

AUTOMATED ROD MOVEMENT TIMING & SEQUENCING TESTING

For Control Rod Drive Mechanism (CRDM) Systems



Timing and sequencing testing of Control Rod Drive Mechanisms (CRDMs) in Pressurized Water Reactors (PWRs) is performed by monitoring the stationary gripper, moveable gripper, and lift coil currents of a group of control or shutdown rods as they are moved in or out of the reactor. This test is normally performed in Westinghouse PWRs near the end of a refueling outage. The outputs of these coils are sampled for each rod and analyzed to ensure proper communication, regulation, and timing of the CRDMs. The CRDM test is often performed in conjunction with rod drop time measurements and slave cycler timing tests.

Automated Report of Results with Outlier Flagging

| | | Stationary Coils | | | | | |
|------|--------|------------------|--------|--------|--------|--------|-------|
| ltem | Rod ID | T1-T0: | T2-T0: | T3-T0: | T4-T0: | TL-T2: | Tsgd: |
| 1 | H06 | 271 | 575 | 771 | 1264 | 95 | -12 |
| 2 | H10 | 272 | 574 | 772 | 1262 | 109 | 6 |
| 3 | F08 | 270 | 575 | 770 | 1267 | 118 | 11 |
| 4 | K08 | 276 | 576 | 776 | 1265 | 116 | 10 |
| 5 | F02 | 271 | 575 | 771 | 1270 | 119 | 12 |
| 6 | **B10 | 277 | 577 | 777 | 1272 | **149 | 44 |
| 7 | K14 | 271 | 575 | 771 | 1267 | 125 | 18 |
| 8 | P06 | 270 | 574 | 770 | 1270 | 125 | 17 |
| 9 | **B06 | 272 | 573 | 772 | 1285 | **127 | 22 |
| 10 | **F14 | 271 | 575 | 771 | 1262 | **130 | 23 |

50 40 30 20 10 Time Results (sec) T1 - T0: T2 - T0: T3 - T0: T4 - T1: TL - T1: LC Amps 0.319 0.496 0.652 0.899 Time Results (sec) 8 6 MG Ampa T1 - T0: 0.091 T2 - T0: 0.591 T3 - T1: 0.898 TL - T1: **0.439 4 0 2 L Time Results (sec) T1 - T0: T2 - T0: T3 - T0: 0.223 SG Amps 0.466 0.778 T4 - T0: TL - T2: 0.897 0.025 . Tsgd: 0. 0.3 0.5 0.7 0.9 1.1 1.3 -0.1

Time (sec)

Example of Anomalous CRDM Withdrawal Step

Plant Benefits

- Recover Critical Path Time
- · Detect Rod Binding
- Identify Stuck Rods and Other Movement Problems

Equipment Benefits

- Connect to All Rods at One Time
- Collect Data in as Little as 15-20 Minutes

Software Benefits

- Timing, Sequencing, and Latching Identified Automatically
- Full Pull Data Collection Provides Information on All CRDM Steps (Up & Down)

Decrease Troubleshooting

Monitor System Reliability

 Identify Performance Degradation

Portable, Lightweight,

Current Order Data

Collects both CRDM and

Slave Cycler / Logic Cabinet

Quick Hookup

Time

- Monitor Coil Current
 Regulation
- Quick Reporting Flags Any Anomalies

Diagnostics Enabled By Acquiring Voltage and Current Data

- Coil Temperature Maps
- Coil Resistance Calculations - Rod Movement Algorithms
- Gripper Load Transfer Analysis
- Firing Angle Calculation



Coil Temperature Map

10CFR50 Appendix B Program

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