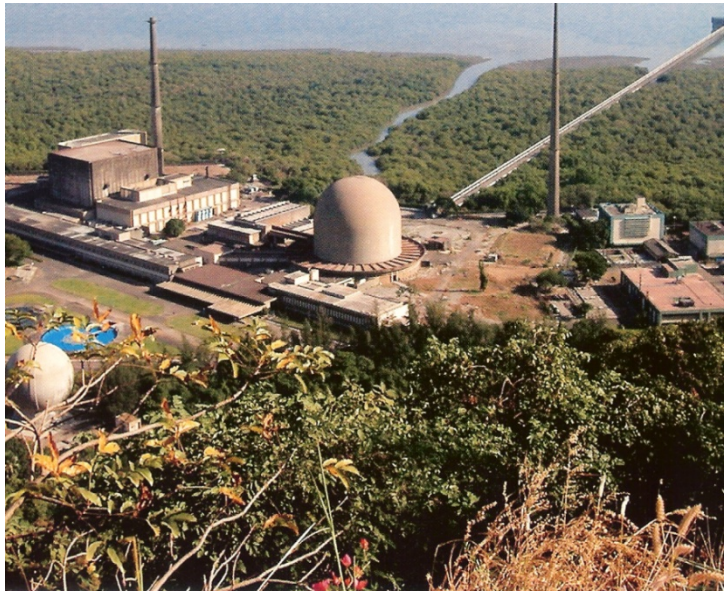
Manpower Development to Support Indian Graduate Training School Program of BARC and its Incorporation in University System



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Expanding Nuclear Power Program for a Large Growing Economy

3 'M's for progress & Accomplishments

- **Man:** Knowledgeable, trained man power
- **Materials**: Raw materials for fuel, structural and control functions
- **Machines**: Safe & Efficient reactors & supporting systems

People and Programs

- **People are the most important input to success of Nuclear Power Program**
- Program to be built around qualified, trained and motivated people
- Generating highly skilled manpower and ensuring its availability is vital
- India needs to enhance contribution of nuclear energy very substantially in the next 40 years

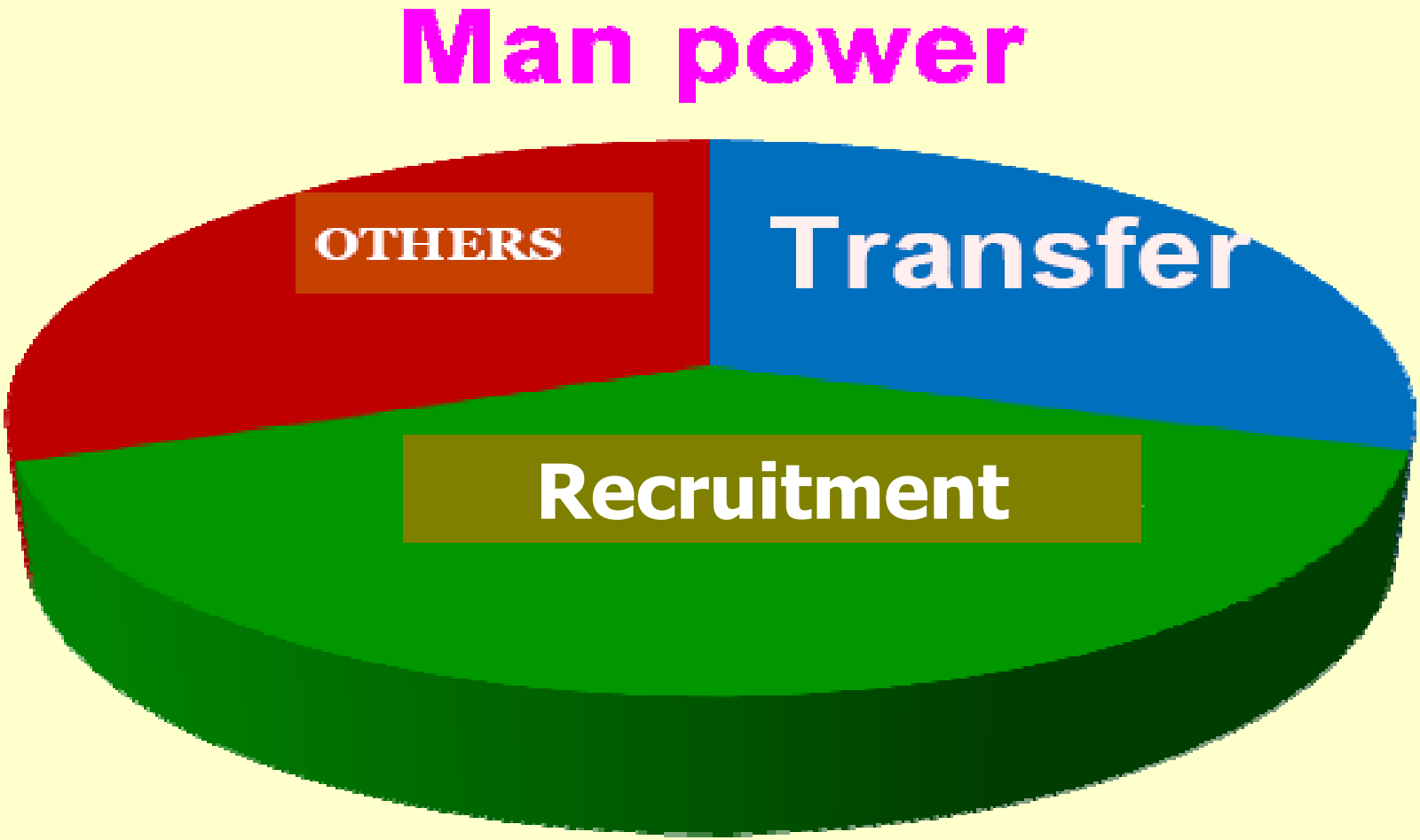
Man Power Required for Construction, Operation & Maintenance of Reactors

Present strength of Engineers	P
Anticipated depletion in the next 5 years	0.4P
Strength needed by 2017	1.8P
New Induction	1.2P

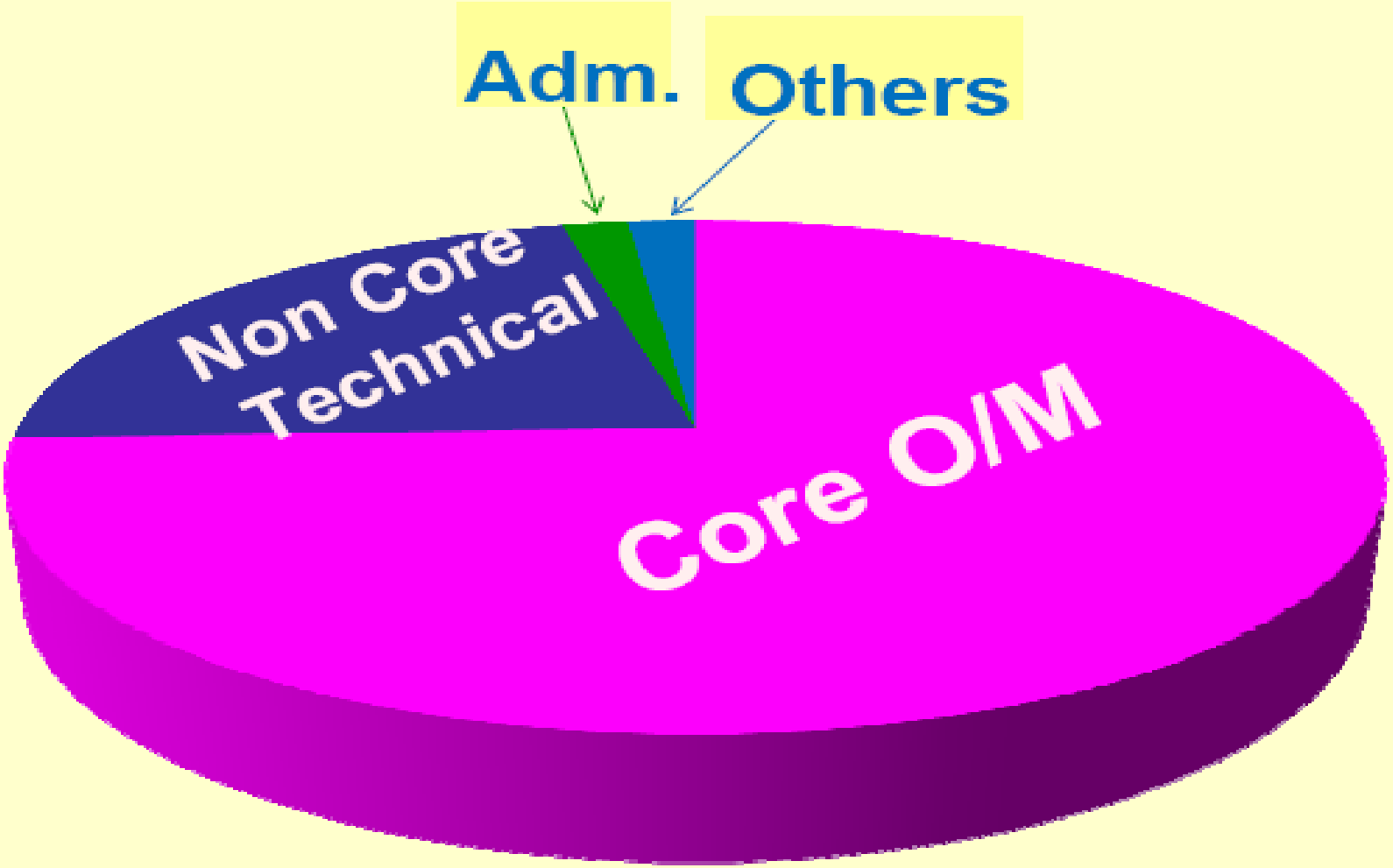
Present strength of Managerial cadre	S
New Induction by 2017	1.8S

New recruits to exceed present total strength

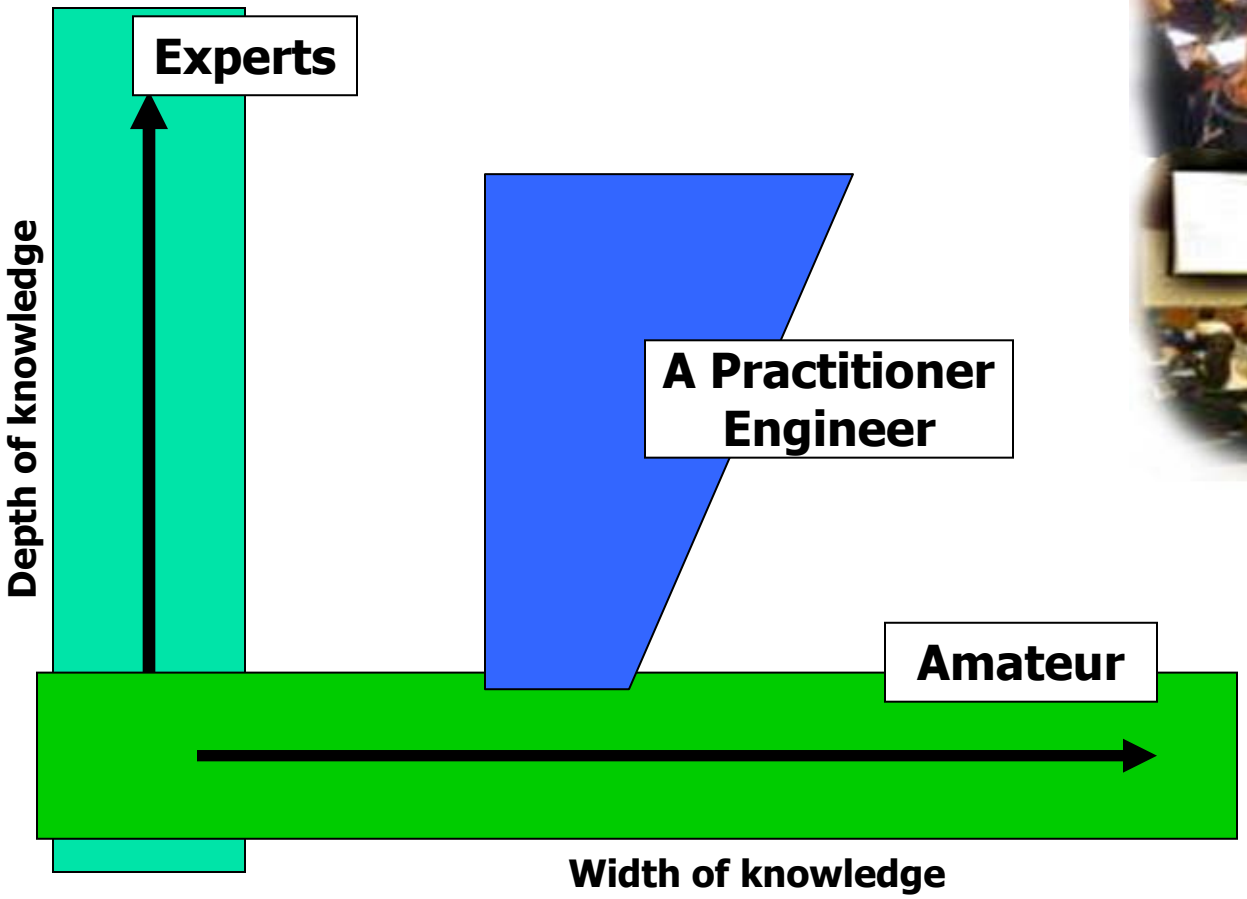
Power Plants: Construction

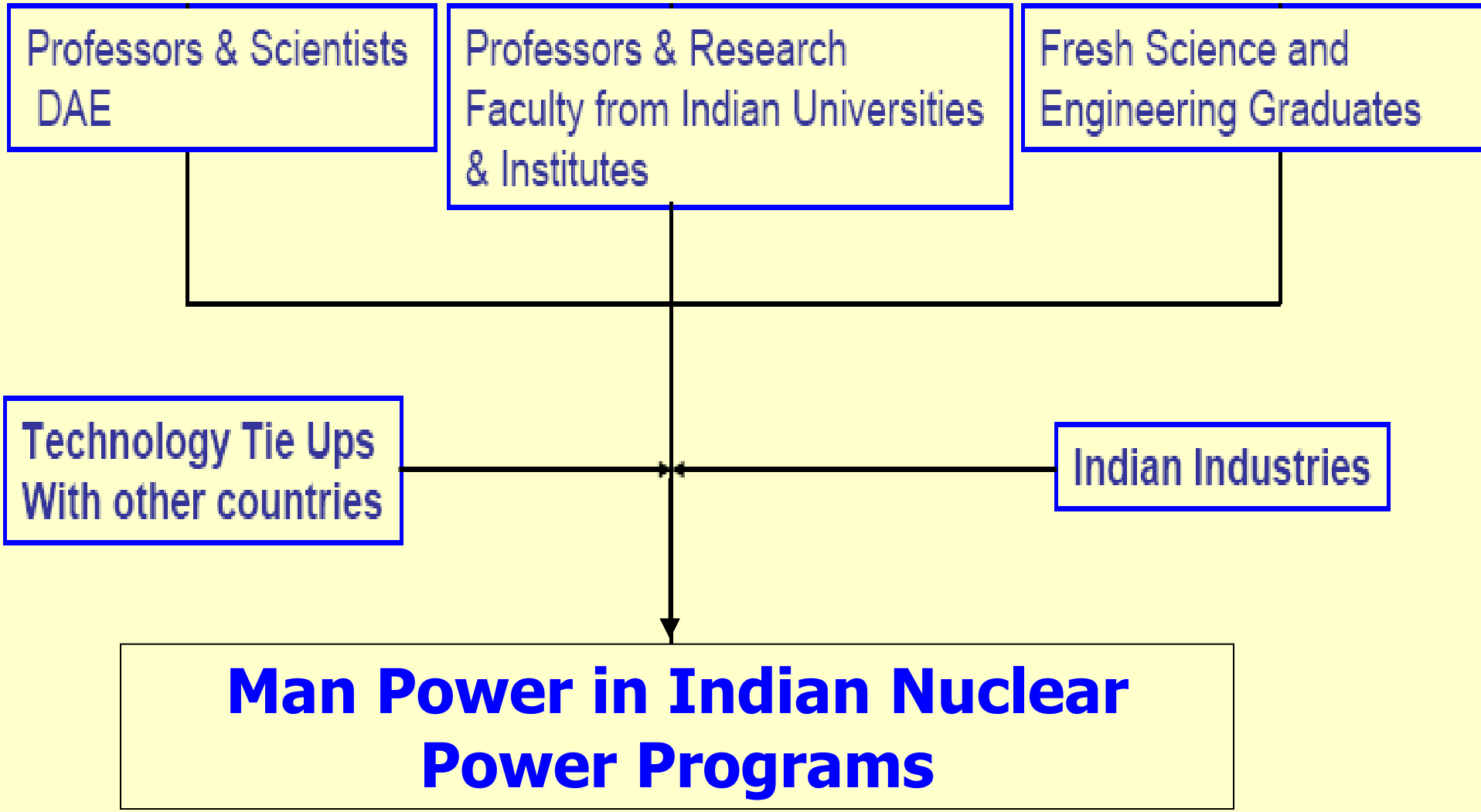


Power Plants:
Operation & Maintenance (O&M)



A Practitioner Engineer




Professors & Scientists DAE
Professors & Research Faculty from Indian Universities & Institutes
Fresh Science and Engineering Graduates
Technology Tie Ups With other countries
Indian Industries
Man Power in Indian Nuclear Power Programs

Induction of Scientific Manpower in DAE (3-Levels)

Qualifications	Schemes	Induction per year
MSc / B.Tech	BARC Training School at various locations in India (OCES)- 1 year	200-250
M.Tech	Two year DAE graduate fellowship scheme (DGFS) – 2 years • M.Tech at IITs in Delhi, Mumbai, Kanpur, Kharagpur, Chennai, Roorkee • One-semester training in nuclear engineering at BARC Training School	25-30
Ph.D.	KS Krishnan Research Associate (KSKRA) – 2-years	10-15

BARC Training School- Objectives

- To bring candidates to a common level of understanding through the foundation courses
- To Impart multidisciplinary training in core courses
- To impart training in specialized areas through elective courses/advanced courses
- Motivate taking up challenging assignments

HYSTORY OF BARC TRAINING SCHOOL (1/2)

•Nuclear education and research began with the setting up of the Tata Institute of Fundamental Research (TIFR), Mumbai, in 1945

•To provide a legal framework for exploitation of nuclear technology, Atomic Energy Act was passed on April 15, 1948 and Atomic Energy Commission was constituted on August 10, 1948

•The Department of Atomic Energy was created on January 3, 1954.

•Several research activities were started as part of what was then called Atomic Energy Establishment, Trombay (AEET) and later renamed Bhabha Atomic Research Centre (BARC).

•No university in the country was conducting any academic programme in nuclear engineering and science at the time the nuclear energy programme was started in India.

•In order to meet the manpower requirements for the atomic energy programme, AEET Training School (now called BARC Training School) was set up in 1957 to train and recruit the engineering and science graduates in to the DAE.

•Though it was not affiliated to any university, it was structured as a Master's level specialization for engineering and science graduates.

HYSTORY OF BARC TRAINING SCHOOL (2/2)

- **The faculty was mainly the practicing professionals. That approach proved successful and is being pursued to date.**

- Devising ways and means to transmit not only explicit but also implicit and tacit knowledge of nuclear technology is a concern of nuclear knowledge management

- The practicing professionals as faculty helps in addressing this concern as they are well versed in all facets of nuclear knowledge: explicit, implicit as well as tacit

BARC Training School: Locations

Unit	Location	Thrust Area
BARC	Mumbai	R & D in Physical, Chemical, Life sciences and Engineering sciences
RRCAT	Indore	Lasers, accelerators, cryogenics, superconductors materials science, power electronics, microwaves
NFC-HWB	Hyderabad	Process development, design, engineering, construction operation & maintenance of plants for nuclear fuel and heavy water
NPCIL	Tarapur, Kota, Kaiga, Kalpakkam, Kudankulam	Operation and maintenance of nuclear power plants
IGCAR	Kalpakkam	Fast breeder reactor technology
AMD	Hyderabad	Geophysics and Geo-Engineering

Recruitment

•Selection for admission to Training Schools is based on a written test for screening followed by a selection interview.

•The selection process is very rigorous.

•This can be judged by the fact that the selection percentage is less than 0.2%.

•The selection process is kept common to ensure uniformity of quality across all schools.

	ME	CE	MT	EE	EL	CS	IN	CV	Engg	PY	CY	BS	GE	GP	Sc	Total
Numbers Applied	14771	4013	834	14886	30596	14864	3544	1498	**85006**	2624	1507	3170	417	247	7965	**92971**
Total Appeared for Interview	1170	321	141	1200	371	118	217	54	**3592**	277	239	101	25	54	696	**4288**
Total Selected	**94**	**45**	**10**	**58**	**23**	**16**	**18**	**15**	**279**	**31**	**35**	**8**	**13**	**6**	**93**	**372**

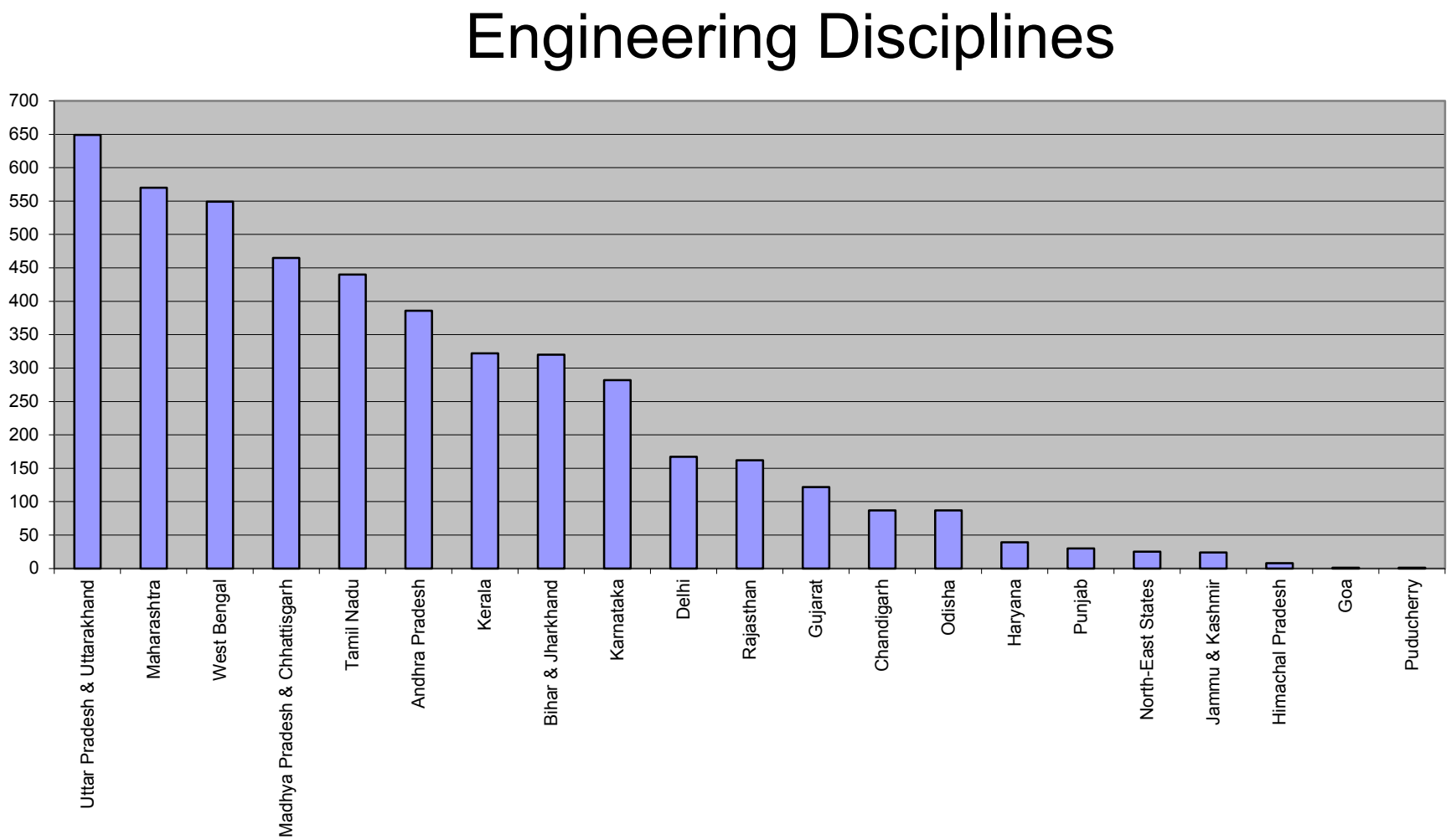
BARC Training School Program

- The programme comprises one year of academic courses at one of the BARC Training Schools and prepares students in their respective disciplines to take up diverse assignments in the units of the department
- Those completing one year course work successfully are absorbed as Scientific Officers.
- After joining DAE, the students can undertake one year project work leading to the award of M.Tech. or M.Phil.
- So far over 8500 students have graduated from the Training Schools since 1957, and about 500 students have gone on to complete M.Tech. or M.Phil. since the setting up of university HBNI in 2006.
- The Training Schools have ensured self-reliance and sustainability of the Indian nuclear energy programme.
- Almost all leadership positions in various units of the Department to date have been occupied by the graduates from this programme.

Statistical Summary : Trainee Scientific Officers (TSOs) Graduated during 1957-2012 from BARC Training School , Mumbai

Eligible Qualification		Number of TSOs	
B.E. / B.Tech.	**Up to OCES-2011**	**OCES-2012 Current Batch**	**To Date Since 1957**
Mechanical	1511	**22**	1533
Chemical	647	**20**	667
Metallurgy	327	**7**	334
Civil	65	**7**	72
Electrical	665	**7**	672
Electronics	678	**2**	680
Computer	162	**4**	166
Instrumentation	256	**4**	260
Total B.E./ B.Tech. TSOs	**4311**	**73**	4384
M. Sc.	**Up to OCES-2011**	**OCES-2012 Current Batch**	**To Date Since 1957**
Physics	1336	**12**	1348
Chemistry	1080	**15**	1095
Bio-Science	174	**7**	181
Radiological Safety Engineering	113	**12**	125
Total M. Sc. TSOs	**2703**	**46**	**2749**
Total (B.E./ B.Tech. & M. Sc.)	**7014**	**119**	7133
In-Plant Training	760	**Nil**	760
Non-Departmental such as Defence etc.	197	**10**	207
Grand Total	**8304**	**146**	**8450**

State wise distribution of number Graduated from BARC Training School, Mumbai from 1957 to 2012 (as per available data)



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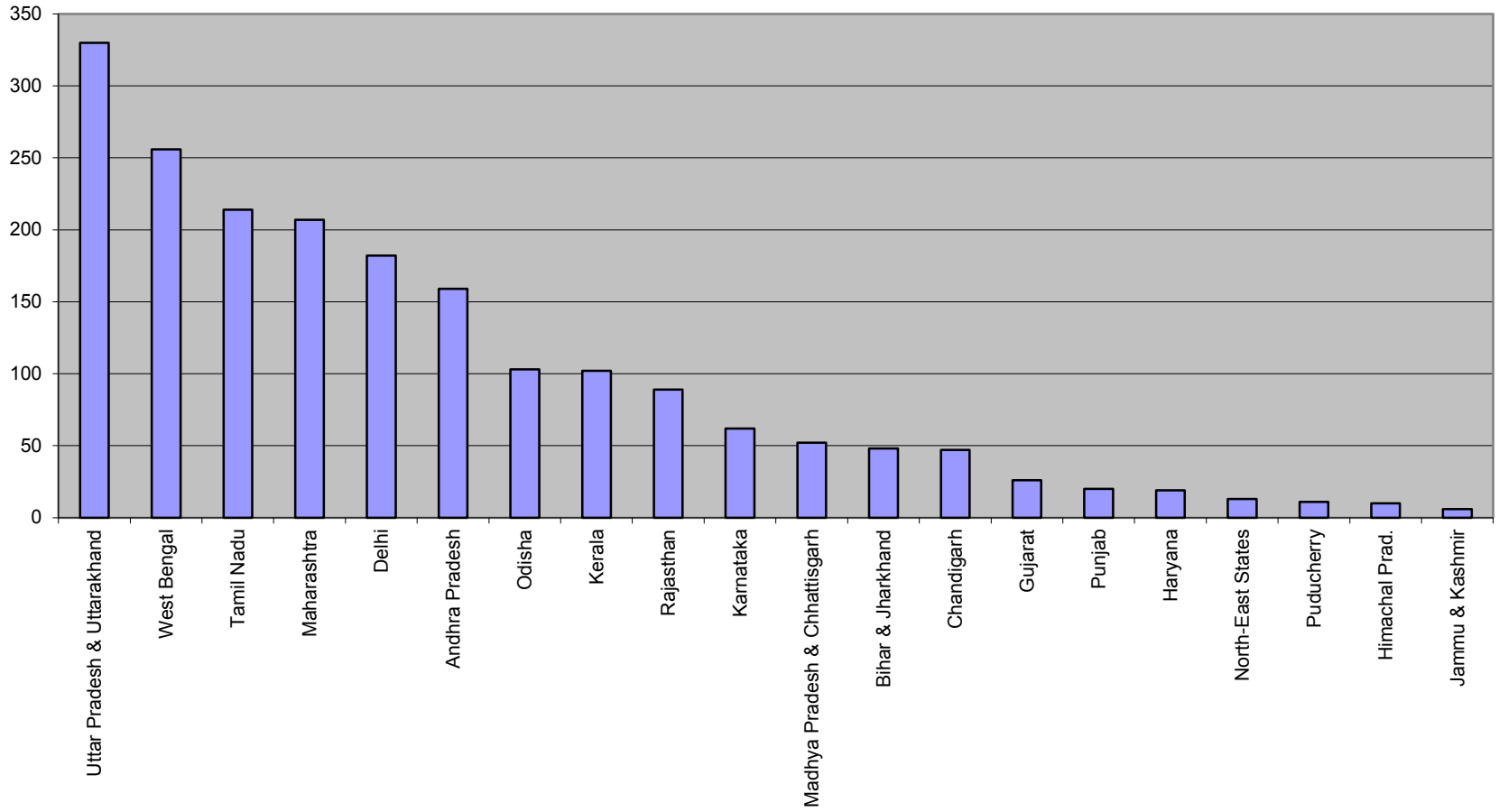


NUCLEAR ENGINEERING (FOUNDATION COURSES)

S.No	Subject Title	Course Coordinator	Hours	Credits
1	Engineering Mathematics	Dr. M.S.Bhatia	35	4
2	Engineering Physics	Dr. D.J.Biswas	25	3
3	Health Physics and Radiological & Industrial Safety	D.A.R Babu	20	2
4	Reactor Physics and Reactor Engineering	K.N.Vyas	45	5
5	Nuclear Power Plants Engineering	Ahmed Ali &	50	5
6	Nuclear Fuel Cycle Technology	K.Agarwal and P.K.wattal	35	4
7	Accelerator and Subcritical Systems	Dr P.Singh	15	2

CORE ENGINEERING (MECHANICAL)

1	Code design for PVP	Dr. J.Chattopadhyaya	60	6
2	Computational fluid Dynamics and Heat Transfer	Dr. A.K.Nayak	50	5
3	Finite Element Method	Dr. R.K.Singh	30	3
4	Fracture Mechanics	Dr. J.Chattopadhyaya	40	4
5	Mechanics of Solids	Dr. B.K.Dutta	40	4

ELECTIVES (MECHANICAL)

1	Seismic and Vibration	A.Rama Rao	30	3
2	Advanced Computational Techniques	R.S.Mundada	30	3
3	Fluid Power Technology	N.L.Soni	25	3
4	Material Science in Nuclear Engineering	Dr. G.K.Dey	20	2
5	Multi Scale material modelling	B.K.Dutta	30	3
6	Preparedness and Response to Nuclear Emergencies	Shri Rajvir Singh	35	4
7	Reliability Engineering	Shri V.Bhasin	25	3

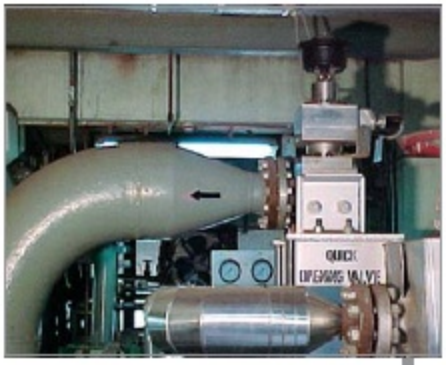
Availability of DAE Facilities for Higher Education

- **Availability of excellent facilities and Scientists for human resource development within DAE**
- **Availability of DAE facilities also to university researchers**
- **Facilities for practical training at BARC & other DAE institutions for students from all over the country**

SOME LARGE SCALE FICILITIES AVAILABLE FOR RESEARCH

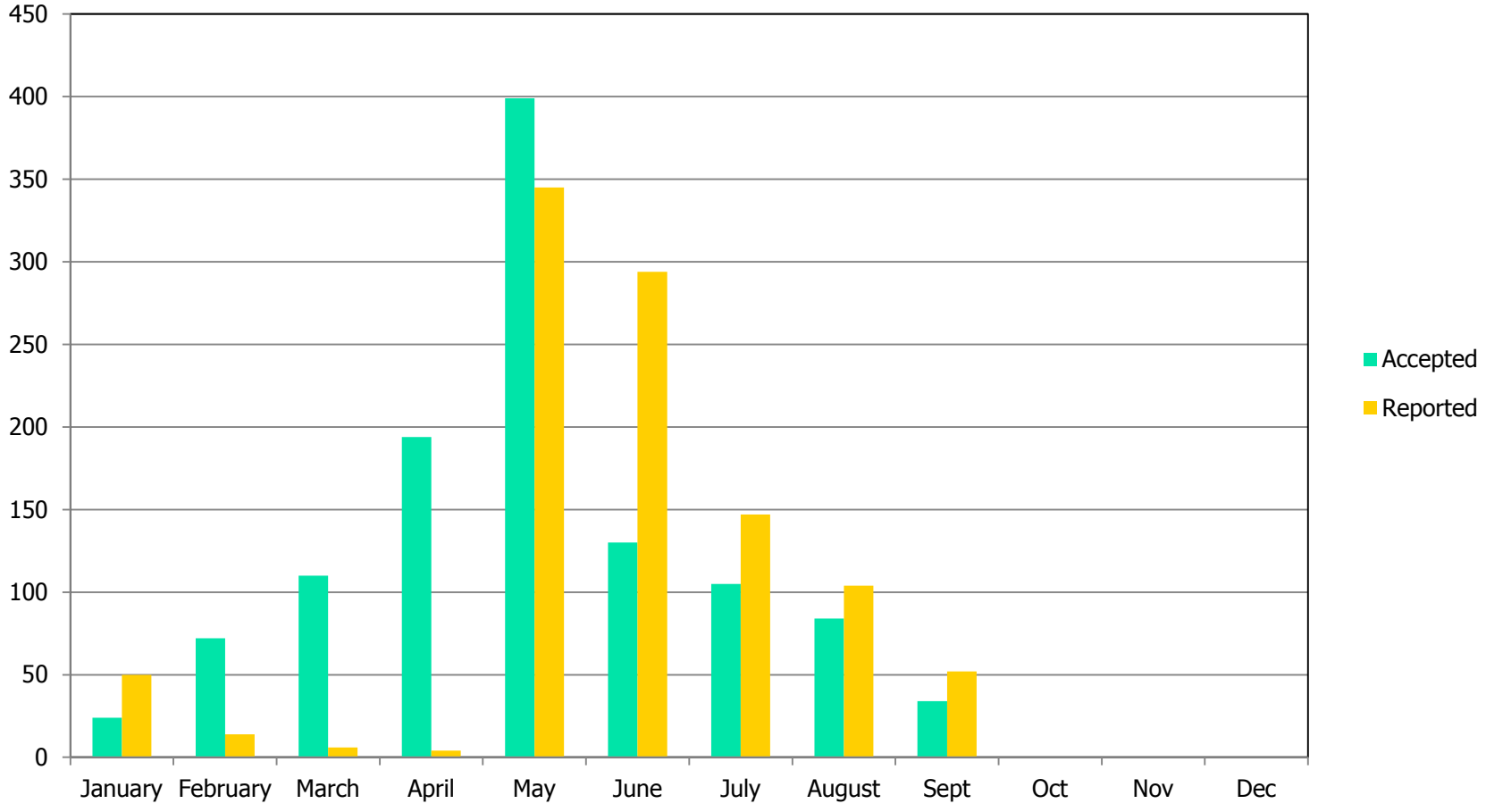
Jet Condenser

Low Pressure Accumulator



Quick Opening Valve

Summer Internship by students from various undergraduate colleges in BARC training School



Homi Bhabha National Institute

•The setting up of the Homi Bhabha National Institute is a recent initiative of DAE.

•It provides an umbrella for academic programmes run by ten institutions of DAE.

• Various institutions of DAE have been running academic programmes for several years. Some of these programmes were affiliated to universities located near to the institutions and some like that at BARC Training School were not affiliated to any university.

• Over the years, a need was felt to create a mechanism to bring all academic programmes under one umbrella and use them to create linkages among various institutions of the department.

• It was also felt that faculty and physical research infrastructure available within the Department could also be used for human resource development for the country.

• Towards this objective, the Homi Bhabha National Institute was set up in 2005 as a deemed to be university by bringing together academic programmes of ten institutions of the DAE.

•It has a distributed structure and is now geared towards providing academic programmes in nuclear science and engineering, mathematics and oncology.

CONSTITUENT INSTITUTIONS OF HBNI

Nature of CI	Focus	Total Number	Units
R & D Centers	Technology Development	4	BARC (1957), IGCAR (1969), RRCAT (1974), VECC (1977)
Grant-in-aid institutions	Basic Sciences	7	SINP (1950), IPR (1986), IOP (1972), HRI (1966), TMC (1941) IMSc (1962), NISER (2007)

ACADEMIC PROGRAMS UNDER HBNI

PGD: Post Graduate Diploma in Nuclear Science & Engineering

D.R.M.: Diploma in Radiation Medicine

D.M.R.I.T.: Diploma in Medical Radio Isotope Techniques

Dip. R.P.: Diploma in Radiological Physics

D. A.: Diploma in Anaesthesia(discontinued since 2009)

M. D.: Pathology, Radiotherapy, Radiodiagnosis, Anaesthesia etc.

D. M. : Medical Oncology, Critical Care etc.

M. Ch. Surgical Oncology, Gynaecological Oncology

M. Sc.(5- Yr. Int.): 5-Year Integrated M. Sc. Programme at NISER, IoP

M. Sc.(Int. Ph.D.): M. Sc. as part of Integrated Ph.D. programme

Statistical Summary of Diplomas and Degrees Awarded

Programme	BARC	IGCAR	RRCAT	VECC	SINP	IPR	IoP	HRI	TMC	IMSc	Total
PGD	323	35	4								**362**
D. R. M.	36										**36**
D. M. R. I. T.	33										**33**
Dip. R .P.	133										**133**
D. A.									4		**4**
Fellowship									18		**18**
M. D.									63		**63**
D. M.									14		**14**
M. Ch.									18		**18**
Nursing									6		**6**
M. Sc.(5-Yr. Int.)							58				**58**
M. Sc. (Int. Ph.D.)								18		31	**49**
M. Phil.	7		1								**8**
M. Tech.	352	81	57	13							**503**
M.Sc. (Engg.)	17	5									**22**
Ph. D.	73	14	7	13	8	8	26	34	6	50	**239**
Total	**974**	**135**	**69**	**26**	**8**	**8**	**84**	**52**	**129**	**81**	**1566**

Conclusions

•Nuclear technology is multidisciplinary, knowledge intensive, and its education and training are constrained by unusual measures demanded by the concerns about radiation and nuclear safety, physical protection of nuclear materials and facilities, and safeguards to prevent diversion of nuclear material.

•This requires vast faculty resources as also extraordinary and expensive infrastructure for conducting nuclear education making the task of human resource development in nuclear science and technology a challenging one.

•The human resource for the nuclear energy programme in India so far has therefore been developed in-house in the DAE.

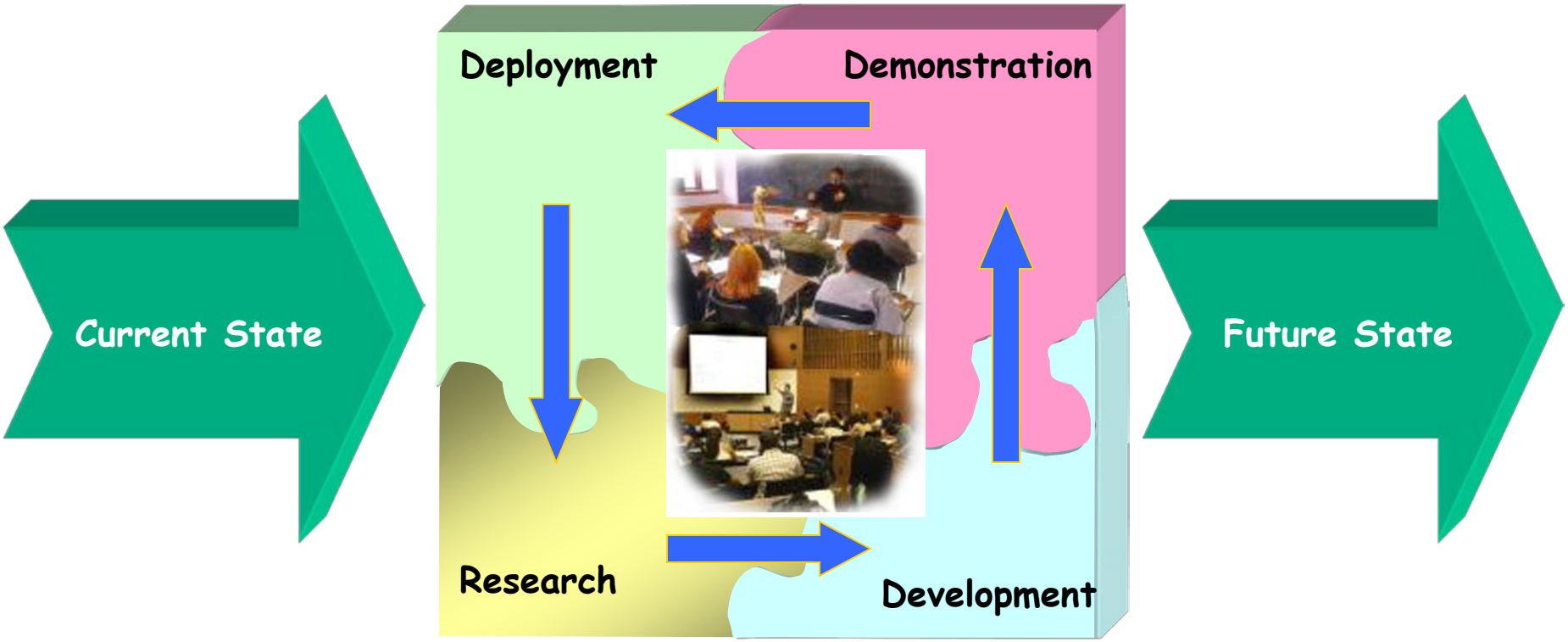
•However, large requirement of manpower to take forward the growing nuclear energy programme in the country can be met only by extending concurrently the reach of the human resource development activity in nuclear science and technology.

•The DAE is therefore supporting the university system in India, and integrating the existing training program with the university system.

• It may be emphasized that nuclear education, being a means of preservation and transmission of explicit knowledge, is just one component of nuclear knowledge management (NKM).

•The NKM also involves creation of mechanisms to preserve and transmit implicit and tacit knowledge.

Model for academic enterprise




Thank You