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April 15, 1993
(BVY 93-41)

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

References: (a) License No. DPR-28 (Docket No. 50-271)
(b) Letter, VYNPC to USNRC, (BVY 93-38) dated April 7, 1993
(c) Letter, USNRC to VYNPC, dated April 9, 1993; Notice of Enforcement Discretion (TAC No. M86128)

Subject: Results of Vermont Yankee Investigation Regarding Scram Insertion Times

Dear Sir:

Background

During performance of routine control rod scram time testing as required by Technical Specification (T.S.) section 4.3.C.2, a preliminary review of the notch 46 scram times found the requirements of section 3.3.C.1 to be exceeded. This was subsequently confirmed by the use of our ERFIS computer system. Specifically, the core average notch 46 time was 0.369 seconds (T.S. limit 0.358) and nine of sixty-eight 2X2 arrays were in the range of .380 to .405 seconds (T.S. limit of 0.379 seconds) for notch 46. Scram performance of all control rods at notch positions 36, 26, 06 and the maximum insertion time specified in T.S. 3.3.C.2 were satisfactory in comparison with the T.S. requirements.

By letter, Reference (b), Vermont Yankee formalized our request for relief (enforcement discretion) from the scram insertion time limits of T.S. 3.3.C.1. We had previously informed the NRC, on April 6, 1993 that we would not be in compliance with the scram insertion time limits for the 46 notch position for both the full core and two-by-two arrays. Justification for continued

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operation was based on an analysis, using NRC approved methods, that showed no significant impact for the limiting transient if the limits were raised from .358/.379 seconds to .500 seconds and that the scram insertion times for the remaining T.S. limits were met. An additional compensatory measure was instituted to maintain power level below 75% until a more thorough analysis was submitted to the NRC. On this basis, the NRC granted enforcement discretion for 48 hours pending the NRC's detailed review of our analysis. (Reference (c))

Subsequently, also on April 6, 1993, a plant shutdown was initiated for an unrelated cause. This terminated the need for the enforcement discretion.

Consistent with our commitment made in Reference (b), the results of our investigation and our justification for resuming power operation within the current T.S. requirements are provided below:

Investigation

On April 7, 1993, Vermont Yankee formed several task forces to identify and resolve the scram time issues. One of the groups was tasked with identifying and providing recommendations to resolve the equipment issue; other groups, including one which was made up of individuals from outside the plant organization, were requested to investigate the programmatic issues that may have contributed to this event. The results of these efforts will be documented per our corrective action process.

The task force formed to investigate and determine the root cause(s) for the slower than expected scram times for notch 46 and propose fixes for any problems identified included members from various plant departments, a Control Rod Drive (CRD) system expert from General Electric and subsequently a technical representative from ASCo Corporation. The Task Force initially identified possible conditions that could cause slow times. Parameters considered that could influence CRD performance included: drive line friction (within the CRD or reactor core), system hydraulic characteristics (air entrapment, valve blockage, valve leakage, etc), internal CRD scram flow blockage or leakage, instrument air parameters, control rod weight and accumulator pressure. By use of a combination of test, evaluation, record reviews and vendor input, the most likely source of the problem was identified. Since slow scram times only appeared at notch 46, particular attention was focused on the CRD Start of Motion (SOM). SOM is defined as the time from de-energization of the scram pilot valves to the drop-out of position 48. This sequence only requires a fraction of an inch of actual CRD travel. The notch 46 scram time consists of SOM plus the time of travel from notch 48 to 46. Data obtained from strip charts for the most recent scram testing shows the time from position 48 to 46 is relatively constant for both "fast" and "slow" CRDs. The data shows, however, that there is a significant difference in the SOM times between the CRDs and that this is the factor affecting the notch 46 results.

In general, the "fast" and "slow" CRDs have similar scram profiles except that they exhibit varying SOM times. This indicates that the slow notch 46 scram times are not attributed to the CRD mechanism, system hydraulic characteristics or flow blockages as this would also effect the other scram notch times. Based on the wide scope of data evaluated, the apparent cause was narrowed down to the Hydraulic Control Units (HCU's). A test involving the swapping of "slow" and "fast" scram solenoid assemblies further isolated the problem to the solenoid assemblies. A simplified diagram of the HCU and solenoid arrangement is provided as Attachment B.

New solenoid rebuild kits, for both the pilot head and diaphragm components, were procured from the vendor and were initially installed on approximately half of the 89 HCU's. All of these CRD's were then tested at zero reactor pressure and some tested at cold hydro (~950 psi) conditions. Significant improvement in scram insertions times at notch 46 were seen during both tests. Based on these results, VY elected to replace the upper and lower kits on all HCU's. Replacement of kits on all 89 CRD's was completed on April 14, 1993.

A chronology of our troubleshooting/testing effort is summarized in Attachment A.

Apparent Cause

Based on considerable testing to date, it has been determined that replacement of scram solenoid kits has resulted in a significant improvement to control rod scram notch 46 times.
On April 11, 1993 Vermont Yankee Engineering assembled a task team to investigate what physical characteristic(s) of the scram solenoid valves may affect the control rod scram times. The Engineering task team is being led by an electrical engineer and included a mechanical engineer, a receipt inspector, various support personnel and technical input from GE and ASCO personnel. The team has been charged with determining if there is a correlation between physical characteristics and scram time. To date, the team has identified minor differences in component attributes but has been unable to correlate any of the attribute differences with control rods exhibiting slow scram times.

In addition to the on-site investigation, a number of parts have been sent to General Electric for a more detailed analysis; at this point no conclusive results have been received from GE.

Conclusion

Although the root cause for the minor delay in scram insertion times has not been clearly established, our testing has shown that replacement of the components on the scram solenoid assemblies has shown a significant improvement in performance. It is our plan to re-scram all 89 control rods at cold hydro conditions, with the drives isolated from the control rod drive pumps, per the surveillance requirements of T.S. 4.3.C.1. We fully expect that a similar level of improvement will be demonstrated during this test. A detailed review of the hydro data will be conducted to validate our conclusions and any additional tests, replacements, or administrative controls will be established prior to plant re-start.

In addition to the cold hydro timing test, Vermont Yankee's plans include single rod testing of all 89 control rods during our initial ascension to full power. Further, we plan to retest 50% of the rods during the next rod pattern exchange currently scheduled for June, 1993.

Based on our investigations to date, our startup test plans and our subsequent at power test plans, we will fully demonstrate and assure our ability to meet the current T.S. requirements for scram times.

We trust that the information provided herein adequately addresses our commitment. However, should you have any questions or should you need further discussion on this matter, please contact us. As noted previously, investigations are ongoing and long term corrective actions will be implemented.

Very truly yours,

VERMONT YANKEE NUCLEAR POWER CORPORATION

Donald A. Reid
Vice President, Operations

cc: USNRC Region I Administrator
USNRC Resident Inspector - VYNPS
USNRC Project Manager - VYNPS
USNRC Director, NRR
USNRC Director, Reactor Projects, NRR
USNRC Director, Office of Enforcement
USNRC Technical Assistant, Reactor Projects, NRR
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ATTACHMENT A - Troubleshooting/Testing Chronology

Baseline Test

Initially, thirteen control rods were selected to be scrammed two times each at zero reactor pressure to provide baseline data for the troubleshooting that was to follow. One of the 13 selected control rod drives showed signs of trapped air at the start of the test and was dropped from the test list.

It was observed, from this population of 12 control rod drives, that re-scramming of a control rod improved its notch 46 scram time in 6 cases and reduced the scram time in 6 cases. The average change was a net slow-down of .008 seconds. These multiple scrams did not appear to provide any useful correlation.

Time vs. Performance Test

Because of a potential that long run times may contribute to long insertion times, the next effort consisted of selecting 3 control rods for scram/flushing. One fast rod and two slow control rods were selected for this effort. The test consisted of a single rod scram and then holding the individual scram signal in for 30 seconds to determine if a continued scram signal would flush the drive and improve scram time performance. After the scram/flushing was completed, the rods were again scrammed with no improvement. One rod was not tested due to indications of air in the drive. This test was inconclusive and supported the GE theory that CRD flushing would yield no benefit.

Start-of-Motion Review

A comparison was made of twenty-four single rod scrams by plotting their insertion traces. A linear rate of rod motion was noted. The twenty-four traces resulted in a family of 24 parallel lines. They differed by varying offsets which were caused by a delay in starting rod motion. Once the rod motion started, the rate of travel on all rods was similar. Since the scram times for all positions other than notch 46 were acceptable, the components of the HCU were suspect for the initiation of the scram.

Air Bleed Test

The next troubleshooting test consisted of taking air bleed-off rate measurements of the scram pilot valves using a 4-pen recorder. These measurements were taken for a known slow CRD and a fast CRD. The scram valve air bleed-off rate was compared to the rate of control rod insertion during the single rod scram test. The charging water valve was left open during this test. The relationship between air bleed-off rate and start of control rod motion was clearly noted. The ratio was the same for both drives. The test results showed that the slow drive had a significantly longer duration of pressure decay for the scram valves than the fast drive.

Pilot Assembly Swap

The entire scram pilot solenoid valve (117/118) assemblies were then swapped between two HCU's. The expectation was that if the scram pilot valves were the cause of the slow start of rod motion, the problem would migrate from the slow drive to the fast drive. The two rods were scrammed with the changing water valves initially closed and then opened. The test results showed that the originally fast drive became significantly slower and the slow drive was inconclusive. An air bleed-off rate test was performed concurrently and it showed the symptoms swapped.

Rebuild Test (Existing Stock)

The next test involved taking a known slow rod and rebuilding its solenoid with VY stock parts (same vintage as was installed). This was done by first installing the pilot head kit and then testing. Then, the diaphragm kit was installed and the rod retested. This test showed some improvement in the notch 46 scram times.

Rebuild Test (New Parts); Phase 1

This test utilized "new" GE supplied rebuild kits on three known slow rods. The new pilot head kit and the diaphragm kit were installed on both scram solenoid pilot valves. The results of this test demonstrated significant improvement ($\approx$ 100 msecs).

Rebuild Test (New Parts); Phase 2

Based on results of the Phase 1 rebuild test, another test was performed to attempt to differentiate the effect of each of the rebuild kits. Eight slow rods and one fast rod were selected for this sample. Four HCU's had the pilot heads refurbished, the remaining five had both the pilot heads and diaphragms refurbished. These rods were then scram tested at zero reactor pressure.

For this test, we determined that the pilot head rebuild provided some improvement, but not as much as when the diaphragm rebuild kit was also installed.

Hydro Test

A vessel hydrostatic test was performed and a new set of baseline data was obtained for all the rods with fully and partially rebuilt solenoids as well as an additional four rods for comparison. Hydro pressure was maintained between 950-1000 psig for the scram testing. The results of this test confirmed the results of the earlier "Rebuild" tests and clearly demonstrated a significant improvement in start of motion and notch 46 times.

Rebuild Test (New Parts); Phase 3

An additional thirty four of the slowest CRD's were selected to have their solenoids refurbished. Solenoid refurbishment included both pilot heads and diaphragms.

Additionally [illegible] our HCU's that only had their pilot heads rebuilt, were completed by also rebuilding the lowe[illegible]hragm section. The four HCUs that had the diaphragms replaced were retested with notch 46 scram times consistent with the others. A total of thirty-two of these CRDs were scram tested at z[illegible] reactor pressure to verify improvements in the expected notch 46 response times. The results again showed significant improvement with the notch 46 scram times.

Rebuild (New Parts); Phase 4

On April 13, 1993, based on the above testing, it was decided to rebuild all the remaining scram pilot solenoid valves with both the pilot head and the diaphragm kits.

ATTACHMENT "B"