CANDU OVERVIEW

WORKBOOK

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TABLE OF CONTENTS

COURSE INTRODUCTION

COURSE OBJECTIVES:

At the successful completion of this course the participants will be able to:

1. **Describe the following features of a CANDU Generating unit:**
   - **the principles of overall unit operation and control**
   - **the functions, equipment and operation of the main process systems**
   - **how each major system is controlled**
   - **how reactor safety and the protection of the public is achieved;**
2. **Conduct normal and abnormal operations on a simulated CANDU-9 Generating unit, including:**
   - **power maneuvers**
   - **poison override operation**
   - **recovery from a reactor trip**
   - **recovery from a turbine trip**
   - **responses to reactor, heat transport, steam and feedwater system malfunctions.**

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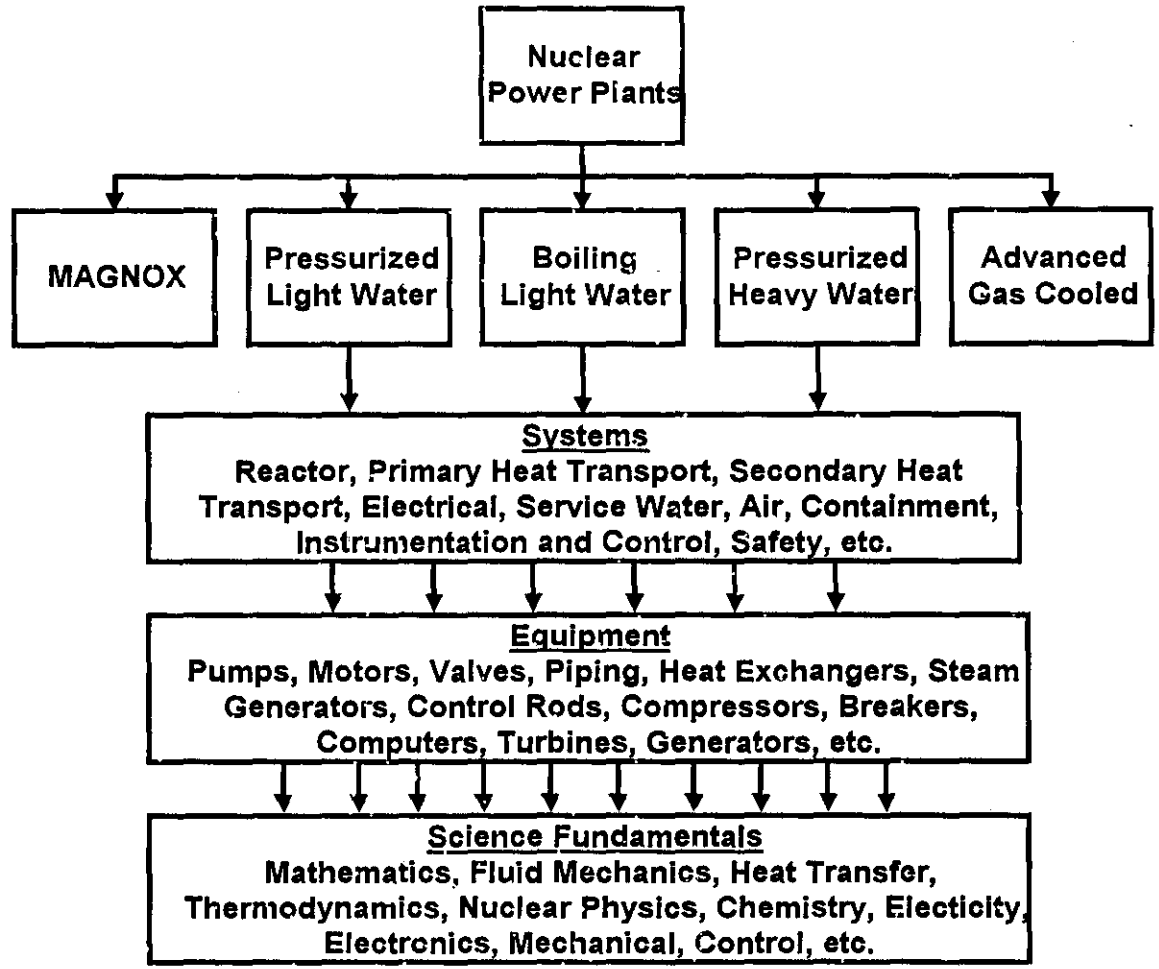
1. COURSE EMPHASIS AND APPROACH

- **Emphasis is on participants learning**
- **Learning is best done by doing:**
  - ⇒ **read the reference text**
  - ⇒ **complete written assignments**
  - ⇒ **understand what you do on the simulator**
- **Learning is helped by repetition and by reference to existing knowledge**
- **This course is about how nuclear power plants 'work'**
- **Importance of each system, subsystem and equipment to overall unit operation**
- **CANDU 9 will be used to illustrate learning objectives that involve station specific details**
- **Specialist training for individual systems, equipment and techniques will be given in subsequent courses**
- **Written assignments based on lectures, reading material and simulator exercises will be done in the classroom**

2. 'Top-down' Approach to Studying Nuclear Power Plants

2.1 Traditional approach is 'bottom-up':

- learn theory and apply to model problems in each subject area;
- do a few case-studies in usually unrelated areas;
- practical equipment and integrated systems applications are rare;
- on-the-job training is usually concentrated on area of specialty;
- usual result: good detailed knowledge in one or two areas of specialty, but limited understanding of overall system.



2.2 Approach in this course 'top-down':

- every participant needs to know how a nuclear power plant 'works';
- each participant has a different need for specialized knowledge;
- each participant has a different level of current knowledge;
- each person has a different learning style;
- expected result: every participant attains a common level of overall knowledge, but individuals will study different areas to different extent depending on personal needs and preferences.

3. COURSE PLAN

DAY 1: INTRODUCTION
OVERALL UNIT

DAY 2: REACTOR AND MODERATOR SYSTEMS
REACTOR CONTROL

DAY 3: HEAT TRANSPORT MAIN CIRCUIT
HEAT TRANSPORT PRESSURE AND INVENTORY CONTROL

DAY 4: STEAM, TURBINE & FEEDWATER SYSTEMS
BOILER PRESSURE CONTROL
BOILER LEVEL CONTROL

DAY 5: SPECIAL SAFETY SYSTEMS

3.1 DAY 1 COURSE PLAN

INTRODUCTION

OVERALL UNIT

- ENERGY CONVERSION IN CANDU GENERATING STATIONS (Ref. Text: 1-2 to 1-7)
- REACTOR SAFETY (Ref. Text: 1-8 to 1-12)
- CANDU STATION SYSTEMS (Ref. Text: 1-13 to 1-31)
  - REACTOR
  - MODERATOR
  - HEAT TRANSPORT
  - STEAM & FEEDWATER
  - TURBINE, GENERATOR, CONDENSATE & FEEDHEATING
  - ELECTRIC POWER
  - INSTRUMENTATION AND CONTROL
  - SAFETY SYSTEMS

SIMULATOR

- START-UP, INITIALIZATION
- COMMON DISPLAY FEATURES
- PLANT OVERVIEW
- TURBINE GENERATOR
- UPR
- POWER MANEUVER

3.2 DAY 2 COURSE PLAN

REACTOR AND MODERATOR

- REACTOR ASSEMBLY (Ref. Text: 2-2 to 2-6)
- FUEL CHANNEL ASSEMBLIES (Ref. Text: 2-7 to 2-9)
- FUEL (Ref. Text: 2-10 to 2-12)
- MODERATOR (Ref. Text: 2-12 to 2-19)

REACTOR CONTROL

- REACTOR CONTROL REQUIREMENTS (Ref. Text: 3-2 to 3-5)
- REACTOR INSTRUMENTATION (Ref. Text: 3-6 to 3-10)
- REACTIVITY CONTROL DEVICES (Ref. Text: 3-11 to 3-19)
- REACTOR REGULATING SYSTEM PROGRAMS (Ref. Text: 3-20 to 3-28)

SIMULATOR

- SHUTDOWN RODS
- REACTIVITY CONTROL
- LIQUID ZONES CONTROL
- ZONAL FLUX TRENDS
- FLUX MAPPING
- RRS/DPR
- REACTOR STEPBACK AND RECOVERY
- ONE BANK OF ABSORBER RODS DROP
- ALL LIQUID ZONE PUMPS TRIP
- FAIL OPEN LIQUID ZONE 1 & 2 INLET VALVES

3.3 DAY 3 COURSE PLAN

HEAT TRANSPORT

- MAIN HEAT TRANSPORT (Ref. Text: 4-2 to 4-7)
- PRESSURE AND INVENTORY CONTROL (Ref. Text: 4-8 to 4-12)
- SHUTDOWN COOLING (Ref. Text: 4-13 to 4-14)
- HEAT TRANSPORT AUXILIARIES (Ref. Text: 4-15 to 4-16)
- HEAT TRANSPORT SYSTEM OPERATION (Ref. Text: 4-17 to 4-19)

SIMULATOR

- PHT MAIN CIRCUIT
- PHT FEED & BLEED
- PHT INVENTORY CONTROL
- PHT PRESSURE CONTROL
- BLEED CONDENSER CONTROL
- PHT LRV (CV20) FAILS OPEN
- PHT STEAM BLEED VALVE (CV22) FAILS OPEN
- PHT FEED VALVE (CV12) FAILS OPEN
- PRESSURIZER SURGE VALVE (MV1) FAILS CLOSE
- PHT BLEED VALVE (CV5) FAILS OPEN

3.4 DAY 4 COURSE PLAN

STEAM, TURBINE & FEEDWATER

- Steam Generator (Boiler) (Ref. Text: 5-2 to 5-4)
- Steam System (Ref. Text: 5-5 to 5-8)
- Turbine and Condenser (Ref. Text: 5-9 to 5-11)
- Feedwater System (Ref. Text: 5-12 to 5-15)
- Generator (Ref. Text: 5-16 to 5-17)
- Conventional Plant Services (Ref. Text: 5-18 to 5-19)

ELECTRIC POWER

SIMULATOR

- STEAM GENERATOR FEED PUMPS
- STEAM GENERATOR LEVEL CONTROL
- STEAM GENERATOR LEVEL TRENDS
- STEAM GENERATOR LEVEL MANUAL CONTROL
- EXTRACTION STEAM
- TURBINE GENERATOR
- UPR
- FAIL CLOSED ALL FEEDWATER LCVs & MVs
- TURBINE SPURIOUS TRIP
- FEEDWATER LCV101 FAILS OPEN
- FEEDWATER LCV101 FAILS CLOSED
- ALL MAIN BFPs TRIP
- THROTTLE PT FAILS LOW

3.5 DAY 5 COURSE PLAN

SPECIAL SAFETY SYSTEMS

- SHUTDOWN SYSTEM REQUIREMENTS (Ref. Text: 6-2 to 6-6)
- SHUTDOWN SYSTEM NUMBER 1 (Ref. Text: 6-7 to 6-15)
- SHUTDOWN SYSTEM NUMBER 2 (Ref. Text: 6-15 to 6-26)
- EMERGENCY CORE COOLING SYSTEMS (Ref. Text: 6-26 to 6-31)
- CONTAINMENT SYSTEM (Ref. Text: 6-32 to 6-35)

SIMULATOR

- REACTOR TRIP AND RECOVERY
- ALL ASRVs FAIL OPEN
- RIH#1 SMALL BREAK
- 100% MAIN STEAM HEADER BREAK
- REACTOR SETBACK/STEPBACK BOTH FAIL
- LOSS OF CLASS IV POWER
- EVENT DIAGNOSIS