NUCLEAR TRAINING DEPARTMENT

COURSE 41001

INTRODUCTION TO CANDU PROCESSES

FOR ONTARIO HYDRO USE ONLY

R1 - 93.09.15

INTERIM APPROVAL FOR USE AT WNTD			
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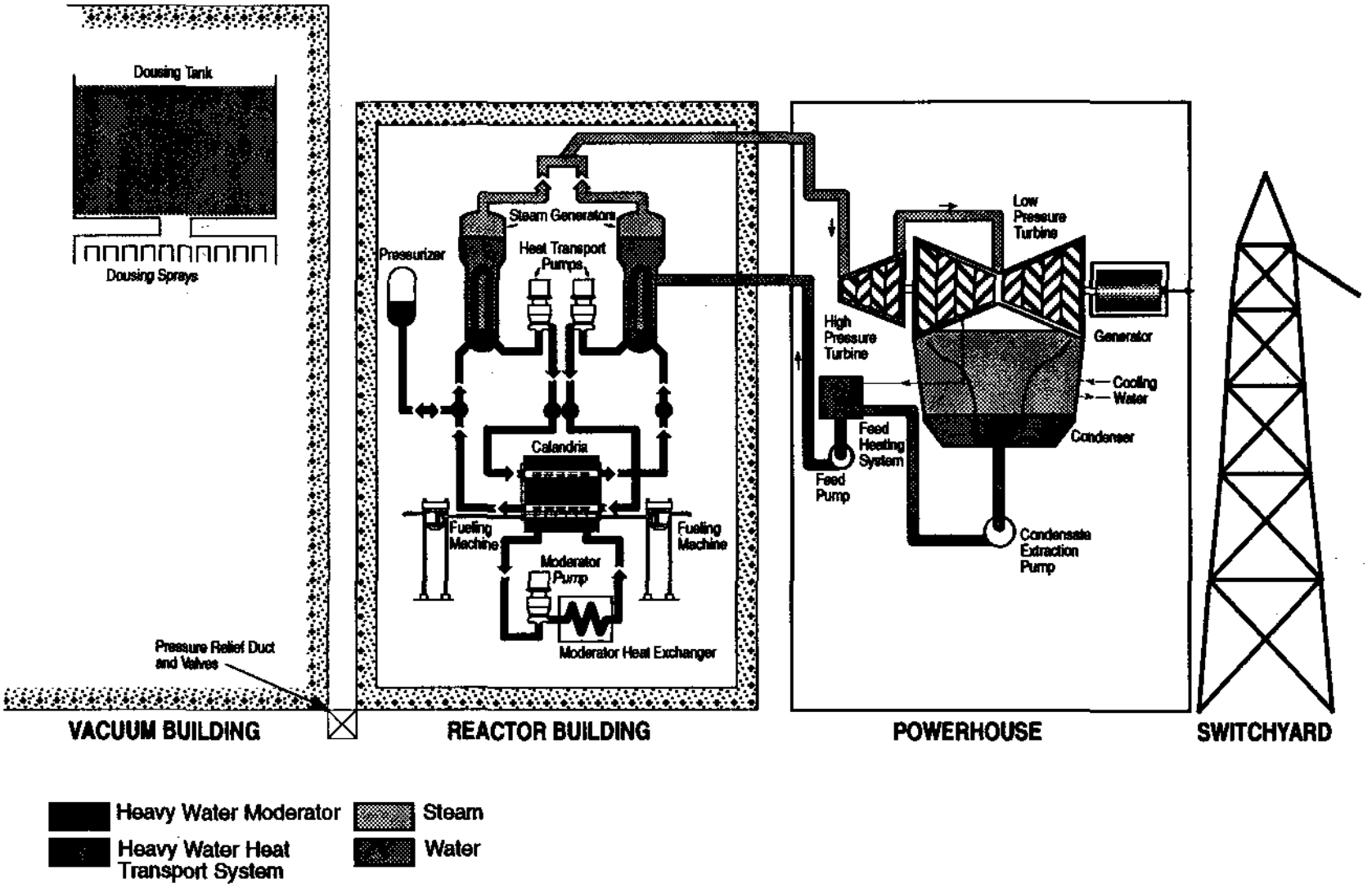
Nuclear Generating Unit Schematic

CANDU Pressurized Heavy Water Reactor



PREFACE

This course will prepare you to use and understand the terminology and concepts of the CANDU Power Station. The course invites new staff to support Hydro's primary goal of providing abundant, competitively priced, safe and clean electrical and heat energy to Ontario's people and industries.

After the course, you will be able to convey the following ideas to your colleagues, families and friends:

- CANDU Reactors are a Canadian invention, with construction and operation of commercial reactors pioneered by Ontario Hydro early on in the history of worldwide nuclear power generation.
- Ontario Hydro is the major user of CANDU technology, deriving over half the province's power from these systems. CANDUs are also operating in Quebec and New Brunswick, and have been purchased by five other countries.
- The CANDU design, using heavy water for cooling and moderation, differs significantly from reactors such as those used in the USA and most other nations.
- The CANDU design is *more* expensive to build and refurbish but provides safer and *less* expensive operation because it uses natural Uranium and has on-power refueling capability.
- The use of a heavy water moderator to sustain a nuclear reaction makes the precise geometry of the reactor vital to continuing the reaction. Any serious damage to the reactor core stops the nuclear reaction.
- Ontario Hydro's Nuclear Operations Branch (NOB) has developed an organizational structure intent on supporting an Operating Philosophy based on staff and public safety as well as reliable and economic power generation.

In summary, CANDU remains a valid, modern technology, based on its inherent economy of operation, safety and reliability.

REVISION SUMMARY

R1 93.09.15

- table of contents added
- course pages renumbered sequentially
- minor changes/additions throughout to clarify/correct text and correction of typos in response to comments received from EAST class in June 1993, from ENTD, and from WNTD instructor
- major rewrite of Module 1 section E to reflect reorganisation of Nuclear during summer of 1993

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INTRODUCTION

BRIEF HISTORY OF CANDU

The CANadian Deuterium Uranium (CANDU) reactor, a product of Atomic Energy of Canada Limited (AECL), is a Canadian invention that evolved from war-time experimentation at the Chalk River Nuclear Laboratories northwest of Ottawa. Commercial construction and operation of CANDU reactors was pioneered by Ontario Hydro in the early 1960s. The CANDU design, using heavy water for cooling and moderation, differs significantly from reactors used in the United States and many other countries. It is more expensive to build, but its use of natural uranium and on-power fuelling make it less expensive to operate. Its heavy water moderator and reactor core geometry also make it inherently fail-safe.

CANDU reactors have been purchased by a number of utilities apart from Ontario Hydro. CANDU reactors are currently operating in Quebec, New Brunswick, India, Pakistan, Argentina and Korea, and several reactors are under construction in Romania. The Indian programme has been the most extensive, starting with an early partnership with AECL and later Ontario Hydro that led to the commissioning of a CANDU reactor in 1972, and culminating in recent years with an independent CANDU programme of significant proportions.

CANDU is one of many reactor designs in use throughout the world. The predominant design in use in the United States and many other countries is the pressurized light water reactor. Other designs include boiling water reactors and graphite moderated reactors (gas cooled designs in Britain, water cooled in the former Soviet Union). More information on reactor designs is provided in an Appendix to this course.

ADMINISTRATION

COURSE OBJECTIVE

This is intended to be the first course in the initial technical training programme for new hires. The **overall objective** of the course is:

to familiarise new employees with the basic terminology and concepts associated with the Nuclear Business with the intent of fostering better understanding and more effective communication within and between work groups.

This is achieved by introducing the function, operation and interactions of the CANDU station and processes associated with CANDU. At the same time this course will also introduce you to:

the technology of CANDU and the importance of economical, reliable operation;

the general process hazards and conditions;

the importance of various CANDU safety concepts and environmental concerns.

The course will enable you to represent CANDU technology knowledgeably to the public.

AUDIENCE

This course is intended for new employees in the following major job families within the Nuclear Business:

Operators,
Mechanical Maintainers,
Control Technicians,
Chemical Technicians,
Civil Maintainers,
Management and Professional Technical Staff.

It is also suitable for anyone requiring a basic introduction to CANDU. To have the maximum effect, the course should be delivered to trainees soon after they have been hired. Staff who have been working at a Nuclear Station for more than one year will gain little from this course.

PROGRAMME STANDARD

The **overall objective** for the course is provided above. In addition, each module of the course is introduced by a **module objective**. These

objectives serve to highlight the general intent of each level of the course. The module objectives are in turn supported by **enabling objectives** which focus on the material to be learned in each section. The checkout is based entirely on the enabling objectives. Often the course text will delve deeper into a topic than is required to meet these objectives. This is intended to provide background and context, **but remember you will only be tested on the enabling objectives.**

In this and subsequent courses, you are required to achieve a mark of at least **80% on the course checkout.**

COURSE STRUCTURE

The course begins with an introduction to the operating philosophy of the Nuclear Business, followed by an examination of the reactor and turbine sides of the CANDU station. The two sides are tied together by a short module on overall unit control. A final module addresses both those systems with a major support role within the station, and other important systems and processes outside the stations (such as heavy water production). Course delivery is spread over a period of seven days including time for structured review and a checkout on the last afternoon.

Each of the modules in the course has been laid out in a common format with a common way of highlighting information to make it easier for you to absorb. Each module begins with a brief introduction that includes the module objective (see above). The module objective lists a number of key points that will be covered. These are lettered A, B, C, etc. and these letters conform to the major sections of the module. Each major section begins with a list of enabling objectives (see above). The text that follows will cover off the objectives in order, but there is no explicit tie back to the enabling objective. A number of subtitles are used within each section to break the material down further in a logical fashion. The **MAJOR SUBTITLE** is in bold capitals and underlined. The **NEXT LEVEL OF SUBTITLE** is in bold capitals. Being aware of this convention will help you to understand the structure of the material. Other conventions to be aware of are the use of:

- **bullets** (• **a key point**) to highlight lists of key points of information;
- **bold** type to highlight the first occurence of a **significant new term**, or a particularly **important piece of information**;
- **footnotes** to provide related information that does not fit in the flow of the text and is not required to satisfy an enabling objective.

Assignment questions are generally provided at the end of a major section of a module. These are not marked. They are provided to help you check your understanding of the information required to satisfy the enabling

objectives. Please take the time to answer the assignment questions as you work through the material. It will pay off in preparing you for the final checkout.

LOOKING FORWARD

Upon completion of this course, further technical courses will be provided in the areas of science fundamentals and equipment principles specifically related to the job functions of the trainee.[1] In addition to the technical courses, all trainees will receive training in the following subjects:

- general safety;
- fire protection;
- emergency first aid;
- initial radiation protection;
- information management.

[1] For M&P staff, these courses may be delayed by a work experience assignment at a nuclear facility of up to 10 months.