Evaluative Report of Indira Gandhi Centre for Atomic Research

1 Name of the CI

Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam

2 Year of establishment

Please see para 6 of the 'Profile'.

3 Is the CI part of the university

Yes

4 Names of programmes offered

IGCAR offers Ph.D., M.Sc.(Engg), and M.Tech. in Engineering Sciences. It offers M.Phil. and Ph.D. in Chemical Sciences and Physical Sciences. Please also see Appendix 1 of the profile.

5 Interdisciplinary programmes

To encourage interdisciplinary research, all engineering disciplines are clubbed together under the engineering sciences. Similarly, physics and material science disciplines are clubbed together under physical sciences. Students from chemical science disciplines carryout multi disciplinary research in the area of chemical engineering and materials science as well. In addition, on a case to case basis, Ph. D students work under joint supervision of two guides, where one is from other than student's primary discipline.

6 Courses in collaboration with other universities, industries, foreign institutions, etc.

Doctoral Students can work under joint supervision of two guides, where one guide is from one of the collaborating institutions with whom HBNI has a formal MoU. In addition, students can also attend credit courses offered at collaborating institutions.

For a list of collaborating institutions, please see Para 2.4.10 of 'Criteria-wise Inputs'.

7 Details of programmes discontinued, if any, with reasons

NIL

8 Examination System

Semester system

9 Participation of the department in the courses offered by other departments

Yes, IGCAR has no rigid boundaries. Faculty participate in activities of other disciplines as well.

10 Number of teaching posts sanctioned, filled and actual (Professors/ Associate/ Professors/ Asst. Professor/ Others)

Please see para 24 of the Profile.

11. Faculty profile with name, qualification, designation, area of specialization, experience and research under guidance

Please see Appendix 1.

12. List of senior Visiting Fellows, adjunct faculty, emeritus professors :

Ramanujam fellows : 2 (Dr. Anthony Arul Raj & Dr. R.N. Viswanath);
Adjunct faculty: NIL; Emeritus professors: NIL

13. Percentage of classes taken by temporary faculty – programme-wise information :

NIL

14. Programme-wise Student Teacher Ratio :

1: 3 for delivering lectures in PG Diploma, M. Tech. and doctoral course works. For doctoral programmes, the norm of maximum 8 students per faculty is strictly followed.

15. Number of academic support staff (technical) and administrative staff: sanctioned, filled and actual

Please see para 24 of the 'Profile'.

16. Research thrust areas as recognized by major funding agencies

At IGCAR, a broad based multidisciplinary programme of scientific research and advanced engineering development, directed towards the establishment of technology of Sodium Cooled Fast Breeder Reactors (FBR) is carried out. The mission includes the development and applications of new and improved materials, techniques, equipment and systems for FBRs and associated fuel cycle. We are currently in the midst of executing challenging projects that include the commissioning of 500 MWe Prototype Fast Breeder Reactor, design of newer reactors including a metal-fuelled FBR for higher breeding, and the establishment of a Fast Reactor Fuel Cycle Facility.

Apart from pursuing a mission-oriented technological development, at IGCAR, a strong emphasis on basic research has been placed, since its inception. Research on topical problems in materials science, condensed matter physics, chemical and engineering sciences are being carried out at IGCAR, that contribute towards sustaining the dynamism and robustness of a research Centre involved in the indigenous development of advanced technologies.

The physical sciences program at HBNI-IGCAR has research and developmental (R&D) activities in the three broad areas: (i) Materials Science (2) Reactor Physics and (iii) Health and Radiation safety.

Thrust areas of Materials sciences include (1) Studies on novel superconducting systems and strongly correlated electron systems (2) high pressure high temperature synthesis of non-equilibrium phases and structural phase transitions at extreme conditions (3) development and utilization of SQUID sensors (4) SQUID based measurement of biomagnetic fields using Magnetocardiography (MCG) and Magnetoencephalography (MEG). (5) Structural ordering, dynamics and flow and deformation behavior of soft matter (6) Phase transitions in anomalous thermal expansion materials and Photonic crystals (7) Accelerator Materials Science (8) Ion beam Simulation of Radiation Damage (9) Computational Materials Science (10) Defect studies in materials using Positron beams (11) Nanomaterials and Sensors (12) Thin films and Coatings, and (14) MEMS and microcantilever based sensors.

Thrust areas in reactor physics, health and radiation safety include (1) FBR safety (2) Nuclear data for FBR (3) Radioactivity transport and improvement of radiation detection and measurements through advanced techniques.

Development of phosphors for X-ray and neutron dosimetry and modeling of sodium aerosols relevant to fast reactor safety.

Some of the thrust areas of research in chemical sciences include (1) Measurement of critical physico-chemical and thermodynamic properties of advanced fast reactor fuels, (2) To develop methodologies to understand and predict the chemical behaviour of fuel/materials, fission products and structural materials through experimental measurements and modelling, (3) To develop advanced fuel fabrication methods, advanced methods of reprocessing, alternate shielding materials and addressing the chemistry problems associated with aqueous reprocessing and (4) To understand the chemistry of Pb-Bi alloy as a coolant in future advanced fast reactors.

Funding in all these areas of R&D activities is provided by the Department of Atomic Energy.

Please see para 3.1 of the 'Criteria-wise Inputs'.

17. Number of faculty with ongoing projects from a) national b) international funding agencies and c) Total grants received. Give the names of the funding agencies, project title and grants received project-wise.

Full funding is received from the Department of Atomic Energy and all the faculties are involved in one or more projects. Details of ongoing projects and grants for IGCAR put together are given in Appendix 2.

18. Inter-institutional collaborative projects and associated grants received

IGCAR is associated with several national and international projects with a large number of research institutions / universities.

National collaboration: National Chemical Laboratory, Pune; Central Electrochemical Research Institute, Karaikudi; Institute of Chemical Technology, Mumbai; Indian Institute of Technology Madras, Chennai; Indian Institute of Science, Bengaluru; Indian Institute of Technology, Kanpur; Anna University, Chennai; B.S. Abdur Rahman University, Chennai; Vellore Institute of Technology University, Vellore; University of Rajasthan, Jaipur; NGRI, Hyderabad ; Pondicherry University ; Loyola college, Chennai ; University of Madras, Chennai; Satyabama University, Chennai; NIT- Calicut; MG University, Kottayam; University of Kerala

International collaboration: Atomic Energy and Alternative Energies Commission (Commissariat à l'énergie atomique et aux énergies alternatives, CEA), France; Karlsruhe Institute of Technology, Germany; Forschungszentrum Jülich, Germany; University of Vienna, Austria; University consortium of UK, Loughborough University, United Kingdom; Photon Factory, Japan; Carnegie Institution of Washington, USA; Geophysical Laboratory, Washington DC; PETRA-III Synchrotron, Germany; University of California,USA; University of Western Ontario, Canada; Tokyo University, Japan; Nagoya City University, Nagoya; Kyoto Sangyo University, Kyoto

19. **Projects funded by DST-FIST; UGC-SAP/CAS, DPE; DBT, ICSSR, AICTE, etc.; total grants received**.

Nil.

20. Research facility / centre with

- **state recognition**
- **national recognition**
- **international recognition**

While IGCAR, or any of the other institutions in the DAE, does not have any formal recognition as a centre of excellence, there are several state-of-the-art equipment / facilities in this Centre in addition to a host of conventional facilities required for carrying out high calibre research in the area of nuclear science and technology.

21. Special research laboratories sponsored by / created by industry or corporate bodies

HBNI is essentially a research university and research output of HBNI is deployed in industrial units and PSU of the DAE. Many technologies are transferred by IGCAR to outside entities through a well established technology transfer mechanism. One can thus say that all research laboratories in IGCAR are sponsored by the government for the purpose of deployment in the industry.

22. Publications:

Please see para 3.3 of the ‘Criteria-wise inputs’.

23. Details of patents

A number of inventions have been patented. Please see Appendix 3 for a list.

24. Areas of consultancy and income generated

Not Applicable. Please see para 3.4 of the 'Criteria-wise Inputs'.

25. Faculty selected nationally/ internationally to visit other laboratories/ institutions/ industries in India and abroad.

Visits within India are very large. For visits abroad, please see Appendix 4.

26. Faculty serving in
a) National committees b) International committees c) Editorial Boards d) any other (please specify)

Please see Appendix 3 of the 'Criteria-wise Inputs.

27. Faculty recharging strategies (UGC, ASC, Refresher / orientation programs, workshops, training programs and similar programs).

HBNI encourages faculty to participate in and organise national and international workshop and conferences, go to universities abroad for post doctoral fellowships and short term research assignments, act as consultants for developing countries under programmes sponsored by IAEA, participate in collaborative projects with universities in India funded by BRNS, participate in collaborative projects with laboratories abroad under various MOUs. All this helps to recharge the faculty.

28. Student projects

- **percentage of students who have done in-house projects:** 100%
- **percentage of students doing projects in collaboration with other universities/ industry/ institute:** 0%.

Situation in HBNI-IGCAR is reverse of what is prevalent in other universities. A large number of UG and PG students from other universities carry out course project work and summer project work at IGCAR.

29. Awards / recognitions received at the national and international level by

- **Faculty**
- **Doctoral / post doctoral fellows**

- **Students**

Please see Appendix 1 of the 'Criteria-wise Inputs'.

30. Seminars/ Conferences/ Workshops organized and the source of funding (national/ international) with details of outstanding participants, if any.

Please see Appendix 5.

31. Code of ethics for research followed by IGCAR

In addition to excellence in Science and Engineering, a strict adherence to high ethical standards is a necessity. The core ethical policy of DAE is to establish a tradition with highest ethical standards, ensuring a harmonious future for the entire humankind, where every individual can live with dignity and self-respect. In accordance with the guidelines of the DAE, adhering to highest ethical standards is one of the guiding values of IGCAR. Every complaint of malpractice or plagiarism received is investigated and appropriate action is taken.

32. Student profile programme-wise

Please see para 15 and para 28 of the 'Profile.'

33. Diversity of students

Please see Para 2.1 of the 'Criteria-wise Inputs'.

34. How many students have cleared Civil Services and Defense Services examinations, NET, SET, GATE and other competitive examinations? Give details category-wise.

Please see para 1.1.3 of the 'Criteria-wise Inputs. This question is not applicable to HBNI.

35. Student progression

Students joining BARC Training School at IGCAR become employees of DAE and at some stage come back to enroll for a Ph.D.

36. Diversity of staff

Please see para 2.4.3 of the 'Criteria-wise Inputs.'

37. Number of faculty who were awarded M.Phil., Ph.D., D.Sc. and D.Litt. during the assessment period

Dr. S. Venugopal has been conferred with D.Sc by University of Madras.

38. Present details of infrastructural facilities with regard to

a) Library :

IGCAR has a state of the art library with about 5000 square meters area. It has 70,000 books, 45,000 back volumes, 1,95,000 reports, 15,000 standards and 815 journals in its collection. In addition to print resources, the library has rich collection of e-resources such as DAE consortium e-journals, scientific/ bibliographic databases, e-books, IGC publications and Full text resources. An advanced 3 tier based digital library infrastructure ensures the access to e-resources 24/7 across the campus throughout the year. Radio Frequency Identification (RFID) based library self check-in /check-out machines are provided for quick library transactions.

b) Internet facilities for staff and students: Yes, for all

a) Total number of class rooms : 11 Class Rooms and 5 Lecture Halls

b) Class rooms with ICT facility : Yes

Consists of the hardware, software, networks and media for the collection, storage, processing, transmission and presentation of information (voice, data, text, images) as well as related services.

c) Students' laboratories : Yes

d) Research laboratories : Yes

39. List of doctoral, post-doctoral students and Research Associates

Please see Appendix 6.

40. Number of post graduate students getting financial assistance from the university.

All students perusing their PG(Diploma), and Ph. D programme get financial assistance from the university. After a year in Training School students become employees and get salary.

41. Was any need assessment exercise undertaken before the development of new programme(s)? If so, highlight the methodology.

Please see para 1.1.2 of the 'Criteria-wise Inputs'.

42. Does IGCAR obtain feedback from

a. faculty on curriculum as well as teaching-learning-evaluation? If yes, how does IGCAR utilize the feedback?

b. students on staff, curriculum and teaching-learning-evaluation and how does IGCAR utilize the feedback?

c. alumni and employers on the programmes offered and how does IGCAR utilize the feedback?

Obtaining feedback from faculty, alumni and employees is a continuous process. Feedback from students is obtained once every year at the end of the academic session. All feedbacks received is analysed and fed to an apex committee for deliberation and decision. Introduction of new programmes and changes in syllabus are decided as needed.

43. List the distinguished alumni of the CI (maximum 10)

The list below includes those, who received a Ph.D. based on the work done at IGCAR, or are from the Training School, but prior to the setting up of HBNI.

Chemical Science

S. No	Name
1.	Dr. C.K. Mathews
2.	Dr. G. Periaswami
3.	Dr. N.P. Bhat
4.	Dr. Raman S. Srinivasa
5.	Dr. O.M. Sridharan
6.	Dr. T.R. Mahalingam
7.	Dr. P. Sriramamurti
8.	Dr. K.S. Viswanathan
9.	Dr. R. Viswanathan
10.	Shri B. Saha

Engineering Science

Sl. No	Name
1.	Dr. Anand Babu C
2.	Shri Balasubramanian G R
3.	Dr. Baldev Raj
4.	Shri Bhoje S B
5.	Shri Chetal S C
6.	Shri Kale R.D.
7.	Dr. Koganti S B
8.	Dr. Mannan S L
9.	Late Dr. Placid Rodriguez
10.	Dr. Swaminathan P

Physical Science

Sl. No	Name
1.	Prof. Ajay K Sood
2.	Dr. S.M. Lee
3.	Prof. A.K. Arora
4.	Dr. A. Natarajan
5.	Dr. C.P. Reddy
6.	Dr. K.G.M. Nair
7.	Dr. R. Jeevanram
8.	Dr. R. Indira
9.	Prof. K.P.N. Murthy
10.	Dr. Raju Nandedkar

44. Give details of student enrichment programmes (special lectures/ workshops/ seminars) involving external experts.

IGCAR regularly hosts eminent national and international experts to give seminars in their field of specializations.

45. List the teaching methods adopted by the faculty for different programmes.

Besides standard class room teaching, interaction though discussions in laboratories.

46. How does IGCAR ensure that programme objectives are constantly met and learning outcomes are monitored?

Professional programmes conducted at the Training School prepare students for

a lifelong career in DAE. Their successful outcome is demonstrated by the success of setting up of accelerators, developments in laser technology including design, construction, operation and maintenance of reactors etc. These programmes have seen continuous evolution over the years in terms of updating of syllabus. Assessment of students includes end-semester viva voce which tend to look at what a student has learned in a holistic manner rather than subject wise. A mini project and viva voce following it evaluates problem solving abilities of students. It may be added that though not articulated formally so far, the expected outcome of programmes at BARC Training School, Kalpakkam is to equip its graduates to apply fundamental knowledge of nuclear science and engineering in day to day working in units of the DAE.

Quality of theses produced by doctoral students is demonstrated by comprehensive research abilities acquired by students. Invariably number of publications in peer reviewed journals coming out of a thesis varies from one to several as can be seen from previous annual reports. Students after their completion of PhDs are generally selected for employment (including as INSPIRE faculty) in national laboratories, universities or industry in India or abroad.

47. Highlight the participation of students and faculty in extension activities.

Please see para 3.5 of the 'Criteria-wise Inputs'. Further, faculty and students at IGCAR pursue various extension activities in the form of 'public outreach programme', 'project training programme' and 'young scientists' research programme'.

As a part of IGCAR public outreach programme, visits are arranged to IGCAR by students and faculty. These visits are carefully planned keeping in mind the visiting group's level and interest, and usually last for 1-2 days with lectures, lab visits and demonstrations. The aim is to induce students to take up a career in science within the country by giving an overview of the research going on at IGCAR and DAE, and also give an exposure to the excellent research facilities at IGCAR. During the year 2013-2014 small groups from the following institutes visited IGCAR:

Name of the College / Institution
R.M.K. College of Engineering and Technology
R.M.K. Engineering College
Dhanalakshmi College of Engineering
Vel Tech Dr. RR & Dr. SR Technical University
Jeppiaar Engieering College

	Sathyabama University, Chennai
	Hindustan university, Chennai
	SKR Engineering College, Chennai
	Theivanai Ammal College for Women, Villupuram
	Sri Sivasubramaniya Nadar College of Engineering, Chennai
	Sri Venkateswara University College of Sciences, Tirupati
	Shree Motilal Kanhaiyalal Forma Institute of Technology, Chennai
	Madras Christian College Chennai
	Arunai Engineering College, Tiruvannamalai

48. Give details of "beyond syllabus scholarly activities".

The faculty is continuously engaged in research necessary for meeting the mandate of the Department. A significant percentage of this engagement is scholarly and results in good publications in peer reviewed journals. The students and faculty give lectures very frequently in various fora like national and international symposia, workshops, awareness programmes and colloquia. They interact on a regular basis with scientists and technologists of repute from the country and from abroad. They organise high level knowledge dissemination activities like organization of advanced schools under the aegis of BRNS/ DST and other similar bodies. Specially designed courses are also conducted.

The details of the special courses conducted are given below.

Principles of Alloy Design

An elective course on Principles of Alloy Design for Ph.D. students was conducted by HBNI, IGCAR during Feb.-May, 2011. The course had 45 video lectures and carried 6 credits, for the benefit of HBNI students across CIs. The faculties were drawn from the international expertise in the field; including Prof. S. Ranganathan, IISc., Bangalore, Prof. T. R. Ramachandran, NFTDC, Hyderabad, Prof. Jacques Foct, France and Prof. M.O. Speidel, Switzerland. Twenty students from IGCAR, eight from BARC and two from NFC, Hyderabad registered and attended the course.

Advanced Chemical Thermodynamics

A Course on "Advanced Chemical thermodynamics" was held during February 2010 to April 2010 with faulty drawn from various institutes in India and abroad. Totally 25 students, drawn from IGCAR and BARC attended the course. The course was handled by senior faculties in the field; including faculty from IIT Madras, Chennai Prof. B.S. Murti, Prof.K. C. Harikumar & Prof.K.

Mangala Sunder, Dr. D. Das / Dr. S. R. Bharadwaj, BARC, Mumbai, Dr. Anil Kumar, NCL, Pune and Prof. Dr. Herbert Ipser, University of Vienna, Austria.

49. State whether the programme/ CI is accredited/ graded by other agencies? If yes, give details.

Yes, by UGC

50. Briefly highlight the contributions of IGCAR in generating new knowledge, basic or applied.

Due to a very large volume of very high quality basic and applied research being carried out by the faculty and the students, the research output is excellent and this gets documented in the form of publications in international journals, patents and reports. A brief description of some important scientific and technological developments is provided below.

Chemical Sciences

Some of the thrust areas of Chemical Sciences research are listed below.

(1) Measurement of critical physico-chemical and thermodynamic properties of advanced fast reactor fuels.

(2) To develop methodologies to understand and predict the chemical behaviour of fuel/materials, fission products and structural materials through experimental measurements and modelling

(3) To develop advanced fuel fabrication methods, advanced methods of reprocessing, alternate shielding materials and addressing the chemistry problems associated with aqueous reprocessing

(4) To understand the chemistry of Pb-Bi alloy as a coolant in future advanced fast reactors.

Engineering Sciences

Research topics are chosen to facilitate design of new reactor systems and associated fuel cycle facilities, safety up-gradation and ageing management of existing reactors and fuel cycle facilities, efficient utilization of fuel resources and development of applications of nuclear technology to industry, healthcare and research.

Material Sciences

Thrust areas of Materials sciences include (1) Studies on novel superconducting systems and strongly correlated electron systems (2) high pressure high temperature synthesis of non-equilibrium phases and structural phase transitions at extreme conditions (3) development and utilization of SQUID sensors (4)

SQUID based measurement of bio-magnetic fields using Magneto-cardiography (MCG) and Magneto-encephalography (MEG). (5) Structural ordering, dynamics and flow and deformation behaviour of soft matter (6) Phase transitions in anomalous thermal expansion materials and Photonic crystals (7) Accelerator Materials Science (8) Ion beam Simulation of Radiation Damage (9) Computational Materials Science (10) Defect studies in materials using Positron beams (11) Nano-materials and Sensors (12) Thin films and Coatings, and (14) MEMS and micro-cantilever based sensors.

Physical Sciences

Thrust areas in physical sciences include (1) Studies on novel superconducting systems and strongly correlated electron systems (2) high pressure high temperature synthesis of non-equilibrium phases and structural phase transitions at extreme conditions (3) development and utilization of SQUID sensors (4) SQUID based measurement of bio-magnetic fields using Magneto-cardiography (MCG) and Magneto-encephalography (MEG). (5) Structural ordering, dynamics and flow and deformation behaviour of soft matter (6) Phase transitions in anomalous thermal expansion materials and Photonic crystals (7) Accelerator Materials Science (8) Ion beam Simulation of Radiation Damage (9) Computational Materials Science (10) Defect studies in materials using Positron beams (11) Nano-materials and Sensors (12) Thin films and Coatings, and (13) MEMS and micro-cantilever based sensors. (14) Nuclear data for FBR, safety and core burn (15) Radioactivity transport and improvement of radiation detection and measurements through advanced techniques. (16) Development of phosphors for X-ray and neutron dosimetry and modelling of sodium aerosols relevant to fast reactor safety.

51. Detail five major Strengths, Weaknesses, Opportunities and Challenges (SWOC) of IGCAR

Strengths

1. The quality of students is very good because of very rigorous selection process adopted. Since a vast majority of the students are scientists recruited by a tough selection process, a very high level of research output is ensured. This is contrary to the general trend seen elsewhere where students not finding employment are taking up research.
2. After a tough selection, the initial training imparted to the students is of very high standard.
3. The quality of research and infrastructural facilities available is very good.
4. The funding is very generous.

5. Besides the students, the faculty is also very strong, nationally and internationally known and there is very strong peer pressure on both the sides to do better.

Weaknesses:

1. Ensuring very high quality sometimes leads to very low number of students in some of the disciplines.
2. The embargo on supply of some items has resulted in lack of some of the sophisticated analytical equipment. This results in delays in research as alternate equipment has to be developed or innovative techniques have to be used for getting results.
3. Doctoral programme in engineering sciences has started expanding only in recent years. Faculty looks at themselves as scientists first and give lower priority to mentoring students. This is expected to improve over the years as faculty takes more and more students.

Opportunities

1. Opportunity to do high level research having immediate application in national programmes.
2. Opportunity to interact with scientist at national level and international level.
3. Opportunity to get various forms of national and international recognitions in the form of fellowships and awards.
4. Opportunity to develop various types of skills.
5. Opportunity to do interdisciplinary research.

Challenges

1. To balance various types of responsibilities for the faculty.
2. To balance between various types of responsibilities for the employees enrolled as students.
3. To publish results of research on strategic topics without compromising classified nature of information.
4. To ensure superiority in quality of research while doing doctoral research on large scale set ups.

52. Future plans of the IGCAR.

Expand the doctoral programme so as to utilise the full potential of the faculties and research infrastructure. Particular emphasis will be given to develop

qualified human resources (both scientists and engineers) required for the rapidly developing fields of high energy particle accelerators and lasers in the country for energy, medical and industrial applications.

List of appendices (to be made available to the assessment team during their visit)

1. IGCAR: Appendix 1: Faculty profile referred to at para 11
2. IGCAR: Appendix 2: Ongoing projects referred to at para 17
3. IGCAR: Appendix 3: List of patents referred to at para 23
4. IGCAR: Appendix 4: Visits of faculties to National/ International, Laboratories/ Institutions referred to at para 25
5. IGCAR: Appendix 5: Seminar/ Meetings/ Conferences/ Colloquia referred to at para 30
6. IGCAR: Appendix 6: List of doctoral students referred to at para 39