## C. UNIT OPERATIONAL CONTROL

**ENABLING OBJECTIVE:**

4.7 Explain why automatic control of a nuclear generating station is necessary.

In a complex plant, such as a nuclear generating station, a very extensive information handling and control system is required for optimum plant control. In this section we will consider the methods used to control a typical CANDU nuclear generating station.

Under steady state operating conditions, the heat output from the reactor must be matched by the electrical output of the generator and any losses that may have occurred in the system. This energy balance is the result of many interacting processes. An upset in any portion of the system could adversely affect all or many of the other systems in the overall plant control scheme. For instance, if the level of water in the boilers was allowed to fall too low, this would affect the Heat Transport System (HTS). The boilers could no longer extract the required amount of heat from the HTS. The effect on the HTS would in turn affect the reactor.

To attempt to control these processes manually is not feasible due to the number of persons required and the quality of control that must be achieved. Automatic control is therefore vital in the running of a nuclear generating station. Operation of the station in a wholly manual mode is not allowed.

Digital computers are used to perform most of the control and monitoring functions of the station and replace much of the conventional panel instrumentation in the control room. (It should be noted, however, that a number of systems make use of controllers for automatic control. To maintain **independence**, the special safety systems in particular are not allowed to use the station computers.) A number of man-machine communication stations, each essentially comprising a keyboard and color CRT monitors, are located on the main control room panels. The displays provided include:

- graphic trends,
- bar charts,
- status displays,
- pictorial displays,
- historical trends.

Copies can be obtained, from the line printers, of any CRT display the operator wishes to record. Certain information is collected routinely in this way every shift and passed on to appropriate work groups in the plant for analysis of station performance.

## OPERATOR/COMPUTER INTERFACE

The Unit Control Computer System was not designed to be a stand alone master brain that could handle all possible situations without intervention of an operator. Major set points, like the unit operating level, are decided by the operator. Also, in many cases, options for manual control are incorporated into the system to allow the operator to intervene during major upsets, equipment failure or computer malfunction.

The operator interface was designed to provide two way communications between the operator and the computer system. The computer provides sufficient information in an appropriate form (easily understandable, meaningful, correct) to the operator to assist in decision making. The computer provides information about field processes, equipment operation, abnormal conditions, computer malfunctions, etc., in the form of displays on the monitor, alarms, or printed logs. The operator can enter information, requests, or instructions to the computer using keyboards and switches. Figure 4.3 shows the computer control process.

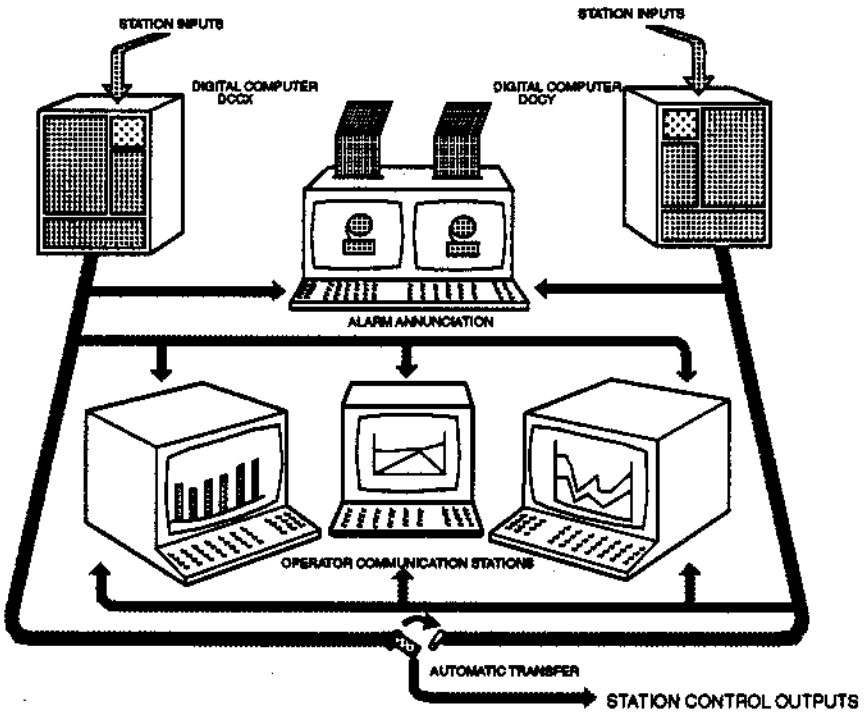


Figure 4.3
Computer Control Process

There are two almost identical Station Control Computers for each operating unit. Either of the two computers can be in control of plant equipment. One of the two computers is designated as the Master and the other as Standby. Output from both computers is connected to field devices (valves, motor starters, etc.) through relays. The system is designed to:

- handle both normal and abnormal situations,
- control the unit automatically at startup and at any preselected power level within the normal loading range,
- shut down the unit automatically if unsafe conditions arise,
- be tolerant of instrumentation failures.

The reliability of the control computer directly affects plant operating costs because if the plant must be shutdown as a result of a failure, revenue will be lost. In principle, any degree of hardware reliability can be achieved by redundancy, but redundancy increases costs so a compromise must be found between the capital cost and the reliability of the system.

## ASSIGNMENT

1. Why is it not possible to allow manual control of a CANDU generating station?