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AMS Fact Sheet: Control Rod Drive Mechanism Timing and Sequencing Tests

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A Pressurized Water Reactor (PWR) is equipped with control and shutdown rods which are inserted into and withdrawn from the reactor core to control the power level in the reactor. The Control Rod Drive Mechanisms (CRDMs) are magnetically coupled positioning units that are used to raise or lower the control and shutdown rods under manual or automatic control. Each CRDM is designed so that in the event of a reactor trip, the withdrawn control and shutdown rod will fall into the reactor core to shut down the nuclear reaction.

CRDM timing and sequencing tests are performed periodically in PWRs to ensure that the rod motion (CRDM timing) function of the rod control system is operating properly. Each CRDM consists of three electromagnetic assemblies and two grippers as follows:

Stationary Gripper

The stationary gripper consists of three latches which are located 120 degrees apart around the control rod drive shaft and an associated electromagnetic coil located outside the control rod drive housing. When the stationary gripper coil is energized, the stationary gripper latches extend into grooves machined on the drive shaft to hold the control rod in place. Under normal operating conditions, the stationary gripper is the only latch holding the rod in place. If power is removed from the stationary gripper coils and the movable gripper coils described below, the rods will fall into the reactor under the force of gravity.

Movable Gripper

The movable gripper (like the stationary gripper) also consists of three latches and a coil. When the movable gripper coil is energized, the latches extend into the grooves on the rod drive shaft. The difference between the stationary and movable grippers (as the names imply) is that the movable gripper can be moved up or down one step when the lift coil is energized or de-energized, respectively.

Lift Coil

The lift coil, when energized, causes the movable gripper to move up one step. If the movable gripper is energized when power is applied to the lift coil, the control rod drive shaft will move up one step with the movable gripper.

When power to the three coils is properly sequenced, a control or shutdown rod can be withdrawn from or inserted into the core one step at a time with reduced risk of dropping the rod or rod binding/sticking.

Test points with shunt resistors are provided in the rod control power cabinets to monitor the current flow to each CRDM coil. The CRDM tests are performed by connecting the AMS data acquisition system to these test points and recording the current levels to the coils while the rod is inserted or withdrawn from the reactor as illustrated in Figure 1. Data is acquired from up to one bank of rods at a time, although the AMS test equipment is connected to all power cabinets at one time to reduce the time needed to perform the work. The analysis of the CRDM data is performed automatically using the AMS test equipment and involves identifying the time differences between the various stepping events to determine whether or not the CRDM is functioning properly.

A normal set of CRDM tests using the AMS test equipment can take as little as 20 minutes to complete.

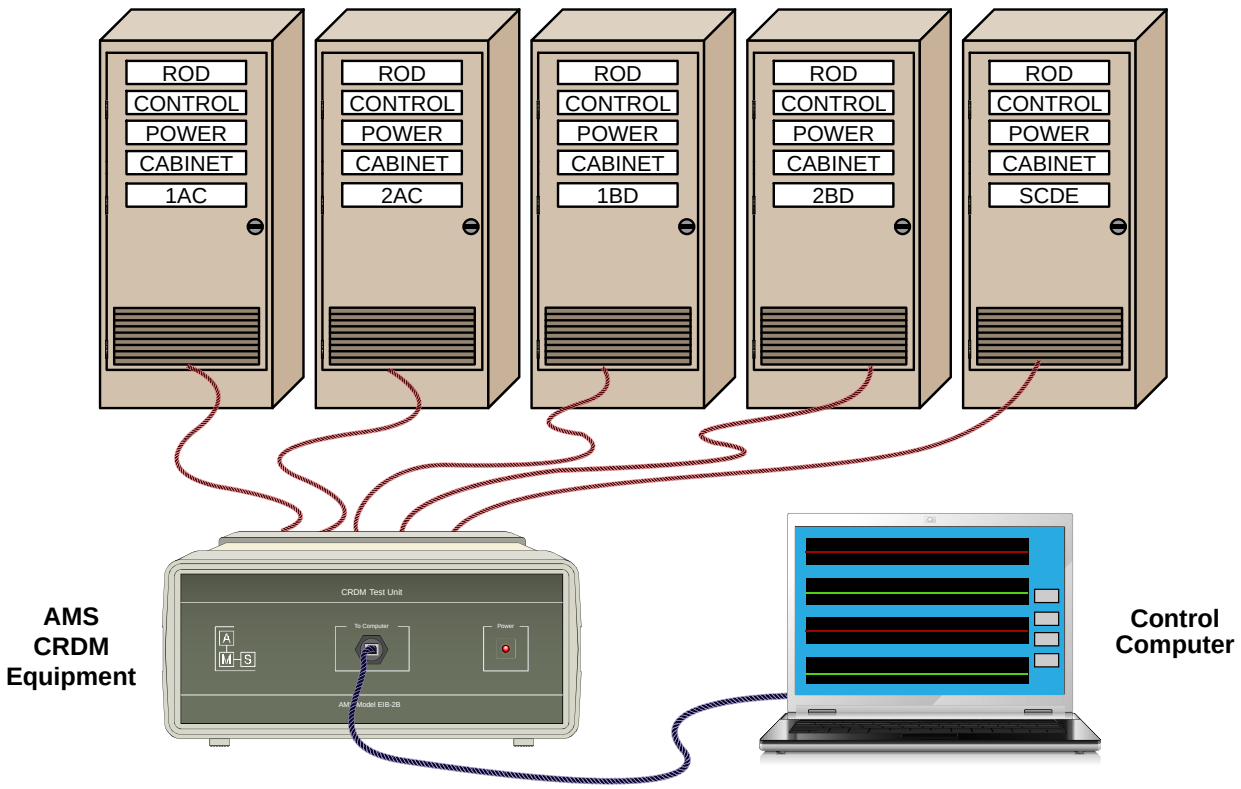

Figure 1. AMS CRDM Test Equipment Configuration