CHAPTER 5: REACTOR CONTROL AND PROTECTION

MODULE 4: RECOVERY FROM A POISON OUTAGE

Override Time

If the reactor is tripped after establishing the equilibrium xenon level, there will no longer be any excess of neutrons available to "burn off" the Xe-135. Xe-135 production (5%) as a fission product has stopped but the decay of I-135 continues to produce Xe-135 (95%). The xenon level rises rapidly following a trip until the transient peaks due to I-135 depletion, and then the xenon starts to decay. Unless sufficient extra reactivity is available to overcome the negative reactivity of this poison, the reactor cannot be restarted until the xenon level decreases sufficiently. The reactor is said to be poisoned out in such a condition.

The interval from reactor shutdown until the xenon level rises to match the extra reactivity available is called the override time. If the override time elapses before the system can be returned to normal, then the reactor will be poisoned out. A typical override time of 40 minutes would consist of:

25 minutes	- diagnose and clear trip
11 minutes	- regain criticality
4 minutes	- raise power level to 60 - 70% FP
40 minutes	- override time

Xenon Transient

- From Figure 1 it can be seen that if the reactor was tripped, the Xe-135 level will peak in approximately ten hours and then gradually reduce.
- Beyond point A, it is only the override reactivity of inserted adjuster rods that prevents the reactor from becoming critical.
- If it is desired to delay the return to criticality beyond point B, it will be necessary to poison the moderator with boron and achieve criticality, when desired, by boron removal.

Assume that it is near the end of a poison outage (approaching Point A). The reactor conditions at this time would have the adjuster rods inserted. The natural approach to criticality can be expedited by manipulating the adjuster rods and zone levels.

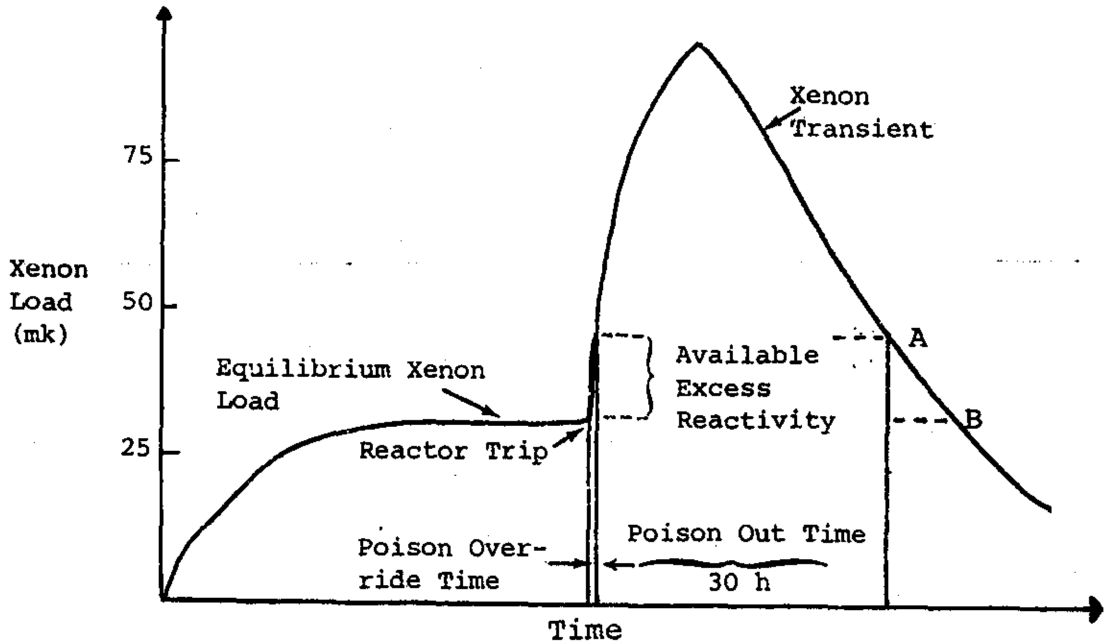

Figure 1: Xenon Load Following a Reactor Trip.

Approach to Critical Following a Poison Outage

The power error could be displayed on DCC1 with the average zone level on DCC2. A "Hold Power" command would be entered by the operator before the first bank of adjusters is driven out of core (following the prescribed sequence). The RRS will respond by increasing zone levels in an attempt to satisfy the "Hold Power" request. It should be noted that the Xe-135 load is decreasing at a rate of approximately 2.5 mk/hour.

When the zone levels approach 70%, the adjusters out drive will be stopped by the operator, allowing the zone levels to stabilize. The reactor power should be noted at this time (expected to be in the order of 2.6E-4).

The entry of a raise power command will cause the zone levels to drop. The zone level decrease can be terminated around 25% by entering another "Hold Power" command. The new power level should be noted (say 2.9E-4) and compared to the last power reading.

The operator would be looking for a doubling of power for a given change in zone level. Once the power has doubled for a given change in zone level, the reactor will go critical for a subsequent, similar change in level (power doubling rule).

In this fashion, the adjusters are pulled to allow the zone levels to respond and rise while a "Hold Power" is in effect. The zone levels are then dropped with a "Raise Power" command. The RRS will initiate a "Hold Power" command once the power doubles the first time. The operator can now approach criticality in half steps of zone level changes. Such an approach will result in the zone level changes approximating a "Squared" quarter decay curve.

The reactor would now be critical and power could be increased on the log range once the post-criticality check list requirements are satisfied.