PI 30.20-1

Electrical Equipment - Course PI 30.2

THE CANDU GENERATING STATION

OBJECTIVES

On completion of this module the student will be able to:

1. Define, in a few sentences, the four classes of power used in a CANDU generation station and list at least two typical loads served from each class of power.

2. Describe, in a few sentences, the normal and the emergency supply for each class of power.

1. Introduction:

This lesson takes a simplified look at a CANDU nuclear generating station and introduces the student to the following.

(a) Main components and their purpose in a CANDU system.

(b) Classes of power in a CANDU nuclear generation station.

2. Main Components and their Purpose:

The pull-out diagram, at the end of this module shows a simplified CANDU generation station.

2.1.1 Reactor: Provides heat from nuclear reaction.

2.1.2 Fuelling Machine: Removes expended fuel bundles from the reactor and replaces them with fresh fuel bundles.

2.1.3 Heat Transport Pump: Circulates heavy water (D_2O) between the reactor and the steam generator. The circulation of D_2O transfers the heat produced in the reactor to the steam generator.

2.1.4 Steam Generator: Takes the heat from the coolant D_2O and converts the light water into steam. This steam is then supplied to the turbine.

2.1.5 Turbine: Converts the energy in the steam into mechanical energy.

2.1.6 Generator: Converts the mechanical energy provided by the turbine into electrical energy.

2.1.7 Main Transformer: Applies the generator output to the Ontario Hydro grid. It steps up the voltage from 24kV at Pickering, for example (18.5kV at Bruce) to 230kV and reduces the current.

2.1.8 Ontario Hydro Grid: The grid can be considered as a pool of electricity. All The generators in the system feed their power into the grid. It is a massive system of transmission lines which operate at 230kV and carry electrical power all over Ontario. Customers, via an appropriate transformation line, can draw power from the grid.

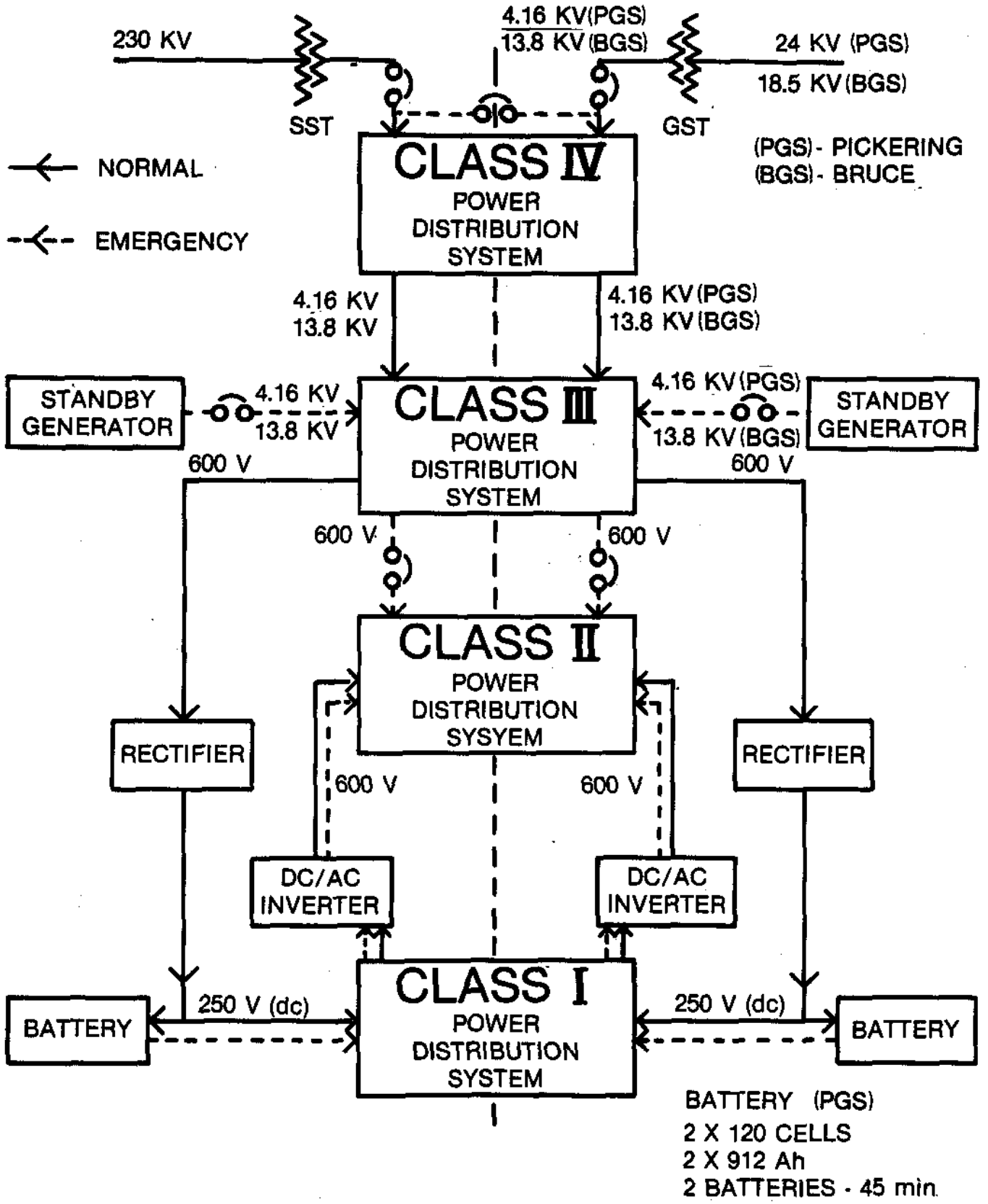
2.1.9 Unit Services Transformer (UST):

A unit is one complete system containing a reactor, turbine, generator and auxiliaries. Power required to operate this system is drawn,from the generator of that unit, by a unit services transformer, called UST. The UST is a step down type of transformer, whose ratings vary from station to station.

2.1.10 System Services Transformer (SST):

If the generator is not operating, some systems must still keep running. The power to run these systems comes from the grid, by means of a system services transformer, SST. This is a step-down type of transformer, whose ratings vary from station to station.

3. Classes of Power and Typical Loads:



3. Classes of Power and Typical Loads:

Personnel and plant safety are of the utmost importance in a CANDU design. To ensure a safe and proper operation of the system, station power supplies are divided into four classes, as discussed below.

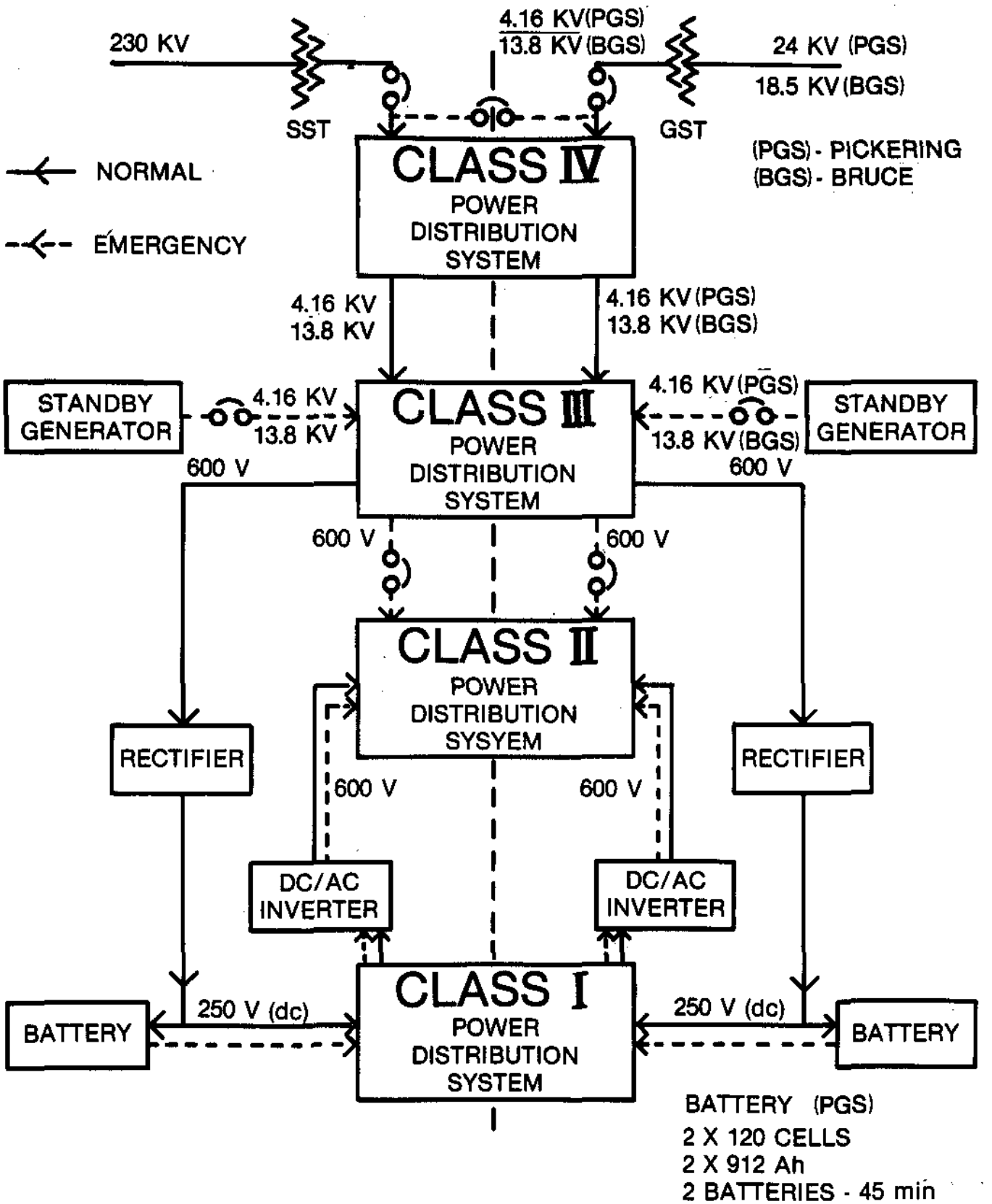
(a) Class IV power: Class IV power/loads can be interrupted **indefinitely** without affecting personnel or plant safety. Typical loads on a class IV system are: normal lighting, and primary heat transport pump motor.

(b) Class III power: Class III power/loads can be interrupted for **one to three minutes** without affecting the safety of personnel or of the plant. Typical loads on a class III system are: moderator main circulation pump motor, the motor driving the pressurizing feed pump in the feed and bleed system.

(c) Class II power: Class II power/loads can be interrupted for **0.25 seconds** without affecting the safety of personnel or the station. Typical loads on a class II system are: digital control computors, reactor safety systems.

(d) Class I power: Class I power/loads can **never** be interrupted without affecting the safety of the personnel or the plant. Typical loads on a class I system are: protective relaying, circuit breaker control, turbine lube oil emergency pump motors, emergency seal oil pump motors, emergency stator conductor water cooling system pump motor.

3.1 Normal and Emergency Sources:



3.1 Normal and Emergency Sources:

What load will be powered by what class of power is determined by its importance. Each power class has a normal power source and an emergency power source which takes over once the normal source is not available. Refer to the figure shown on the left.

(a) Class IV power: Half of the load is carried by the unit services transformer (UST) and the other half of the load is carried by the system services transformer (SST). However if the UST fails, the SST will supply 100% power from the grid. In this manner, the Ontario Hydro grid also serves as an emergency power supply for the class IV system. Other modes of supplying power to class IV systems are used depending on which Nuclear Station is being considered.

(b) Class III Power: Normally, class III power is supplied from the two class IV sources. Should the UST and the SST both fail, then the standby diesel generators or gas turbines automatically turn on and begin picking up the load, sequentially. This whole process would take less than three minutes.

(c) Class II power: Class II power is normally fed from class I, via an inverter, which changes dc to ac. The "inverter" at Pickering NGS is a dc motor which drives an ac generator. The inverter at Bruce NGS is a static (electronic) device. At either station, if the normal class I supply fails, class II power is supplied from the battery banks until the standby generators in class III are operating.

(d) Class I power: Class I is normally obtained from class III, via a battery charger (rectifier). Should the battery charger or the class III supply fail, then the class I is obtained from a battery bank, which is always maintained in its fully charged state by a battery charger. Class I power is generally 250V dc.

3.2 Load Distribution

For reliability reasons each class of power is split into two separate circuits. Each circuit draws the power from an independent source. This is shown in the diagram on the left by a dotted line dividing the diagram into two halves. Total load can be transferred from one to the other circuit.

ASSIGNMENT

1. In the basic CANDU diagram shown on the pull-out sketch, label and briefly explain the purpose of each component. (Section 2).

2. Define the four classes of power as used in the CANDU system and give two examples of a typical load on each class of power. (Section 3).

3. What is the normal and emergency supply, for each class of power. (Section 3).

S. Rizvi

NOTES

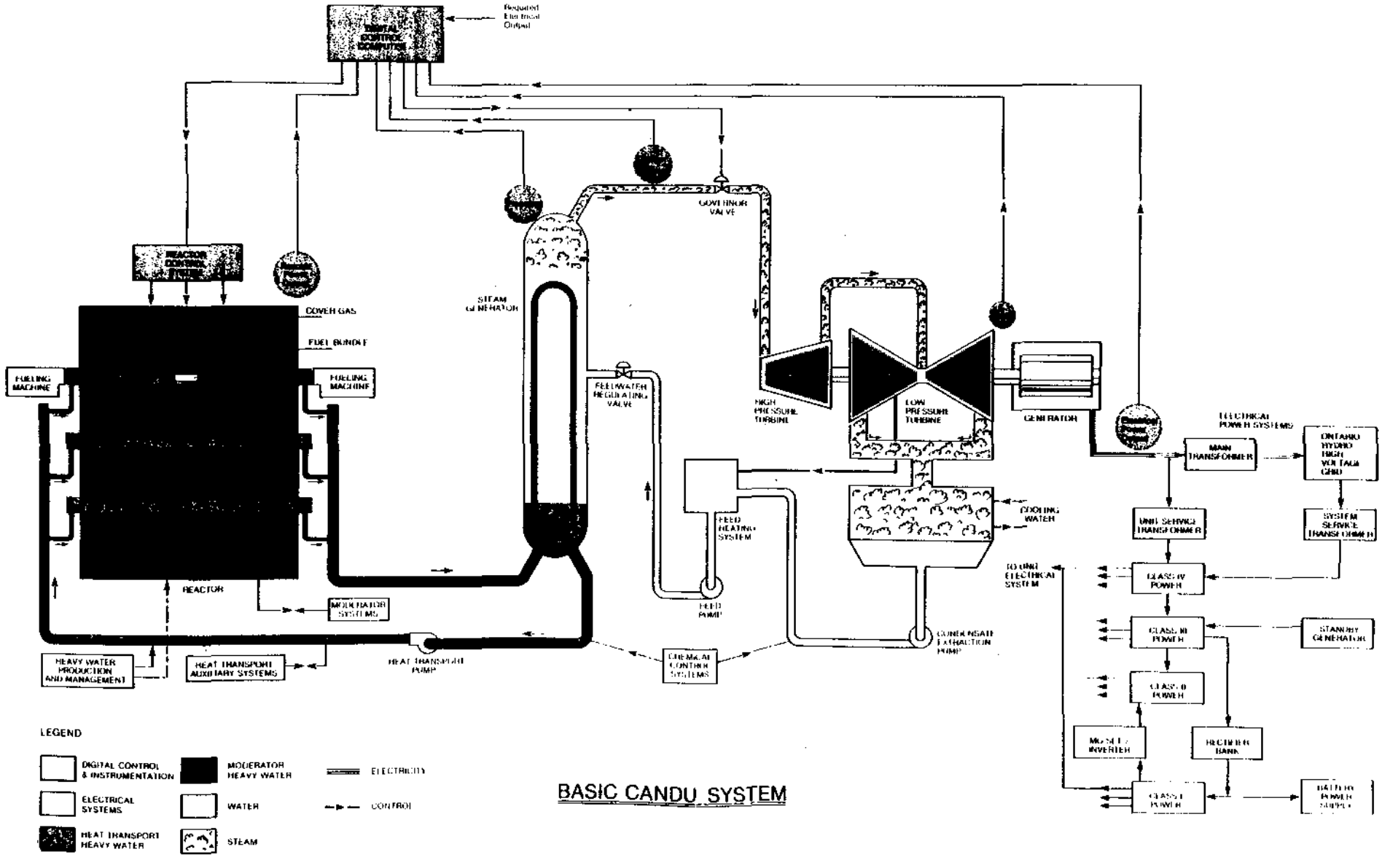
REACTOR AND AUXILIARIES
30,000

INSTRUMENTATION AND CONTROL
60,000

STEAM GENERATOR

TURBINE GENERATOR AND AUXILIARIES
40,000

ELECTRICAL POWER SYSTEMS
50,000



BASIC CANDU SYSTEM