

On the Issue of Initial Disablement Activities at a Reactor

Given the complexity of reactors, there are many different types of activities that could be taken to disable such a plant from further operation. Some types of disablement functions are more permanent than others, some could have significant safety and environmental remediation considerations, and some disablement functions could have severe impacts on the ability verify past operations of the plant. Therefore, any disablement function should be very carefully weighed against these types of concerns.

From the standpoint of disablement, we recommend a series of activities that would be phased with the appropriate verification and nuclear forensics activities. It is also important to note that, in the zeal to “permanently disable” the plant, verification and forensics activities should be preserved wherever possible. Verification will be important in order to determine past operations at the facility, and could be key in determining the total amount of plutonium produced in the fuel rods. Each disablement activity in the phased approach would be successively more severe and more permanent or irreversible (i.e., would require the facility operators to do more to recover to full plant operation).

The recommendation for initial disablement of the reactor is to ***disable the control rods in the reactor pile***. Before we proceed further, however, a short digression on the issue of control rods seems appropriate.

Reactors operate on the premise of controlled nuclear chain reactions. In a chain reaction, neutrons produced from a given fission event induce fissions in other fissile nuclei; the neutrons from these fissions may then induce fissions in still other fissile nuclei; and so on and so on. The control rods in the reactor serve to “control” the chain reaction by absorbing neutrons within the reactor and preventing them from causing additional fissions. The reactor operator can then control the reactor by selectively removing or replacing one or more of the control rods within the reactor. The control rods allow the operator to control the power output of the reactor, the power shape of the reactor across the core, or optimize the plutonium production by the reactor. When all of the control rods are fully within the core, there is, generally speaking, sufficient neutron absorption present (due to the control rods) to prevent the chain reaction from continuing (or occurring). This is, in fact, one way that reactors are shut down, by placing all of the control rods back into the reactor pile.

Generally speaking, there are many control rods in a reactor spread throughout the core. These control rods can be operated independently or semi-independently in banks or group of rods. When the operator shuts down the reactor, he places all of the control rods back into the reactor pile. One way to prevent the operator from turning the reactor back on, therefore, would be to prevent the operator from being able to remove the control rods from the reactor pile.

How might one do this? As just discussed, the control rods are movable and can be partially or completely removed from the core. As such, there is a drive mechanism that controls the placement and movement of the control rods back and forth in the core. Although the specific technical aspects of the drive mechanism are reactor-dependent, such a drive mechanism might typically consist of a set of motors, winches, pulleys, and chains. Therefore, once the control rods are fully inserted in the core and the reactor is safely shut down, one could disable this drive mechanism to prevent the operator from removing the control rods. The simplest way to do this might be to detach or “cut” the

drive chains from the control rods. Without the control rods being connected to the motors, they cannot be removed from the core. And, if the control rods cannot be removed from the core, the reactor cannot be restarted.

One could argue, of course, that all the operator would have to do to recover from this disablement activity is reattach the control rods to the drive mechanism. This is indeed true, but it is not necessarily a simple operation. The operator might actually need to climb down onto the reactor pile to reconnect the drive chains or even, perhaps, fish the rods out of the pile in order to reattach them to the drive mechanism. Although this could be done, it is certainly not a simple task, and would definitely be an unsafe (unhealthy) task for the unfortunate person required to do it. Additional measures in this same vein that would require even more recovery activity would be to remove additional parts of the control rod drive mechanisms. For example, the motors and other components of the drive mechanism could be removed.

Again, this is not a permanent or irreversible activity, but it is a tangible activity on the part of the operator and would require a reasonable amount of effort from which to recover plant operation.

Down the road, after some preliminary assessments and aspects of the verification process have been performed, additional disablement functions could be employed. For example, one could disable or destroy the secondary cooling discharge outlet (eg, the cooling tower nearby the reactor building), or disable/remove/destroy the fuel rod handling machine. After verification and nuclear forensics are complete, one could then completely dismantle or permanently entomb the reactor pile. Again, as the process proceeds, each action becomes successively more and more “permanent” leading towards complete and irreversible disablement of the plant.