# Human Resource Development for Safety Review of Expanded Nuclear Power Programme in India


## R. BHATTACHARYA, INDIA

**Secretary, Atomic Energy Regulatory Board (AERB) &**
**Director, Industrial Plants safety Division (AERB) &**
**Director, Information and Technical Services Division (AERB)**
**Email: rbhattacharya@aerb.gov.in**

# Outline

Nuclear Power Programme

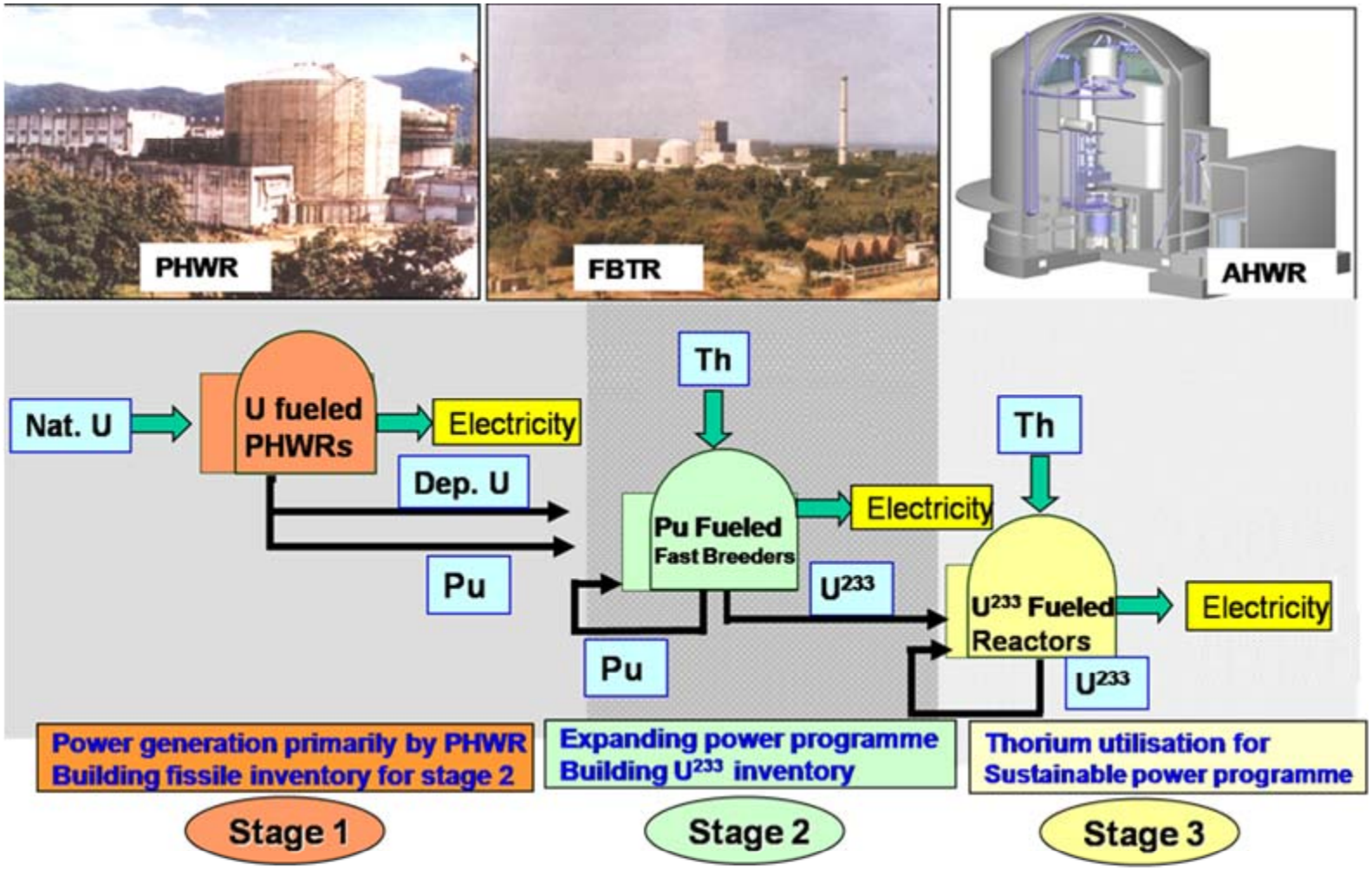
Regulated Installations

Regulatory Control by AERB..*from cradle to grave*

Human Resource Management at AERB

Future steps

# Three stage nuclear power programme of India



# Regulated Installations


# Nuclear Power Plant Sites in India (existing and under construction plants)

# Nuclear Power Plants under operation

| NPPS | Capacity | Total Output |
|---|---|---|
| BWRs | 2 x 160 TAPS-1&2 | 320 Mwe |
| PHWRs | 1 x 100 RAPS-1 | defuelled |
| | 1 x 200 RAPS-2 | 200 MWe |
| | 14 x 220 (MAPS-1&2, NAPS-1&2, KAPS 1&2, Kaiga-1,2,3&4, RAPS 3,4,5&6) | 3080 MWe |
| | 2 x 540 TAPS-3&4 | 1080Mwe |
| VVERs | 1 x 1000 KKNPP-1 | 1000 Mwe |
| | **Total 21 Units** | **5680 MWe** |

**Regular workers: 7300 Temporary Workers: 6500**

# Nuclear Power Projects

Kundankulam –2 (1000 MW, VVER)

Unit – 2 construction completed. Under pre-commissioning stage

(southern India)

Prototype Fast Breeder Reactor (500 MW, PFBR), Kalpakkam

construction completed. Under pre-commissioning stage

(southern India)

Kakrapar – 3 & 4 & Rajasthan – 7 & 8 (700 MW, PHWR)

Construction in progress

(western India)

**Regular workers: 1700 Temporary Workers: 13000**

# Nuclear Power Plants under planning

## Siting evaluation stage

Kudankulam (southern India): 4 x 1000 MW, VVER

Jaitapur (western India) : 6 x 1650 MW, EPR

Gorakhpur (northern India) : 4 x 700 MW, PHWR

## New sites identified for

### PHWRs 700 MW

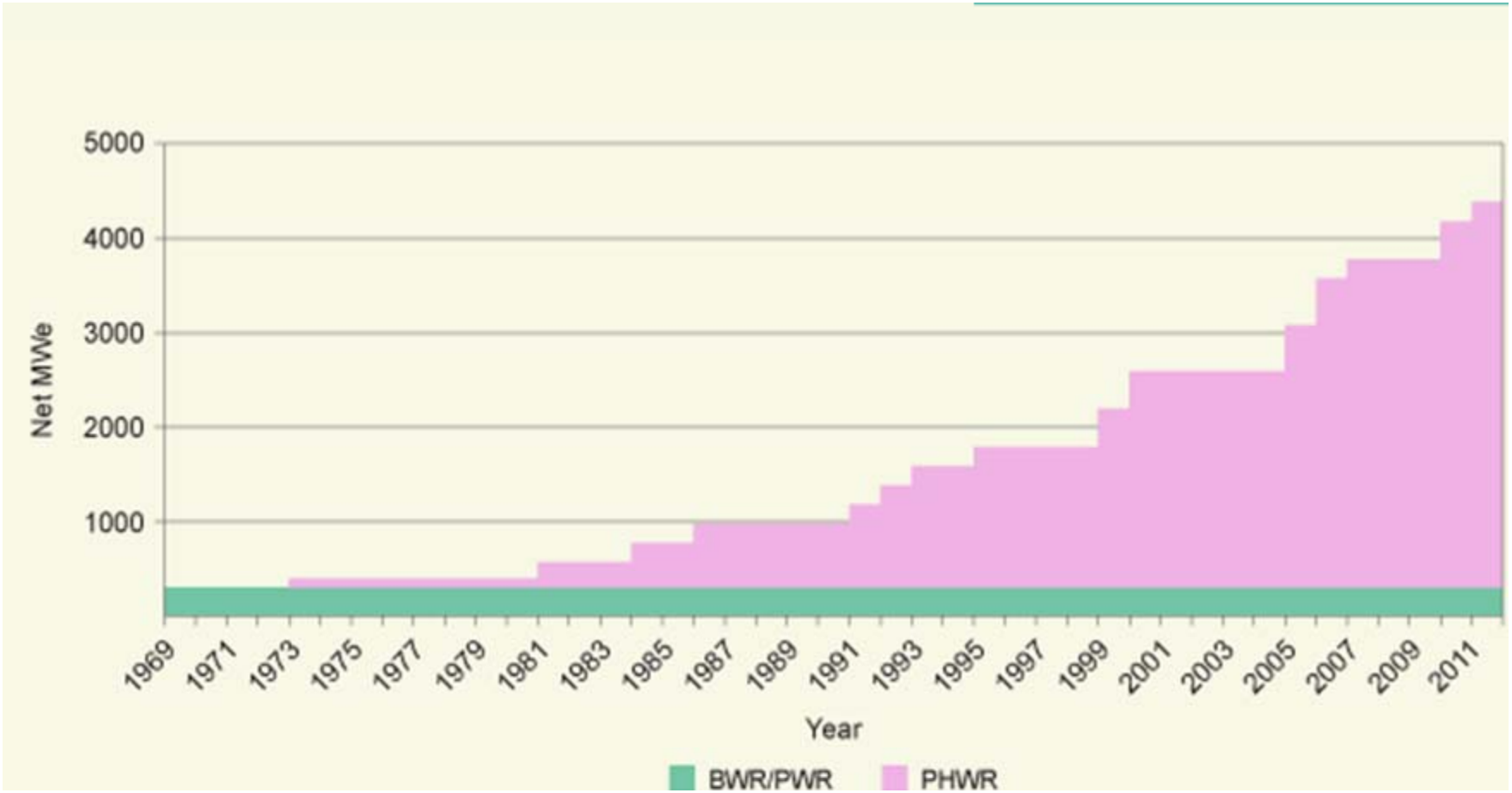
Bargi (central India) :2 Units

### LWRs 1000 MW & above

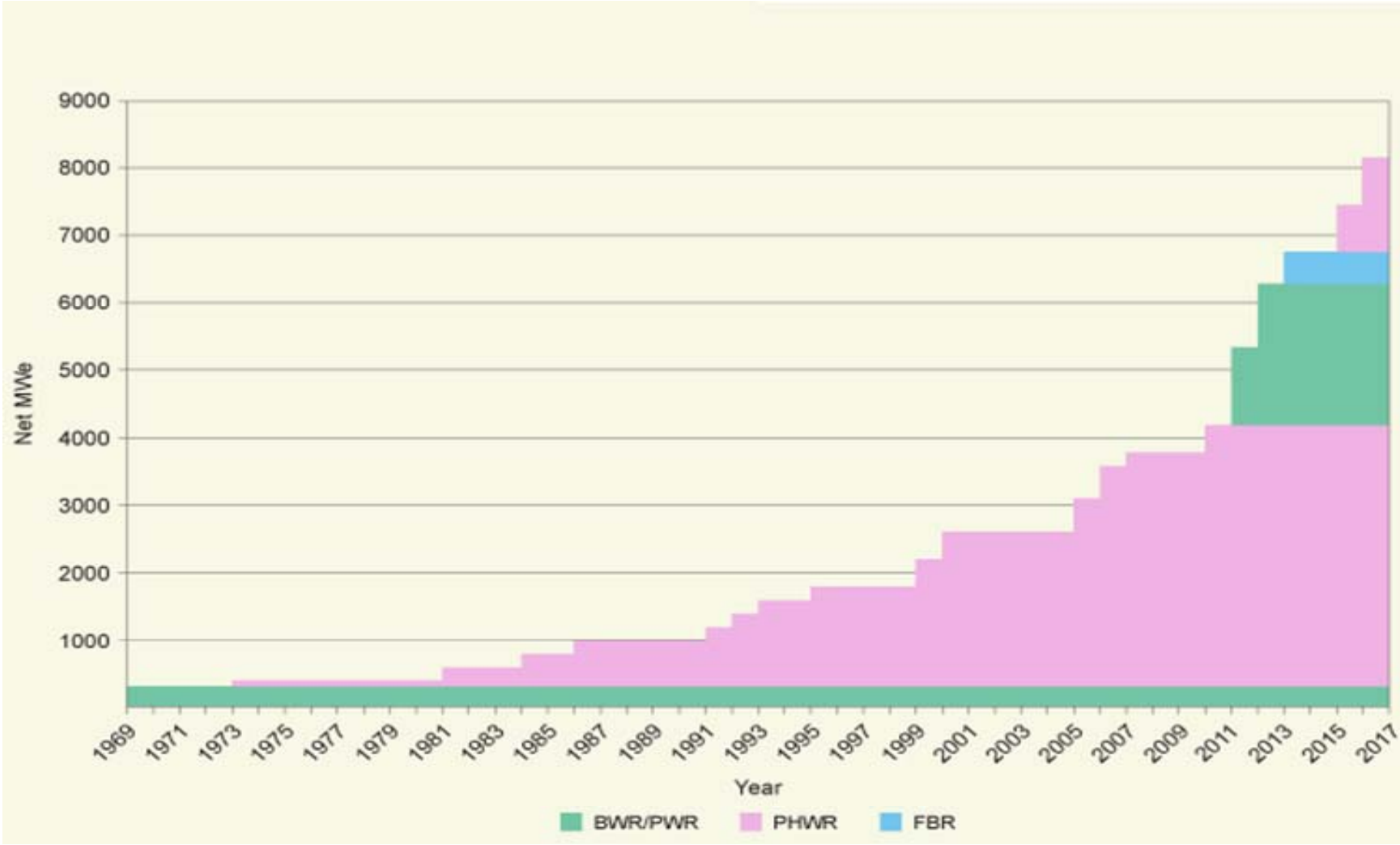
- Mithi Virdi (western India)
- Kovvada (eastern India)
- Haripur (eastern India)

***Government accorded "in principle" approval for setting up 20 new NPPs (10 PHWR-700 MW and 10 LWRs of 1000 MW or above)***

# Installed capacity (20 units) till 2011



# Projected capacity (25 units) till 2017



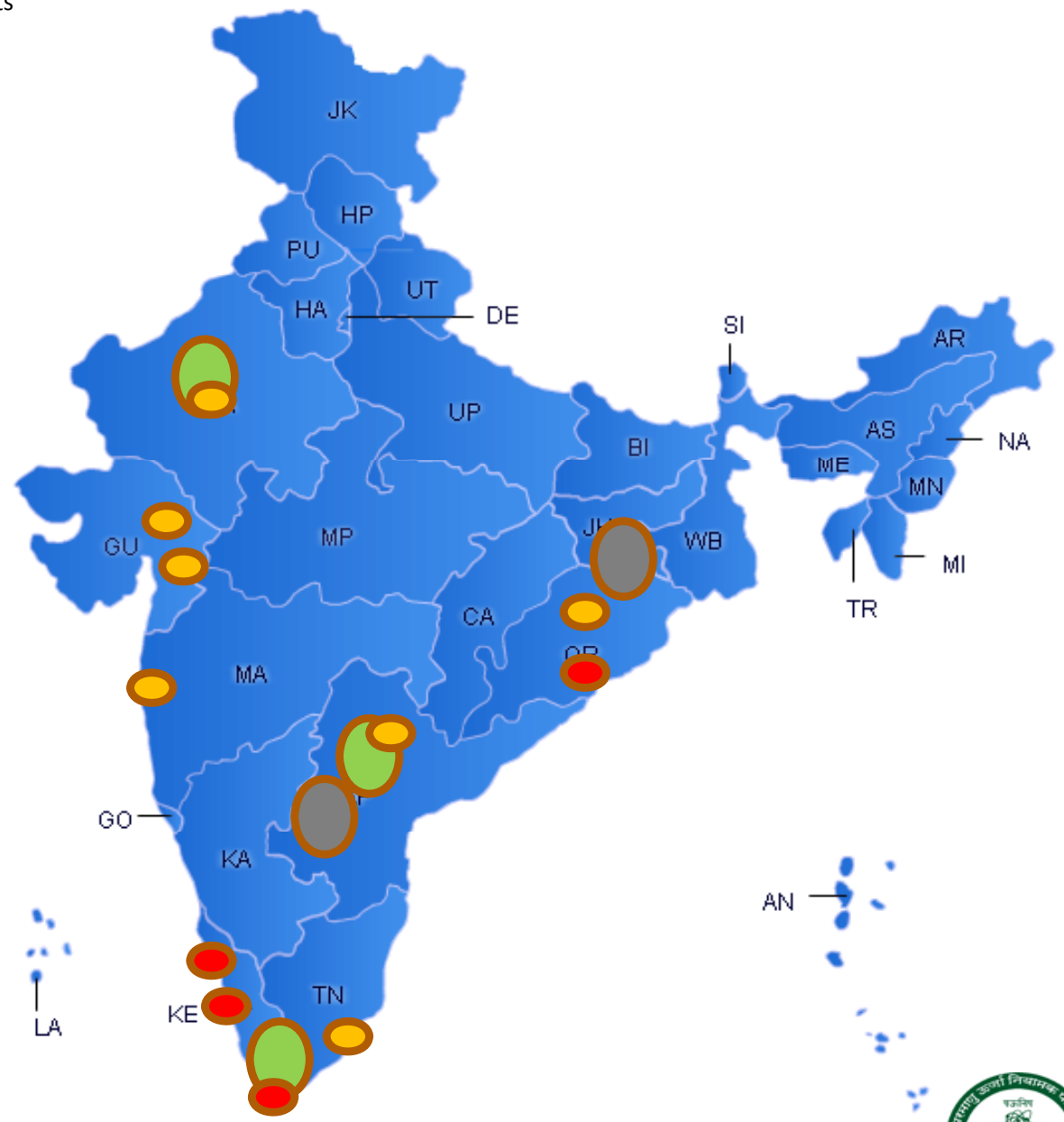
Fuel Fabrication Facilities/ projects

Heavy Water Plants

Thorium Mines and Mills

Uranium Mines and Mills

# Fuel Cycle Facilities Sites in India (existing and projects)



# Fuel Cycle Facilities and projects in India

**Uranium Mines (eastern and south eastern India)**

6 operating underground mines

1 operating open cast mine

2 underground mines under development

**Regular workers: 2700 Temporary Workers: 1660**

# Fuel Cycle Facilities and projects in India

**Uranium Mills (eastern and south eastern India)**

2 operating ore processing plants (acid leaching)

1 ore processing plant under commissioning (alkali leaching)

**Regular workers: 1600 Temporary Workers: 1050**

# Fuel Cycle Facilities and projects in India

**Thorium mines (southern and eastern India)**

3 mineral separation plants

**Thorium mills (southern and eastern India)**

2 chemical plants

**Regular workers: 700  Temporary Workers: 200**

# Fuel Cycle Facilities and projects in India

**Fuel Fabrication Plants**
**(south central, southern and western India)**

2 operating fuel fabrication complexes

1 fuel fabrication complex under development

**Regular workers: 3500  Temporary Workers: 500**

# Fuel Cycle Facilities and projects in India

**Heavy Water Plants**
**(western , southern and eastern India)**

4 operating heavy water plants

3 plants with diversified projects

**Regular workers: 3800 Temporary Workers: 1600**

# Radiation facilities (spread all over India)

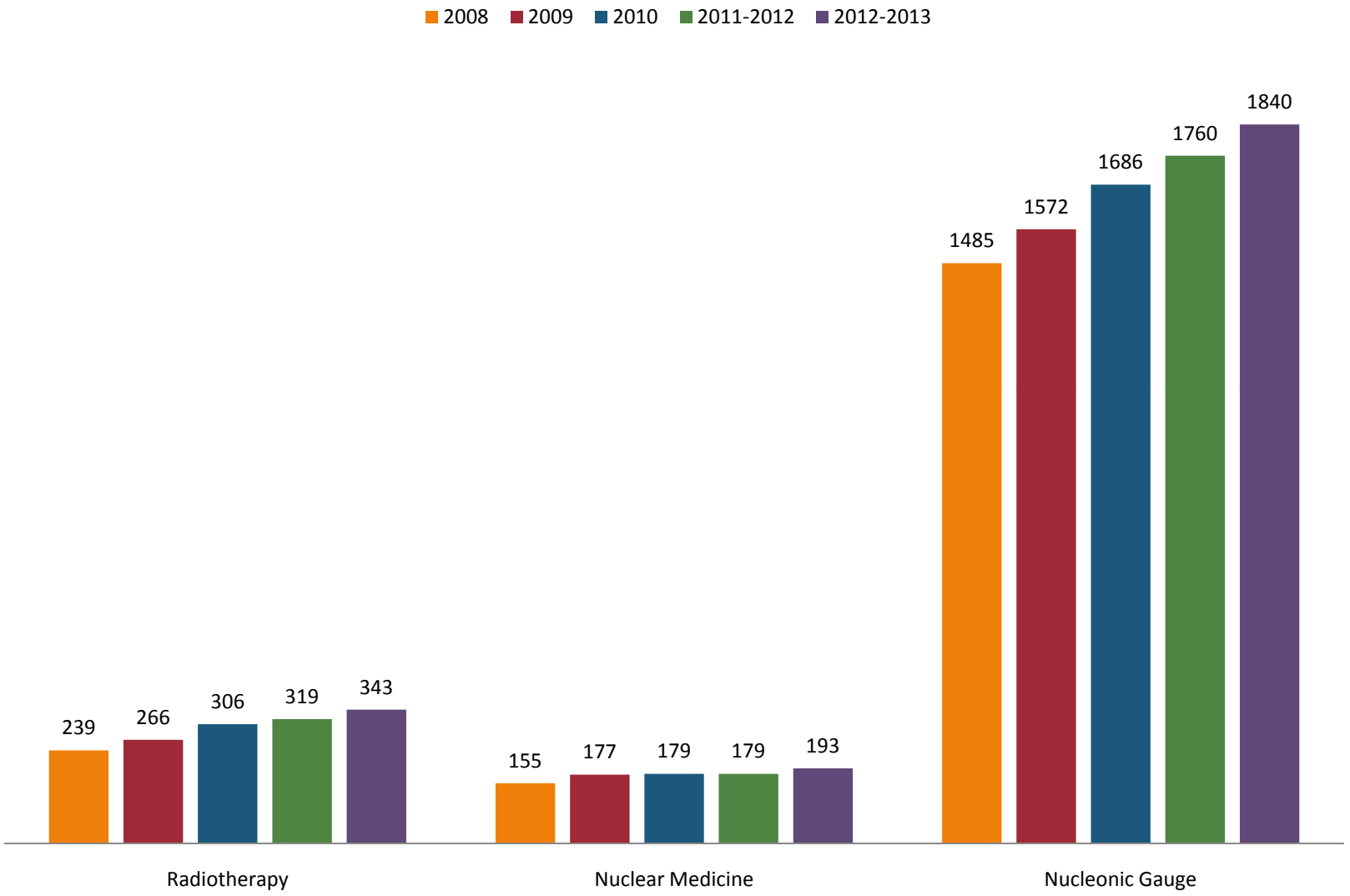
Radiation applications in medicine
(around 72,000 monitored workers)

Radiation applications in industry
(around 7500 monitored workers)

Radiation applications in research
(around 4300 monitored workers)

| Radiation Facilities | No. of facilities/ equipments (as on March 2014) |
|---|---|
| Nuclear Medicine Centers | - 201 |
| Industrial Radiography Installations | - 521 (2891 devices) |
| Radiotherapy Installations | - 358 (1001 equipment including simulator) |
| Institutions using Nucleonic gauges | - 1859 |
| Gamma Irradiation Chambers | - 104 (125 equipment) |
| Medical cyclotrons and Research Accelerators | - 19 |
| Medical X-ray declared in e LORA | - 5708 |
| Gamma Radiation Processing Facilities | - 21 |
| Others (RIA labs, Research labs) | - 716 |
| Consumer goods manufacturing facilities- | 46 |

# Growth in Radiation Facilities



# EVOLUTION OF NUCLEAR SAFETY REGULATION..1/2

Mid fifties: Self regulation (APSARA : 1956)

*"Radioactive material and sources of radiation should be handled in Atomic Energy Establishment, in a manner, which not only ensures that no harm can come to workers in the Establishment or anyone else, but also in an exemplary manner so as to set a standard which other organization in the country may be asked to emulate".*

*- H.J. Bhabha; Directive issued 27 Feb, 1960*

# EVOLUTION OF NUCLEAR SAFETY REGULATION..2/2

Sixties: Safety monitoring and surveillance by designated groups in BARC (Health Physics Division; Directorate of Radiation Protection)

1972: DAE – Safety Review Committee

- RAPS-1 Commissioning
- All DAE Units

1983: Atomic Energy Regulatory Board

# ATOMIC ENERGY REGULATORY BOARD

Established by Government of India by exercising the powers conferred by Section 27 of the Atomic Energy Act 1962 through a gazette notification.

Mission: to ensure that the use of atomic energy and ionising radiation shall not cause undue risk to the health of the people and the environment

# SCOPE

To carry out regulatory and safety functions under Sections 16, 17 and 23 of the Atomic Energy Act.

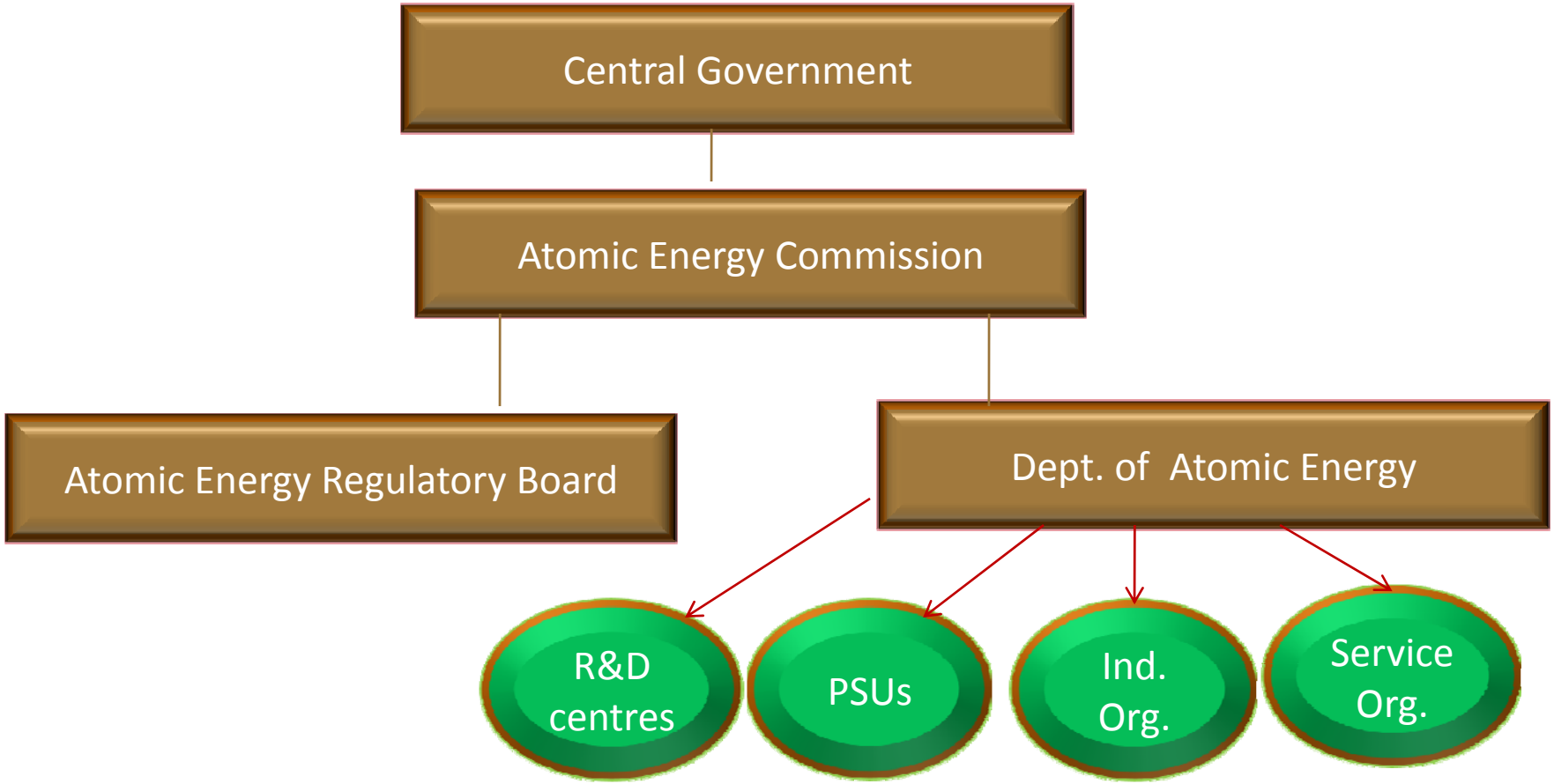
- radiation safety in nuclear and radiation facilities
- industrial safety in DAE units

The present scope of AERB's functioning and the organizational structure has evolved over the years

Presently, an ISO: 9001:2008 certified organisation for

- Consenting Process
- Regulatory Inspection
- Safety Document Development

# Organisational Framework



# COMPOSITION OF AERB

## The Board

Chairman
Ex-Officio Member (Chairman, SARCOP)
4 outside Members
Secretary

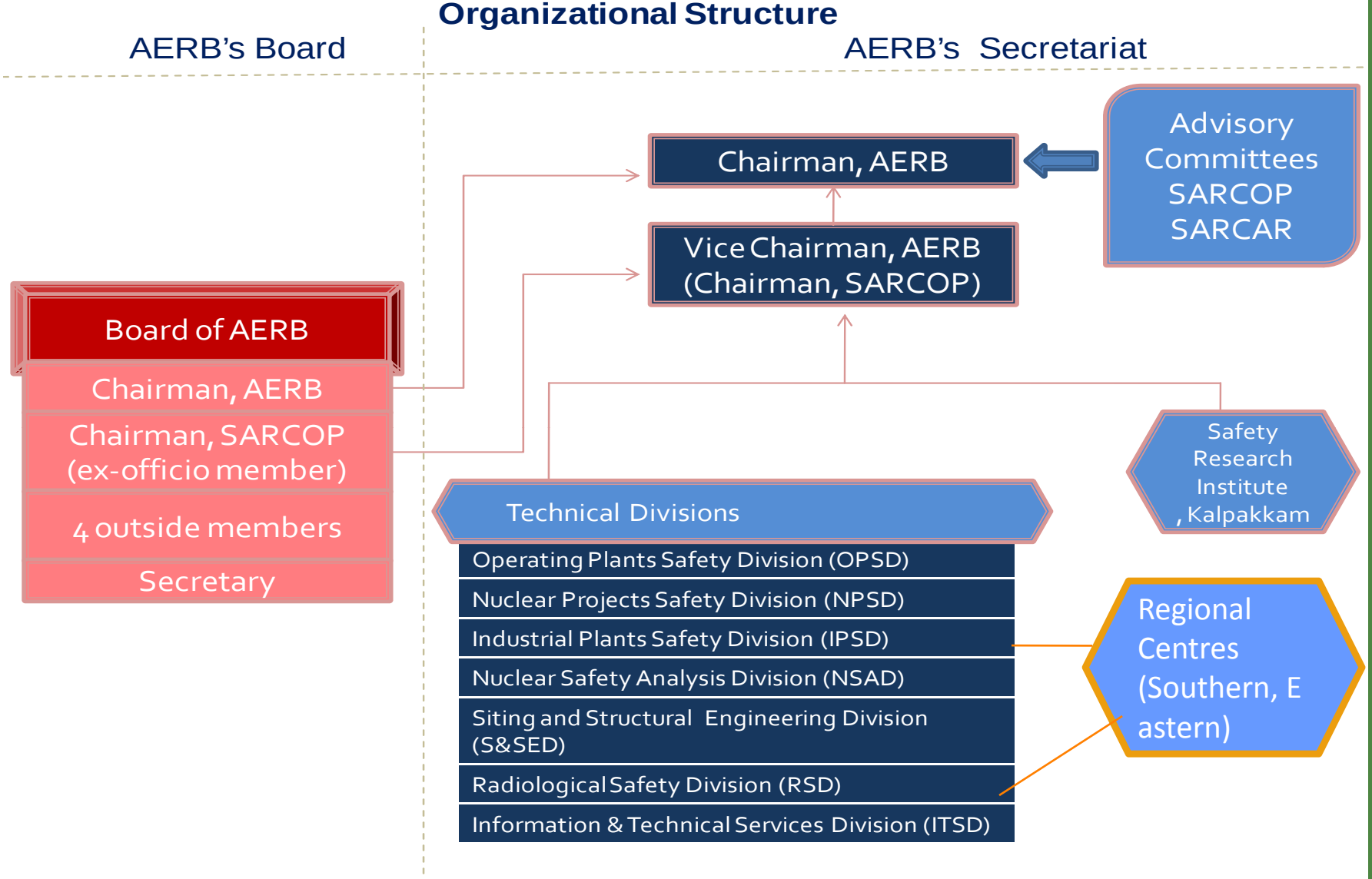
## The Secretariat

Seven Technical Divisions
Safety Research Institute
Regional Centres-Southern, Eastern, Northern (planned)
Staff Strength - >250 (Scientific & Technical)

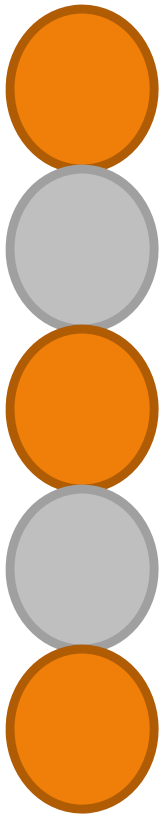
## Technical Support

BARC, Academic Institutions

# Organizational Structure



# Regulatory Control by AERB



- Siting stage
- Construction stage
- Commissioning stage
- Operation stage
- Decommissioning stage

*..from cradle to grave*

# Core regulatory activities

- Safety review and issue of consents
  - Nuclear and radiological safety
  - Industrial safety in units of DAE
  - Nuclear security
  - Licensing of key operating personnel
- Regulatory inspections (routine and special)
- Safety Regulatory Document Development

# Other regulatory activities

- Safety research of regulatory interest
- Public Information (annual report/bulletin/newsletters/press releases etc)
- International Cooperation
  - IAEA (CSS, technical meetings, CRP,CNS,IRS)
  - NEA (Committee and working groups, MDEP)
  - Regulators' Forums: VVER, CANDU
  - Bilateral Agreement – (USA, France, Russia, Ukraine, Romania)
- Safety Promotional Activities (workshops/awards etc)

# Human Resource Policy of AERB

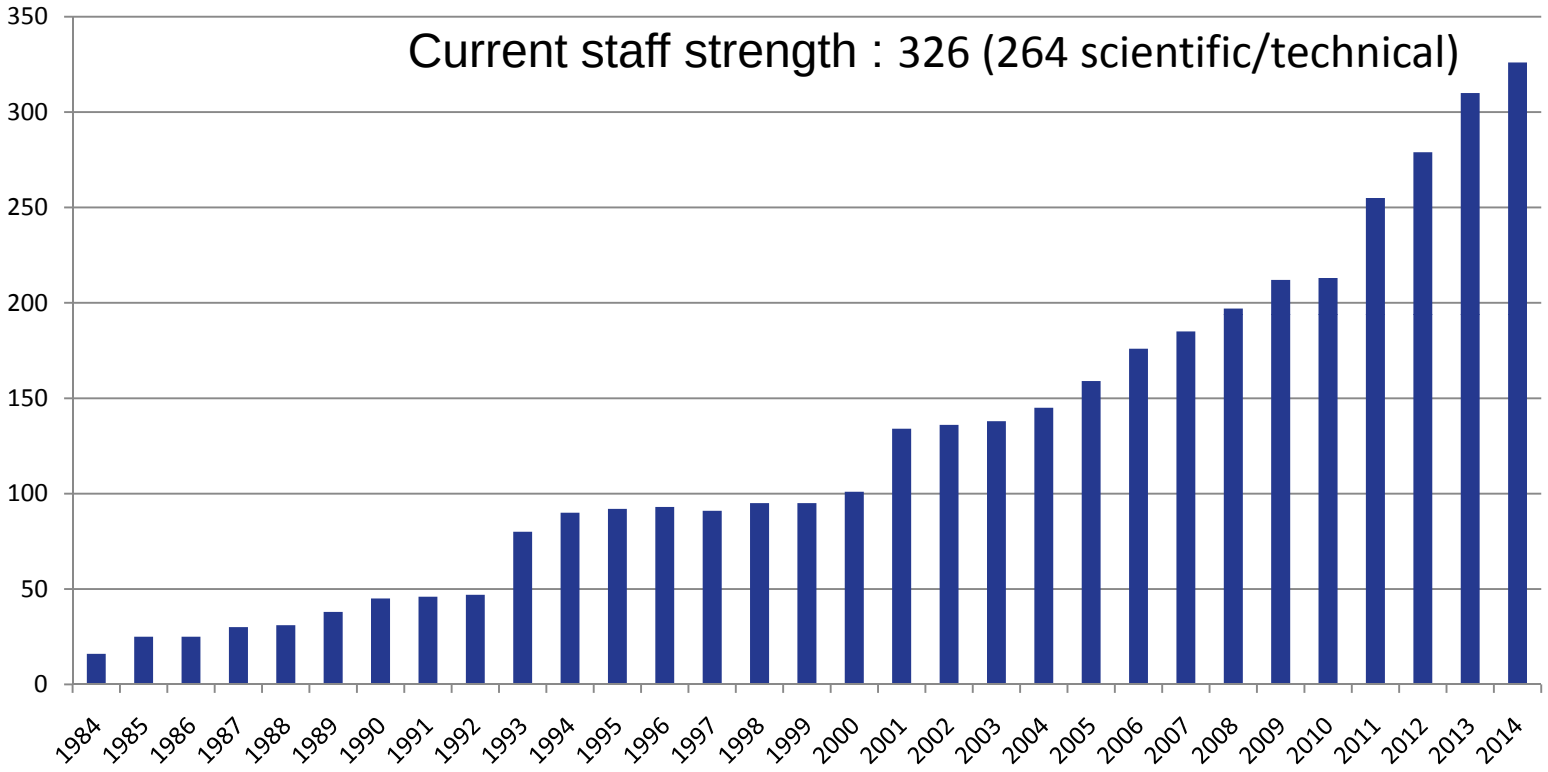
In order to fulfill its mandate, AERB is required to be staffed with adequate number of qualified and experienced personnel, who are aware of the technical and administrative requirements for safety.

To establish and maintain a high level of competence, appropriate training and qualification programmes have been instituted and regularly reviewed to ensure their relevance in accordance with an HR policy

**Policy Statement**

AERB is committed to the training and continual development of its staff to enable efficient and effective discharge of their roles and responsibilities to achieve its mandate at all times and encourage their development as motivated regulatory professionals with required competence and versatility.

# Human Resource in AERB




A large pool of educated and qualified manpower. Mix of

- graduate/post graduate engineers
- post graduate in science
- Ph.Ds in engineering/science

# Recruitment

AERB follows methodical and transparent approach for recruitment of new personnel consistent with its functional goals.

AERB determines the size and composition of required staff to fulfill its duties.

The staff strength distribution depends on the number of utilities/activities to be regulated, their associated hazard potential and regulatory approach

# Selection mode for AERB recruits

- Post graduation Training schools of nuclear engineering, physics, chemistry and radiation safety for engineers and scientists.
- Transfer/deputation of experienced scientists/engineers from other nuclear industries/R&D units
- Induction of engineering post graduate students from reputed academic institutions providing scholarships.
- Open advertisements for fresh and experienced personnel in other organsiations.

# Divisional activities V/s manpower qualification

**NPSD** is responsible for safety review and assessment including inspections during siting, construction and commissioning and initial operating phase of nuclear projects as part of consenting process.

Qualification :

engineering graduate with training in nuclear engineering
post graduate/graduate in science with training in reactor physics

**OPSD** is responsible for safety review and monitoring of all operating nuclear power plants and other nuclear facilities under the purview of AERB and assures it through periodic safety review, regulatory inspections and enforcement actions.

Qualification :

engineering graduate with training in nuclear power plant operation
post graduate/graduate in science with specialisation in operational health physics and waste management

# Divisional activities V/s manpower qualification

**IPSD** is responsible for safety review and assessment of Nuclear Fuel Cycle Facilities and Industrial Plants/R& D centres of DAE, NORM industries and Review of Industrial & Fire Safety Aspects in all DAE units under purview of AERB.

Qualification :

engineering graduate with training in chemical process safety
post graduate/graduate in science with specialisation in operational health physics and waste management

**SSED** is responsible for safety review and assessment of siting, external events, civil and structural engineering aspects of nuclear installations towards issuance of regulatory consents.

Qualification :

Civil/structural engineering graduate

# Divisional activities V/s manpower qualification

**RSD** is responsible for radiological safety review of radiation facilities in medicine, industry, education and research and ensures it through consenting process, regulatory inspections and enforcement actions. It also regulates the transport of radioactive material.

Qualification :

post graduate/graduate in physics/ radiologicla physics/medical physics

**NSAD** is responsible for independent verification of safety analysis carried out by facilities. It is also responsible for carrying out specifically identified safety related research for new concepts, standard problem exercises and arising out of incidents.

Qualification :

engineering graduate/ post graduate in science with training in nuclear safety analysis (PSA, thermal hydraulics, environmental modelling etc)

# Divisional activities V/s manpower qualification

**ITSD** is responsible for development of regulatory documents, safety review of reactor physics aspects, information technology, coordinated safety research programme, training, coordinating international relations, public information and knowledge management.

Qualification :

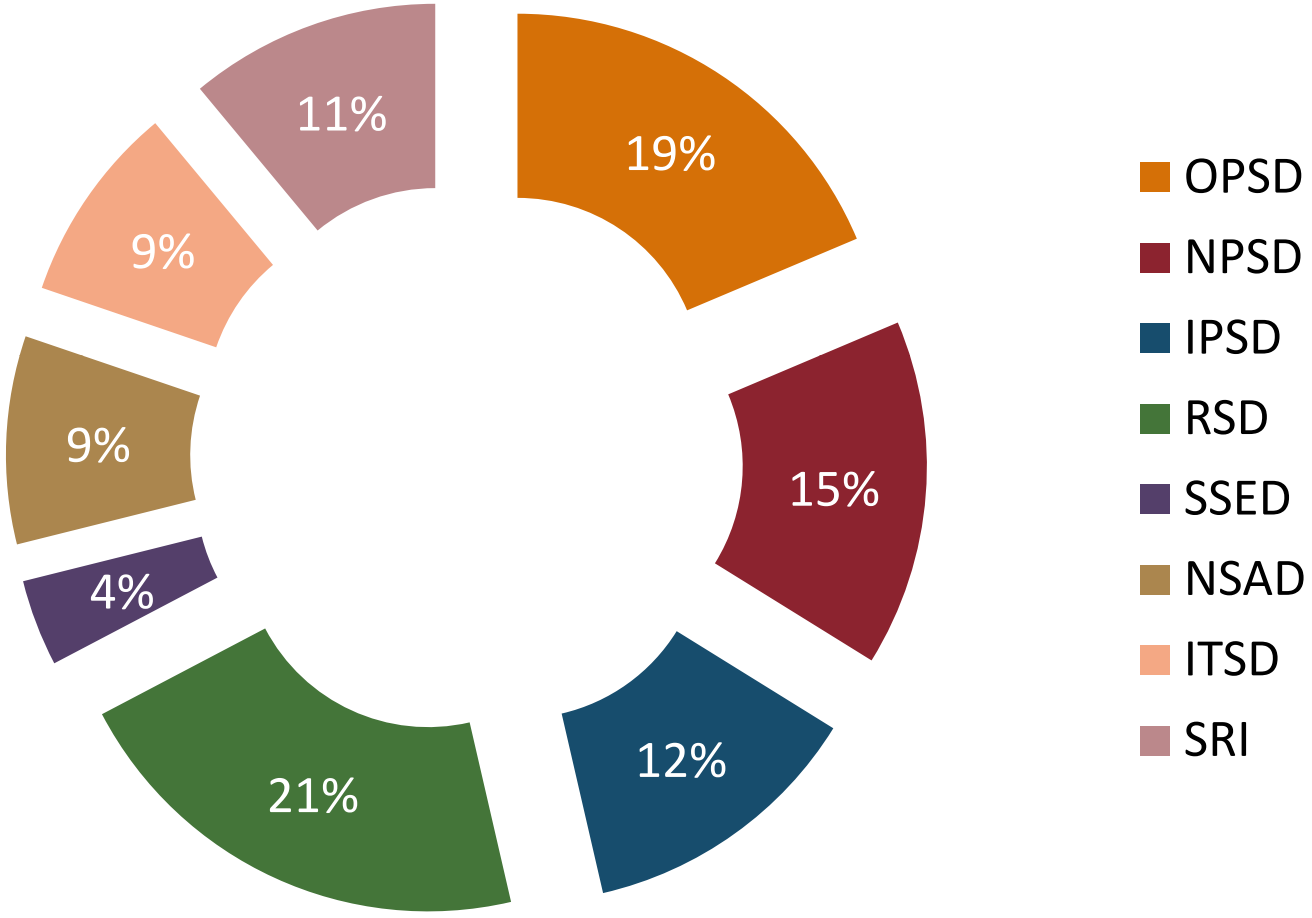
engineering graduate with training in nuclear engineering
engineering graduate/post graduate or graduate in science in computer/IT
post graduate/graduate in science with training in reactor physics

**SRI** is responsible for research in frontier areas of regulatory purposes.

Qualification :

engineering graduate/ post graduate in science with training in nuclear safety analysis (PSA, thermal hydraulics, environmental modelling etc)

# Manpower Distribution in various Divisions




Additional expertise available:

170 retired experts

200 experts from R&D Organizations and Universities

# TECHNICAL SUPPORT SYSTEM

## Purpose of Technical Support System (TSS):

To assist the regulatory body in achievement of its functional and technical objectives. This ensures that regulatory body has at its disposal a group of highly qualified technical staff capable of providing technical analysis and advice to support its activities.

AERB derives technical support from Bhabha Atomic Research Centre (BARC), Indian Institute of Technology ( IITs), and other academic institutions as:

- members of Expert Committees
  - For safety reviews of plants/projects
  - Regulatory Document Development
- For Regulatory Inspections
- For Special investigations /Tests/Post-Irradiation Examinations

*Arrangements are made to ensure that there is no conflict of interest for those who provide advice or assistance.*

# CONSULTANTS

To discharge its responsibilities, AERB seeks advice or assistance from consultants

Consultants are individual experts in specific fields of competence who may not belong to any specific organizations.

Retirees from a regulatory body or other organizations also function as consultants.

It is ensured that the consultants are effectively independent of operator.

**AERB obtains technical or other expert professional advice or services as necessary in support of its regulatory functions, but this does not relieve AERB of its assigned responsibilities. Final decision lies with AERB.**

# Training of AERB staff

AERB follows a systematic approach to training (SAT) that provides a logical progression from the identification of the competencies required to perform a job to the design, development and implementation of training to achieve these competencies, and subsequent evaluation of this training.

SAT is a methodology that applies quality assurance to training in order to achieve the intended objectives.

SAT contains five steps, namely,

- Analysis
- Design
- Development
- Implementation
- Evaluation

# Training programme....1/3

The training programme in AERB is designed to meet the following training needs.

Orient the freshly recruited staff with AERB's regulatory functions.

Provide job-specific training.

Arrange technical talks, colloquia and refresher courses at regular intervals.

Professional qualification upgradation for staff.

Impart management training to staff.

Impart full term training course to the stipendiary trainees.

# Training programme....2/3

Training is provided by classroom-based training and on the job training or a combination of both.

Feedback is obtained for:

- Assessment of comprehensive programme for review and upgradation.
- Assessment of Trainees and Trainers.

Training Section of AERB :

- Maintains the training material, records.
- Schedules the programme.
- Evaluates the feedback from trainees and trainers for improvement.
- Identifies retraining requirements based on competency mapping.
- Identifies the improvements required in training infrastructure.

# Training programme....3/3

Inspectors/Lead Inspectors

- Documents available
- Training module

Induction training

Control engineer certification at operating NPPs

One year training on nuclear engineering and basic radiation protection

Training manual

# Knowledge Management....1/2

As part of upgradation of knowledge for regulatory and safety activities, AERB encourages its staff to pursue higher studies and achieve additional qualifications.

- Some of the AERB officers completed their Ph.D. They worked on topics relevant to AERB and published papers in International Journals.
- Some of the AERB officers completed M.Tech.
- Few AERB officers acquired M. S. in Nuclear Safety from Korea Advanced Institute of Science and Technology, South Korea.
- AERB initiated an award scheme to promote excellence among its staff and recognize outstanding achievements of those engaged in the AERB regulatory and associated research and development activities.
- Considering the need of the hour, selected AERB officers have been sponsored to undergo three year course in law

# Knowledge Management....2/2

| | |
|---|---|
| **Knowledge** | Conceptual understanding of information, theories, principles, and research |
| **Skill** | Strategies and processes to apply knowledge |
| **Attitude** | Beliefs about the value of particular information or strategies |

Technical Talks

Colloquia

Discussion Meets

Theme Meetings

Workshops, Seminars and Conference

*Exposure in different areas for knowledge, skill and aptitude (KSA) development*

# COMPETENCY MAPPING

IAEA Safety Standards

for protecting people and the environment

The Management System

GS-R-3 includes a section dealing with human resources. The requirement is that senior management shall determine *(paragraph 4.3)* *"…<u>the competence requirements for individuals at all levels.</u>"*

Safety Requirements

No. GS-R-3

IAEA International Atomic Energy Agency

and to establish, implement, assess and continually improve the management system.

4.2. The information and knowledge of the organization shall be managed as a resource.

HUMAN RESOURCES

4.3. Senior management shall determine the competence requirements for individuals at all levels and shall provide training or take other actions to achieve the required level of competence. An evaluation of the effectiveness of the actions taken shall be conducted. Suitable proficiency shall be achieved and maintained.

4.4. Senior management shall ensure that individuals are competent to perform their assigned work and that they understand the consequences for safety of their activities. Individuals shall have received appropriate education and training, and shall have acquired suitable skills, knowledge and experience to ensure their competence. Training shall ensure that individuals are aware of the relevance and importance of their activities and of how their activities contribute to safety in the achievement of the organization's objectives.

INFRASTRUCTURE AND THE WORKING ENVIRONMENT

4.5. Senior management shall determine, provide, maintain and re-evaluate the infrastructure and the working environment necessary for work to be carried out in a safe manner and for requirements to be met.

## 5. PROCESS IMPLEMENTATION

DEVELOPING PROCESSES

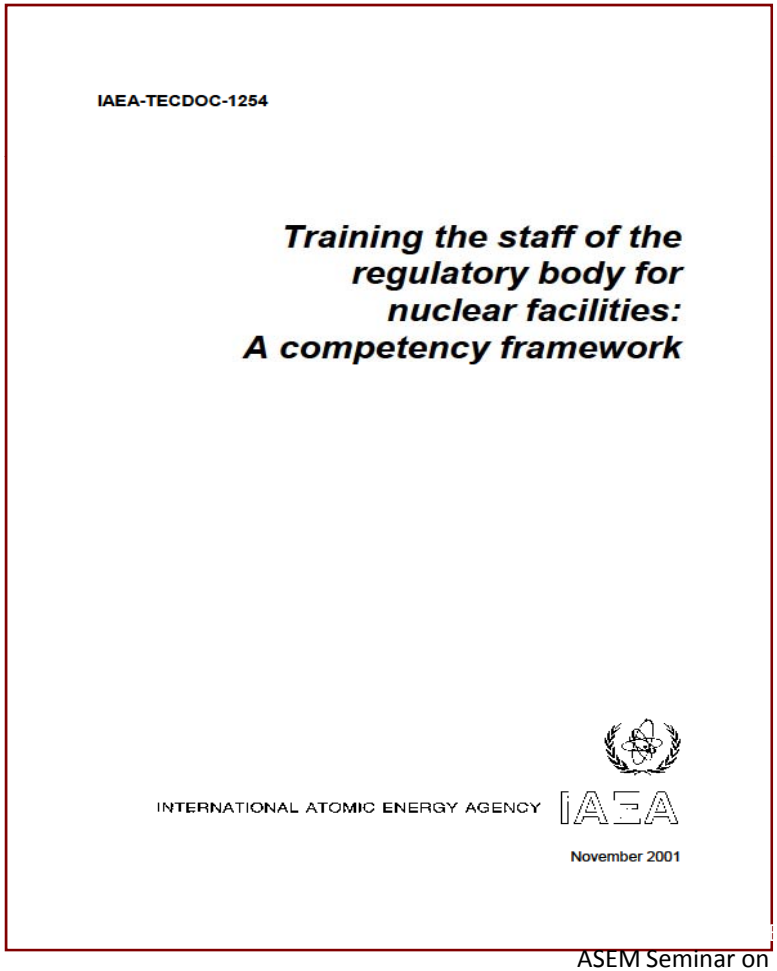
5.1. The processes of the management system that are needed to achieve the goals, provide the means to meet all requirements and deliver the products of

10

# FRAMEWORK FOR COMPETENCY MAPPING

***The COMPETENCY FRAMEWORK FOR REGULATORY BODY (Chapter 3)*** **- Training the staff of the regulatory body for nuclear facilities: A competency framework (IAEA-TECDOC-1254)**

- **The Four – quadrant model applicable to any Regulatory body**


IAEA-TECDOC-1254

*Training the staff of the regulatory body for nuclear facilities: A competency framework*

INTERNATIONAL ATOMIC ENERGY AGENCY IAEA

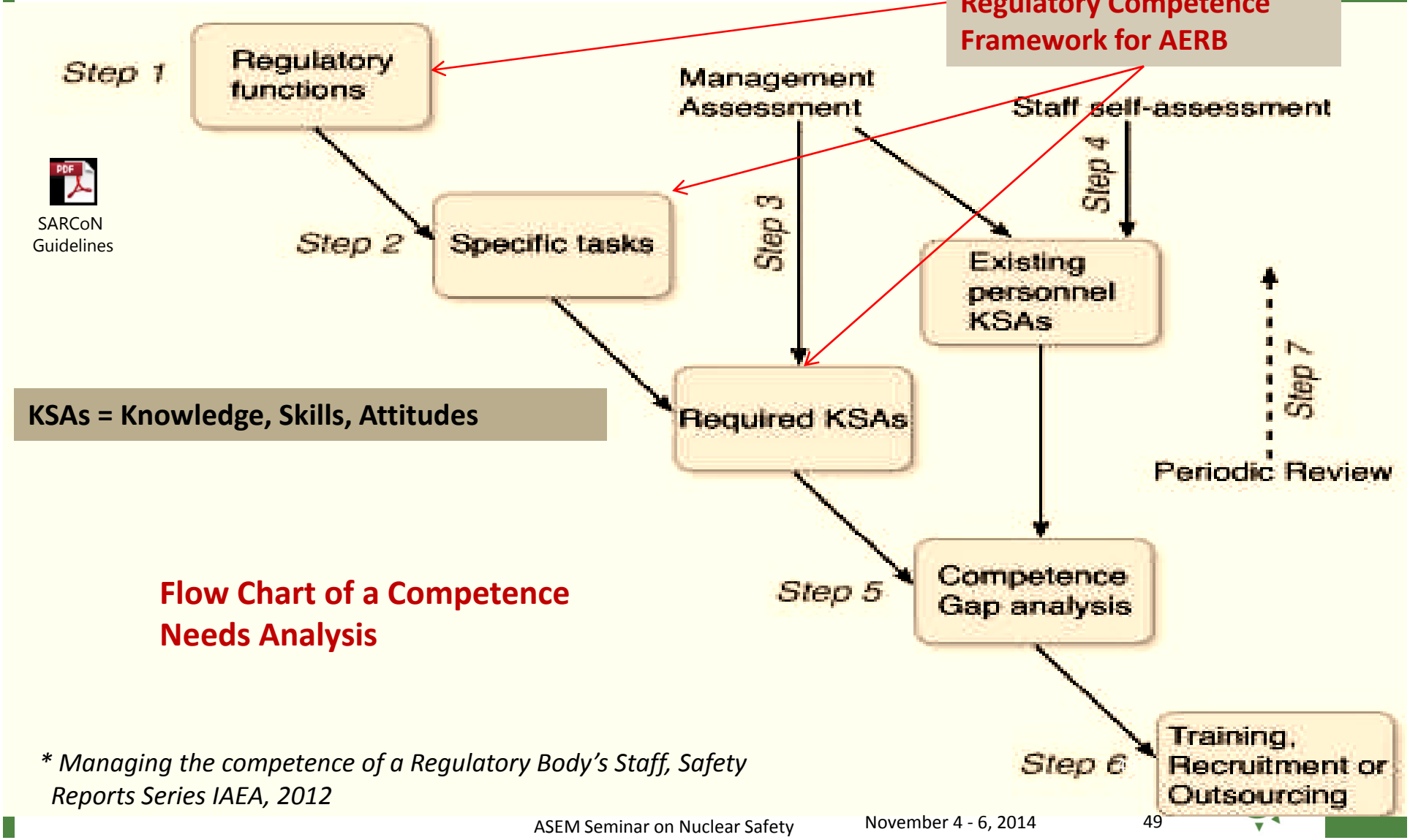
November 2001

**Table 1. Quadrant Model of Competences**

| | |
|---|---|
| **4. Personal and interpersonal effectiveness competences**<br>• Analytical thinking, problem solving and decision making<br>• Personal effectiveness<br>• Communication<br>• Team work<br>• Management | **1. Legal basis and regulatory processes competences**<br>• Legal basis<br>• Regulatory processes<br>• Regulatory guidance documents<br>• Licence and licensing documents<br>• Enforcement process |
| **3. Regulatory practices competences**<br>• Safety focused analytical techniques<br>• Inspection techniques<br>• Assessment techniques<br>• Investigation techniques | **2. Technical disciplines competences**<br>• Basic technology<br>• Applied technology<br>• Specialized technology |

# SARCoN*- Systematic Assessment of Regulatory Competence Needs for Regulatory Bodies of Nuclear Facilities

**Incorporated in the Regulatory Competence Framework for AERB**




SARCoN Guidelines

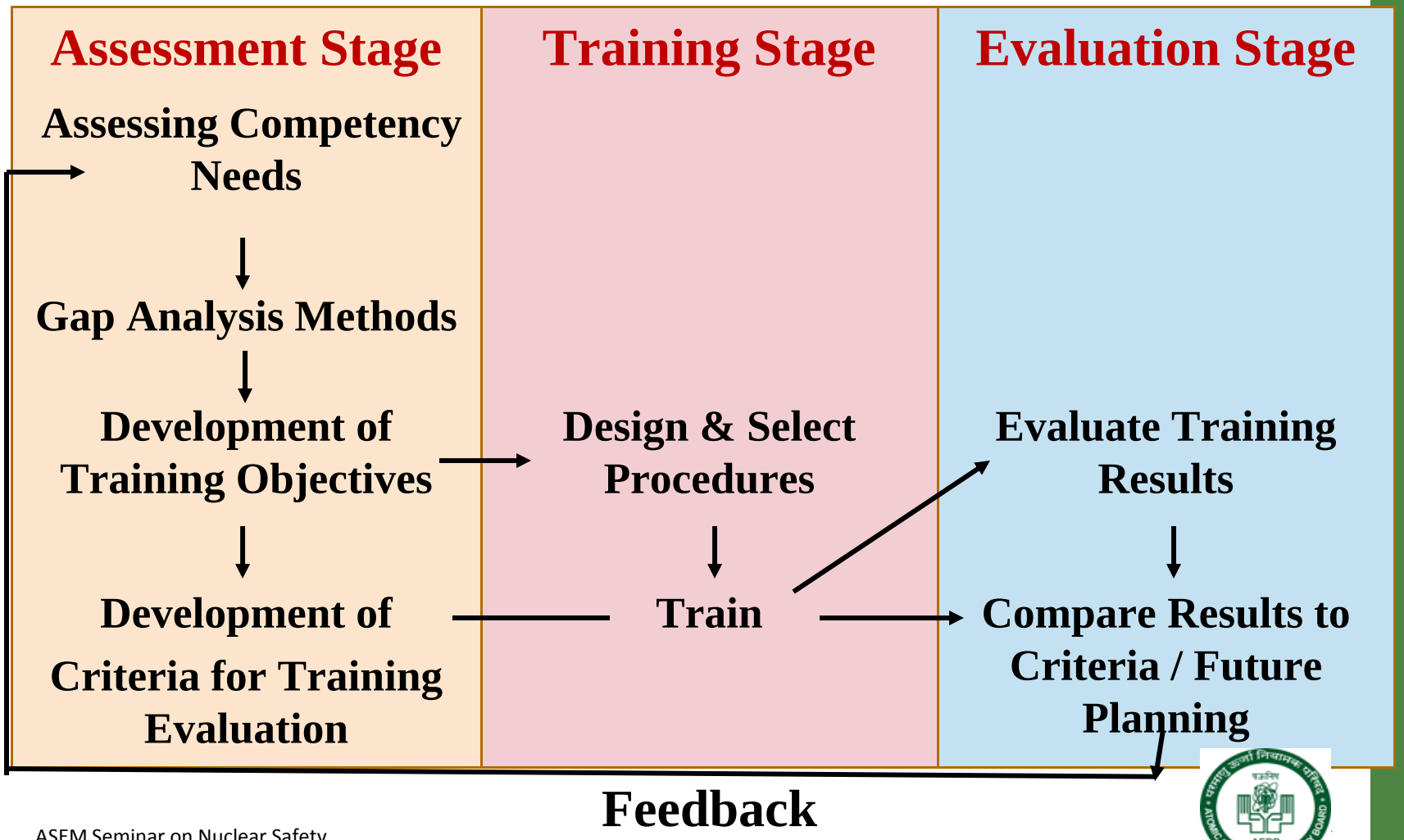
**KSAs = Knowledge, Skills, Attitudes**

**Flow Chart of a Competence Needs Analysis**

** Managing the competence of a Regulatory Body's Staff, Safety Reports Series IAEA, 2012*

# Proposed Implementation Model for Competency Mapping at AERB

- 3 Stage Process



# CHALLENGES AHEAD

Challenges can arise from

- Lack of adequate technical knowledge on new reactor designs.
- Attrition of experienced staff resulting in reduction in competency levels.
- Lack of experience on modern computerized systems for reactor controls.
- Public perception about safety performance of reactors.

“ Excellence is an art won by training and habituation. We do not act rightly because we have virtue or excellence, but we rather have those because we have acted rightly. We are what we repeatedly do. Excellence, then, is not an act but a habit.”

---Aristotle

# Thank You