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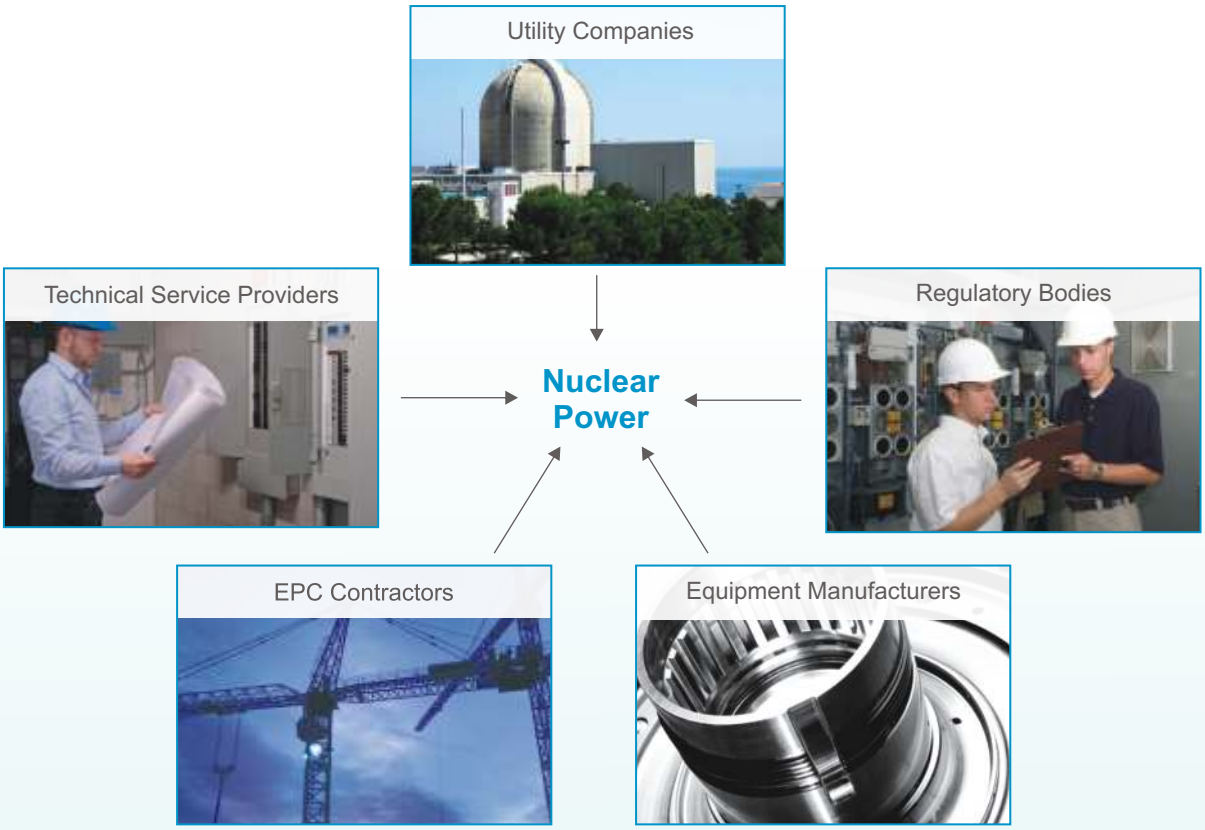
Civilian Nuclear Power Projects: Global Opportunities for Indian Industry

Energy is an important determinant of sustained growth, economic stability and prosperity of a rapidly developing country. In India, energy projections to sustain economic growth in excess of 8% suggest an installed capacity requirement of 800 GWe by the year 2032. Undoubtedly, the country is exploring all options to ensure energy security.

In this context, the Indian government has taken a strategically important decision to formally recognize the inevitability of nuclear power and accelerate alignment of the country's civilian nuclear power program with the global renaissance in this field through mechanisms such as the Indo-US nuclear deal.

In addition to triggering exponential growth in the domestic nuclear power industry, such politico-economic events also herald the country's participation in global civilian nuclear commerce. Various research reports peg the value of such business opportunities at USD 150 billion over the next decade. Emergence of such opportunities coincides with increased global recognition of Indian engineering talent and specific efforts by domestic industry to penetrate various markets. As a result, every civilian nuclear power project in the world can potentially provide business opportunities in various shapes and forms to Indian industry.



Understanding the Complex Nuclear Business: The Biggest Challenge

As always, opportunities come with challenges. Here, the biggest challenge that each and every stakeholder related with the nuclear power industry will face is to source a critical mass of competent human resources who have an in-depth understanding of the complexities of the nuclear technology and business.

Some realities are:

- **Shortage of competent nuclear industry professionals:**
  In India, as in other developed countries, there is a shortage of competent nuclear industry professionals. This shortage is the combined effect of an aging workforce and the relative dormancy of the industry which did not encourage periodic infusion of young talent in large numbers

- **Limited options for nuclear training:**
  Easily accessible options to avail nuclear power related training, be it in academia or industry are limited. This is applicable across managerial and operational levels and also for all stakeholders

"How can Indian organizations rapidly develop a comprehensive understanding of the complexities of the civilian nuclear technology and business?"

Nuclear Knowledge Needs: Requirements of the Indian Industry

Any participant in the nuclear power value chain requires to develop an in-depth understanding of several areas such as technology, operations, quality, safety, regulations. A comprehensive understanding across independent areas and also their inter-relationships can only be developed through sustained efforts in capability development over a period of time.

The knowledge requirements of new nuclear power industry participants typically evolves as follows:

- Acquisition of sufficient knowledge to participate in technical and business interactions
- Detailed understanding for application in design, planning & execution
- Post application knowledge improvements in specific areas

Keeping in mind the evolving requirements of the Indian civilian nuclear power program PM Dimensions has developed a unique offering structured to meet the immediate requirements of various stakeholders.

PM DIMENSIONS' Nuclear Energy Practice

Amongst leading providers of specialized technical and project management training in the Asia Pacific region, PM DIMENSIONS is India's only private sector organization to offer nuclear power related training. It's nuclear energy practice comprises of a team of senior industry professionals with hands on expertise across all aspects of nuclear power related technology and business. In prior career assignments these individuals have held leadership roles with Nuclear Power Corporation of India Ltd., Bhabha Atomic Research Center and other organizations associated with the Department of Atomic Energy, Government of India.

PM DIMENSIONS has assembled such capabilities in order to undertake a pivotal role in the creation of a "nuclear ready" workforce in India.

Program Overview

The training needs of the various stakeholders in the nuclear power business is addressed through a set of 30 short term training modules which cover an array of topics, where content and delivery is structured for specific knowledge transfer.

Program Highlights:

- Comprehensive coverage across all technical and business aspects
- Designed to address current knowledge requirements and key issues
- Modules have a combination of theoretical concepts and practical insights
- Developed and delivered by subject matter experts and industry veterans
- Simultaneous delivery across 4 cities over 9 months

Recommended Modules for Each Stakeholder

To be a stakeholder of consequence in the global civilian nuclear business, Indian industry will have to acquire requisite knowledge in the 2009-2010 time frame which will aid emerging business scenarios where detailed technical and business strategies are developed, new or associated lines of business ramp-up, international partnerships are formalized and markets are penetrated.

Depending upon the nature of business activities, PM DIMENSIONS' makes specific recommendations of module sets for each stakeholder category.

Stakeholders Module

Module Code	Module Title	Utility Companies	EPC Companies	Electrical Equipment Manufacturers	Mechanical Equipment Manufacturers	Instrumentation Equipment Manufacturers	Technical Services Providers	Engineering Design Consultants	Legal Service Providers	Govt. Agencies & Regulatory Bodies	Financial Institutions
NP01	Nuclear Reactor Theory & Types of Reactors	√	√				√	√		√	
NP02	Reactor Plant Engineering	√	√	√	√	√	√	√		√	
NP03	Nuclear Fuel Cycle	√	√				√	√		√	
NP04	Nuclear Reactor Chemistry	√	√				√	√		√	
NP05	Radiation Protection	√	√	√	√	√	√	√		√	
NP06	Reactor Thermal Hydraulics	√	√		√		√	√		√	
NP07	Nuclear Materials	√	√	√	√		√	√		√	
NP08	Turbine Generator Basics	√	√	√	√	√		√	√	√	
NP09	Economics of Nuclear Power Plant	√	√	√	√	√	√	√		√	
NP10	Regulatory Framework for Nuclear Power Plant	√	√	√	√	√	√	√	√	√	√
NP11	Environmental Considerations in Nuclear Power Plant	√	√	√	√	√	√	√	√	√	√
NP12	Nuclear Power Plant Project Planning, Construction and Commissioning	√	√	√	√	√	√	√	√	√	√
NP13	Power Systems & Nuclear Power Plant Operation	√	√	√			√	√		√	
NP14	Design & Operation Safety	√	√	√	√	√	√	√		√	
NP15	Industrial Safety in Nuclear Power Plant	√	√	√	√	√	√	√		√	
NP16	Plant Dynamics & Control	√		√	√	√	√	√		√	
NP17	Reliability & Maintenance Engineering	√	√	√	√	√	√	√		√	
NP18	Nuclear Steam Supply Systems	√		√	√	√	√	√		√	
NP19	Fuel Management, Safeguards & Operational Physics	√	√				√	√		√	
NP20	Turbine Generator & Feed Water Systems	√	√	√	√	√	√	√		√	
NP21	Mechanical Equipment for Nuclear Power Plant	√	√		√		√	√		√	
NP22	Electrical Systems for Nuclear Power Plant	√	√	√			√	√		√	
NP23	Control & Instrumentation Systems for Nuclear Power Plant	√	√			√	√	√		√	
NP24	Refueling Systems & Procedures	√	√		√	√	√	√		√	
NP25	Reactor Auxiliaries & Common Service Systems	√	√	√	√	√	√	√		√	
NP26	Station Operation & Technical Specifications	√	√	√	√	√	√	√		√	
NP27	Risk Management & Emergency Preparedness	√	√	√		√	√	√		√	
NP28	Quality Management	√	√	√	√	√	√	√		√	
NP29	Processing, Storage and Disposal of Nuclear Waste	√	√				√	√		√	
NP30	Decommissioning of Nuclear Power Plant	√	√				√	√		√	

Specific recommendations on modules is possible after the PM DIMENSIONS' team understands the nature of business and the profile of participants from potential client organizations.

NP01 - Nuclear Reactor Theory & Types of Reactors

Theoretical fundamentals of nuclear fission and fusion processes, chain reaction and safe generation of heat energy from nuclear reactors. Different types of reactors, steady and dynamic behavior and control of reactors

Module Structure

- Scientific fundamentals of fission and fusion processes and resultant release of energy
- Interaction of sub-atomic particles and ionizing radiations with matter
- Nuclear structure and functions of the reactor systems
- Various types of reactors
- Moderator and coolant
- Boiler and reactor auxiliary systems
- Typical reactor control system
- Steady and dynamic behavior of reactors
- Requirements of the safety systems in nuclear power plants
- Application of regulation and protection systems
- Integration with Reactor Engineering

Instructors: Mr. T. A. Subramanian, Mr. S. B. Bhoje

NP02 - Reactor Plant Engineering

Reactor structure design aspects, process systems, fuel & refueling systems, etc. Configuration of PHWR, BWR, PWR and FBR, key constituents (core, coolant, fuel, etc), regulation and protection systems and fuel management

Module Structure

- Conceptual design base for reactors
- Types of nuclear reactors & comparison on key parameter
- Reactor core materials
- Reactor process systems and equipment
- Reactor auxiliary system
- Reactor protection systems
- Reactor control systems
- Reactivity mechanisms
- Types of nuclear fuel
- Fuel management systems

Instructors : Mr. S. B. Bhoje, Mr. K. Rajendren

NP03 - Nuclear Fuel Cycle

Basics of nuclear fuel cycle, production, properties and selection of reactor core materials. Includes the complete cycle ranging from mining, processing, enrichment, manufacturing and usage and burning in the reactor for generating energy. Reprocessing of spent fuel.

Module Structure

- Nuclear fuel cycle options for PHWR, BWR,PWR and FBR
- Nuclear materials
- Nuclear fuel cycle in India
- Specifications of fuel
- Mining, processing, enrichment, manufacturing and usage and burning of fuel
- Quality control aspects
- Storage and safe transportation of spent fuel bundles
- Nuclear fuel enrichment
- Fuel reprocessing
- Generation and management of radioactive wastes

Instructors : Mr. S. Majumdar, Mr. S. P. Singh

NP04 - Nuclear Reactor Chemistry

Chemistry requirements of nuclear power plant systems and methods for maintaining the chemical parameters under control. This includes corrosion and its control, behavior of chemicals in radiation environment and overview of analytical instruments used in chemical laboratories

Module Structure

- Chemistry of reactor materials
- Chemical compatibility of materials for different nuclear system
- Chemical changes in nuclear reactor vicinity
- Relevant chemical parameters to be monitored and controlled in a nuclear power plant
- Difference in chemical parameters for various types of nuclear power plants
- Analytical instruments for chemical analysi
- Corrosion control
- Regulatory limits for chemical parameters

Instructors : Mr. G. C. Shah

Training Modules

NP05 - Radiation Protection

Basics of nuclear radiation, radioactivity, decay process, biological effects of radiation, and radioactive contamination and operational radiation protection including radiation monitoring instruments and processes. Regulatory parameters are also presented.

Module Structure

- Radiation Theory
- Radiation hazardss
- Protection against radiation exposure
- Calculation of radiation dose, field, manrem and duration of work
- Biological and genetic effects
- Manrem budgeting and control
- Selection of instruments for measuring radiation parameters
- Radiation emergency preparedness
- Surface contamination and control

Instructors : Mr. K. K. Narayanan, Mr. M. L. Joshi

NP06 - Reactor Thermal Hydraulics

An introduction to reactor thermal hydraulic describing processes involved.

Module Structure

- Heat transfer and Fluid flow mechanism
- Safe energy removal from reactor core
- Calculations of thermal hydraulics in channels
- Thermal hydraulic design
- Influence of power conversion methods on reactor design
- Hydraulics of reactor system loops & heated channels
- Steam and gas power cycles

Instructors : Mr S. B. Bhoje, Mr. T. K. Rajendren

NP07 - Nuclear Materials

Application of science and engineering for selection of reactor materials. Covers fracture mechanics, non-destructive testing, plant monitoring and other issues.

Module Structure

- Materials science and engineering
- Structure of materials and usage
- Corrosion with real life examples of corrosion failures
- Pressure vessel and fracture mechanics
- Methods of structural integrity assessment of reactor pressure vessels
- Non-destructive testing and plant monitoringl
- Factors affecting the lifetime of reactor componentss
- Specifications and methods of fabrication for high reliability

Instructors : Mr. S. Majumdar, Mr. S. P. Singh

NP08 - Turbine Generator Basics

Basics of steam turbine cycle, design description of turbine-generator and its auxiliary equipment for nuclear power plants. Turbine - generator working and control system.

Module Structure

- Steam turbine cycle
- Selection of steam turbine and its specifications
- Turbine Generator and its auxiliaries
- Erection, commissioning, operation and maintenance
- Heat balance and thermal efficiency calculations
- Factors affecting overall plant efficiency
- Turbo-visory instruments and parameters
- Cold and hot start up
- Load fluctuations and controls
- Regulatory limits for chemical parameters

Instructors : Mr. S. L. Mandowara, Mr. B. L. Sharma

NP09 - Economics of Nuclear Power Plant

Economic aspects of nuclear power, cash flows for the entire life-cycle, unit energy cost components, cost of capital, provisions for mandatory liabilities like decommissioning and international safeguard obligations.

Module Structure

- Elements of nuclear power plant cost
- Cash flows covering its entire life cycle
- Cost estimation and revision methods
- Cost of capital
- Unit energy cost
- Mandatory liabilities like decommissioning and international safeguard obligations
- Financial planning, analysis and control
- Revision of cost estimates
- Comparison of cost of nuclear power plant with thermal & other power plants

Instructors : Mr. K. J. Sebastian, Mr. S. B. Bhoje

NP10 - Regulatory Framework for Nuclear Power Plants

Legal aspects of establishment up of nuclear power plants and its operation. Legislation applicable to nuclear power plants. Role of regulatory bodies such as Atomic Energy Regulatory Board (AERB), its objectives, structure and functioning.

Module Structure

- Importance of legislation and its effective implementation in relation to nuclear power plants
- Role of Central and State Electricity Regulatory Commissions
- Role of Atomic Energy Regulatory Board (AERB) and Department of Atomic Energy (DAE)
- Legislation, rules and regulations for safe electricity generation :-
  - The Factories Act 1948
  - Applicable AERB Safety Codes, Guides and Technical Specifications
  - The Atomic Energy Act 1962
  - The Indian Electricity Act 1910
  - The Environmental Protection Act 1986
  - The Air (Prevention and Control of Pollution) Act 1981
  - The Water (Prevention and Control of Pollution) Act 1974
  - The Boiler Act
- Compliance of legal and regulatory requirements
- Surveillance requirements and systems
- Comparison with the regulatory framework of conventional industry

Instructors : Mr. M. S. Gupta, Mr. Deepak De

NP11 - Environmental Considerations In Nuclear Power Plants

Need for environmental protection, Indian legislation and control related to environment, environmental impact assessment, clearances related to setting up of nuclear power plant and its operation, environmental survey requirements.

Module Structure

- Introduction to environmental aspects of the nuclear power plant
- Need for environmental protection
- Legislation and control
- Assessment of public perception and its impact on environmental decision making
- Socio-economic factors and stakeholders interests
- Methods used in environmental decision making
- Scientific basis of risk assessment and public perception
- Regulatory criteria for environmental protection

Instructors : Mr. S. L. Mandowara

NP12 - Nuclear Power Plant - Planning, Construction and Commissioning

Elements of project planning, selection of project team, understanding of stakeholder roles and responsibilities (this includes utilities, government agencies, regulators, suppliers, manufacturers and contractors covering different stages of project), cost estimates and budgeting, monitoring and control of project, operation and life extension.

Module Structure

- Selection of team for project management: organization structure
- Challenges, key success factors and issues relevant for nuclear power projects
- Cost estimates and budgeting
- Elements of project planning and risk management
- Work breakdown structure and network diagrams
- Monitoring and control of project
- Safety and regulatory requirements
- Stages of project implementation
- Project commissioning and operation
- Reporting and closure
- Renewal of operation license
- Radiation protection and waste management

Instructors : Mr. M. S. Gupta, Mr. S. C. Katiyar

NP13 - Power Systems and Nuclear Power Plant Operation

Interaction and behavior of electrical power system with nuclear power plant operation. Principles of operation of power systems. Effective evacuation of electricity generated in nuclear power plant.

Module Structure

- Role of power systems in plant operations
- Power system parameters and grid characteristics
- Layout of station service power systems
- Impact of grid disturbances on main generator and electrical standby systems
- Voltage and frequency control
- Generator synchronizing and load shedding
- Main output and station service power systems
- Line, transformer and generator protections
- Short circuit calculations

Instructors : Mr. S. C. Katiyar, Mr. S. P. Sharma, Mr. S. L. Mandowara

NP14 - Design and Operation Safety

Concepts of safety in design and operation of nuclear power plant, safety and reliability analysis, design of safety systems and safety related systems, operational procedures and controls, regulatory requirements related to design and operations safety.

Module Structure

- Conceptual design of safety systems
- Basic concepts in safety and reliability
- Risk and reliability analysis of systems
- Operational safety procedures
- Regulatory Process

Instructors : Mr. T. A. Subramanian, Mr. M. S. Gupta

NP15 - Industrial Safety in Nuclear Power Plant

Basic industrial safety practices, electrical, chemical, fire and radiation hazards. Work procedures of job execution and standard protection codes, first aid training, principles of working safely in nuclear power plants.

Module Structure

- Standard work procedures in nuclear power plant
- Safety rules and regulations - isolation, maintenance, testing and normalization
- Safety of personnel and equipment
- Responding to emergencies
- Accident prevention and industrial safety
- Standard protection code

Instructors : Mr. S. L. Mandowara

NP16 - Plant Dynamics & Control

Concepts of process control and reactor dynamics, control of plant and processes transients, plant dynamics and control theory. Instrumentation and controls for nuclear power plants.

Module Structure

- Concepts of process control and reactor dynamics
- Control of disturbances and transients and integrated operation of the plants
- Plant dynamics and control
- Design of nuclear power plants - Instrumentation and control systems
- Total and partial load throw off
- Reactor trip transients
- Reactor step back and set back transients
- Turbine trip transients
- Transients related to discrepancies in feed water and cooling water systems
- Disturbance analyzers

Instructors : Mr. T. K. Rajendren, Mr. A. S. Bhattacharya

NP17 - Reliability and Maintenance Engineering

Reliability engineering in design and maintenance, concepts of maintenance engineering, management and planning of maintenance activities in nuclear power plants. Maintenance organization –systems, methods and practices.

Module Structure

- Reliability engineering and maintainability
- Basic concepts in Safety and Reliability
- Protection Systems
- Safety Analysis
- Maintenance concepts and policies
- Maintenance planning and management
- Maintenance activities in nuclear power plants
- Maintenance engineering elements for reliability of equipment
- Spare parts management and inventory control
- Maintenance performance indicators
- Regulatory Processes
- Operational parameters for safety
- Human Resource Development for Nuclear Safety
- Reliability centered maintenance (RCM)

Instructors : Mr. A. K. Babbar, Mr. R. K. Saraf

NP18 - Nuclear Steam Supply System

General description of nuclear power plants. Heat transport system, moderator system and nuclear steam production system and engineered safety systems.

Module Structure

General description of nuclear power plants
Primary Heat Transport System

- Primary heat transport main system
- Primary heat transport auxiliary systems.
- Controls and instrumentation
- Primary heat transport System operation
- Small and large leak handling system

Moderator System

- Main circulation system
- Cover gas system
- Automatic liquid poison addition system (ALPAS)
- Liquid poison injection system
- Moderator auxiliary systems
- Control systems and operational procedures

Nuclear Steam Production System

- Steam generators
- Feed water system
- Steam systems

Engineered safety systems

- Containment systems
- Emergency core cooling system

Instructors : Mr. M. S. Gupta, Mr. B. Dey

NP19 - Fuel Management, Safeguards and Operational Physics

Application of reactor physics, principles in design and operation. Hazards and precautions during the initial criticality. Fuel management systems. International Atomic Energy Agency (IAEA) safeguards. Steady state high power operations. Reactor start up and shut down. Reactor power transients

Module Structure

- Application of reactor physics - principles in design and operation
- Design basis of reactor regulation and protection systems
- Initial and subsequent approaches to criticality and Phase-B experiments
- Importance of various physics measurements
- Functions of Delayed Neutron Monitoring (DNM) system and method of identifying failed fuel
- Neutron flux monitoring
- Steady state operation of the reactor
- Nuclear Fuel Accounting
- Fuel management aspects (fresh core, plutonium peak, equilibrium core and factors affecting reactivity)
- International Atomic Energy Agency (IAEA) Safeguards

Instructors: Mr. T. A. Subramanian, Mr. B. Dey

NP20 - Turbine Generator and Feed Water Systems

Nuclear power plants turbine generator, its auxiliaries, boiler feed water and steam systems. Condensate and cooling water system. Normal, transient, and emergency operations.

Module Structure

- Introduction to Turbine Generator for nuclear power plants
- Turbine Main system
- Turbine lubricating oil system
- Turbine governing and protection
- Turbovisory system
- Generator and its auxiliary systems
- Turbine generator (TG) operation
- Boiler, feed water and steam systems
- Condensate and cooling water system
- Functional requirement of equipment in these systems
- Normal, transient, and emergency operations
- Operational logics and interlocks with the other systems

Instructors : Mr. B. L. Sharma

NP21 - Mechanical Equipment for Nuclear Power Plants

Design, procurement, operation, maintenance and testing of mechanical equipment of nuclear power plant. Codes, standards and specifications. Life assessment and life extension. Maintenance equipment and tools.

Module Structure

Design, procurement, operation, maintenance and testing of:-

- Reactor pressure vessels
- Reactor shielding
- Reactor internals
- Reactor vessel penetrations and nozzles
- Circulating pumps
- Feed pumps
- Pressurizer
- Valves and pipes
- Steam generators
- Ventilation and cooling equipment
- Air compressors and dryers
- Codes, standards and specifications
- Life assessment and life extension.
- Maintenance equipment and tools.

Instructors : Mr. N. K. Agarwal, Mr. S. B. Bhoje

NP22 - Electrical Systems for Nuclear Power Plant

Electrical systems of nuclear power plants. Normal and emergency operations. Power evacuation and auxiliary power systems including standby power systems.

Module Structure

- Main functions of Electrical system (Power evacuation and auxiliary power systems)
- Functional requirement of each equipment
- Main generator, exciter and Automatic Voltage Regulator (AVR)
- Standby power system equipment
- Steady state, anticipated transients and emergency operations
- Operational logics and interlocks with the other systems
- Electrical protection systems
- E-SCADA

Instructors : Mr. S. P. Sharma

NP23 - Control and Instrumentation Systems for Nuclear Power Plant

Control and instrumentation system for nuclear power plants. Normal and emergency operations. Reactor and process controls - design philosophy, erection, commissioning and operation.

Module Structure

- Control requirements of nuclear power plants - information, control and protection
- Functional requirements and design features
- Normal and emergency operations
- Reactor regulation and protection systems
- Process control systems
- Steam generator pressure and level control
- Computerized Channel Temperature Monitoring system (CCTM)
- Channel Flow Monitoring system (CFMS)
- Failed fuel monitoring systems
- Computerised data acquisition system and logic control system

Instructors : Mr. R. K. Kulkarni, Mr. V. K. Agarwal

NP24 - Refueling Systems and Procedures

Fuel handling systems for different types of reactor plants. Online refueling and refueling procedures. Fuelling machines and component details. Fuel transfer systems, spent fuel management systems and controls.

Module Structure

- Fuel handling systems for different types of reactor plants
- Operational logics and interlocks
- On line refueling in Pressurised Heavy Water Reactors (PHWRs)
- Refueling in other type of reactor plants
- Spent fuel storage and Inspection
- Operation of spent fuel storage bay facility
- Fuel transfer systems
- Fuelling machine valves, doors, and auxiliary systems
- Fuel Handling System (FHS) controls
- Fuel Handling System (FHS) organization, planning and procedures

Instructors : Mr. A. B. Ghare, Mr. B. Dey

NP25 - Reactor Auxiliaries and Common Service Systems

Reactor auxiliaries and common service systems of nuclear power plants. Design and safety features. Normal and emergency operations.

Module Structure

- Reactor auxiliary systems of nuclear power plants
- Common service systems
- Functional requirement of major equipment of these systems
- Steady state operations, transient and emergency operations
- Operational logics and interlocks
- Interaction with the other systems
- Testing of logics and controls

Instructors : Mr. B. Dey, Mr. T. K. Rajendren

NP26 - Station Operation and Technical Specifications

Station operations including technical specifications for operations of nuclear power plants. Station policies, procedures and documentation for surveillance testing.

Module Structure

- Station operating policies and principles
- Station instruction, operating manual and administrative controls
- Operational procedure for normal and emergency modes
- Technical specifications for operation of major system
- Limiting safety system settings (LSSS) and Limiting conditions of operations (LCO)
- Basis for technical specifications
- Documentation for operation and surveillance testing
- Regulatory requirements and audits

Instructors : Mr. S. C. Katiyar

NP27 - Risk Management & Emergency Preparedness

Risk management in nuclear power plants. Probabilistic risk analysis comparisons across various plants. Accident management and emergency preparedness.

Module Structure

- Concepts of Risk management
- Probabilistic Risk Analysis (PRA)
- Accident management and emergency preparedness
- Plant emergency
- Site emergency
- Off site emergency
- Emergency preparedness procedures and records
- Emergency Exercises and regulatory controls

Instructors : Mr. A. K. Babbar, Mr. R. K. Saraf, Mr. M. L. Joshi

NP28 - Quality Management

Concepts of quality management in nuclear power plants. Quality management policies and procedures. Quality assurance programme for design procurement, erection, commissioning and operation. Organization and activities of quality assurance section. In service Inspection (ISI) and condition monitoring. Codes and standards related to quality management system.

Module Structure

- Principles and Concepts of quality management
- Quality management policies
- Quality assurance during design and procurement
- Quality assurance during construction and erection of equipment
- Quality assurance during commissioning and operations
- Organization of quality assurance section
- Quality assurance audits and records
- Nuclear Fuel Accounting
- In service Inspection (ISI), quality control and inspection, and condition monitoring
- Codes and standards

Instructors : Mr. M. S. Gupta

NP30 - Decommissioning Of Nuclear Power Plant

Describes decommissioning process and considerations during design. Also covers environmental requirements of waste management

Module Structure

- Overview of national and international legislation.
- Decommissioning approaches and planning systems
- Environmental approaches for plant decommissioning
- Safety aspects for plant decommissioning

Instructors : Mr. Deepak De

NP29 - Processing, Storage and Disposal of Nuclear Waste

Nuclear waste management - techniques of processing, storage, and disposal of different types of nuclear waste.

Module Structure

- Radioactivity, radio nuclides and types of radioactive waste
- Approaches to nuclear waste management
- Techniques of nuclear waste processing
- Performance and safety assessment methods
- Radioactive waste recycling, waste minimization and immobilization
- Nuclear decay law
- Contaminants and hazards and contaminations from heavy metals
- Background radiation
- Nuclear waste regulations
- Sources of nuclear waste
- Short-lived and Long-lived waste radio nuclides.
- Basic management approaches and characterization of radioactive waste
- Pre-treatment of radioactive wastes
- Treatment of solid and liquid radioactive wastes
- Hydraulic cements in waste immobilization and cementation technology
- Immobilization of radioactive wastes in bitumen
- Glasses for radioactive waste immobilization
- Vitrification technology and Performance assessment

Instructors : Mr. N. K. Bansal

Mr. A.B. Ghare
Mr. A. B .Ghare is the former Senior Executive Director of Nuclear Power Corporation of India Limited (NPCIL). He has worked on the design and manufacture of highly sophisticated remote operated refueling system equipment and significantly contributed to achievement of self sufficiency in this field. He has played a key role in several nuclear power related projects of Department of Atomic Energy (DAE). Mr. Ghare has also addressed a number of national & international seminars and delivered lectures on technical as well as managerial subjects.

Mr. A.K. Babbar
Mr. A.K. Babbar is the former Head (Probabilistic Safety Assessment Section, Reactor Safety Division) at Bhabha Atomic Research Centre (BARC). He has worked as a consultant to Atomic Energy Regulatory Board for preparation of compendium of standard generic data base for probabilistic safety assessment of Nuclear Power Plants. Mr. Babbar is a renowned faculty on Reliability Engineering and Risk Assessment, Probability Theory and Operations Research at Indian Institute of Technology (IIT) Kanpur, IIT Bombay and BARC Training School.

Mr. A.S. Bhattacharya
Mr. A. S. Bhattacharya is the former Associate Director (Simulators and Training), General Manager (HRD) and Chief Engineer (Training) of Nuclear Power Corporation of India Limited (NPCIL). He has extensive experience in the area of human resource development in the nuclear industry. As the management representative of NPCIL, Mr. Bhattacharya has also worked with several leading institutes including Indian Institute of Management, Ahemdabad (IIMA), National Institute of Industrial Engineering (NITIE) and National Thermal Power Corporation (NTPC) etc.

Mr. B. Dey
Mr. B. Dey has over 37 years of experience in diversified areas with Nuclear Power Corporation of India Limited, (NPCIL) where he held the position of Additional Chief Engineer. Mr. Dey is a licensed engineer and has experience with a variety of nuclear technologies. He has worked at India's first heavy water reactor at Rajasthan Atomic Power Station. Mr. Dey was also a member of the IAEA Expert Committee for developing the training programs for Indian nuclear power plants. In his earlier career assignments, Mr. Dey has also worked on Thermal Power Plant operated by the Delhi Electric Supply Undertaking (DESU).

Mr. B. L. Sharma
Mr. B. L. Sharma has over 35 years of experience in the field of Nuclear plant operation. He is an expert on turbine and its auxiliaries, and was instrumental in improving efficiency of turbine and extraction systems at Tarapur Atomic Power Station (TAPS). He was also involved in quality assurance, life extension, repairs and replacement of turbine blades at TAPS. He has been a member of various safety committees at TAPS. As Technical Superintendent - Quality Assurance he was responsible for meeting technical specification and implementation of surveillance requirements as per ASME section XI . He was also the Chairman of committee for plant life extension for Tarapur Atomic Power Station .

Mr. Deepak De
Mr. Deepak De is the former Director, Nuclear Projects Safety Division at Atomic Energy Regulatory body. He has extensive experience in the field of nuclear power plants commissioning, operation and regulation. He was responsible for commissioning of Kakrapara Atomic Power Station. He was involved in project safety reviews of power plants under construction and licencing and reinforcing of regulatory requirements for plants. He was a member of different safety committees for preparation of codes and guides.

Mr. G. C. Shah
Mr. Shah is the former Head (Reactor Chemistry) at Bhabha Atomic Research Center (BARC). He has extensive experience in the field of power water reactory chemistry and operation of modern analytical chemistry instruments. He was involved in the commissioning of several PHWR reactors including the Cirus and Dhruva reactors. Mr. Shah has also served as a member of the DAE committee on power water reactors.

Mr. K.J. Sebastian
Mr. K. J. Sebastian is the former Director (Transmission), Director (Economic & Commercial) and Director (Corporate Finance) of Nuclear Power Corporation of India Ltd (NPCIL). He is also a Certified Energy Auditor. He has extensive experience in the power sector in a wide range of roles covering technical, commercial and financial management of power projects. He has worked in the Madras, Narora and Kakrapar atomic power projects. Mr. Sebastian has also been a member of the Regional Electricity Boards of the Southern, Western and Northern regions of India. He specializes in the field of financial management, project management and energy management.

Trainer Profiles

Mr. K.K. Narayanan
Mr. K.K. Narayanan has over 38 years of work experience in the areas of Radiation Control and Protection. He has worked as a Senior Scientist at Bhabha Atomic Research Center (BARC). He participated in the first peaceful nuclear explosion test at Pokhran as a member of Radiation Protection Group and has also worked as a member of two Technical committees of International Atomic Energy Agency (IAEA), Vienna on topics related to radiation protection. Mr. Narayanan has authored a book titled 'Population Exposure in India from Ionizing Radiations' published by Indian Society for Radiation Physics.

Mr. M.L. Joshi
Mr. M.L. Joshi has over years 37 of experience in radiation control and related fields. He is the former Head of Health Physics Division at Bhabha Atomic Research Center (BARC). Mr. Joshi has also served as a member of Safety Committees for all the power plants, which are appointed by Atomic Energy Regulatory Board (AERB). He is an expert in radiation protection for nuclear fuel cycle, nuclear power plants and research reactors and has been a lecturer in IAEA training courses on radiation protection subjects. Mr. Joshi has authored several papers published in International Journals and has presented at several International conferences.

Mr. M.S. Gupta
Mr. M.S. Gupta has over 35 years of experience across operations, quality assurance, safety reviews, planning and scheduling functions. He has been actively involved with training personnel on subjects such as project management, operation and maintenance. He has hands on experience of Root Cause Analysis, Quality Assurance and Regulatory Compliances. Mr. Gupta has held the position of Associate Director (Regulatory Affairs) at Nuclear Power Corporation India Ltd (NPCIL). He was also the Advisor to Heavy Water Board and has worked with the Rajasthan Atomic Power Station and the Bhabha Atomic Research Center.

Mr. N.K. Bansal
Mr. N. K. Bansal has more than three decades of experience in the areas of waste management facilities of power stations (PHWR, BWR and FBTR), research reactors, fuel reprocessing and research laboratories. He is the former Associate Director (Operations), Nuclear Recycle Group, Bhabha Atomic Research Centre (BARC). He was closely associated with safety review of reprocessing and waste management facilities and has served on various committees of Department of Atomic Energy. He has been advisor to IAEA in the preparation of technical reports, safety codes and guides. Mr. Bansal has presented papers in both national and international conferences.

Mr. R.K. Kulkarni
Mr. R. K. Kulkarni is the former Chief Engineer of Nuclear Power Corporation of India (NPCIL) and has over 36 years of experience in the field of planning, design, engineering, renovation and modernization of Control & Instrumentation (C&I) systems of nuclear power plants. He has served as a specialist member on the committee for finalizing the overall specification of Control & Instrumentation Systems for the first 500 MWe Prototype Fast Breeder Reactor (PFBR) of Bharatiya Nabhikiya Vidyut Nigam (BHAVINI), Kalpakkam. Mr. Kulkarni has also overseen the preparation of several in-house engineering standards.

Mr. R.K. Saraf
Mr. R.K. Saraf is a renowned scientist from the Bhabha Atomic Research Centre (BARC) and an expert in reliability engineering and risk assessment. He is a consultant with the Atomic Energy Regulatory Board (AERB) for reliability and probabilistic safety assessment issues. Mr. Saraf has trained several professionals at renowned corporate organizations and has been a faculty with BARC Training School and the Indian Institute of Technology, Bombay. Mr. Saraf has been trained by International Atomic Energy Agency (IAEA).

Mr. S.B. Bhoje
Mr. S.B. Bhoje, is a veteran with over four decades of experience in reactor designing, project management and construction of nuclear test reactors. He is the former Director, Indira Gandhi Center for Atomic Research Training School. He is an expert in the areas of Fast Breeder Reactor Technology. Mr. Bhoje has published over 200 papers in journals and conferences. He has represented India in several committees of International Atomic Energy Agency (IAEA). Mr. Bhoje has won several prestigious awards including Sir Visvesvaraya Memorial Award from Engineers Foundation and Life Time Achievement award from Engineers Forum, Nagpur. His immense contributions to the field of Nuclear Science have been recognized by the Government of India by conferring him with the prestigious Padmashri Award in the year 2003.

Mr. S.C. Katiyar
Mr.S.C.Katiyar is the former Station Director of Tarapur Atomic Power Station and has over three decades of professional experience in the areas of plant management, operations, maintenance, QA, training etc. He was responsible for the comprehensive planning and implementation of retro fitment of the Tarapur Atomic Power Station. He has held several leadership roles which necessitated close interaction with the Atomic Energy Regulatory Board, Department of Atomic Energy and other institutions on matters of regulatory requirements. He is also certified to conduct peer reviews of power plants and has done several peer reviews at international locations.

Mr. S. L. Mandowara
Mr. S.L. Mandowara has over 35 years experience in the areas of nuclear power generation. He is an expert on root cause analysis, peer review, plant trouble analysis, systems development and implementation, plant commissioning and operations. Mr. Madowara has also been involved in the areas of health, safety and environment management systems as well as training of personnel at several Nuclear Power Reactors. In his earlier career assignments he has held the position of Associate Director (HSE) Nuclear Power Corporation of India Limited.

Mr. S. Majumdar
Mr. S. Majumdar has over forty years of experience in the filed of nuclear fuels technology. He is the former Head of Radimetallurgy Division at Bhabha Atomic Research Centre (BARC). Presently Mr. Majumdar is the Honorary Chairman AERB and BARC's design safety review committees for all new nuclear fuel cycle facilities from siting of projects to decommissioning .He is also a member in AERB's Advisory Committee for Safety Documents for Fuel Cycle Facilities.

Mr. S.P. Sharma
Mr. Sharma has more than 35 years of experience in diversified areas in the field of Nuclear Power. He has successfully completed several projects related to erection and commissioning for electrical substations, electrical design, procurement, engineering services and nuclear safety. Mr. Sharma has also been involved in quality assurance and industrial safety projects. In his earlier career assignment, Mr. Sharma held the position of Additional General Manager and Additional Chief Engineer at Nuclear Power Corporation of India Limited (NPCIL)

Mr. S.P. Singh
Mr. S. P. Singh is the former Head (Nuclear Safety Division) of Atomic Energy Regulatory Board (AERB). He has obtained advanced training in nuclear fuel management, safety, reliability analysis, risk management and emergency response. He has over 37 years of experience in design, technical services, and regulation for safety of nuclear facilities. He has been a consultant to International Atomic Energy Agency and its member states. He specializes in the field of quality assurance, review of design and safety documents of nuclear power plants.

Mr. T.A. Subramanian
Mr. T. A. Subramanian is the former Scientific Officer, Training Division at Bhabha Atomic Research Center (BARC). He has taught at several Department of Atomic Energy (DAE) establishments on several subjects including computational reactor physics, applied mathematics and other engineering subjects. He was in-charge for the complete establishment of three DAE training centers at Indore, Hyderabad and Kalpakkam. Mr. Subramanian has served in special committees constituted by the Planning Commission related to Manpower & Training Development in Energy sector. He has also represented DAE at several International Atomic Energy Agency (IAEA) meetings on training in nuclear technology.

Mr. T.K. Rajendren
Mr. T. K. Rajendren has over 37 years of extensive experience across commissioning and operation of PHWR nuclear power plants, development & testing of nuclear power plant training simulator and training of personnel on nuclear power related subjects. Mr. Rajendren has been involved in development and delivery of several training modules for licensing and qualification of personnel for nuclear power plants. Mr. Rajendren has also served as a consultant to the International Atomic Energy Agency (IAEA) for the development of a guide book for "Education and Training of Technicians for Nuclear Power Plants"

About PM Dimensions

PM DIMENSIONS is engaged in the development and deployment of practicing workforces, technical solutions and project management frameworks for the engineering industry. We provide industry focused consulting, training and outsourcing services.

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