Presentation to Tamilnadu Government nominees and people representatives regarding safety of KKNPP on 18-11-2011 in the office of District Collector, Tirunelveli by Expert Group on KKNPP constituted by Government of India.

Background

The activities relating to the establishment of KKNPP were progressing satisfactorily till recently when a protest by a section of the local population against KKNPP started from the last week of July, 2011. From October 13, 2011, KKNPP staff could not go to Site to carry out normal functions. Presently, only a few personnel of KKNPP are attending to bare minimum surveillance work. Government of India constituted an Expert Group of 15 specialists to interact with the officials of State Government of Tamil Nadu and spokespersons of the people in the neighborhood to explain the factual position on various aspects of the project and to dispel the apprehensions of a section of local people through a platform, provided by the State Government.

The Expert Group (EG) had the first meeting with the State Government nominees and the People's representatives on 8th of November, 2011 in the office of the District Collector, Tirunelveli. After brief introductory remarks and discussions, the people's representatives submitted a memorandum with several points and requested the Expert Group to provide the information. During the meeting both the Expert Group and the People's representatives agreed to work jointly to resolve the issues keeping in mind both the Welfare of People and the Welfare of the Nation.

The Kudankulam site was evaluated by the DAE Site Selection Committee and approved after due process then prevalent in 1988. Detailed studies comprising geo-technical examination, seismo-tectonic data, safe grade level, meteorological, hydrological and other studies were carried out by the expert agencies in the country. Based on these studies, a detailed Site Evaluation Report (SER) was submitted to Atomic Energy Regulatory Board (AERB) who accorded the site clearance vide approval No.CH/AERB/KK/8486/89 dated 10.11.1989.

The Environment Clearance was obtained from the Ministry of Environment and Forest vide letter No.4011/1/88-1A dated 9th May, 1989, as per the Environment Protection Act 1986 with stipulations and the same was revalidated by MoEF vide their letter dated 06.09.2001, in which it was indicated that public hearing is not required. The stipulations are being complied with. NEERI carried out a comprehensive EIA for KK-1&2 in the year 2003. Further, a comprehensive EIA by NEERI and Public Hearing including the

response to stake holders were carried out as per the EIA notification of 2006 when clearance for additional nuclear reactors was sought.

In 1989, MoEF while granting environmental clearance, permitted for construction of plant structure within 500m of high tide line. As per CRZ notification introduced for the first time in 1991 and subsequently revised in 2011 “Projects of Department of Atomic Energy are permitted activities in CRZ areas and require to obtain environmental clearance from MoEF”.

The Expert Group learnt that recently some members of the public residing in the vicinity of KKNPP developed certain apprehensions related to safety of the plant. It appears that these apprehensions got mainly generated as a sequel to the accident that occurred at the Fukushima Daiichi NPP in Japan on 11.03.2011. The preparatory work for conducting an off-site emergency exercise at KKNPP, which is required as per AERB’s safety regulations prior to loading of nuclear fuel seems to have further aggravated these apprehensions. The EG has reviewed the design safety aspects of KKNPP and have concluded that an accident similar to that occurred at Fukushima, is not conceivable at KKNPP. The root cause of the accident at Fukushima was complete loss of power supply at units 1 to 4 on account of flooding at the site caused by the tsunami. While units 1, 2 &3 got shut down automatically (unit-4 was already in shut down state with its fuel unloaded in the spent fuel pool), the cooling of their cores could not be maintained in the absence of power supply, which caused the accident. The EG has carefully examined the design of the KKNPP in this respect and finds that all safety related structures, systems and components of KKNPP are located well above the maximum flooding that can cover the site from all possible causes including tsunami. A total loss of power supply at KKNPP, unlike in the case of Fukushima, is therefore not possible. In addition, KKNPP has been provided with certain engineered safety features (ESF) like the Passive Heat Removal System. With these ESFs, the reactor core can be effectively cooled even under the condition of total loss of electric power.

The EG also noted that a very detailed and in-depth review of KKNPP that includes its siting, design and operational safety and QA aspects has been conducted by AERB over the last few years following its established multi-tier review process before issuing clearances for various stages of the Project. This review by AERB has been done through a thorough study of the design documents that run in several thousands of pages and intense discussion in a large number of meetings of its Advisory Committee on Project Safety Review of KKNPP and its specialists working groups. In addition, members of the Advisory committee and working groups have spent considerable time and effort in studying the technical material outside the formal meetings and in discussing the safety matters with NPCIL officials and with the design experts from Russian Federation. This extensive review by AERB provides assurance of the

robustness of the safety design and construction of KKNPP. The commissioning program is also progressively reviewed by AERB.

Observations of Expert Group on the memorandum submitted by people's representatives

The Expert Group examined the memorandum, interacted with the KKNPP officials and visited the KKNPP for a detailed study. The observation of the Expert Group on the global trends in the use of nuclear energy for power generation, Indian experience on Nuclear Plants, Radiation in the Environment around Nuclear Plants in India and Safety Features in KKNPP are presented in Annexure-1 and the observations on the points mentioned in the memorandum are presented in Annexure-II.

The EG wishes to express that quite a few points contained in the memorandum lack clarity and consequently leads to difficulty in providing focused feedbacks. The information provided are based on the data and the documents supplied by KKNPP and NPCIL officials, on request by EG and the findings of the group members during the plant visit and interactions with the plant officials. Further clarifications can be provided on specific relevant points, if required.

The following five points in the memorandum have not been addressed by the EG since they fall outside its purview:

1. Inter-Governmental Agreement
2. Impact on Bilateral relations between governments
3. Russian and Indian liability issues
4. NSG related issues
5. Setting up possible weapon facility at KKNPP

ANNEXURE- I

1. **The global trend on the use of nuclear energy for power generation**.

Globally, as on date, 433 Nuclear reactors are operating in 30 countries and producing 366590 MW(e) and 65 reactors are under construction to produce 62592 MW(e). Further the following Nuclear Power Plants (NPPs) are connected to respective grids after Fukushima accident on March-2011:-

- Chashapp Unit-2 (300 MWe, PWR, Pakistan) – on 14th March 2011
- Lingao 4 (1000 MW, PWR, China) – on 3rd May 2011
- CEFR- China experimental Fast Reactor (20 MWe, FBR, China)- on 21st July 2011
- Bushehr 1- (915 MWe, PWR, VVER, Iran)- on 3rd September 2011

The status in some other countries, post Fukushima, is summarized below:

Russia: 9 reactors are under construction. 14 reactors are further planned.

USA : There are proposals for over 20 new reactors.

France: Building a 1600 MWe unit at Flamanville for operation in 2012 and second to follow at Penly.

UK : Four 1600 MWe units are planned for operation in 2019

Germany : It had 17 reactors and it has not granted sanction for further life extension to 8 reactors among them that had completed design life. The design life of the remaining 9 will be completed by 2022. Germany announced that they will not consider further extension of life of these plants. There had been a debate in Germany about the need for nuclear power plants, even before Fukushima accident, based on sufficient availability of electrical energy from other sources and energy availability from neighboring nations.

Switzerland : It has 5 reactors in operation. It has decided to phase out Nuclear power by 2034 on completion of their design life.

Japan : It has 54 Nuclear reactors. 11 reactors continued to be in operation even during earth quake and tsunami in Japan and are still in operation. The remaining 43 reactors were on shutdown/maintenance. Decisions were taken to start them after safety review and the first of these 43 reactors, has been restarted in August 2011.

Bangladesh has recently signed intergovernmental agreement with Russia to start construction of a new VVER plant in Bangladesh in November 2011.

Vietnam has signed an agreement recently with Russia for the establishment of their first nuclear power plant (VVER) and with a consortium from Japan to construct a second nuclear plant.

UAE continues work related to setting up of its first nuclear plant through a consortium in South Korea.

Turkey has initiated action for setting up its first nuclear power plant (VVER)

From the above, the trend appears to be on increased use of Nuclear Power in the global energy scenario.

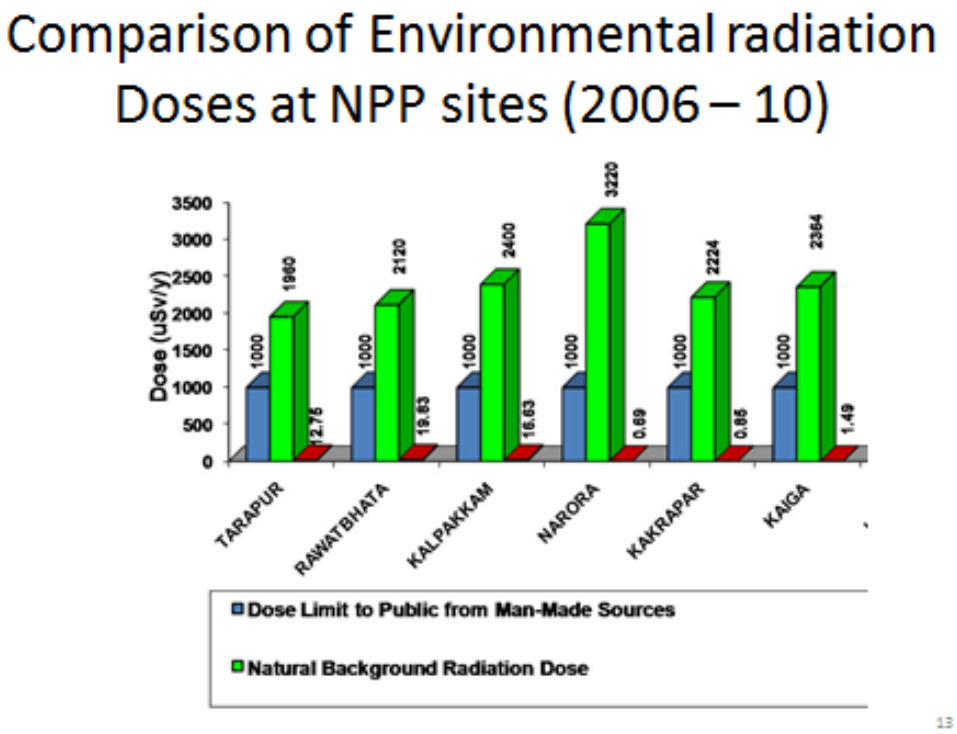
2. **Indian Experience on Nuclear Plants.**

India has 20 reactors in operation in 6 different places all over the country. The first one started about 40 years back. India has an excellent record of performance with no incidents of radiation exposure to the public exceeding the allowable limit. The details can be seen from the Web site of NPCIL. India also has well trained personnel with knowledge and expertise. India has demonstrated capability in establishing, maintaining and operating Nuclear Power plants for power generation.

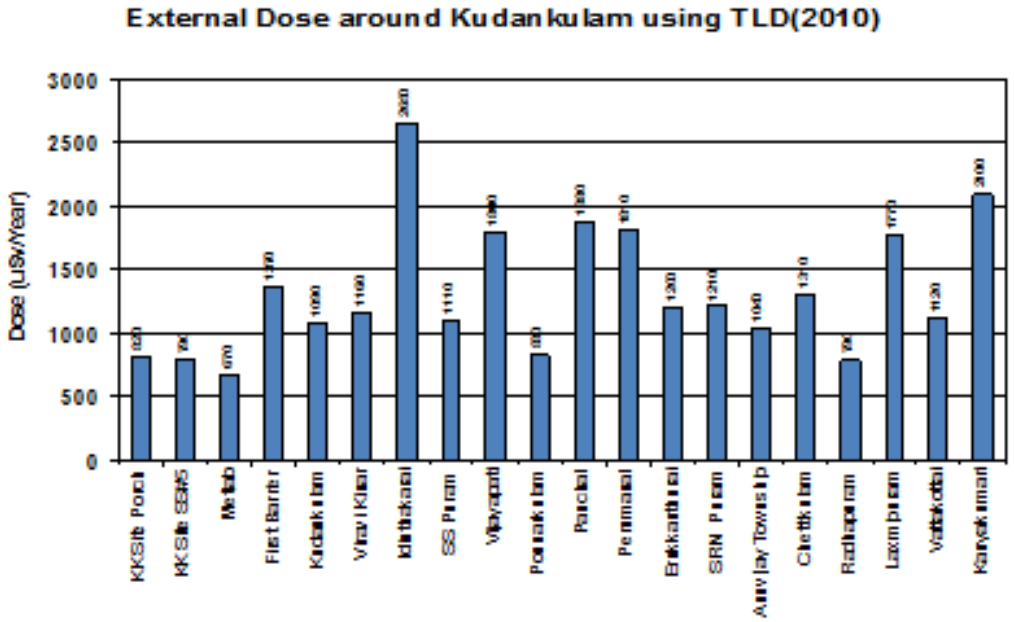
3. **Radiation in the Environment around Nuclear Plants in India**.

The DAE establishes Environmental Survey Laboratories at all the power plant sites well before a nuclear power plant goes in operation, and regularly monitor the radiological conditions in the environment. A comparison of the

Environmental radiation doses at NPP sites during 2006 to 2010 is given fig 1 below.



Radiation doses measured by the Environmental Survey Laboratory around Kudankulam is given in Fig-2 below.



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Further in places like Manavalakuruchi, Kanyakumari, Karunagappalli, Chavara etc. where radioactive mineral deposits exist, the natural background levels are far in excess of those measured near the NPP sites. People live for generations in these places without any major health hazards.

4. **Safety Features in KKNPP**.

The reactor being built at KKNPP is advanced model of Russian VVER-1000 MW Pressurised water reactor which is a leading type of reactor worldwide. The design has been evolved from serial design of VVER plant and fall in the category of Advanced Light Water Reactor. The salient features are:

-Passive heat removal system to provide cooling for the removal of decay heat.

-Higher redundancy for safety system.
-Double containment.
-Additional shut down system like quick boron and emergency boron injection systems.
-Incorporation of core catcher to provide safety in the event of fuel melt down
-Passive hydrogen management system

The safety features of KKNPP were comprehensively reviewed by a task force of NPCIL in the context of recent Fukushima accident. The report of the task force is available in the website of NPCIL and DAE.

ANNEXURE II

1) KKNPP Status

During the visits to KKNPP the Expert Group observed that the further construction activities are not progressing and the status quo is maintained by only some essential surveillance of the installed equipment.

2) Statements on Safety of KKNPP

Statements on the KKNPP have appeared in the press on the safety and present status of the plant. In the opinion of the expert group, there have been no contradictions among statements made regarding the current status and safety of KKNPP.

3) Availability of EIA Report, Performance Reports etc.

The EIA report is available on the NPCIL website www.npcil.nic.in. The VVER performance data is available on the IAEA website www.iaea.org and has also been given below.

Performance of VVER reactors worldwide has been very good. There are about 55 VVER type reactors. Four new VVER-1000 plants have been connected to grid (three in Russia in 2010, and one in Iran) in 2011.

There are nine VVER-1000 units in operation in Russia and eleven VVER-1000 units in Ukraine. Seventeen VVER-1000 units built in the 1980s in erstwhile USSR have cumulative load factor of 72%.

Three VVER-1000 units which started commercial operation (a) in 1996 (Zaporozhe-6, Ukraine), (b) in 2002 (Rostov-1, Russia) and (c) in 2004 (Kalinin -3, Russia) have lifetime cumulative load factor of 83%.

Outside Russian Federation, the reactors at Loviisa 1 & 2 of VVER-440 (Finland) which went into commercial operation in 1977 and 1980 respectively have around 88% cumulative load factor and they are considered amongst the best performing PWRs in the world.

The Site Evaluation Report and the Safety Analysis Report are documents that have been made available to AERB which is the statutory body authorized to accept and review these documents.

4) Inter governmental Agreement

Not addressed.

5.1) Siting of KKNPP 1&2

- NPCIL submitted an application for site clearance of twin units of 1000 MWe capacity of Russian VVER in 1988 to AERB
- Specialist Committees were appointed by AERB to review the application.
- Based on the specialist committee recommendation, Atomic Energy Regulatory Board granted Clearance for Siting of two 1000MWe VVERs at Kudankulam site on Nov 10 ,1989
- The review and assessment process was based on the
  a) IAEA Safety Codes & Guides ;
  b) prevalent International documents on the subject and
  c) AERB Safety Code on Siting
- For KKNPP basic design considered was V320 with enhanced safety features/ systems as specified by NPCIL
- The Review process and Assessment were based on the following areas of significance
  a) Those related to the site and the environmental conditions and aspects that will influence the design basis of NPP such as geological data, topography, hydrology and hydro-geology, meteorology data, natural phenomena such as earthquakes, floods, tornadoes, tsunami, potential external man-induced events such as plane crash, fires and explosions, failure of dams, availability of cooling water.
  b) Those related to the effects of the plant on the environment that could warrant specific design and operational requirements, namely dispersion of radioactive/ toxic liquid and gaseous effluents, the impact of radiation exposures to public during Normal Operation and Postulated Accident conditions taking into account dispersion patterns, population distribution, public water supply, milk and food consumption
  c) Exclusion Zone of 1.6 Km and Sterilized Zone up to 5 Km are provided. Emergency preparedness planning is done for zone up to 16km. ESL carries out the radiation monitoring in this area.
  d) Availability of Infrastructural facilities to assess response to a Postulated Emergency condition

5.2) EIA

Environmental clearance obtained from MoEF, New Delhi for KKNPP 1&2 as per Environmental Protection Act 1986 on 09-05-1989.

No Public hearing was stipulated as per the above act.

Ministry (MoEF) vide their letter dated 6th Sept 2001 (Letter no: J.14011/I/88-IA.II(M) dated September 6, 2001 issued by Director MoEF) confirmed that the Environmental Clearance issued in May 1989 is valid and there is no requirement of public hearing and fresh environmental clearances.

However, NPCIL with the assistance of NEERI prepared a Rapid EIA for KKNPP 1&2 in the year 2001 and subsequently a comprehensive EIA was prepared in year 2003. The comprehensive EIA report is available in NPCIL Web site www.npcil.nic.in.

Comprehensive EIA and EMP for KKNPP 3-6 was prepared as per EIA notification 2006 (latest), This includes impact of KKNPP 1&2 and Unit No KKNPP 3-6 (which are similar in design to that of KKNPP 1&2) has obtained environmental clearance from MoEF in 2008 & 2009.

5.3) CRZ

The environmental clearance for KKNPP 1&2 was obtained in 9th May 1989 as per Environmental Protection Act 1986 with the exemption for constructing the plant within 500 Mtrs from HTL.

All the conditions were fulfilled as per the stipulations. Hence there is no violation

5.4) Public hearing process

There was no requirement by MoEF for the public hearing process at the time when the KK NPP1&2 clearance was granted in 1989. The brief history of the MoEF clearance for KKNPP 1&2 is given at 5.2 above.

5.5) Construction QA

Nuclear Power Corporation of India Limited is having a corporate quality management program which gives assurance of quality in all activities undertaken.

Based on the observations and perusal of documents available at site it is concluded that adequate quality standards are incorporated in all stages of works in the project. The assurance of quality is accorded highest attention in all fields i.e. in design, manufacturing and procurement, construction, erection, commissioning and operation.

The components manufactured in Russia and supplied to KKNPP 1&2 from Russian Federation are subjected to undergo the stringent checks as detailed in the quality assurance plans developed jointly by NPCIL and Russian Nuclear authorities.

The construction works are carried out in accordance with QA manual especially in respect of civil construction, the materials used are tested for every batch at the concrete testing lab at site. The construction QA personnel inspect the works as per the QA plan and the works are carried out as per approval of QA staff. The records of testing and inspections which are extensive are well documented. The regular reviews of the quality are carried out by internal audits within NPCIL and audits on specific systems by AERB.

The reactor building containment has withstood a structural integrity and leak rate test at the test pressure, which is much higher than the design pressure. The hydrotests, non-

destructive tests (radiography, ultrasonic test) etc were carried out and records are maintained. Hot run has been carried out to validate the design.

All the relevant documents pertaining to quality are kept properly for ready reference.

5.6) Contract of Works

Expert group noted that NPCIL has appropriate procedures in place for award of contracts and works.

5.7) Local Employment Opportunities

1.0 On the subject of employment opportunities for the local population in KKNPP, on a query by the expert group, the KKNPP authorities provided the following information.

1.1 As per the existing order of Government of India, post to be recruited for Group-B, C and D to be notified to District Employment Exchange and also to be published in Employment news. The advertisement had also been circulated to Land Loser Village Panchayats for vide circulation.

1.2 Being an organization under the Government of India, basic qualification and experience required for the post has to be fulfilled by each applicant. Relaxation in age and posts is as per existing orders of Government of India

1.3 As per G.O. Ms. No. 188 dated 28.12.1976 of Personnel & Administrative Reforms (Personnel Dept.), "only land losers who are displaced as a result of acquisition of land by public sector undertakings are to be given priority". Honble' Division Bench of Madurai bench, Madras High Court has also emphasized for providing employment opportunity to the displaced land losers. However at KKNPP no displacement of family had taken place due to acquisition of land.

1.4 As can be seen from the data provided below, out of 541 employees recruited at KKNPP, 528 employees (97.5%) belong to Tamilnadu in the category of Group-B, C&D.

1.5 Details of employees recruited are as below.

S.No	Description	No. of employees	Remarks
1)	Land affected panchayats such as Kudankulam, Chettikulam, Vijayapathi and Irukundurai.	110	62 employees belongs to land loser category.
2)	Radhapuram Taluk	160	Includes S.No.1
3)	Tirunelveli district	295	Includes S.No.1&2
4)	Tirunelveli, Kanyakumari and Tuticorin districts	386	Includes S.No.1 -3
5)	Tamilnadu	528	Includes S.No.1 -4.

2.0 Additional employment opportunities:

Plant is having the fixed sanction strength of regular manpower employment as per guidelines of NPCIL. There is more scope for getting employment opportunities by way of working with the contractors. In addition, various contract employees are working under major contractors and also through jobs like housekeeping, civil maintenance etc., through Self Help Groups. In this process, around 2000-3000 local persons are working with various contractors. In addition, the requirement of persons under the contract varies from time to time and it is a continuous process depending upon the time of contract period and new contracts coming up thereon based on the work exigencies. Further due to expansion of plant to have more units in future the job opportunities will increase. NPCIL has been supporting the education of the children around the plant with the intention that more and more persons in future qualify for these jobs. NPCIL intends to expand the activities related to education/ training in a bigger way."

5.8) VVER Reactor Design and Engineering

a) VVER is a pressurized light water cooled and moderated reactor with four independent cooling loops. The reactor has horizontal steam generators in each loop that gives high water storage capacity. It uses hexagonal fuel assemblies which have low enriched fuel in oxide matrix, housed in sealed Zirconium- Niobium alloy tubes.

b) KKNPP VVER 1000 adopts the basic Russian design by model marked V320 with Enhanced Safety Features to make it in line with IAEA GEN III reactors. Further, certain additional safety features were incorporated like Passive Heat Removal System taking it to GEN III+ category. Russian Federation has marked KKNPP reactor as V412.

c) Salient Normal Operating Parameters of KKNPP Reactors:

- Electrical Power 1000 MWe
- Thermal Power 3000 MWt
- No. of FAs 163
- Coolant inlet temp 291°C
- Coolant outlet temp 321°C
- Coolant Pressure 15.7 MPa
- No. of Loops 4
- No. of Control Rods 103
- Pressure Maintenance by Pressurizer

d) **Enhanced Safety Features**: Key Safety Features incorporated in KKNPP as required India:

- Quick Boron Injection System
- Passive Heat Removal System
- Second Stage Hydro Accumulators

- Passive Hydrogen Re-combiners
- Annulus passive filtering system (passive system)
- Core Catcher
- Emergency Control Room

The above systems have been developed based on extensive R & D and simulated testing by Russian design institutes. Functional performance of these systems are established during commissioning stage. These systems are described in subsequent sections.

e) VVER 1000

Plant model	Site (units)	Status	No. of Units
V-320	Balakovo NPP (1-4), Zaporozhe NPP (1-6), Rovno NPP (3,4), Khmelnitsky NPP (1,2), South Ukraine NPP (3), Rostov NPP (1,2), Temelin NPP (1,2), Kalinin NPP (3), Kozloduy NPP(5,6)	Operating	22
V-412	Kudankulam NPP (1,2)	Under Construction	2
V-428	Tianwan NPP (1,2)	Operating	2

* In addition to the above:

- VVER -1000 reactors are under construction in Russian Federation.
- Recently VVERS are planned in Vietnam, Turkey and Bangladesh.

f) IAEA Safety Review Of VVER1000 (V-320)

This review was done by international Experts in 1994 and recommendations have been incorporated in the V-320 and are part of KKNPP - V412 also.

g) Safety Functions for a NPP

The following safety functions shall be performed in all operational states, i.e. during normal operation, during and following design basis events conditions and specified beyond design basis events (BDBEs):

- Control of the Reactivity (control of fission chain reaction)
- Heat removal from the core and
- Confinement of radioactivity

h) **Safety during Normal Operation:**

During Normal Operation (NO) & Operational Transients (such as Turbine trip, pump trips etc), the reactor is controlled by the controllers within certain operational limits and conditions. The control is achieved by following parameters:

- Control of Reactivity:
  i) CPSAR (Control and Protection System Absorber Rods)
  ii) CVCS (Chemical Volume Control System)

- Heat Removal from Core:

  i) Primary Coolant Circuit (four independent loops)
  ii) Steam Generator (one in each loop)
  iii) Turbine & Condenser

- Confinement of Radioactivity by following multiple barriers:

  i) Fuel Matrix and sealed Fuel Clad
  ii) Reactor Coolant System with Chemistry control
  iii) Containment and Containment filtration Systems

- Plant operation shall be carried as per Technical Specifications for operation approved by AERB which ensures that the plant is operated within safe parameters.

i) **Systems Catering to Design Basis Events (DBE):**

Though a detailed design analysis indicates that the rector will operate within the design parameters, safety systems have been provided to ensure safety during postulated events, known as Design Basis Events (DBEs).

DBE postulations have been made as per AERB guidelines which follow international practices. An example of DBE is break of main coolant pipe resulting in loss of coolant accident, known as LOCA.

During DBEs, reactor is shutdown by the control rods.

The Reactor core cooling will be maintained by the following safety systems, which are four train independent systems:

- High Pressure Emergency Injection System: Starts injecting borated water to the reactor core when primary pressure falls below 7.9 MPa

- First Stage Hydro Accumulators (Passive system): Starts injecting borated water to the reactor core when primary pressure falls below 5.9 MPa
- Long term decay heat removal System: Starts injecting borated water to the reactor core when primary pressure falls below 1.9 MPa
- Emergency Safety Boron Injection System: Injects borated water to the pressuriser to depressurize the reactor during steam generator tube leak, so as to minimize the leakage of primary coolant.

j) Backup Systems for Control Rods (4 Trains):

Control rods are passive systems which are designed to drop under gravity. They are tested extensively in the test set ups and during commissioning. During reactor operation and annual shutdown, the performance of the rods is monitored. However, even under the postulated failure of control rods (eventt known as Anticipated Transient Without Scram or ATWS) , reactor is designed to shutdown using following additional safety systems:

- Emergency Boron Injection System: Injection of boric acid solution to the reactor at high pressure - 16 MPa
- Quick Boron Injection System (Passive System): Injection of concentrated boric acid solution to the reactor.

k) Systems for catering to Beyond Design Basis Events BDBE (Enhanced Safety Features)

In line with the current international practices, certain beyond design basis events have been postulated. To ensure the safety under these conditions, following systems have been provided. These enhanced safety features are additional systems in KKNPP.

- Passive Heat Removal System (PHRS):

Decay heat removal from the core following complete loss of power supply, known as station black out (SBO).

- Additional Core Passive flooding system (passive II stage accumulator):

Supplies borated water to the reactor core during a multiple failure such as simultaneous occurrence of LOCA and SBO.

- System for retaining and cooling of molten core (Core Catcher):

Retention and long term cooling of molten core under a postulated severe accident condition.

l) Reactor Containment

Nuclear steam supply systems are housed in a Reactor Containment, to contain any release of radioactivity. It also provides protection against external hazards.

- Salient Features of Containment structure
  i. Double containment structure: Pre-stressed inner Containment (IC) with leak tight inner steel liner & Reinforced concrete Secondary Containment.
  ii. Air locks with double doors;
- Design pressure is 0.4 MPa (g) based on estimated pressure due to loss coolant accident
- Design temperature is 120ºC
- Containment has been tested up to a test pressure of 0.46MPa
- Permissible containment leakage rate is 0.3% volume/day. Leakage rate observed during containment leak rate test conducted during pre-commissioning was 0.18 % volume/day. As part of in-service inspection, containment leak test is carried out periodically.
- Secondary Containment Designed to withstand
  i. Aircraft Crash (such as Cessna and lear jet aircraft)
  ii. Air Shock wave
- Sub-atmospheric pressure maintained during normal operation and under accident conditions so as to minimize ground level releases

m) Containment Systems:

Following systems are provided to maintain the integrity of the containment and its functional capability under abnormal conditions:

- Containment Spray System: Condenses steam due to any leakage from the primary or secondary system, thus limiting pressure rise in the containment.
- Annulus passive filtering system (passive system): The annular space between the primary and secondary containments is always maintained at a negative pressure which prevents any ground level releases. During an SBO condition, this negative pressure is maintained by the natural draught created due to the PHRS operation.
- Passive Hydrogen Re-combiners: Hydrogen, if generated during accident conditions, is recombined in Passive Hydrogen Re-combiners to convert it to water. This prevents any hydrogen ignition within the containment. They are located at various locations within the containment.

n) Supplementary Control Room

Supplementary control room (SCR) is provided in the shielded control building, to enable essential safety functions and monitoring of all the important parameters in case of main control room (MCR) becoming inaccessible.

o) Training and Qualification

- Training - Three Phase Programme
  i. Operators are graduate engineers with adequate experience
  ii. Phase – A → Orientation course and Examination
  iii. Phase – B → Theory & Simulator Training in RF
  iv. Phase – C → Participation in commissioning activities and Simulator Training – in India
- Qualification of O & M
  i. Licensing of O&M personnel by AERB and their periodic
  ii. Requalification including managerial cadre.
  iii. Details of Qualification Methodology Finalized

p) In Service Inspection

- Monitoring of healthiness of equipments and components is conducted as per ISI program.
- ISI data is compared with baseline data collected during Pre-Service Inspection
- Typical systems monitored are
  i. Reactor coolant pressure boundary.
  ii. Systems essential for safe reactor shut down and/or safe cooling of nuclear fuel.
  iii. Containment Systems
  iv. Other systems and components whose functioning is essential for systems mentioned above.

q) Material Surveillance

- Material surveillance coupons are installed inside the reactor to assess state of RPV material typically due to neutron irradiation & temperature effects.
- These set of coupons are withdrawn at specified interval of reactor operation and subjected to destructive testing to assess change in mechanical properties of RPV material.
- This method provides sufficient lead time for actions, if required.

5.9) VVER Performance Information

Given in Annexure-1

5.10) Dummy Fuel

Dummy Fuel is used to simulate the Nuclear Fuel Assembly, both by geometrical and by weight consideration. Dummy Fuel is made of lead encapsulated in steel tubes and has no radioactive material.

These are required to be installed in the reactor during commissioning, to study hydraulic characteristics like pressure and temperature variations, flow pattern with various combinations of Reactor Coolant Pumps, temperature etc., in the Primary Coolant System. The Dummy Fuel assemblies have no problems of disposal as they are non-radioactive, but in fact are preserved and re-used in subsequent new reactors during commissioning test.

5.11) Fuel Supply

Fuel for initial and reload of Unit-1&2 of KKNPP is procured as per Fuel Contract signed between Russian Federation and DAE, GOI. The fuel is supplied in the form of finished fuel assemblies of designated enrichment to be loaded in to the core. The quality of fuel fabrication at the fuel fabrication plant in Russia is inspected by DAE/NPCIL fuel experts at different stages of fuel fabrication as per approved Quality Assurance Plan.

The finished fuel assemblies are packed in specially designed casks and transported by special air craft from Russia to India. From Airport to the KKNPP facility, the transportation is done by road. The entire transportation, starting from fabrication plant in Russia to KKNPP facility, strictly adheres to the safety regulations of International Atomic Energy Agency (IAEA) and AERB of India. Security arrangements are followed as per the DAE Security norms.

5.12) Fresh Water Supply

Desalination plant, based on Mechanical Vapour Compression technology, at KKNPP site has been designed to meet the process requirements of Unit # 1&2 and the potable water requirements.

The plant water requirement is 5664 m3/day and the potable water requirement is 1272 m3/day. Against this, the installed desalination plant capacity is 7680m3/day. This is met by three units, each of capacity 2560 m3/day, with one additional unit of 2560 m3/day unit, as a standby. The output water from the desalination plant is further purified by de-mineralizing and used for industrial purpose. The product water is treated further for making it potable water.

The provision of water storage and inventory available in various tanks are adequate for cooling requirements of Reactor Plant for at least ten days, in case of power failure from the Grid (even though the regulatory requirement is only 7 days).

5.13) Other Water Sources

The desalination plants have been designed for sufficient capacity and have been erected and commissioned. Hence, the question of water utilization from other sources such as Pechiparai dam and Tamirabharani river does not arise.

5.14) Desalination Plants

Desalination Plant at KKNPP site is based on thermal desalination i.e Mechanical Vapour Compression (MVC) system. The system draws sea water from the main cooling water intake channel provided for the power plant. The brine reject from the desalination plant will be mixed with the condensed cooling water discharges, diluted and released into the sea through the existing outfall channel.

A base line environmental assessment and mathematical modeling study on flow, dispersion of brine reject and extent of mixing in the sea has been done by Indomer Coastal Hydraulics Pvt Ltd, Chennai, who is a certified consultant by Ministry of Agriculture, Department of Animal Husbandry & Dairying, New Delhi and also a certified 'A' grade hydrographic surveyor by Inland Waterways Authority of India, Noida.

The brine reject volume is 350 m3/ hour and it gets diluted with sea water discharge through the outlet canal which is 2,50,000 m3/hour during plant normal operation. This will give an initial dilution of the order 700. This pre-dilution would reduce the brine concentration from 69 ppt to an ambient value of 35.1 ppt.

The brine reject will not have any impact in the marine environment while joining the sea.

The brine reject does not contain any toxic or organic pollutant.

5.15) Environmental Impact of Desalination Plants

This is covered at 5.14) above.

5.16) Nuclear Waste Management

The origin of radioactivity in a reactor is the fuel that is undergoing irradiation/ fission. The fuel is clad in a metallic tube so all the radioactivity produced in the fuel stays within the fuel tube or clad. In the unlikely event of any pinhole leak from the fuel tube, radioactivity could come into contact with the circulating coolant water which is constantly being recirculated through the core of the reactor for removal of heat, produced by fission.

1.1 If any radioactivity enters the primary cooling water circuit, it is effectively removed by Filters and Ion-Exchange columns provided in the circuit. As the primary cooling water circuit in KKNPP is a closed cycle, any radioactivity that escaped from the fuel gets trapped in Filters and Ion Exchangers and would not pose any hazard to either plant or personnel and there is no way it can find its way to environment. Other liquid process effluents are evaporated for an extremely high decontamination, rendering the condensate with insignificant contamination, considered fit for reuse in the plant and the concentrates are

concreted to result in a stable matrix for safe storage and subsequent disposal

1.2 Similarly if any solid wastes get contaminated with radioactivity, they are carefully collected and as a first step volume of the wastes produced are reduced to a small fraction by treatment methods like incineration and compaction, apart from size reduction; then the wastes are conditioned by being fixed in cement concrete before they are stored safely for an interim period, .They would be considered for disposal in a Near Surface Disposal Facility, in a few years time, giving adequate time for decay of short-lived radioactivity.

1.3 Any radioactivity, in the exhaust air system from the reactor buildings, though insignificant is invariably treated through a series of off-gas clean up system, before release through tall stacks.

1.4 Due to the total containment of all radioactivity in the fuel tube, the type of wastes that result from various systems in this reactor are essentially low level wastes, with a small quantity of intermediate level wastes. There are no high level wastes associated with the operation of the reactors at Kudankulam

1.5 Thus, as a matter of abundant caution and abiding concern for safety of environment and members of Public, a number of state-of-the art technologies are employed in the Safe Management of Radioactive Wastes. The track record of DAE in this regard has been exemplary over the past four decades, and compares favourably with the best in the world.

2.0 Spent fuel : First and foremost it should be remembered that Spent Fuel is not a waste in the Indian Nuclear Programme. A closed fuel cycle is followed, where the valuable fissile materials like Uranium and Plutonium which are present in the Spent Fuel are recovered for reuse.

2.1 Spent fuel is therefore an asset that needs to be preserved. At Kudankulam, Spent Fuel from the Reactors will be carefully stored in Storage Pools, which are always filled with pure, demineralized, borated water which is constantly recirculated. These pools are high-integrity concrete pools which are additionally lined with stainless steel sheets, to ensure effective containment for extended periods of time. The Department of Atomic Energy has long experience and expertise of a high order in the safe management of Spent Fuel

2.2 There is no plan to do the reprocessing of the Spent Fuel at Kudankulam site. As such the storage of Spent Fuel at Kudankulam is to be considered only as an interim measure till they are transported to a Reprocessing Facility.

2.3 Adequate Technology and years of experience are available with Department of Atomic Energy for transporting Spent Fuel from one site to another through both Railways and by roadways, in a safe manner without any public hazard. This is done as per stipulations of AERB, regarding Transport Regulations that govern safety.

5.17) Reprocessing:

This has been covered at 5.16) above.

5.18) Radiation Safety

Routine Emissions:

After going through the documents of KKNPP, it is seen that

- No radioactivity release through the sea water cooling is possible since this loop is physically separated by three levels from the coolant loop which enters the reactor.
- However some low and medium level waste would be generated in the station which is treated inside the plant. Very low level effluents from these would be generated and there are norms and limits for their releases.
- Gaseous routine emissions are basically exhaust air from building ventilation systems. It is filtered in High Efficiency Particulate Air (HEPA) filters and Activated Charcoal filters before discharge to the Stack.

People's safety and wellbeing:

The authorized limit of low level effluents through air and water from KKNPP is restricted such that it will not lead to more than around 4.36 percent of the dose limit for the public recommended by ICRP (1 mSv). The expected rated releases would however be much lower (0.02 %). The concentrations of discharges are measurable and their limits are fixed to ensure this. The limits of concentrations in aquatic and atmospheric releases fixed are such that the dose will never exceed the authorized limits. The concentrations of discharges through stack are monitored continuously. The activity levels of liquid discharge are monitored daily to ensure this. Further the environmental survey program of the Environmental Survey Laboratory, an organization independent of NPC is sufficiently intense to assess the impact, if any, on the flora and fauna and in estimating the dose to a member of the public. The laboratory is in operation since 2004 and routine pre operational radioactivity analyses of the samples are being carried out to establish background levels. As in all the other nuclear sites the environmental radioactivity assessment program would be continued after the station goes into operation to ensure that there is no impact of the station on the environment and to the public. The periodic reports are audited by the Regulatory Board.

ESL monitors the Environment around the Plant. It has been collecting and analyzing the samples like water, air, soil, flora and fauna, right from the pre-operational stage of the plant from the year 2003, which forms the baseline data. The baseline data has been established and records are available for reference. This activity will be continued

throughout the entire lifetime of the Plant and records maintained. Records at other Nuclear Power Plants (NPP) sites in India indicate no impact on the flora and fauna. As a matter of fact the flora around NPP sites are vastly improved with large scale plantings and landscaped gardens as can be seen at KKNPP which improves the fauna around the station. This can be corroborated in all NPP sites.

People's health

People who have been living for generations in the high background areas in our country, receiving 25 times more dose from natural radiation do not have any ill effects as medically proved by the studies of Regional Cancer Centre Trivandrum.

DAE workers live in close vicinity of atomic centers all over India (their limit for exposure is 100 times more than the KKNPP limit)have been proved to have no noticeable health effects.

As such we feel that the radiation safety of the people around KKNPP is guaranteed and there would be no impact of the operation of the power station on the public.

A word about the genetic effects of radiation.

- People in the high background areas of Kerala stay for generations exposed to more than 10 times the natural radiation background elsewhere. Many independent studies particularly by the Regional Cancer Research Centre, Thiruvananthapuram on the people there have been conducted and the conclusions show that no deleterious effect could be noticed which is attributable to radiation.
- The epidemiological survey of the radiation workers in the country whose dose limit is 20 times more than that for the public does not show any such effects.
- UNSCEAR, an International committee on the effects of atomic radiation working for more than 60 years found no genetic effects even amongst the progenies of the Hiroshima Nagasaki atomic bomb victims.

When this is the fact how a small percent (1%) of the natural radiation dose that might be received around nuclear power stations lead to any genetic effect or cancer incidence?

The fear about genetic effects of radiation around nuclear sites is more psychological and is contrary to scientific facts.

Baseline data on health concerns:

Pre operational health data around Kudankulam

A health status and demographic survey of the people in 52 villages around Kudankulam was conducted by M S University during 2004-2008. This will serve as the baseline data to evaluate the impact due to the operation of the station later.

67,029 subjects were involved and data on cancer incidence was part of this survey

136 cases of cancer were reported. Cheek and uterus cancer were the most common.

The prevalence of cancer corresponds

to 202.8 per lakh of population which is in par with the rate for Tamil Nadu (225)

The world over investigations show that only certain type of cancers notably that of thyroid is due to the effect of radiation.

Workers safety and well being:

The recommendations of limits of exposure for radiation workers by ICRP are:
20 mSv/yr averaged over five consecutive years
A dose of 30 mSv in any year;
Lifetime effective cumulative dose limit - 1Sv

These are the limits adopted by AERB. KKNP further stipulates in house limits to ensure that in no case workers will exceed these limits. They have monthly, quarterly limits to ensure this. The experience in all NPCIL nuclear reactors shows that during the last 5 years no worker has exceeded the cumulative limits.

The limits are such that these do not lead to any adverse health effects. KKNPP has an intense program of monitoring the radiation exposures using monthly monitoring using TL dosimeters. These are augmented by use of direct reading dosimeters. The records of the exposures are kept by the station and by the centralized DAE dose registry.

The operations carried out in KKNPP do not envisage leading to any significant internal exposures through inhalation or ingestion of radioactivity. However there are internal monitoring programs at KKNPP such as whole body counting to assess the dose to workers through this route.

5.19) Routine Emissions:

This has been covered at 5.18) above.

5.20) Worker's safety and well-being:

This has been covered at 5.18) above.

5.21) People's safety and well-being:

This has been covered at 5.18) above.

5.22) Health Survey and baseline data

This has been covered at 5.18) above.

5.23) Radiation illness

The limits of radiation exposure from the nuclear power plants, for the public and occupational workers in India, are such that, the question of radiation illness is not relevant.

5.24) Population:

The 2001 census population figures for the area around KKNPP are as follows:

Distance	Population
0-2 km	0
2-5 km	23960
5-16 km	94733

5.25) Oceanography

1.0 Flood design of KKNPP and Important plant levels and locations

1.1 Design Basis Flood Level

The safe grade elevation of KKNPP site has been kept at 7.5 Mtr above MSL and a shore protection bund is constructed all along the shore to a height of + 8.0 Mtr to MSL.

The detail of arriving at the safe grade elevation, considering either tsunami or storm surge is listed in the table below.

Sl No	Rise Water level Due to (m)				
	Wave Run up	Max. Tide	Storm Surge	Tsunami	Total (w.r.t CD)
1	2.0	1.42	2.46	---	5.88

2	2.0	1.42	---	2.50	5.92
	Therefore the maximum water level = 5.92 – 0.481 = 5.439m with respect to MSL.				
Keeping a further safety margin of 2.0m, the safe grade elevation is kept as 7.44m (say 7.5m) w.r.t MSL					

1.2 KKNPP Building elevations.

In addition to the safe grade elevation, sufficient margins are available in each building. Elevations and locations of important safety buildings are given in the table below.

Description	Elevations in meters above MSL	Margin available meters
Pump house grade elevation	+7.65 m	2.21
Reactor Building grade elevation	+8.7 m	3.26
Safety DG building (sealed building)	+9.3 m	3.86
Diesel tanks in DG building	+13.8 m	8.36
Battery Banks (sealed building)	+16.5 m	11.06
Passive Heat Removal System Heat exchangers	+ 52.2m	46.76
Main control Room	+26.0	20.56

In addition, having a higher grade elevation, all the safety related buildings are closed with double gasket leak tight doors.

1.3 Shore stability

No potential of shore instability exists at Kudankulam site area, as protruding rock outcrops are present all along the coast protecting the shore from erosion. Also, no historical shore erosion has been recorded in the area.

2.0 Tsunami warning systems available:

Tsunami Event Identification: Possible Tsunami occurrence can be known as alerts form the following agencies:

- KKNPP is registered with INCOIS, Hyderabad (Indian National centre for ocean information service). In case of any Tsunami warnings, information in the mobile numbers of the station management will be received.

- Madras Atomic Power station, Kalpakkam has established PC based Earthquake Notification System (ENS) which gives alarm in the control room in case of an earthquake. ENS is an application which scans USGS (US Geological survey) and EMSC (European Mediterranean Seismic Centre) sites. Immediate alert will be given to KKNPP control room from Kalpakkam in case of any alarm.

5.26) FISHERIES, SEAFOOD SECURITY AND COOLANT WATER DISPOSAL & THERMAL ECOLOGY.

Base line data collection.

The baseline data of the marine environment of KKNPP has been well established through the studies undertaken by

a. Manonmaniam Sundaranar University,.
b. Institute of Ocean Management, Anna University
c. Engineers India Limited/ CMFRI

Special feature in intake: Fish Protection system

Kudankulam project uses sea water for condenser cooling for which water is drawn from intake dykes. . To save the fishes from coming into the fore bay / pump house area and getting trapped, KKNPP houses a unique "fish protection system" where in all the fishes which are coming into the intake will be separated by means of a unique air curtain and "Oogee weirs" and are safely returned back into the sea. This is an unique facility to protect the marine organisms..

Effect of Condenser cooling water in the marine life

The approximate quantity of coolant water, when the plant is in operation released in sea will be 70,00,000 CuM per day per unit with a maximum delta T of 7 degree Celsius.

The seasonal variation in surface water temperature of Kudankulam Marine Environment ranged from 23°C during monsoon and winter season to 29°C during summer season, with an annual average of 26.6°C.

The studies on the lethal affects of temperature on selected fishes and prawns of Kudankulam Marine Environment showed that the lethal temperature of fin & shell fishes was found to be between 38.2 and 43.2° C. Considering maximum possible surface sea water temperature of Kudankulam areas as 29°C, during summer months and the rising the temperature as stipulated by MoEF as 7°C, the maximum temperature at discharge point will be 36°C, which may not harm any fish even in the vicinity of discharge point. But during monsoon and winter season the ambient surface water temperature will be considerably low (23°C) and hence no effect will be envisaged in the discharge area. In fact the mixing will be very fast due to wave action and other water currents. Due to the wave action the

mixing of warm water from condenser with ambient sea water will be instantaneous and a possible reduction of ambient sea water temperature will be expected. Considering the fact it is obvious that there may not be any harm to the fishery potential of Kudankulam Marine Environment due to the establishment of KKNPP. It is again supported by the fact that fish, being a cold blooded animal, it can adjust the body temperature with that of environment within the sub lethal temperature and a rise in body temperature will enhance all biological activities, including growth and production. In addition, the fish and prawns will have the capacity to sense the change in temperature in ambient water and try to avoid and move away from the adverse condition, if any., from the point of discharge

The operation of Nuclear Power Plant in the country at the coastal locations at TAPS, Tarapur in Maharashtra and MAPS at Kalpakkam in Tamil Nadu has also not shown any adverse effects on Marine life including the fish.

5.27) IMPACT ON LAND, AGRICULTURE, LIVE STOCK AND FOOD SECURITY.

Impact on Land:

Beneficial impacts would be felt on land use pattern and topographical features of the area due to greening of the area through plantation and green belt development. Under operating conditions, there will not be any impact on the land environment as discharges are insignificant as compared to the combined natural background parameters.

As of now, a total of 23890 plants and trees have been developed for green belting, at Kudankulam site (KKNPP). The area covered by lawns and gardens is 16419 Square meters. Hedges accounts for 2467 Running meters and this will help to improve the quality of environment around NPP. The green belt development will be continued in future which will attract more fauna specially avian species resulting in improvement in biodiversity as evident in other nuclear power station like Kaiga, Kalpakkam,Tarapur etc.

Impact on Agriculture, live stock and food security:

National Environmental Engineering Research Institute (NEERI) has prepared the Environmental Impact Assessment (EIA) report and had documented the land use classification in 30 Kms radius of the plant site based on satellite mapping.

The land use/ land cover classification indicates 8.73% area covered by vegetation, 8.73% are covered by Barren land, 23.39% area covered by scrubland, 8.52% area covered by sandy area, 0.08% built-up area, 49.68% water body including sea, river/nala etc.

This is the baseline data. However data from the other nuclear power plants in the country indicate that operation of NPPs do not have any adverse impact on agriculture, live stock and food security.

5.28) IMPACT ON FLORA AND FAUNA

As such the land acquired has been dry and barren and hence there is no impact on the flora and fauna inside the plant area. NEERI has conducted the base line study of the biological environment in and around KK site and is well documented.

Also as on June 2011, a total of 23890 plants and trees have been developed for green belting, at KKNPP. The area covered by lawns and gardens is 16419 Square meters. Hedges accounts for 2467 running meters.

The Green Belt programme will be continued to develop a green belt in the vacant land, after assigning the plant structures of KKNPP 3 to 6.

Because of the green belt developed, the area around plant and township has become a hub for migratory birds.

5.29) COOLANT WATER DISPOSAL&THERMAL ECOLOGY

Already discussed at 5.26) above.

5.30) Seismology

Structures, systems and components (SSC) of Indian nuclear power plant (NPP) are designed for two levels of earthquakes which are estimated according to safety requirements laid down by the Atomic Energy Regulatory Board (AERB) which are in line with the IAEA (International Atomic Energy Agency) guidelines (IAEA Guide 50-SG-S1):

1) S1 level of ground motion or OBE (Operating Basis Earthquake).
2) S2 level of ground motion or SSE (Safe Shutdown Earthquake).

S1 level corresponds to the maximum ground motion which can be expected to be

experienced at the Site during the life of the NPP i.e. once in a 100 years. All SSC necessary for power generation are designed for this level of ground motion.

S2 level corresponds to the conservatively estimated level of ground motion which can be expected to occur once in 10,000 years. All SSC important to safety are designed to remain functional during a S2 level earthquake.

SSE is derived on the basis of maximum earthquake potential associated with the tectonic structures and seismotectonic province in the region and takes into account,

I. the maximum earthquake potential inside the seismic tectonic province of the site associated with specific tectonic structures

II. the maximum earthquake potential inside the seismic province of the site not associated with specific tectonic structures

III. the maximum earthquake potential for the adjoining seismotectonic provinces associated with specific tectonic structures and

IV. the maximum earthquake potential for the adjoining seismotectonic provinces not associated with a specific tectonic structure.

Earthquake Design Basis for Kudankulam Nuclear Power Plant (KKNPP) -1 & 2

Kudankulam Nuclear Power Plant is located in Indian Seismic Zone II which is the least seismic potential region of our country. (ref. IS 1893). However, for designing of the Plant, detailed studies are conducted to conservatively estimate extent of ground motion applicable to the specific Site with reference to Seismotectonic and Geological conditions around it so that NPPs are designed for a SSE level earthquake which has a very low probability of being exceeded (return period of 1 in 10,000 years).

For Kudankulam NPP, the following tasks were undertaken for detailed evaluation of Site specific conditions as below:

a) Study of the seismotectonic and geological setup of the region.

b) Selection of a set of recorded accelerograms with source and site conditions resembling those at Site for computing response spectra.

c) Generation of response spectra of the selected time-histories for various values of damping and statistical analysis of the ensemble of response spectra.

d) Collection of additional information on earthquakes, regional and local geology and tectonics pertinent to evaluating fault activity and design basis ground motion parameters.

e) Integration of the above information to arrive at the Earthquake Design Basis (EDB). This involves the generation of peak ground acceleration and response spectral shapes for various components of ground motion for both S1 and S2.

f) Generation of spectral compatible accelerograms.

All potential, active and non-active faults, lineaments and seismic history within a radius 300 kms have been analyzed to arrive at the SSE and OBE levels of earthquake. As per above data, there are no faults / lineaments in the near vicinity of the site. The most intense earthquake experienced in this 300km region is the earthquake that occurred at Coimbatore (307 km) on 08/02/1900 which had an epicentral intensity of VII on the MMI scale (6.0 in the Richter scale).

Towards enhanced conservation, the high intensity earthquakes that occurred in this seismotectonic region have been assumed to act at the closest faults/ lineaments near the site in arriving at the SSE level. The Site specific response spectra for SSE at KKNPP has been derived from the envelope of these hypothetical events.

Considering the above events, a rock-site-specific formula for the maximum peak ground acceleration valid for the range of magnitude and distance of interest has been derived.

The peak ground accelerations thus evaluated for KKNPP are as follows.

Peak ground acceleration (g)		
Level	**Horizontal**	**Vertical**
SSE	***0.15***	***0.11***
OBE	***0.05***	***0.036***

References:

i) Report on "Earthquake Design Basis for Kudankulam Site" prepared by Dr.A.K.Gosh, BARC & Shri D.C. Banerjee, AMD.

Conclusion: the seismic parameters for the design of SSC of KKNPP have been arrived at in a highly conservative manner following the AERB stipulations and thus the seismic safety of the plant is assured with a large safety margin.

5.31) CONSERVATION ISSUES (GULF OF MANNAR BIOSPHERE AND WESTERN GHATS)

Gulf of Mannar Biosphere reserve:

- The nearest biodiversity richness region of Gulf of Mannar biosphere reserve is located north of Tuticorin which is more than 80 Kms from the plant site.

- CMFRI while preparing the marine EIA had conducted exhaustive sampling covering 60 Sq Kms of the site. They have clearly stated that "the marine ecosystem of the KKNPP region has characteristics of an oceanic region which is different from the productive ecosystems of the west coast , gulfs and bays."

- Another significant ecological feature of KKNPP Site is the absence of sensitive habitats like mangrove and coral reefs in KKNPP coast. The CMFRI have confirmed that there are no formations of coral reefs south of Tuticorin and along the Kanyakumari coast (including the Plant neighborhood).

Western Ghats:

- The EIA document confirms that there is no forest area within 15 km of the plant site.

- As such there is no impact on the Western Ghat due to setting up of KKNPP.

5.32) Terrorist and Security Threats

Elaborate measures have been taken for the security of KKNPP as is done for all the NPP in the country. An exhaustive physical protection system with 24X7 monitoring is implemented for the plant areas. These systems consist of multi-layered security and online surveillances which are regularly reviewed with regard to threat perception to ensure adequate protection.

5.33) Bilateral relations

Not addressed

5.34) Impact of mining activities

No mining activity is carried out by KKNPP.

5.35) Severe Accident Management:

NPPs are designed and operated following the principle of defense-in-depth. This principle requires that there be successive barriers against release of radioactivity and several layers of protection be provided for each of the safety functions.

The first level of defense-in-depth is achieved by ensuring that the plant is designed in such a way that all safety parameters like pressure, temperature flow etc. are maintained within the specified limits.

The second level corresponds to upset operating conditions that can be expected during plant operation, like, failure of grid power supply. The design ensures that safety is not jeopardized on account of such upset conditions.

The third level relates to the situation where plant parameters exceed the prescribed safety limits. The safety design of the NPP ensures that the reactor is promptly shut down automatically and cooling of fuel is adequately maintained to prevent it from overheating and cause any release of radioactivity.

The fourth level corresponds to a situation where adequate cooling of the fuel cannot be maintained for some reason whereby the reactor gets into the accident mode. Even for such accident conditions, the NPP design provides the means to be able to control the progression of the accident and prevent any major release of radioactivity to the environment such that there are no significant adverse radiological consequences in the public domain.

The fifth level of defense-in-depth assumes, in a hypothetical manner that due to unforeseen reasons or due to any failures in design or operating procedures or in their implementation, radioactivity release does take place. Hence an emergency preparedness plan must be in place which can be executed, if required, to mitigate the consequences of such a release.

The emergency preparedness plans should therefore be viewed in the overall context of the safety philosophy of defense-in-depth. Needless to mention that for any plan to be effective, it must be tested periodically. The emergency exercise including the off-site emergency exercise that may require evacuation of a section of the population, are carried out accordingly. It must, however, be reiterated that the possibility of an emergency situation arising is extremely remote and the exercises are done only to be in a state of preparedness, should the need arise.

In India, NPPs have been in operation over the last more than 40 years and there has never been any accident of the need for any emergency actions in the public domain. Even in the entire world where over 430 NPPs are in operation, the need for emergency action in the public domain has arisen only twice; once in 1986 from the Chernobyl accident and the other in 2011 from the Fukushima accident.

5.36) Emergency Preparedness at KKNPP:

It may be noted that in KK reactor design, many advanced safety features are deployed. These include the passive heat removal system, which ensures cooling of the fuel even if power is not available (as was the case in Fukushima) and other safety provisions like the double containment and core catcher that strengthen the plant safety such that any

intervention in the public domain outside the plant exclusion zone will not be required even in case of an accident. However, as a matter of abundant caution following the defense–in-depth safety philosophy, emergency plan for actions to be taken in public domain during any off-site emergency were prepared and provided to District Authorities.

These procedures are accordingly included in the "Emergency Preparedness Plans" Vol-1 and Vol-2 duly approved for Kudankulam Nuclear Power Project. Volume– 1 covers Plant Emergency and Site Emergency conditions which have been prepared by the KKNPP Site, reviewed and approved by Atomic Energy Regulatory Board. The document no. is I01.KK.0.0.TM.MN.WD001. Volume -2 is for the Off-site Emergency Preparedness which has been prepared by NPCIL in consultation with the State authorities, concurred by Atomic Energy Regulatory Board and approved by the District Collector, Tirunelveli District. Document No. is I01.KK.0.0.TM.MN.WD002. Both of these documents are in place.

These emergency preparedness plans brings out the conditions at which plant, site and off site emergencies may be declared by the respective authorities. They also bring out in detail the roles and responsibilities of various agencies involved. The plants are tested periodically by conduct of emergency exercises such that any deficiency can be observed and corrected and to keep the plant updated. Plant emergency exercise is conducted once in 3 months, site emergency is conducted once in a year. The off-site emergency is conducted once is two years. Prior to first criticality, plant, site and off-site emergency exercises have to be conducted once.

For the plant and site emergency, all the KKNPP employees and the CISF personnel have been trained. First plant emergency mock exercise has been conducted involving KKNPP personnel and contract personnel.

Implementation of offsite Emergency plan involves various State Government Departments like District Revenue, Social Welfare, Fire, Health, Horticulture & Agriculture, Fisheries, Irrigation, Forest, Animal Husbandry, Electricity Board, Transport, Local Administration & Police Departments. A detailed training programme was conducted as per the schedule provided by the District Collectorate for the officials from all the above departments in the month of August 2011 about the roles and responsibilities of the respective departments. Around 600 officials from these departments have been trained on off-site emergency preparedness.

Fresh Fuel transportation will be done with due consents from AERB, following all the stipulations.

No Radioactive Waste will be transported out of the plant premises.

All the above are subject to AERB approval and audit.

5.37) Russian and Indian liability issues:

Not addressed.

5.38) Project Cost and Russian Debt Analysis:

On a query to NPCIL, they have given the following information

"The sanctioned cost of the KKNPP 1&2, is Rs 13,171 crores including interest during construction. About half of the cost is financed by the credit facility extended from the Russian Federation. As per the agreement, the credit is to be utilised during the construction of the plant and is to be repaid in 14 annual installments, after commissioning of the plant.

The set back in project completion schedule has resulted in revision of the cost estimates , mainly due to increase in the interest on borrowings, establishment cost and escalation on the cost of balance works. The revision of cost estimates is in process".

5.39) Generation and Transmission

The transmission system was finalised taking into considerations the various requirements i.e reliability and security levels as stipulated in the "Transmission Planning criteria" document issued by Ministry of Power Government of India, New Delhi.

2000MW(e) electrical power generated from KKNPP Unit#1 and Unit#2 is exported through the 400KVpower transmission lines.

The power generated from KKNPP is exported to Tirunelveli through the four 400KV transmission lines. KKNPP station loads normally derive power from the four 400KV power supplies.

5.40) CAPACITY FACTOR MONITORING

Capacity factor is monitored by NPCIL.

5.41) Spent Fuel Transportation

This is covered at 5.16) above.

5.42) Decommissioning

The objective of decommissioning is to release the NPP site for reuse or for unrestricted use, depending on the requirement, ensuring safety of members of the public and occupational workers as well as protection of the environment. Provisions for facilitating decommissioning in KKNPP-1&2 have been made in the design.

Decommissioning strategy consists of de-fuelling of reactor and removal of all radioactive fluids from the systems, at the end of its operating life. The SSCs are then kept in a safe storage mode for a period of time to allow for natural decay of radioactivity for ease of

dismantling of components and their packaging and transportation for disposal. The necessary machinery, components, structures and the building are left intact for such safe keeping. Some of the conventional SSCs may be dismantled at this stage.

The cost of decommissioning of NPPs in India has been worked out through a detailed exercise. The estimates indicate that decommissioning cost can be met by a decommissioning levy of 2 paise per KWh to be charged along with tariff to create a corpus to be used at the time of decommissioning. The levy will be reviewed periodically to ascertain its adequacy to meet the decommissioning fund requirements and may be revised if necessary.

In this context, it may be noted that some of the Indian NPPs have undergone significant renovation and modernization activities. These included replacement of components like pressure tubes end fittings, feeder pipes etc. This experience has demonstrated that technology for such dismantlement activities that are similar to decommissioning, is available in the country. The experience also shows that costs involved are within the estimated values. The radioactive waste arising from decommissioning is not significantly different than the waste generated from normal operation of the NPP, except that its volume will be comparatively large. In India we have good experience in handling and disposal of such waste and therefore no difficulty is foreseen for handling and disposal of waste arising from decommissioning work.

5.43) Impact of increased sea patrol and militarization of the area:

Sea Patrol and militarization of the area is governed by the requirements of National Security. KKNPP is also covered in these requirements.

5.44) Erosion of civil liberties

Only the Plant area is a restricted area. Other than this area, movement and actions of the people are governed by the Laws of Land.

5.45) Noise Pollution

1. **Base line data collection:** M/s Engineers India Limited (EIL) has measured the noise levels at the following places for preparing a rapid Environmental Impact Assessment (EIA) for Kudankulam Nuclear units.

Location (Residential area)		Day time*			Night time**			Standards	
	Date	Maximum [dB (A)]	Minimum [dB (A)]	Average [dB (A)]	Maximum [dB (A)]	Minimum [dB (A)]	Average [dB (A)]	Day time* [dB	Night time**

								(A)]	[dB (A)]
Vijayapathy	01.07.2011	57.0	37.4	52.5	39.0	30.0	36.0	55	45
	07.07.2011	54.6	33.2	49.4	40.6	33.4	38.0		
	14.07.2011	56.9	36.9	51.0	45.4	33.2	39.7		
	20.07.2011	58.2	36.4	50.8	42.5	33.2	39.4		
Chettikulam	05.07.2011	54.2	36.4	50.0	40.1	30.4	37.8	55	45
	11.07.2011	56.2	33.2	51.1	41.2	30.2	37.2		
	17.07.2011	56.2	33.4	50.7	41.2	33.6	38.7		
	27.07.2011	57.2	39.2	49.5	41.6	33.4	39.6		
Erukandurai	02.07.2011	54.2	36.2	49.9	40.9	30.6	38.1	55	45
	09.07.2011	55.6	34.2	51.1	40.6	30.9	36.5		
	15.07.2011	28.6	30.4	51.9	42.6	34.5	39.0		
	21.07.2011	59.2	34.2	50.8	45.6	32.1	40.1		
Udayathur	02.07.2011	56.4	35.4	51.5	37.9	30.8	35.1	55	45
	09.07.2011	56.2	32.6	50.3	44.2	33.4	39.0		
	15.07.2011	57.0	34.6	51.8	41.2	36.4	39.4		
	21.07.2011	57.0	38.6	50.3	44.1	33.6	40.1		

*Day time: (6 AM to 10 PM) ** Night time: (10 PM to 6 AM)

2. **Standards:** The standards prescribed as per the noise pollution rules 2000 are as follows.

Ambient Air Quality Standards in respect of Noise

Area Code	**Category of Area/Zone**	**Limits in dB(A) Leq ***	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Note:-

1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is defined as an area comprising not less than 100 metres around hospitals, educational institutions and courts. The silence zones are zones which are declared as such by the competent authority.
4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

*dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

A "decibel" is a unit in which noise is measured.

"A", in dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.
Leq : It is an energy mean of the noise level, over a specified period.

3. **Impacts due to Noise pollution:**

3.1 Construction phase: During construction phase the noise levels are minimal and there is no impact to the outside areas.

3.2 Commissioning Phase: Nuclear Power Plants are relatively silent operators. However, during Hot Run test, the steam is vented to atmosphere through relief valve. Testing and Venting of steam relief valves are occasional operations.

3.3 Operation phase: During operation of the plant, there is no equipment, which will produce sound above the prescribed limits during continuous operation**.**

5.46) KKNPP Expansion Plans

In principle approval for establishment of KK-3 to 6 exists from Govt of India.

5.47) IAEA Safeguards

Government of India has entered into an agreement with International Atomic Energy Agency for the application of Safeguards for the nuclear fuel to be supplied for KKNPP by the Russian Federation. The agreement entered into force on 27th September 1988 and follows the guideline available in . 'INFCIRC/360' available on IAEA website. We have long experience in implementation of safeguards on nuclear fuel in some of our NPPs and the procedures to be followed at KKNPP will be o different. Hence there are no problems in implementation of IAEA safeguards for the nuclear fuel in KKNPP.

5.48) NSG related issues

Not addressed

5.49) Setting up of possible weapon facility at KKNPP

Not addressed

5.50) any other related issues

Nil
