WYLE
LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

April 14, 1993

Mr. Lief Norholm
Division of Reactor & Inspection & Safeguards
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission MS-9-D4
Chief, Vendor Inspection Branch
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Subject: Wyle Response to NRC Comments on Potential Part 21 on AVC Solenoid Manifold Assemblies Supplied To TVA

Dear Mr. Norholm:

Wyle Laboratories appreciated the opportunity on April 2 to discuss our responses to your questions after which you indicated all questions had been satisfactorily answered. This letter is our formal response and we trust it will serve as closure to the matter. Some general comments, before specific answers, are appropriate.

During the LOCA, the only safety function is to assure closure of the MSIV by allowing an exhaust path through the AVC Manifold Assembly, since it is the AVC Manifold Assembly that is supplying the air pressure, which is holding off the MSIV piston. The solenoid coils are normally energized and have to de-energize to perform the safety function. The solenoids are in two out of two logic, and thus both safety related solenoids' plungers have to change state for the air to exhaust. A failure of one solenoid in service, not during an accident, does not cause a transient by inadvertent closure of the MSIV.

The AVC Solenoid Manifold assemblies were tested for all functions throughout the original qualification program, but only the safety related function was demonstrated during LOCA, which is per the requirements of the IEEE Standard 323 and the NRC's regulations including 10CFR50.49, NUREG 0588, DOR Guidelines and Reg. Guide 1.89.

The original test program (Wyle Report 17514) was a generic qualification for four utilities, TVA, CECO, PP&L and DE. Wyle actually found the initial problem with excess amounts of Parker's Super-O-Lube that caused operability problems after exposure to high radiation. Wyle then qualified five options (Super-O-Lube, Houghton 620, DC 200, DAG-156, and unlubricated), from which each utility could decide for themselves that was appropriate for them within the qualification umbrella. Wyle qualified Super-O-Lube, using minute amounts and the application procedure in the test report. The Houghton 620, which has been the focus of the problem at PP&L did not cause a problem in Wyle's tests. As was seen by a March 1993 inspection of the original test specimen, it is relatively clean, has very light corrosion, is still operational, even after surviving radiation, thermal aging, cycle aging, pressurization cycle aging, a severe seismic test series, and six LOCA profiles in two different series. Since then it has been exposed to normal aging in Alabama's weather in an unair-conditioned and unheated warehouse for four years and Class B storage for approximately four years.

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The solenoid coils are manufactured to an AVC drawing specification, which identifies the materials of construction, which are the same for both vendors. The coils are from third tier suppliers, Quality Coils and Five Star, through the solenoid vendor Airmatic/Allied/ Snap-Tight to AVC.

At the time of qualification, we were aware of multiple coil vendors and attempted to have representation in the test specimens, however, looking back at the specimens that have been through all of the aforementioned testing, we definitely know that we had at least the Five Star coil as a test specimen, which had a unique marking. Other test specimen coils do not have the Five Star marking, but the location where the Quality Coil marking may have been is obliterated by the application of epoxy and the aged condition of the coils, since Quality Coil marked the outer tape, prior to encapsulating.

Thus Wyle has relied on chemical and physical tests, supplemented with a series of temperature and temperature and steam tests to demonstrate that the AVC Solenoid Manifold assemblies are qualified. The chemical and physical tests provide the evidence that the materials of construction are as anticipated and thus, while not being exactly the same, are indicative of what was specified in the drawings, identified in the qualification plan and are consistent in the test specimens and samples of the new TVA lot. Since the evidence does not show that materials are different, it is concluded that they are essentially the same and are qualified.

Wyle's responses to the eight questions are as follows:

1. Under accident conditions, the normally energized coils are de-energized and the return spring (Item 10) forces the plunger down and seals the pilot seat (Item 4). The compensating spring (Item 9) loads the stem seat seal (Item 7) which performs no function during the safety related operation of the SOV. Therefore, only the temperature effects on the return spring will be investigated.

   The return spring is made from 302 SS which has an average thermal coefficient of expansion of 9.9 (micro in/in/°F) over the temperature range of 32 to 572°F. The plunger is made from 430F SS with a coefficient of expansion of 6.1. Increasing temperature will increase the clearances between the spring and the plunger since the spring will be increasing in size at a greater rate than the plunger. Therefore, an increase in temperature will not adversely effect the relative movement of the spring and the plunger.

   The stem (Item 12) has an ID of 0.688" where the spring seats and the OD of the spring (large end) is 0.578" which gives a total clearance of 0.110". The stem is made of 304 SS which has the same coefficient as 302 SS and 430F SS. In the worst case, going from 75°F to 355°F (peak accident temperature) the total clearance would be reduced about 0.0004 to 0.0006". It is judged by Wyle that this 0.4 to 0.6% reduction in the clearance has no measurable affect on the relative motion of the spring and the stem.

   The above calculations were based on two conservative assumptions. First, that the internal components of the SOVs are at the "hot spot" temperature of the coil. Second, that there is no thermal delay during the accident transient and the internal components of the SOVs actually see these peak conditions.

Therefore, Wyle concludes that operational testing of the SOVs at accident temperatures would have resulted in the same conditions as experienced at ambient temperatures.

2. The plunger travel (Item 22) of the qualified plunger was calculated as 0.0343" and the new ones were 0.0372" which is a difference of 0.0029" which is well within the manufacturing tolerances for this type of assembly which is usually +/- .005" (based on conversations with several manufacturers). Variations caused by normal manufacturing tolerances are accounted for by the margins added to the accident test conditions. A change from ambient to accident conditions will have no effect on the difference in plunger travel. Wyle concludes that this difference will have no measurable effect on the operability of the SOVs under accident conditions.

3. The distance from the bottom of the coil to the top of the manifold (Item 48) is inversely proportional to the magnetic force exerted on the plunger. Under accident conditions the normally energized coils are de-energized and the plungers seal the pilot seats. Since the new coil was slightly further away from the top of the manifold than the qualified one, the restraining force on the plunger will be less. Therefore, as the magnetic field decays, the return spring will be able to overcome the magnetic field slightly sooner and therefore close ever so slightly sooner.

   The average thermal coefficient of expansion of the stainless steels used ranges from 6.1 to 9.9 (micro in/in/^{o}F) over the temperature range of 32 to 572^{o}F. Aluminum alloys average about 13.5 over the same temperature range. Since the new and old designs use the same metallic materials there would be no additional difference between these designs due to the elevated temperature during an accident.

4/5. It is Wyle's position that all the Viton seals in the manifold assembly are subjected to the same basic operating and accident conditions. Therefore, it is acceptable to qualify the small exhaust adapter o-ring (Item 19) by comparing it to the stem o-ring (Item 13) and to qualify the large exhaust adapter o-ring (Item 20) by comparing it to the pilot seat seal (Item 6).

   Both TGA and IR tests were performed on the test specimen o-rings and a sample from the new lot. The only differences between the TGA tests performed, i.e. TGA 6 for the small o-ring and TGA 4 for the stem o-ring, is a 2% difference in the location of the first 1st derivative point (which is well within our normal +/- 5% range) and 6% difference in the ash content which is only 1% outside our normal +/- 5% range. The addition of 1% additional mineral filler will slightly increase the o-ring's resistance to radiation, aging and temperature. Wyle judges that the Viton materials in the new lot are essentially the same as the original test specimen and thus the minor differences noted will have no measurable effect on the operability of the SOVs under accident conditions.

   The only differences between TGA 10 for the large o-ring and TGA 7 for the pilot seat seal is a 3% difference in the location of the first 1st derivative point (which is well within our normal +/- 5% range) and an additional 1st derivative point at the 83% point. This difference occurs at approximately 600^{o}C (1100^{o}F) which is about 700°F above the accident conditions in the plant. Wyle concludes that this difference will have no measurable effect on the operability of the SOVs under accident conditions.

On the basis of the above TGA data and the IR analyses that show the analyzed o-rings are Viton, Wyle concludes that all the seals are made of the same basic material.

6. The bobbin is not safety related. It was degraded during the original qualification program, but still used in the assembly to demonstrate that its failure would not cause failure of the Manifold assembly and it did not. The manifold assembly functioned properly during the accident tests.

7. The source of silicone can only be from one of two places, the coil lead wire, unlikely, or the Super-O-Lube from the o-rings, most likely. Wyle surmised that it most likely occurred during the disassembly procedure which allowed some cross contamination. The o-rings were removed first and the silicone compound was thus inadvertently transferred to the bobbin when it was disassembled.

8. Wyle only experienced one coil that had a solder joint failure and it happened during thermal aging for this specimen that was attempting to qualify it for 10 years. Wyle assumed that this was common mode failure and lowered the qualified life goal to 5 years. Another test specimen was then aged to a 5-year equivalent life and completed the testing with no further events.

   Wyle did not inspect the solder joints of the coils in the new order for TVA since the coils were already potted by the time we saw them at AVC. Since we had successfully tested multiple sets of coils in the 17514 LOCA simulations, this one failure may in fact be random, or indicative of a reliability problem, but since EQ only addresses common mode problems, it doesn't impact EQ.

In further confirmation of the above responses, which we feel in themselves properly answer your questions, Wyle has recently tested three Quality Coils (one AVC solenoid assembly), sampled from the same lot shipped to TVA to a series of temperature tests. These tests were of the same severity and durations of the peak temperature conditions as the original Test Report 17514 test including dry heat tests and steam tests in a LOCA chamber. Additional tests were also performed at values greatly in excess of the original profile. A proprietary Wyle test report is available at Wyle, which documents these tests. The operating times were consistent in these tests and well within the expected duration. These tests, therefore, provide additional confirmation of the Wyle position that the AVC assemblies supplied by Wyle to TVA met all requirements.

Sincerely,

Wyle Laboratories
Eastern Operations

Edward W. Smith, Director
Contracts and Purchasing

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