of radioactive waste generated at different stages of nuclear fuel cycle.

As a waste management philosophy, no waste in any physical form is released/disposed to the environment unless the same is cleared, exempted or excluded from regulations. A comprehensive radioactive waste management practices are established taking into account the operational capability for the management of radioactive waste and an independent regulatory capability for its overview. The nuclear waste management practices are on par with international practices following the guidelines of International Atomic Energy Agency. Nuclear waste in the form of gaseous, liquid and solid are generated during operation & maintenance activities of nuclear power plants. Radioactive waste streams are commonly classified as low level waste (LLW), intermediate level waste (ILW) and high level waste (HLW), primarily depending upon the concentration of radioactive constituents present in the waste. A brief summary of the processes being adopted for management of the wastes arising from nuclear power plant is given below.

99% of material in spent fuel is useful material. The spent fuel is reprocessed and useful material is recovered using complex solvent extraction process. The material is recycled back to reactor as fuel. High level radioactive waste generated during reprocessing of spent fuel, containing mainly fission products and long lived minor actinides, is converted into glass through a process called vitrification. The vitrified waste is stored for an interim period in a Solid Storage Surveillance Facility prior to its eventual disposal in geological disposal facility. This policy is at par with international practices following the guide lines of International Atomic Energy Agency. With the advent of new technologies based on partitioning of waste, where long - lived radioactive waste constituents are separated prior to immobilizing them in glass matrices, the need of geological disposal facility will not be there in near future. The long lived radio-contaminants is planned to be burnt in fast reactors or Accelerator Driven Sub-Critical systems to get converted into short- lived species. Main fission products like Cs-137 & Sr-90 present in the waste are recovered using in-house developed technologies and deployed for societal applications covering medical applications as an external irradiators and other industrial applications. This is accomplished first time in the world by India, where radioactive waste is regarded as a useful by-product.

So far, no serious incident related to waste management."

Public Awareness about Nuclear Technology

4.14 When asked about the steps taken to bring awareness among the people about nuclear power and also to bring awareness among the people living near or around the nuclear power Plants in the Country, DAE furnished following written information to the Committee:

"NPCIL is implementing a public outreach programme based on a multipronged approach to spread awareness about nuclear power and address the apprehensions of the people living in the vicinity of nuclear power plants in a credible manner. The efforts include distribution of single sheets in simple local language addressing each of the issues concerning the local people, arranging visits to nuclear power plants, holding exhibitions, briefing local press & media, addressing community leaders and people’s representatives etc. Showcasing short films in local languages in theatres, short films on TV, radio jingles, and several innovative approaches like exhibitions on wheels, street plays etc. have also been adopted.

Awareness on nuclear power among the people living near and around Nuclear Power Plants in the Country is imparted through a variety of programmes.

These include:

Exhibitions:

Public awareness exhibitions and Science Expos are held on nuclear power and interaction with the people by experts, especially in vernacular, depending upon the location of the power plant.

Lecture series:

A series of lectures are delivered by experts on the Indian Nuclear Power Programme with focus on the need for nuclear power and safety of the Indian nuclear reactors.

Awareness through Nuclear Power Plant Site visits:

Site visits are organised periodically for citizens in the neighborhood of nuclear power plants and they are made aware of the benefits of nuclear energy.

Awareness by Development & Distribution of Public Awareness documents/printed material

Printed material disseminating authentic detailed information based on scientific facts is distributed to public in the neighbourhood of the plants.

Miscellaneous Initiatives:

Workshops and competitions were organised for school children through the pan-India (including neighboring areas of nuclear power plant sites) outreach programme."

4.15 The Committee were further informed in an oral deposition by a representative of the DAE:

"….your next point is regarding fear in the people for nuclear power plants. I think, Sir, this fluctuates.

If we do not have direct jobs in office, we have to give them jobs in terms of contracts. This is what we should try to do. My experience is that if we arrange some kind of a livelihood for these people, then there is no resistance. It is not that they are really scared of it, they are looking for some help from us."

Rehabilitation and Resettlement Policy

4.16 When asked whether the DAE has specific Resettlement and Rehabilitation (R&R) policy to ensure that there would not be any opposition in land acquisition for setting up of new nuclear power plants or expansion of the existing ones, the DAE furnished following written information to the Committee:

> "Land acquisition for nuclear power projects is carried out through the State Governments. A comprehensive rehabilitation package including compensation for land, provision of various facilities for the PAPs etc. is worked out by the respective State Governments based on the prevalent Central/State laws, in consultation with NPCIL. The R&R package is implemented by the State Government and the cost for the same is funded by NPCIL.
>
> In addition, NPCIL under its Neighbourhood Development Programme carries out several activities for the welfare of the PAPs and persons in the neighbourhood. For livelihood generation, skill development training programmes are arranged for people among the Project Affected Peoples (PAPs) under Corporate Social Responsibility (CSR) Programmes and Neighbourhood Development Programme.
>
> Public awareness campaigns are also carried out to address any concerns about livelihood loss among the PAPs and others in the neighbourhood."

Chapter -V

Application of Nuclear technologies for societal benefits.

5.1 There are spin-off uses of technologies used in the nuclear power plants in various fields such as agriculture, food processing, health care, drinking water, etc. A number of problems facing us today can be addressed by application of nuclear technology.

Water desalination/removal of toxic materials

5.2 When asked about using nuclear technology spin-off for improving water quality, the DAE furnished following information to the Committee:

> "DAE has the technology to convert both sea/saline water into potable/drinking water as well as for removing/reducing contaminations from polluted water. Desalination Technology converts sea/saline water into potable/drinking water and is thoroughly reliable, robust and sustainable. Desalination of sea/saline water can be done through one of the following processes:
>
> 1. Thermal Desalination technology whereby distilled water is produced directly from sea/saline water with the application of low grade steam/waste heat/solar thermal heat and electricity. The two main principles used for desalination are Flash Evaporation (Multistage Flash Desalination, MSF) and Boiling (Multi-effect Distillation, MED). The distillate product is as such suitable for process and/or boiler make-up feed applications and it may be further polished to make it suitable for potable/drinking water as well.
> 2. Membrane based Technology like Reverse Osmosis (RO) whereby the sea/saline water when pressurised through a semi-permeable membrane produces directly potable/drinking water as per IS: 10500.
>
> A Hybrid Sea water Desalination Plant of 6.3 MLD (Million Liters/Day) capacity based on both the above technologies has been installed, commissioned and is under operation in Kalpakkam, BARC, DAE for several years now.
>
> Recently, BARC has developed and transferred the technical knowhow of preparing sea water desalting membranes to a private entrepreneur for mass scale production and its deployment.
>
> The cost of desalinated potable/drinking water depends on many factors like siting, availability of infrastructure, availablity of sea water intake system, cost of power available at site, scale of operation of the plant, load factor etc. As a typical example, for the Kalpakkam 6.3 MLD seawater desalination plant, the cost of desalinated water comes to about 6 to 10 paise per liter.

Desalination technologies are sustainable and are applicable for mass scale. DAE is now putting-up a 5.0 MLD Hybrid Desalination plant at Indian Rare Earths Ltd. (IREL), OSCOM, Odisha."

5.3 About technology for detecting and removing arsenic and other pollutants in Water, DAE furnished following information:

"1. Technology for removal of arsenic and other pollutants

Water quality problems exist nearly in all parts of our Country. Micro-biological contamination is a common problem in most parts of the Country. Specific regions have some predominant geogenic based contaminants like iron in north eastern States and arsenic in the eastern part of the Country. Considering limited infrastructure in rural areas, household level point-of-use (POU) water treatment methods are better alternative to community scale plant from the point of view of long term sustainability and maintenance. BARC has developed a combo domestic water purifier device which is made of polysulfone based nano composite ultrafiltration membrane in cylindrical configuration. This configuration/device can be effective for removal of microbial contaminations, arsenic and iron without the need of any electricity and overhead water tank. The device is most suitable for rural and slum areas. The salient features of the device are:

- The heart of the purifier is nano material impregnated polysulfone ultrafiltration membrane in candle configuration.
- The device is stand alone and can remove suspended materials and microorganism with bacteria removal efficiency of 99.99 %.
- The device can remove arsenic contamination by an in situ generated sorbent with simple addition of two pre-formed reagents and subsequent membrane filtration to provide product water with arsenic contamination < 10 ppb as per WHO standard.
- The device can remove iron contamination by addition of slaked lime and subsequent membrane filtration to provide product water with iron contamination < 0.3 parts per million (ppm) as per WHO standard.
- The simple two compartment device can treat 25-30 Liters of contaminated water per day and cost about ₹1500-2500/- per unit with membrane life of about 3 years. The operating cost of the units is 2-3 paise/ liter of pure water.

Nuclear Power Corporation of India Ltd. (NPCIL) under the CSR programme is planning to deploy these units in the villages around their nuclear power plant sites. Know-how of this technology has been transferred to four private parties for commercialization.

2. Technology for removal of brackishness and other contaminants

Reverse Osmosis (RO) is an efficient water purification technology for providing safe drinking water from saline and/or contaminated water. The technology developed by BARC provides a process for the preparation of thin film composite polyamide (TFCP) membranes and procedure to assemble them in commercially usable spiral modules. These membranes are capable of providing safe drinking water by removing 90% salinity from brackish water of Total Dissolved Salts (TDS) up to 5000ppm. Besides removal of salts, it also removes/reduces virtually all the contaminants from water like turbidity, heavy metals, fluoride, halocarbons etc.

The entire process involves the following steps:

- Preparation of polymeric micro-porous support membrane using casting machine.
- Thin film coating of Polyamide over support membrane by in-situ poly-condensation technique using appropriate reagents
- Assembling of Thin Film Composite (TFC) membranes in spiral module configuration

This technology has been transferred to several private entrepreneurs for commercialization and the domestic Reverse Osmosis (RO) unit of capacity about 25 liters/day, costs about ₹12,000-15,000/- and has an operating cost of about 25-30 paise/liter."

5.4 With respect to application of technology for drinking water, a representative of the DAE made following oral deposition before the Committee:

"I will give one example of water. In Uttarakhand, the villages are dependent on spring. They all dried out. That problem was referred to us by xxxxx who is local associated with a local NGO. He wrote to us and we went there and started helping. Now, all those springs recharged by very simple means and I am proud to announce that that is known as BARC water."

Further,

"...we are working on a nuclear based desalination plant which purifies almost 6300 cubic meter water per day, which will take care of around one lakh people per day. This is not exactly nuclear based, it is basically done through the steam which is the secondary product of it."

Agriculture

5.5 With respect to application of technology in agriculture, a representative of the DAE made following oral deposition before the Committee:

"In agriculture, by mutation breeding, we have developed 42 varieties of seeds which we have released and they are in the range of groundnut, edible oils and also pulses, cost of which varies every year. These take care of protein requirement of the Country. Our numbers all over India may be 15 or

20 per cent of our seeds, and if you take Maharashtra where we are present, the number is about 50 or 60 per cent or in some places it is 15 per cent also. After sometime, this would spread all over India. We try to go to many other States, almost all the States with the help of the local agricultural universities where we would deliver this technology, with their help it would spread into those States. This is a big programme, it is going on at reasonable speed."

Food Processing

5.6 The Central Institute of Post-Harvest Engineering and Technology (CIPHET), Ludhiana has estimated the annual value of harvest and post-harvest losses of major agricultural produces at national level to be of the order of ₹92,651 crore calculated using production data of 2012-13 at 2014 wholesale prices. Annual wastage of agricultural produce, milk, meat, marine and poultry products as assessed by CIPHET is as under:

Commodity/Crop	Losses during Transportation (%)	Losses during Farm Operations (including transportation loss) (%)	Losses during Storage (%)	Overall Total Loss (%)	Monetary value of the loss (in ₹ crore)
Milk	0.02	0.71	0.21	0.92	4409
Meat	0.00	1.99	0.72	2.71	1235
Marine Fish	0.91	9.61	0.91	10.52	4315
Inland Fish	0.17	4.18	1.05	5.23	3766
Egg	0.36	4.88	2.31	7.19	1320
Poultry Meat	0.66	2.74	4.00	6.74	3942
Cereals				4.65-5.99	20698
Pulses				6.36-8.41	3877
Oilseeds				3.08-9.96	8278
Fruits & Vegetables				4.58-15.88	40811

5.7 With respect to application of technology in food processing, a representative of the DAE made the following oral deposition before the Committee:

> "... Similarly, in food preservation, food samples are treated with different doses of ionizing radiation that enhances the shelf life of various foods. Such treated foods can be stored at room temperature (such as grains, pulses and spices and products derived) and also in cold storage (such as fruits and vegetables, stored at 4–5°C, depending upon the commodity). The shelf life of packed and radiation treated grains, pulses, spices and products more than one year, whereas fruits (such as mango, pomegranate and grapes) and vegetables (such as potato and onion) can be stored for 2–6 months. Irradiation as a phytosanitary requirement of fruits (mango and pomegranate) also helps in its international trade. Currently, 15 food irradiation plants are functional in the country; some more are in advanced stage of construction."

Waste Management in Cities

5.8 With respect to application of technology in urban waste management, a representative of the DAE made following oral deposition before the Committee:

> "Similarly in waste, particularly municipal waste from big cities – one or two million citizens – there, we can do this sludge where you can give radiation. After that all the bacteria, etc. are killed then it becomes a very good source of organic manure. One plant is coming up in Ahmedabad. Any day, it would be operational because they took interest. So, we have been able to make the plant. They say, in about three or four years, they would recover their cost. Cost of the manure that they would sell, also the subsidy that goes into various types of chemical fertilizers that also would be saved. Big saving would be there. In Indore we are putting up this plant.
>
> Similarly the waste water where you can give some radiation. Most of the waste water in Ganga even, it comes from tanneries and textile dyes plants."

Health Care

5.9 With respect to application of technology in health care, a representative of the DAE made following oral deposition before the Committee:

> "… In Cancer care, we do three types of work. One is treating the patient. Then, creating a manpower base to treat the patient and third, developing drugs and supplying it – radio isotopes – for doing this. उसके लिए रिएक्टर और साइक्लोट्रोन बनाना पड़ता है। We have to compare us with the world. Tata Memorial Centre at Mumbai is looking after 70,000 new patient per year. And

they see five lakh patient every year. Thus we have taken up seven new hospitals - both big and small - are under construction today. In the next three to four years, 70,000 new patients will be increased to 1.50 lakh. More important is the cost of the Cancer care if you go to private hospitals, it is probably $1/5^{th}$ or $1/10^{th}$ of that. It is actually very good and this care is of world care type. NITI Ayog demanded a projection for next 15 years in which they have said, this number of patients which is 70,000 today, will be able to take it to 5 lakh in about 15 years. Today it is said that about 10 lakh new patients come up every year, we want to take care of 50 per cent of the patient… On tuberculosis we have one very big centre in Mumbai with whom we have some collaboration on this. We have made some kits for tuberculosis detection and we have also offered them. But that is under Mumbai Municipal Corporation. We have offered them technology to apply radiation to whatever waste they have and kill all the bacteria. But that has not gone ahead because they have not taken it. If they take it, it will go ahead. Technologically it is very easy to do."

Environmental Pollution

5.10 With respect to application of technology in addressing the issue of environmental pollution, a representative of the DAE made following oral deposition before the Committee:

"…I would say that we improve the environment and this is what is our moto. If anybody approaches us, we will be very happy to help. We have many technologies and we can show what we have done in our various fields. We can show how to improve the environment."

5.11 The Committee were further informed that nuclear technology can be applied for sucking out CO_2 particles from atmosphere in small scale and can also help in removing bacteria and other pollutants from air which will improve air quality in the cities.

Research activities and capacity building in Nuclear power sector:

5.12 When asked about the DAE's linkages with educational institutions, the DAE furnished following written information to the Committee:

" i) Awareness about carrying out the R&D activities related to nuclear energy programme is created among researchers across the Country through interactions with DAE Scientists during various symposia and other outreach programmes. DAE's extra mural funding through Board of Research in Nuclear Scientists is open to all the Government recognised and academic and R&D Institutions. Research project proposals submitted to BRNS undergo a well established different stages scrutiny, evaluation., review, revision etc. before sanction.

ii) Financial grant for carrying out the research project is given to the institution for duration of typically 2 to 3 years under a specified budget head.

iii) List of 54 projects funded in nuclear energy related field is given in the table. **(Appendix -II)**

iv) The studies provided useful inputs to the ongoing DAE activities, particularly in connection with Uranium exploration, impact of Uranium mining and nuclear waste management.

v) The basis of granting financial support and the process followed is quite robust and it has evolved over decades of experience and therefore no major change is envisaged."

5.13 Following oral deposition was also made before the Committee:

"But most of the universities, who are a little progressive, they have taken some amount of funding from us... Four universities have started courses in nuclear engineering at M.Tech. level. We have included private universities also. IIT-Kanpur was the first one to start. But there are some issues. One is designing the course; another one is giving them faculty and some infrastructure. The next issue is how to absorb those persons who come out of these universities. We are not able to meet this requirement because they have to go through the system; they cannot be directly recruited. That is why it has not progressed… Other than IIT-Kanpur, Jadhavpur University has started it. Then we have Pandit Deendayal Upadhyay University in Gujarat where we are giving faculty members and other support. Maybe there are two or three more institutions. But the problem again remains that the students choose a subject keeping in mind the possibility of getting a job in India... There are Centres of Excellence being created in many of the universities with the support from the Department of Atomic Energy. We have the Board of Research for Nuclear Sciences……That is the main agency for interacting between DAE and NSTs… IIT-Bombay is nearby. We have created a centre and for 15 years, the work is going on 50:50 partnership. We give our work to them, they employ Ph.D. students who work on our problems and provide the data and information. Similarly, Institute of Chemical Technology is there. I think one-third programme of their Institute is in collaboration with Bhabha Atomic Research Centre. So, there are many success stories… I just want to say that the Budget is going up. There are many universities where we are going and giving a talk saying that these are the areas where we need collaboration and so please submit projects. But unfortunately, we are finding only IITs and NITs which are getting away with ten or twenty projects."

5.14 When asked about the observation made by the C&AG on the issue of shortage of technical manpower in DAE and cost-time overshoot in the construction and commissioning of some of the Nuclear Power Plants, DAE submitted following reply to the Committee:

> "The above report has not made any mention of shortage of technical manpower in NPCIL. However, it is stated that NPCIL has taken actions for recruitment and training of technical manpower to ensure meeting of the requirements of the planned expansion programme in time. As per the Report of the C&AG, the increase in cost was due to additional Russian manpower requirement along with other expenses, which is explained as: "although deployment was always done judiciously, yet due to specialized nature of work, the overlapping activities that could have been carried out simultaneously got spread over due to prolongation of project duration, resulting in increase in the manpower requirement."

Part - II

Recommendations/Observations

Introductory

Nuclear power provides an important and clean energy option for mitigating the energy shortfalls in the Country. India considers nuclear power as a sustainable and cost-effective source of power. In view of our limited uranium resources and in order to ensure long term energy security, India has opted for a three stage nuclear power programme aiming to multiply the domestically available fissile resource through the use of natural uranium in Pressurised Heavy Water Reactors, followed by use of plutonium obtained from the spent fuel of Pressurised Heavy Water Reactors in Fast Breeder Reactors. Large scale use of thorium will subsequently follow making use of uranium-233 that will be bred in Fast Breeder Reactors, when adequate nuclear installed capacity in the Country has been built.

As per data of the Central Electricity Authority, per capita consumption of power in the Country was 1075 kWh in 2015-16 as compared to 1010 kWh in the previous year. In comparison, per capita power consumption was 3927 kWh in China, 5130 kWh in UK and in the USA, it was 12984 kWh in the year 2014 (World Bank data). The Indian power sector is largely thermal based, with 64.3% of installed capacity accounted for by coal, gas and diesel based plants. The percentage of nuclear source of energy to the total installed capacity is just about 2% of the total installed capacity. Therefore, there is immense scope and need for expansion of power or energy consumption in the Country. In order to become energy sufficient, India has to look beyond the conventional sources of energy. Energy generated from Nuclear Power Reactors, Nuclear plants can be a reliable source of energy for the Country.

At present, Nuclear Power Corporation of India Limited (NPCIL) operates 22 nuclear power reactors (including RAPS-1, which is under long shutdown) with an installed capacity of 6780 MW and another 08 reactors of 6200 MW are under construction at various stages. Besides, for 12 new reactors of 9000

MW, administrative and financial approval has been accorded by the Government. Indian nuclear power plants have for about five decades, demonstrated safe and reliable operation and generated about 598 Billion units of clean electricity up-till financial year 2017-18. Besides generation of electricity, DAE has been playing a significant role in the development and applications of various radio-isotopes in healthcare, industry, agriculture and research. India is one of the leading countries in the isotope technology today as a result of the consistent efforts of DAE.

To enable nuclear power plants to work smoothly, there is a need to ensure unhindered uranium supply to our reactors. NPCIL expected requirement of fuel during 2018-19 is 354 (tons UO_2) which would increase to 535 (tons UO_2) during 2021-22. Out of 22 nuclear power reactors, 14 reactors are under IAEA safeguards and use imported fuel. The remaining 8 reactors are fuelled by the indigenous fuel. Imported nuclear fuel requirement for IAEA safeguarded power reactors annually for one effective full power year based on tariff norms for fuel consumption for various types of reactors is 795 (tons UO_2).

International trade in uranium is governed by the 48 nation Nuclear Suppliers Group (NSG). The trade in uranium and nuclear-related technology is restricted among the members of this group. Although, India is not a formal member of the NSG, as a recognition to excellent non-proliferation track record of India's nuclear programme, NSG granted a country-specific waiver in 2008 exempting India from the NSG's rules governing civilian nuclear trade. The Committee appreciate the sincere efforts made by the DAE which resulted in getting this waiver from NSG, which means that India now has the legal right, under the world nuclear regulatory regime, to trade for civilian nuclear fuel and technology. Observations/recommendations emerging out of deliberations held by the Committee on various issues related to the subject `Import of Uranium for Nuclear Plants' are discussed below.

Financial Allocation and revenue generation by DAE

2. The Committee note that the Department of Atomic Energy (DAE) has been allocated ₹13,971.41 crore as BE 2018-19 which is 5.76% more than the RE 2017-18 (₹13209,94 crore). The Committee also note that the actual expenditure of the DAE in 2016-17 was ₹12,894 crore. The BE and RE in the year 2017-18 were ₹12,461 crore and ₹13,209.94 crore respectively. The Committee have been informed that the Government has made a special provision of ₹3000 crore per year for construction of nuclear power plants and the DAE is also getting ₹1000 crore to ₹2000 crore from the National Clean Energy Fund. The Committee also note that the DAE has sought a funding of about ₹15000 crore per year from the Government for its requirements relating to Uranium import and nuclear power plants. For procurement of uranium, the DAE spent ₹1500 crore in the year 2016-17. Taking advantage of low prevailing uranium prices, the DAE was able to procure two and a half times more uranium than it had planned for. The Committee appreciate that the DAE has been able to utilize the financial allocation made to it and recommend that flow of adequate financial allocation may be maintained by the Government to enable it to undertake further expansion of nuclear power generation and also reach the target of maintaining the stockpile of uranium to ensure continuity in supply.

3. So far as mobilisation of sources internally by DAE is concerned, the Committee find that sources of revenue generation include revenue from interest receipts, dividend, contributions & recoveries, power, industries and atomic energy research. The analysis of the data of revenue generation by DAE, as made available to the Committee during the course of examination, reveal that the overall revenue generated has fluctuated during the last five years. The revenue generated during 2013-14 was ₹6716 crore which increased to ₹6911 crore during 2014-15 and subsequently declined in 2015-16 and 2016-17 to the level of ₹6802 and ₹5733 crore, respectively. During the year 2017-18, although the overall revenue generated has increased to ₹7175 crore as compared to ₹5733 during the previous year, the revenue generation under the `heads' - power, industries and atomic energy research has declined from

₹2009 crore, ₹1400 crore and ₹104 crore to ₹1520 crore, ₹1330 crore and ₹84 crore, respectively. With regard to the financial performance of NPCIL, revenue from operations has increased from ₹9626 crore during 2015-16 to 12026 crore during 2017-18. The Committee have been informed that ₹10660 crore is the revenue target for the year 2018-19. The Committee would like the Department to furnish the reasons for declining of revenue generation under power, industries and atomic energy research heads and the lesser targets set during 2018-19 by NPCIL.

<u>Supply of Uranium</u>

4. The Committee note that a major portion of domestic production of uranium comes from Jaduguda mines of Jharkhand. These mines are old where uranium is now found at one of the greatest depths in the world. High extraction cost involved in mining makes it unviable as compared to imported uranium. Apart from Jharkhand, uranium reserves are available in Meghalaya, Andhra Pradesh, Rajasthan, Haryana, Karnataka and Tamil Nadu. There are possibilities in other regions also. The Committee have also been informed that imported uranium will continue to be used in reactors which are sourced from abroad. The dependence on imported uranium will reduce in case the domestic production is ramped up and new mines are developed and made functional. The Committee recommend that adequate financial allocation should be provided and all the requisite steps be taken to ensure that new mines are opened as soon as possible for increasing domestic production of uranium.

5. The Committee observe that the decades of nuclear isolation of the Country due to its determination to pursue indigenous nuclear programme came to an end with the signing of Indo-US Civil Nuclear Agreement in 2008. The agreement enabled India to access other countries for nuclear fuel and technology. Although the Agreement and subsequent NSG 'waiver' lifted the embargo on nuclear trade, India still need bilateral agreements with all the member countries of NSG because framework of an Inter-Governmental Agreement (IGA) includes supply of nuclear and non-nuclear materials specifically included in such an IGA and also provides for ancillary matters

such as exchange of training personnel, organisation of symposia and seminars, technology transfer, provision of relevant technical assistance and services, exchange of scientific and technical information and documentation, joint research and/or development projects and other forms of cooperation, as may be mutually determined in writing, by the two sides. Such IGAs help structured cooperation towards development of nuclear power, Research and Development, Radiation and Nuclear Safety, Regulatory exchanges, etc. in India. The Committee have been informed that IGA is required even if uranium is mined by private companies in any country, as its export is strictly regulated by that country in accordance with its legal requirements to ensure non-proliferation. Nuclear trade with India by a foreign enterprise is possible only based on the assurance of the concerned foreign Government which is secured in the form of an IGA.

The Committee note that even though India has entered into IGA with countries, namely, USA, UK, Russia, South Korea, Japan, Kazakhstan, Australia, Argentina, Canada, Czech Republic, France, Mongolia, Namibia, Vietnam and Bangladesh, import of Uranium, so far, has been sourced from only a few countries, namely, Canada, Kazakhstan, France and Russia. No uranium has been imported from other leading producers such as Uzbekistan and other for a number of reasons. The Committee feel that it is important to have multiple sources of uranium supply to protect against supply uncertainties. This is all the more important as the prevailing prices of uranium in the global market are, at present, low and imported uranium will continue to be used in reactors which are sourced from abroad as also in the safeguarded projects. The Committee, therefore, recommend that earnest efforts including diplomatic efforts should be made to explore import of uranium from some more countries with whom India has IGAs. Besides, IGAs should also be concluded with other countries for import of fuel, equipments and technology. The Committee desire to be apprised of the steps taken in this regard within three months of presentation of the Report to Parliament.

6. The Committee note that the DAE aims at a stockpile of 15000 tonnes of uranium for achieving a level of comfort in so far as achieving supply security

of nuclear fuel for nuclear power plants is concerned. The Committee also note that the Government has approved 10 more Pressurised Heavy Water Reactors (PHWRs) for which there will be a requirement of about 1250 MT of natural uranium dioxide fuel. More reactors will be built in future as the economy moves away from fossil fuels towards greener sources of power. Given the prevailing low international prices of uranium, the Committee feel that it is right time to undertake large-scale procurement of uranium. The Committee, therefore, recommend that adequate financial allocation be made for procurement of required quantity of the approved reactors and the DAE may also consider revising the target of stockpile upwards if the prices and other situations are favourable. Besides adequate storage capacity for reserved stockpile of uranium with adequate safety measures should be created expeditiously.

Nuclear Power Generation

7. The Committee note that the DAE was earlier given a target of 63 GW electricity by 2032 or 2034 in nuclear sector and subsequently a revised target was given by the Government to triple the generation by 2024 which would come to about 14 GW. The Committee have been informed that the revised target is likely to be achieved. The Committee note that total nuclear power generation in 2015-16 was 37456 million units which increased to 38336 million units in 2017-18, an increase of 2.45% in two years. The Committee also note that DAE has planned a tenfold increase in the installed capacity by way of setting up of additional nuclear power projects. Ten indigenous PHWRs of 700 MW each have been sanctioned in June 2017 for which preparatory work has already started. The Committee also note that the DAE is now planning to add 2500 MW to 3000 MW of nuclear power generation every year. The Committee have also been informed that the constraint of funding has now been addressed and the Government has agreed to provide funds on a regular basis for the next 15-20 years. The Committee note that with the availability of sufficient funding and favourable raw material availability scenario, the targeted increase in capacity addition is achievable. The Committee, therefore, recommend that the DAE should get into more agreements with the

organizations, get uranium and reactors and also make their own reactors to reach the target. They should also exercise adequate monitoring and supervision to ensure that the reactors under construction are completed without any time or cost over-run and the target of adding about 3000 MW nuclear power per year is achieved.

8. The Committee note that Nuclear Power Corporation India Limited (NPCIL) is responsible for siting, designing, constructing, commissioning and operation of nuclear power reactors in the Country. At present, the NPCIL operates 22 nuclear power reactors with a total installed capacity of 6780 MW. Of these, one reactor RAPS-1 (100 MW) is under extended shutdown for techno-economic assessment and KAPS-1 (220 MW) is also under long shutdown for Renovation and Modernisation activities - En masse Coolant Channel Replacement (EMCCR) and En masse Feeder Replacement (EMFR). KAPS-2 (220 MW), which was under shutdown for Renovation and Modernisation activities, has restarted after undergoing the EMCCR and EMFR procedures. The Committee observe that the plant load factor (PLF) for nuclear plants was 77.09% in 2015-16 (for 21 plants) which came down to 74.32% in 2017-18 (for 19 plants). In comparison, the PLF for coal based power plants was 60.67% in 2017-18. Therefore, the PLF for nuclear power plants is better than coal-based plants. As regards cost of power, the Committee note that the nuclear power plants are capital intensive plants. However, once the plant is installed and starts running, the cost comes down drastically. The Committee have been informed that in the old plants of Tarapur, the cost of power is as low as 90 paise per unit whereas in the newer plants at the same location, the cost is about ₹2.70 per unit which is still competitive to State Electricity Board supplied power. In view of requirement of heavy capital investment at the outset, it is necessary to provide capital at a low rate so that the input cost is contained. Although the Central Government has assured funding for the sector, given the ambitious targets set for the nuclear power sector, the Committee feel that since the recent amendments in the Atomic Energy Act, 1962 provide for joint venture companies with other PSUs, NPCIL should make efforts in this direction to meet additional funding requirements for the sector.

Use of thorium as part of long-term nuclear power programme

9. The Committee note that thorium reserves in India are among the largest in the world and the DAE has a plan to use thorium as part of its long-term nuclear power programme. With this in view, a three-stage nuclear power programme, based on a closed nuclear fuel cycle has been chalked out to use thorium as a viable and sustainable option which aims to multiply the domestically available fissile resource through the use of natural uranium in Pressurised Heavy Water Reactors, followed by use of plutonium obtained from the spent fuel of Pressurised Heavy Water Reactors in Fast Breeder Reactors. Large scale use of thorium will subsequently follow making use of uranium-233 that will be bred in Fast Breeder Reactors, when adequate nuclear installed capacity in the Country has been built. The third stage of Indian nuclear power programme which contemplates making use of this uranium-233 to fuel uranium-233 – thorium based reactors, can provide energy independence to the Country for several centuries.

With the sustained efforts over years, India has gained experience over the entire thorium fuel cycle- fabrication, irradiation and reprocessing on a semi-industrial scale. As a long term plan, the Department is working on technology development for High temperature reactors where thorium will be used as a fuel. While taking pride in India being one of the most advanced Country in thorium research, the Committee strongly recommend that adequate financial allocations and other support should be provided and constraints of funds should not come in the way of implementation of different stages of the nuclear power programme.

10. The Committee note that the second stage of the three stage nuclear programme of the Country involves reprocessing of spent fuel and utilising recovered plutonium to build Fast Breeder Reactor (FBR) initially as the FBR uses a plutonium core and depleted Uranium blanket to breed more plutonium than the original output. The Committee also note that the Prototype Fast Breeder Reactor (PFBR) with the capacity of 500 MW is being established in Kalpakkam, Tamil Nadu. The Committee have been informed that the PFBR is at the advanced stage of completion and is expected to be commissioned by

the fourth quarter of 2018-19. The Committee further note that owing to certain issues in the commissioning of PFBR, there has been a cost overrun and an additional requirement of ₹423 crore has been projected. The Committee recommend that additional funding for the PFBR project should be expeditiously granted and the DAE should also ensure that the PFBR is made operational without any further time and cost overrun.

11. The Committee note that the Country has achieved expertise in the designing of PHWR. Moreover, the safety design of Indian PHWRs have been upgraded to the post-Fukushima safety requirements. The Committee also note that the DAE currently does not have any proposal for joint or individual export of nuclear reactors. The Committee have been informed during the deliberations that efforts are being made to explore the possibilities in bilateral discussions and also through Ministry of External Affairs (MEA). The Committee further note that India is currently the only pressurised heavy water nuclear producer in the world and feel that the opportunities for export of PHWR reactors to friendly uranium producing countries should be explored with a view to pool their expertise and for greater mutual advantage. The partner country can supply the required Uranium for such a PHWR plant, while India could be a source for heavy water and other major reactor components. The Committee, therefore, recommend that the Government should capitalize on its expertise in the PHWR nuclear reactor market. Efforts may also be made for joint export of PHWRs with Uranium supplier countries. The Committee may be apprised of the steps taken in this direction.

Nuclear Safety and Waste Management

12. The Committee have been apprised that Atomic Energy Regulatory Board (AERB) is the nodal agency in the country responsible for ensuring safety of all atomic power plants in the Country. The mission of the AERB is to ensure that the use of ionizing radiation and nuclear energy in India does not cause undue risk to the health of people and the environment. The Committee note that the AERB conducts regular inspections to ensure radiation protection compliance by the facilities which are using radioactive materials for diagnostic or research purposes. Besides DAE trains large

number of security agencies including trainers to train the first responders. While appreciating the impeccable safety track record of Indian nuclear reactors, as presented before the Committee by the DAE, the Committee emphasize for taking all requisite measures for safety and security of atomic power plants.

13. The Committee note that radioactive wastes are generated during various operations of the nuclear fuel cycle. Mining, nuclear power generation, and various processes in industry, defence, medicine and scientific research produce by products that include radioactive wastes. Radioactive waste can be in gas, liquid or solid form, and its level of radioactivity can vary. The Committee have been informed that the waste can remain radioactive for a few hours or several months or even hundreds or thousands of years. The Committee also note that the safe management and disposal of radioactive wastes from the Atomic Plants/Nuclear Plants are regulated by the Atomic Energy Regulatory Board (AERB) in accordance with the Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987 and the requirements of AERB Safety Code on 'Management of Radioactive Waste (AERB/SC/RW)'. The waste management aspects are reviewed by AERB throughout the life cycle of the plants, *viz*, siting, construction, commissioning and operation. The Committee have been informed that India is one of the most developed countries in nuclear waste management in the world. In the spent fuel in reactors, 99 per cent material is useful and only one percent is waste. Even in the remaining one percent, many useful materials are found. The Committee appreciate that the nuclear waste management practices in India are at par with international practices following the guidelines of International Atomic Energy Agency. It is a matter of satisfaction that no major nuclear disaster has taken place in the Country since the beginning of nuclear programme. The Committee, however, observe that lessons should be learnt from nature as to how it protects from the deleterious effects of solar radiation by creating absorbents in the form of ozone layer in-between. If such absorbents are created in a systemic manner that no harmful radiation can pass through them, it can protect the danger of having any skin cancer or any other cancer from nuclear radiation.

14. The Committee observe that in most of the installations administering X-Ray, sonography, etc. for diagnostic purposes, record of radiation administered to the patients are not kept or provided to the patients. The Committee also observe that no institutional mechanism or manpower or equipment exists- either in public or private sector- to monitor the quantity of radiation to which patients are exposed during examinations such as X-ray, MRI, etc. The Committee recommend that there should be systemic and institutionalized way of recording radiation administered during diagnostic tests. Adequate manpower for the purpose should be created by way of imparting training to the youth. The equipment should be such which can indicate when the prescribed safe limit of radiation is crossed. The patient should also be educated and informed before performing tests involving exposure to radiation.

15. The Committee note with concern that in AERB, as on 01.05.2016, the sanctioned staff strength was 459 against which the total staff in position was 326, the shortage being of 133 personnel, *i.e.*, about 29% of its total strength. The Committee consider it unacceptable to have such an acute shortage of manpower in such a vital organization. The Committee, therefore, recommend that the DAE and the AERB should immediately take urgent steps to fill these vacancies. The Committee be apprised of the steps taken in this regard within three months of presentation of the Report to Parliament.

16. The Committee observe that there is apprehension in the mind of people, particularly those living in the neighbourhood of nuclear installations about the hazards they are exposed to. The Committee, therefore, recommend that the DAE should give wide publicity through print and electronic media in local languages about the safety aspects and safety arrangements for the benefit of the populace living near nuclear installations. The Committee also recommend that periodical community awareness camps be organised in the area for the awareness of the local inhabitants.

Application of Nuclear Technology for Societal Benefits:

Water Quality Improvement

17. The Committee note that the technologies developed in nuclear plants have made applications in different areas. For instance, the Committee have been informed that DAE is working on a nuclear based desalination plant which purifies almost 6300 cubic meter water per day, which will be sufficient for meeting needs of around one lakh people per day. This is not exactly nuclear based, it is basically done through the steam which is the secondary product of it. DAE has the technology to convert both sea/saline water into potable/drinking water as well as for removing/reducing contaminants from polluted water and this is thoroughly reliable, robust and sustainable. Further the BARC has developed and transferred the technical knowhow of preparing sea water desalting membranes to a private entrepreneur for mass scale production and its deployment.

The Committee observe that in the river Ganga, starting from Kanpur and going right up to Bangladesh, there is terrific amount of arsenic. The DAE has the technology for removing arsenic from water. This is called ultra filtration membrane that removes arsenic. The Committee also note that these technologies may also be used for removing brackishness and other pollutants from water. The Committee feel that the application of nuclear and spin-off technologies may be immensely useful for India in the field of providing potable water to all. The Committee are fully conscious of the fact that while DAE has this technology, they do not have that mandate for its application at mass scale. For an effective solution of drinking water, the Ministry of Water Resources, River Development and Ganga Rejuvenation needs to take steps in collaboration with the Department of Atomic Energy, so as to utilize such technologies for improving water quality in the Country in coordination with the Ministries/agencies concerned, especially in the areas where potable water is in scarcity. The Committee feel that such technologies are not meant only for transfer to a handful of entrepreneurs for commercialization. Provision of clean drinking water to the common people in both rural and urban areas at affordable cost has to be the top most priority of

the Government and huge investments and initiatives on their part is required in this connection. Such applications should also be given wide publicity. The Committee may be apprised of the steps taken in this direction within three months of the presentation of the Report to Parliament.

<u>Agriculture and Food Processing</u>

18. The Committee note that the nuclear technologies have applications in the agriculture and food processing sector also. In agriculture, by mutation breeding, 42 varieties of seeds of groundnut, edible oils and pulses have been developed and released. The Committee recommend that linkages with State Governments and agricultural universities may be strengthened so that the seeds may be widely distributed among the farming community for its maximum impact and high yield.

19. In food processing, the Committee note that almost 16 percent of our fruit and vegetable products worth about ₹41,000 crore are wasted every year during transportation and storage. Similarly, the wastage of foodgrains is also high. The Committee note that with the use of nuclear technology by giving small amount of radiation, their shelf life can be increased substantially. The Committee recommend that an institutional mechanism with the partnership of the stakeholders may be created to promote the application of nuclear technology for promoting food processing and preservation.

<u>Solid Waste Management in Cities</u>

20. The Committee note that with the application of nuclear technology, urban waste management can be improved. With radiation of urban waste - whether solid or liquid - all the bacteria present in the waste are killed and the waste may become a good source of organic manure. Similarly, the waste water coming out of textile dyes and tanneries may also be improved by radiation. The Committee recommend that DAE may give publicity to their technologies which are useful for waste management in cities and rural areas. The DAE may also publicise the ways for contacting them so that the urban

and rural local self-government institutions may become aware of these technologies for waste management and get maximum benefit.

Health Care

21. The Committee note that nuclear technologies have application in health care sector in the treatment for diseases such as cancer and tuberculosis. In health care, Cancer care is a very big success. In Cancer care, they do three types of work- treating the patient, creating a manpower base to treat the patient and third, developing drugs and supplying it – radio isotopes – for doing this.

The Committee also note that the DAE provides financial assistance in the form of Grants-in-aid to Tata Memorial Hospital in Mumbai for cancer patients. They also have collaboration with a tuberculosis centre under Mumbai Municipal Corporation to whom they have offered kit for TB detection. They have also offered them technology to apply radiation to waste and kill bacteria. The Committee further note that these institutions provide quality care for cancer and TB at affordable cost. In view of rising number of cancer and TB patients in the Country, the Committee recommend that more such hospitals be opened in various parts of the Country so that the patients do not have to travel to Mumbai for quality health care and that adequate financial allocation be made to DAE for this purpose.

Environmental Pollution

22. The Committee note that nuclear technologies also have application in addressing the issue of environmental pollution in our urban areas. Air pollution is one of the major problems facing the urban population today and a large number of people in cities suffer from various diseases on account of air pollution. The Committee have been informed that nuclear technology can be applied for sucking out CO_2 particles from atmosphere in small scale and can also help in removing bacteria and other pollutants from air which will improve air quality in the cities. The Committee, therefore, recommend that DAE may give wide publicity to their technologies which are useful for addressing

atmospheric pollution in cities. The DAE may also give publicity about the availability of consultation mechanism for the benefit of State Governments.

23. India is advocating peaceful use of atomic energy. The Committee appreciate that with its successful record of nuclear power generation and research for more than five decades, India has achieved expertise in the field. The Committee are of the opinion that India should make efforts to become a hub for disseminating technologies for peace time uses in the field of agriculture, health, water purification, solid waste management, etc. and export the same to other friendly countries. This will not only generate revenue but also make the DAE a self-reliant Government Department.

<u>Public Awareness about safety of Nuclear Safety</u>

24. The Committee note that there is a general apprehension among the people who are living near nuclear reactors and other nuclear installations about the impact of nuclear radiation on their health as well as impact on land resources. As a result of such apprehensions there have been sporadic protests on the installation of nuclear reactors and demand that they may be located away from populated areas. The Committee have been informed that the DAE, in order to, address such concerns and remove such apprehensions from the minds of people living near to nuclear installations, have undertaken activities such as distributing pamphlets in local language, arranging visits to power plants, holding exhibitions, briefing local media, street plays and other audio visual media like films and radio jingles to reassure them that it is completely safe to live near nuclear installations and there is no hazard of radiation. The Committee, while appreciating the efforts of the DAE to create awareness among the local people, also observe that it is necessary to make local people stakeholders in the entire exercise by offering them jobs wherever possible and also contributing to the development of local area through activities such as assisting in construction of hospitals, schools, supply of potable water and other utilities. The Committee recommend that adequate financial allocations for such activities should be made on priority.

Rehabilitation and Resettlement (R&R) Policy

25. The Committee note that for establishment of new or expansion of existing nuclear power plants and for other related purposes, land is acquired under the Land Acquisition Laws. The Committee also note that a comprehensive rehabilitation package including compensation for land, provision of various facilities for the Project Affected Peoples (PAPs), etc. is worked out by the respective State Government based on the prevailing laws and consultations with NPCIL. The R&R package is implemented by the State Government and the cost for the same is funded by NPCIL. Apart from that other outreach activities including skill development training are also undertaken by the NPCIL to the project affected people. The Committee feel that the NPCIL and the DAE need to work for the overall development of the area. This will not only ensure smooth operation of nuclear power plants but also bring development and prosperity to the region. Therefore, adequate financial allocation should be made for the purpose and the DAE may also develop a standard list of activities that may be undertaken in all the project areas-whether existing or proposed. The Committee may be apprised of the steps taken in this regard within three months of the presentation of Report to Parliament.

Research activities and capacity building:

26. The Committee note that the DAE carries out interaction with researchers in universities through symposia and other outreach programmes. Besides, it provides financial grant to the institutions for carrying out research projects related to Uranium exploration, impact of Uranium mining and nuclear waste management. The Committee also note that the DAE invites research proposals in nuclear sciences and such proposals, after being duly approved, are supported through 'Extra Mural Research Funding'. The Committee further note that post-graduation courses in nuclear engineering have started in four universities. This initiative is also extended to private universities. The Committee appreciate the initiatives being taken by the DAE to promote such courses and research activities in universities in the nuclear sciences. The Committee, however, express concern that such activities are limited to just a

few universities and few research projects. Given the ambitious programme of the Government to increase the power generation through nuclear sources and many nuclear reactors likely to come up in the near future, there will be requirement of trained manpower in the coming years. It is important that the DAE expands its outreach programmes with universities and encourages formal studies in nuclear sciences as soon as possible so that the Country has a pool of trained manpower when it is needed. The Committee, therefore, recommend that the DAE should undertake necessary steps to ensure that such research support and funding are extended to universities in all parts of the Country. Necessary financial allocation should also be made for this purpose and also for starting formal studies in nuclear sciences in different universities.

*****

NEW DELHI;	**Dr. MURLI MANOHAR JOSHI,**
10 December, 2018	**CHAIRPERSON,**
19 Agrahayana, 1940 (Saka)	**COMMITTEE ON ESTIMATES.**

अनुलग्नक Annexure -A

दिनांक 12 मई, 2018 तक आयात किए गए यूरेनियम और भुगतान का विवरण

Details of imported Uranium and payments made as on May 12, 2018

वर्ष Year	M/s. AREVA, France*		M/s. JSC TVEL Corporation, Russia**		M/s. JSC NAC Kazatomprom, Kazakhstan*		M/s. Cameco, Canada*	
	यूरेनियम की मात्रा (मे.टन) Quantity of Uranium (MT)	भुगतान (करोड़ रु. में) Payment (`Cr.)	यूरेनियम की मात्रा (मे.टन) Quantity of Uranium (MT)	भुगतान (करोड़ रु. में) Payment (`Cr.)	यूरेनियम की मात्रा (मे.टन) Quantity of Uranium (MT)	भुगतान (करोड़ रु. में) Payment (`Cr.)	यूरेनियम की मात्रा (मे.टन) Quantity of Uranium (MT)	भुगतान (करोड़ रु. में) Payment (`Cr.)
2008-09	60.49	266.08	शून्य Nil	शून्य Nil	शून्य Nil	शून्य Nil	शून्य Nil	शून्य Nil
2009-10	239.39		120.17 58.3@	229.08 480.48	शून्य Nil	शून्य Nil	शून्य Nil	शून्य Nil
2010-11	शून्य Nil	शून्य Nil	210.13	329.29	600.00	379.84	शून्य Nil	शून्य Nil
2011-12	शून्य Nil	शून्य Nil	296.12	440.84	350.00	318.32	शून्य Nil	शून्य Nil
2012-13	शून्य Nil	शून्य Nil	295.64	521.10	402.50	339.30	शून्य Nil	शून्य Nil
2013-14	शून्य Nil	शून्य Nil	296.32	538.07	460.00	382.82	शून्य Nil	शून्य Nil
2014-15	शून्य Nil	शून्य Nil	296.55	542.52	283.42	216.95	शून्य Nil	शून्य Nil
2015-16	शून्य Nil	शून्य Nil	303.79 42.15@	565.17 303.65	शून्य Nil	0.86	250.74	158.28
2016-17	शून्य Nil	शून्य Nil	187.33	395.29	1923.66	893.75	1233.68	534.51
2017-18	शून्य Nil	शून्य Nil	शून्य Nil	शून्य Nil	1490.00	639.47	989.45	373.82
2018-19	शून्य Nil	शून्य Nil	शून्य Nil	शून्य Nil	576.14	##	शून्य Nil	शून्य Nil

* प्राकृतिक यूरेनियम अयस्क सांद्रण के रूप में। In the form of Natural Uranium Ore Concentrate.

** प्राकृतिक यूरेनियम डाई-ऑक्साइड गटिकाओं के रूप में। In the form of Natural Uranium Di-oxide Pellets.

@ समृद्ध यूरेनियम डाई-ऑक्साइड गटिकाओं के रूप में। In the form of Enriched Uranium Di-oxide Pellets.

भुगतान करना बाकी है। Payment yet to be released.

Annexure-2

Research Projects Sanctioned BRNS on Topics Related toNuclear Energy (2008-2015)

Sr. No.	Sanction No.	Project Title	Name & Address of the Principal Investigator	Amount in Lakhs
1	36(5)/14/24/ 2014-BRNS	Paragenesis of unconformity related uranium mineralization in the eastern part of Chattisgarh basin using isotope geo-chemistry and fluid-inclusion micro thermometry	Dr. S.N. Lal, Department of Geology, Centre of Advanced Study, Kumaon University, Nainital 263 002, Uttarakhand	18
2	36(5)/14/33/ 2014-BRNS	Study of metamorphics and granites of AlmoraNappe, Kumaun Lesser Himalaya, for possible uranium minerali	Dr. Mallickarjun Joshi, Department of Geology, Banaras Hindu University, Varanasi 221 005	34
3	36(5)/14/34/ 2014-BRNS	Petrochemical, rare metal and rare earth studies of the carbonatite-alkaline complex at Hogenakal, Dharmapuri District, Tamil Nadu, I	Dr. M. Srinivas, Department of Geology, University College of Science, Saifabad, Osmania University, Hyderabad 500 004	34
4	36(5)/14/35/ 2014-BRNS	Process development for the recovery and extraction of Nb and Ta from carbonatites of Sevathur deposit, Tamil Nadu	Dr. Shiva Kumar Angadi, Scientist, Institute of Minerals and Materials Technology (IMMT), Bhubaneswar 751 103	27
5	36(5)/14/36/ 2014-BRNS	Structural control of uranium mineralization in VindhyanMahakoshal contacts in Central India	Dr. Vaibhava Srivastava, Department of Geology, Banaras Hindu University, Varanasi 221 005	28
6	36(5)/14/37/ 2014-BRNS	Origin and structural control of uranium mineralization in paleoproterozoicBomdilla Group, Upper Subansiri and West Siang Districts, Arunachal Pradesh	Dr. Nilanjan Das Gupta, Department of Geology, Presidency University, 86/1 College Street, Kokata 700 073	35
7	36(5)/14/44/ 2014-BRNS	Physico-chemical and deformational control of rare earth and rare metal (REE-RM) mineralization in parts of south and north Purulia shear zone (SPSZ and NPSZ), East Indian shield	Dr. SanjoySanyal, Department of Geological Sciences, Jadavpur University, Kolkata 700 032	55
8	2012/36/23	Strutural and petro-minerological controls of uranium mineralization in Hurra-Ki-Dhani-Jahaz area, Sikar District, Rajasthan	Dr. Dilip K. Mukhopadhyay, Department of Earth Sciences, Indian Institute of Technology-Roorkee, Roorkee 247 667	30
9	2012/36/30	Mapping of placer sand bodies, land use / land cover pattern and delineation of palaeo-shore lines using Remote Sensing and GIS in the coastal districts of Kerala	Dr. C.J. Kumanan, Centre for Remote Sensing, BharathidasanUniversity, Tiruchirapalli 620 023	65
10	2012/36/31.	Coastal morpho dynamics, landform and land use / land cover	Dr. J. Saravanavel, Centre for Remote Sensing,	63

Annexure - 1 (contd.)

		based places mineral exploration for Andhra Pradesh sung Remote Sensing and GIS	BharathidasanUniversity, Tiruchirapalli 620 023	
11	2012/36/32	Mapping of placer sand bodies, land forms and land use / land cover pattern using Remote sensing and GIS in coastal districts of Odisha and West Bengal	Dr. K. Palanivel, Centre for Remote Sensing, BharathidasanUniversity, Tiruchirapalli 620 023	65
12	2012/36/36	Geomatics based structure, land form and land use / land cover mapping for placer mineral exploration in coastal Tamil Nadu	Dr. D. Ramesh, Centre for Remote Sensing, BharathidasanUniversity, Tiruchirapalli 620 023	77
13	2011/36/29	Flowsheet development for recovery of Nb-Ta from carbonatite rocks and the derived soils / gravel from Samchampi and SungValley	Dr. C. Eswaraih, Scientist C, Institute of Mining and Materials Technology (IMMT), Bhubaneswar 751013	
14	2011/36/30	Mineralogical and leaching studies for the recovery of uranium, niobium and REE values from Rasimalai alkali syenite pluton, Tamil Nadu, India	Dr. S. Subramanian, Department of Materials Engineering, Indian Institute of Science, Bangalore 560 012	
15	2011/36/31	Structural petromineralogical, geochemical and fluid inclusion studies of U- and REE– bearing rocks around Bangurdih, Simulbera-Rangamatia areas, Singhbhum shear zone, eastern India	Dr. Dipak C. Pal, Department of Geological Sciences, JadavpurUniversity, Kolkata 700 032	
16	2011/36/32	Evaluating the potential of malani igneous suite rocks, Rajasthan for uranium mineralisation by petrological and geochemical studies	Dr. DewashishUpadhyay, Department of Geology and Geophysics, Indian Institute of Technology-Kharagpur, Kharagpur 721 302	
17	2011/36/33	Structural, mineralogical and geochemical appraisals of the Pur-Banera basin, Rajasthan for assessing its uranium potential	Dr. Biswajit Mishra, Department of Geology and Geophysics, Indian Institute of Technology-Kharagpur, Kharagpur 721 302	
18	2011/36/53	Geo-chemical and litho-structural characterization of basement and sediment rocks for delineating potential uranium mineralized zones in the Pakhal basin, in Andhra Pradesh	Dr. B. Srinivas, Department of Applied Geochemistry, OsmaniaUniversity, Hyderabad 500 007	
19	2011/36/54	Iron isotope fractionation during ore genetic processes : A new exploration tool	BulusuSreenivas, Senior Scientist, National Geophysical Research Institute, Hyderabad 500 007	
20	2011/36/55	Hydrogeochemical studies in Kurnool - Narnuru area of Cuddapah basin with special reference to uranium and trace metal speciation modeling	rof. V. Sudarshan, Department of Applied Geochemistry, OsmaniaUniversity, Hyderabad 500 007	
21	2011/36/56	Delineation of teri / red sediments, palaeo shorelines and land use and land cover pattern in Vaigai river basin in between Taruvaikulam and Tondi, Tamil Nadu	. D. Ramesh, Centre for Remote Sensing, BharathidasanUniversity, Tiruchirapalli 620 023	

Annexure-2(contd)

22	2011/36/59	Structural control of unconformity-proximal type uranium mineralization in the northwestern part of the Srisailam sub-basin, Andhra Pradesh	Dr. Gautam Ghosh, Department of Geology, Presidency University, Kolkata 700 073	
23	2011/36/60	Deciphering the history of hydrothermal activity and controls on uranium mineralization at Koppunuru : Constraints from mineral chemistry, stable isotope and fluid inclusion studies	Dr. K.L. Pruseth, Department of Geology and Geophysics, IIT-Kharagpur, Kharagpur 721 302	
24	2011/36/61	Petro-minerological and geochemical studies to identify rare metal and rare earth rich phases in PrakasamAlkalineProvince, Andhra Pradesh	Dr. R. Mallikarjuna Reddy, Department of Geology, KakatiyaUniversity,Warangal 506 009	
25	2011/36/66	Hyperspectral radiometry for identifying mineral alteration around Chitrial area, Nalgonda and Mahoobnagar districts, Andhra Pradesh	Dr. S. Sanjeevi, Department of Geology, AnnaUniversity, Chennai 600 025	
26	2010/36/96	Sedimentological, geological and structural studies of Vindhyansediments in areas around Bundelkhandcraton for assessing potentiality of sandstone type uranium mineralisation	Prof.K.K. Agarwal, Centre of Advanced Study in Geology, University of Lucknow, Lucknow (Uttar Pradesh)	
27	2010/36/97	Structural, sedimentological and geochemical characterisation of DeonarPorcellanite of Vindhyan Basin in parts of Madhya Pradesh, to assess the potential for hosting uranium mineralization	Prof.Hari B. Srivastava, Department of Geology, Banaras Hindu University, Varanasi 221 005	
28	2009/36/53	Modelling of fluid processes in the unconformity type uranium mineralisation in Srisailam and Painad sub-basins of Cuddapah basin, Andhra Pradesh	Dr. M.S. Pandian, Department of Earth Sciences, Pondicherry University, Puducherry 605 014	
29	2009/36/54	Geostatistical modelling of uranium deposits in nothern part of Srisailam sub-basin and Simulation modelling for adjoining environments	Prof. A.C. Narayana, UCESS, University of Hyderabad, Hyderabad 500 046	
30	2009/36/55	Nature and composition of fluids and their role in uranium mineralization in the basement granites, quartzites from Gulcheru – Pullivendla and Vempalledolostones, Cuddapah basin, Andhra Pradesh	Dr. S. Govindaiah, Department of Geology, University of Mysore, Mysore 570 006	
31	2009/36/56	Structural and tectonic control of Albitite related uranium mineralization and associated metallogeny in Northern Rajasthan	Dr. Sumit Kumar Ray, Dept. of Geology, Presidency College, 86/1-College Street, Kolkata 700 073	
32	2009/36/57	Localisation of uraniferous zones along albitite line around Khandela in NDFB using microstructural techniques	Dr. Harsh Bhu, Department of Geology, MohanlalSukhadia University, Udaipur 313 001	
33	2009/36/58	Studies on applications of botanical surveys in mapping and prospecting of uranium in north Rajasthan along zone of albitisation	Dr. B.L Jagetiya, Department of Botany, M.L.V. Government College, Bhilwara 311 001 (Rajasthan)	

Annexure-II (Contd)

34	2008/36/16	Facies analyses, palaeo environmental reconstruction of quartz pebble conglomerates vis-avis uranium mineralisation: Tomkadaitari basin, Orissa	Dr. P.P. Chakraborty, Department of Applied Geology, Indian School of Mines University, Dhanbad-826 004	
35	2008/36/33	Integrated lithofacies and biofacies analysis of cretaccous sediments, south Shillong plateau, Meghalaya	Dr. P. Phukon, Department of Geological Sciences, Gauhati University, Guwahati 781 014	
36	2008/36/36	Pressure temperature fluid evolution in parts of SPSZ: Implication for boron metasomatism and U-Fe-Cu-P mineralization	Dr. PulakSengupta, Department of Geological Sciences, Jadavpur University, Kolkata 700 032	
37	2008/36/37	Sedimentological controls of QPC hosted uranium mineralisation in the Mahagiri quartzite, southern part of Daitari-Tomka basin, Jajpur, Orissa	Dr. JoydipMukhopadhyay, Department of Geology, Presidency College, Kolkata 700 073	
38	2008/36/38	Geochemical and petromineralogical characterization of Delhi supergroup of rocks along zones of albitisation in Rajasthan with relation to uranium mineralization	Dr. M.K. Pandit, Department of Geology, University of Rajasthan, Jaipur 302 004	
39	2008/36/39	Hydrothermal alteration pattern based exploration model for unconformity type uranium and other associated metals in southern part of Sonrai basin, Lalitpur District, Uttar Pradesh	Dr. A.K. Sen, Department of Earth Sciences, Indian Institute of Technology-Roorkee, Roorkee 247 667	
40	2008/36/40	Lithostructural studies of the uraniferousmetasomatities of Delhi supergroup rocks, Haryana and Rajasthan utilizing aerospace data on the GIS platforms	Dr. Anand Mohan Bhola, Department of Geology, University of Delhi, New Delhi 110 007	
41	2008/36/41	Sedimentological and structural studies of Badami sediments of KaladgiSupergroup, in and around Deshnur area, Belgaum District, Karnataka, to explore unconformity related uranium mineralization	Dr. S. Ramaswamy, Department of Geology, University of Madras, Chennai - 600 025	
42	2008/36/42	Integrated hydro geological investigations for concealed uranium mineralisation in Kamarwadi and Sedam area, Bhima basin, Karnataka	Dr. K.L. Narahari Rao, Department of Geology, Bangalore University, Bangalore 560 056	
43	2008/36/43	Characterization of granitic phases and associated igneous suites to assess their potentiality for uranium mineralization in the northern part of Cuddapah basin	Dr. R. Pavanaguru, Department of Geology, Osmania University, Hyderabad 500 007	
44	2008/36/44	Sedimentological and geochemical characterization of Gondwana sediments and basement rocks in Betul district, Madhya Pradesh, for their uranium potential	Dr. Anil M. Pophare, Department of Geology, Nagpur University, Nagpur 440 001	
45	2008/36/45	Integrated geochemical surveys in the Srisailam formation in Chitrial and Akkavaram areas in Nalgonda and Mahboobnagar Districts, Andhra Pradesh	Dr.R.S.N. Sastry, Department of Applied Geochemistry, Osmania University, Hyderabad 500 007	
46	2008/36/46	Characterization of ore forming fluids and fluid flow analyses in the proterozoic unconformity type uranium	Dr. C. Srikantappa, Department of Geology, University of Mysore, Mysore 570 006	

76 Annexure-B (contd)

		deposits in Srisailam and Kaladgi basins, Southern India		
47	2008/36/47	Bioremediation studies of tailing ponds of uranium mines	Dr. G. Sudhakar, Director (Development), Environment Protection Training and Research Institute, Hyderabad 500 032	
48	2008/36/48	Characterization of organic matter in proterozoicunconfirmity related uranium deposits – A case study from Srisailam and Palnad sub basins	Dr. R. Ramesh, Institute for Ocean Management, Anna University, Chennai 600 025	
49	2008/36/49	Geochronological studies on uranium mineralization and host granitoids in parts of South India using 233U / 236U isotope tracer solution	Dr. S. Balakrishnan, Department of Earth Sciences, Pondicherry University, Pondicherry 605 014	
50	2008/36/56	Geological and geochemical characterization of calcretes and provenance rocks in parts of Jodhpur, Barmer, Nagpur Districts, Rajasthan	Dr. K. L. Shrivastava, Department of Geology, JNV University, Jodhpur 342005	
51	2007/37/21/BRNS	Preconcentration of uranium by using cloud point technology	Dr. B.K. Mishra, Department of Chemistry, Sambalpur University, Jyoti Vihar-768 019	15
52	2007/37/29/BRNS	Marine Cyanobacteria – A Potential Candidate for Uranium Mining	Dr. L. Uma, Director, National Facility for Marine Cyanobacteria, Bharathidasan University, Tiruchirappalli-620 024, T.N.	15
53	2010/37C/57/BRNS	Gum kondagogunano-composite: A natural carbohydrate polymer based nano-particle for efficient uranium removal from radioactive wastes.	Prof. B. Sashidhar Rao, Head, Department of Biochemistry, University College of Science, Osmania University, Hyderabad - 500007, A.P	15
54	2012/20/37C/12/BRNS	Synthesis of Uranium co-ordination complexes and probing its electronic and magnetic properties	Prof. MaheswaranShanmugam, Dept. of Chemistry, IITB, IIT, Powai, Mumbai - 400076	20

Annexure - I

MINUTES OF THE SECOND SITTING OF THE COMMITTEE ON ESTIMATES (2016-17)

The Committee sat on Thursday, the 19th May, 2016 from 1500 hrs. to 1725 hrs. in Room No. 53, Parliament House, New Delhi.

PRESENT

Dr. Murli Manohar Joshi – Chairperson

Members

2 Shri George Baker
3 Shri Dushyant Chautala
4 Shri Ashok Chavan
5 Shri Ashwini Kumar Choubey
6 Shri Col. Sonaram Choudhary
7 Shri Ram Tahal Choudhary
8 Shri P.C.Gaddigoudar
9 Smt. Kavitha Kalvakuntla
10 Shri Arjun Ram Meghwal
11 Shri K.H. Muniyappa
12 Shri Rajesh Pandey
13 Shri Ravindra Kumar Pandey
14 Shri Konakalla Narayan Rao
15 Shri Arvind Sawant
16 Shri Jugal Kishore Sharma
17 Shri Rajesh Verma
18 Shri Jay Prakash Narayan Yadav

SECRETARIAT

1. Shri Devender Singh - Additional Secretary
2. Shri Vipin Kumar - Director
3. Shri Srinivasulu Gunda - Additional Director

WITNESSES

DEPARTMENT OF ATOMIC ENERGY (DAE)

1.	Dr. Sekhar Basu	Chairman, Atomic Energy Commission & Secretary, DAE
2.	Shri Sanjeev Sood	Joint Secretary, DAE
3.	Shri N. Sai Bana	Chief Executive, Nuclear Fuel Complex, DAE

2. At the outset, the Chairperson welcomed the Members to the sitting of the Committee. He then directed the representatives of the Department of Atomic Energy (DAE) be called in.

[*The representatives of DAE enter*]

3. The Chairperson welcomed the representatives of DAE and drew their attention to Direction 55(1) of 'Directions by the Speaker, Lok Sabha' regarding the confidentiality of the proceedings of the Committee and asked Secretary, DAE to introduce themselves.

4. The representatives of DAE, after brief introduction, made a power-point presentation on the sites for existing Nuclear Power Plants which are under operation, commissioning and construction, details of present status of contracts with various partner countries for Uranium import, fund requirement in the year 2016-17 for import of Uranium, year-wise stock position of Uranium with the existing orders, etc.

5. Thereafter, the Members raised various queries on the issues such as energy generation capacity of each of the Nuclear Power Plants, consumption percentage of domestic Uranium and the efforts to increase domestic production of Uranium, details of country-wise import. The Committee also enquired about the legal and regulatory hurdles faced by India in importing Uranium in the country, the diplomatic efforts made in easing of nuclear trade with foreign countries, financial aspect of importing Uranium, terms and conditions of purchasing of Uranium from partner countries, roadmap of India's future civil Nuclear energy generation, etc.

6. The representatives of the Department responded to queries raised by the Members. The Chairperson asked the representatives of the Department to furnish written replies to the points for which information was not readily available.

7. The verbatim proceedings of the sitting of the Committee were kept on record.

The Committee then adjourned.

Annexure - II

MINUTES OF THE SECOND SITTING OF THE COMMITTEE ON ESTIMATES (2018-19)

The Committee sat on Tuesday, 22nd May, 2018 from 1100 hrs. to 1300 hrs. in Room No. 53, Parliament House, New Delhi.

PRESENT

Dr. Murli Manohar Joshi – Chairperson

Members

2 Shri George Baker
3 Shri Kalyan Banerjee
4 Shri Ramesh Bidhuri
5 Col. Sonaram Choudhary
6 Shri Ramen Deka
7 Shri Nishikant Dubey
8 Shri Kaushalendra Kumar
9 Shri P. Kumar
10 Shri Rajesh Pandey
11 Dr. Bhagirath Prasad
12 Shri Md. Salim
13 Shri Arvind Sawant
14 Shri Jugal Kishore Sharma
15 Shri Jay Prakash Narayan Yadav

SECRETARIAT

1. Smt. Sudesh Luthra - Additional Secretary
2. Shri N.C. Gupta - Joint Secretary
3. Shri Santosh Kumar - Additional Director

WITNESSES

DEPARTMENT OF ATOMIC ENERGY (DAE)

1.	Dr. Sekhar Basu	Chairman, Atomic Energy Commission & Secretary, DAE
2.	Shri Dinesh Srivastava	Chief Executive, Nuclear Fuel Complex, DAE
3.	Shri Gautam Pal	Director, Directorate of Purchase & Stores, DAE
4.	Shri Anupam Sharma	OSD, DAE Branch Secretariat, New Delhi

2. At the outset, the Chairperson welcomed the Members to the sitting of the Committee. The Chairperson apprised the Members that Estimates Committee (2016-17) had a briefing meeting on the subject and also mentioned about the main issues related to the subject 'Import of Uranium for Nuclear Plants'. The Chairperson then directed that the representatives of the Department of Atomic Energy (DAE) be called in.

[*The representatives of DAE enter*]

3. The Chairperson welcomed the representatives of DAE and drew their attention to Direction 55(1) of 'Directions by the Speaker, Lok Sabha' regarding the confidentiality of the proceedings of the Committee and asked Secretary, DAE to introduce himself and colleagues to the Committee.

4. During the sitting, various aspects of the import of Uranium, domestic production and application of nuclear radiation technology were discussed. The main highlights of the discussion *interalia* were changes/development in the last two years in Uranium import and nuclear power production; importance of stockpiling of nuclear fuel, i.e. Uranium to the tune of 15000 MT for use in the next 15 years; annual consumption of nuclear fuel by civil nuclear plants; reasons for proportional rise/fall of pricing of Uranium with that of oil price; implications for India for not being a member of Nuclear Suppliers' Group (NSG); IAEA safeguards; role of nuclear power plants in reducing air pollution by replacing thermal power plants; compensatory/insurance mechanism in case of any nuclear disaster like Fukushima; application of nuclear radiation technology in medicine such as cancer care, food preservation - increasing shelf life of perishable vegetables such as potato and onion

from 1 month to almost 2 years, improving productivity of crops like groundnuts and pulses, treatment of waste water and other harmful pollutants like arsenic in water; CAG's Audit Para on DEA regarding shortage of technical manpower; R&D activity in the field of atomic/nuclear science in Universities and the role of Institutions like IISc, Bengaluru and IITs, etc. therein were also discussed.

5. The representatives of the Department responded to the queries of the Members. The Chairperson asked the representatives of the Department to furnish written replies to the points for which information was not readily available.

7. The verbatim proceedings of the sitting of the Committee have been kept on record.

***The Committee, then, adjourned*.**

Annexure - III

MINUTES OF THE ELEVENTH SITTING OF THE COMMITTEE ON ESTIMATES (2018-19)

The Committee sat on Thursday, the 11th October, 2018 from 1630 hrs. to 1830 hrs. in Committee Room '53', Parliament House, New Delhi.

PRESENT

Dr. Murli Manohar Joshi – Chairperson

Members

2 Shri Ramesh Bidhuri
3 Col. Sonaram Choudhary
4 Dr. Nishikant Dubey
5 Shri P. C. Gaddigoudar
6 Shri Sanjay Jaiswal
7 Shri Rajesh Pandey
8 Shri Ravindra Kumar Pandey
9 Dr. Bhagirath Prasad
10 Md. Salim

SECRETARIAT

1.	Smt Sudesh Luthra	-	Additional Secretary
2.	Dr. Preeti Srivastava	-	Joint Secretary
3.	Shri Santosh Kumar	-	Additional Director

2. At the outset, the Chairperson welcomed the Members to the sitting of the Committee.

3. The Committee then took up for consideration the following draft Reports:-

(i) The Committee considered the draft Report on 'Import of Uranium for Nuclear Plants' and adopted the same.

(ii) *** *** ***

The Committee authorised the Chairperson to finalise the draft report(s) mentioned at (i) & *** above on the basis of factual verification from the respective Ministry/Department and present the same to the House.

(iii) *** *** ***

The Committee, then, adjourned.