Chapter 7

PROGRAM CBS: MCA CONTROL

7.1 MCA

There are four Mechanical Control Absorbers (MCA) for regulation purposes. These rods are cylinders of cadmium sandwiched between two stainless steel layers. The cadmium is a very strong absorber of thermal neutrons. These rods are thus highly absorbing, and are used to control mostly extreme conditions, for example when power error is very large, or when LZC levels are very high. They will also be used, via reactor stepback, to eliminate certain states of the core which would eventually lead to activation of one of the shutdown systems.

The adjusters are normally out of core. A pierced zircalloy guide tube is used to direct them on their vertical course. A motor and pulley system are used to control the position and speed of each individual MCA. If a reactor stepback occurs, a clutch system disengages and let the four MCA's rapidly fall under gravity into the core. This movement is not spring assisted as is the case for the twenty eight shutoff rods of SDS1.

The four MCA are grouped in two banks by RRS. Each bank contains two MCA's. The assignation of MCA's to the banks is shown on Table 1. Note that during a reactor stepback, the four MCA's move together, and banks are irrelevant in this case.

7.2 SLOW AND FAST PART

CBS is composed of a slow part and of a fast part. The slow part, executed every two seconds, performs only the end of course checks. All the rest of CBS is executed at the fast rate, each half second.

7.3 END OF COURSE TEST

CBS determines if each MCA has reached an end of course position, either fully inserted, or full extracted. If the end of course electrical contacts are not in agreement with the position readings, an alarm is sent to the control room.

7.4 FORCED INSERTION AND EXTRACTION INHIBITED

The insertion of the four MCA's will be ordered via reactor stepback if any of the shutdown systems is activated. Furthermore, if either one of SDS1 or SDS2 is not armed, the extraction of the MCA's will be inhibited.

7.5 CONTROL RULES

In the same general way as CBC, the power error, ERPU, and the NMBL are used to determine the desired movement of the MCA's. The operation point, formed by the couple(ERPU,NMBL) is placed on the control rules diagram of the MCA's, shown on Figure 7.1. Depending on the position of the operation point, insertion or extraction of one or two banks could be performed.

7.6 DISPLACEMENT SPEED

The displacement speed of the MCA's depends on the power error ERPU, and is obtained from the graph of Figure 7.2. This is actually identical to the adjuster speed calculation.

7.7 INSERTION/EXTRACTION SEQUENCE

If the insertion command is given, CBS verifies that at least one rod of bank 1 is available for insertion; if this is the case, bank 1 is then inserted. If there is no rod available in bank one, CBS determines if there is an available MCA in bank 2; if this is the case, bank 2 is then inserted.

If extraction is chosen by the control rules, the extraction sequence starts form bank 2, and then bank 1, according to rod availability. The extraction sequence is thus the reverse of the insertion sequence.

Bank	MCA belonging to Bank
1	1,4
2	2,3

Table 1: MCA Banks Assignments.

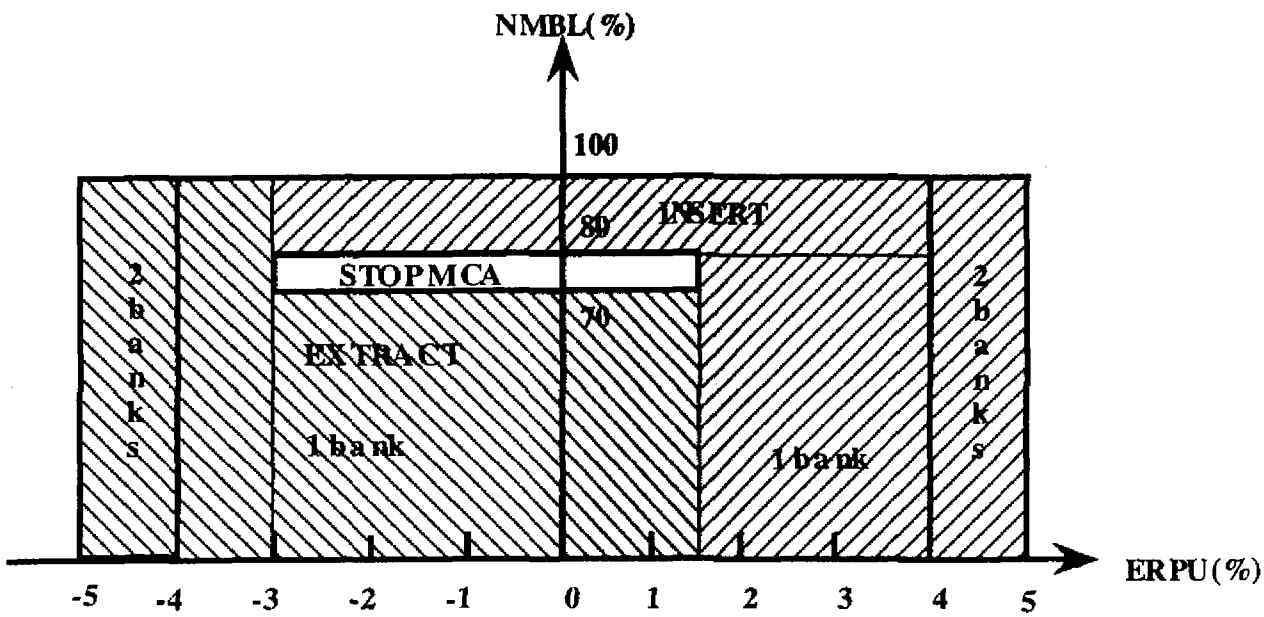

Figure 7.1: MCA Control Rules

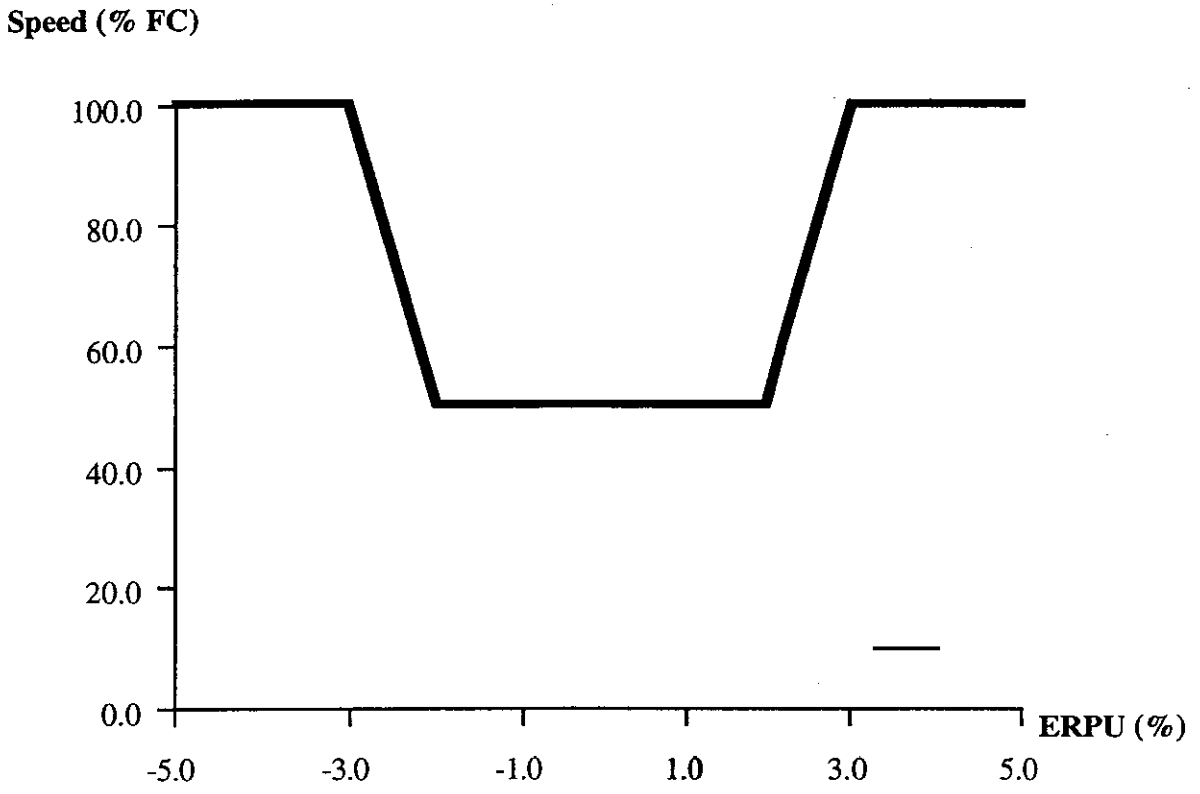

Figure 7.2: MCA Speed Calculation