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10 CFR 50.55a

U.S. Nuclear Regulatory Commission
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Duane Arnold Energy Center
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Fourth Ten-Year Interval Inservice Testing Program Relief Requests

Reference: NG-05-0427, dated August 1, 2005, Inservice Testing Program, Fourth Ten-Year Interval Update

The referenced letter submitted the Duane Arnold Energy Center (DAEC) Inservice Testing (IST) Program update for the fourth ten-year interval, including relief requests PR-01, PR-02 and VR-01. As discussed during conference calls with the Staff, additional information is required to support the Staff's review of these relief requests.

The relief requests have been revised to provide additional information and are provided in the enclosure. In addition, incorrect Code references have been corrected in PR-02. Changes are denoted by revision bars.

Should you have any questions regarding this matter, please contact Steve Catron at (319) 851-7234.

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Enclosure

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Enclosure
to NG-06-0005

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Pump Relief Request – PR-01

Proposed Alternative Limits for HPCI Pump Vibration
In Accordance with 10 CFR 50.55a(a)(3)(i)

Systems: High Pressure Coolant Injection

PUMP: 1P216 HIGH PRESSURE COOLANT INJECTION PUMP

Class: 2

Function: Injects Coolant into the reactor vessel independent of AC power.

Test Requirement : Table ISTB-5100-1; Comprehensive pump test vibration alert limit of 0.325 in/sec

Bases for Relief:

The HPCI pump consists of a centrifugal main pump, a separate centrifugal booster pump, a speed reducing gear for the booster pump, and a Terry drive train. Therefore, there are four independently balanced and aligned rotating assemblies that are coupled together. As a result, the normal (baseline) vibration readings in the horizontal direction on the main pump is approximately 0.4 in/sec. Application of a 0.325 in/sec alert limit would require DAEC to enter accelerated test frequency each time the pump was tested because of the likelihood that 4 of 10 ASME points measured would exceed this limit. (Note: A total of 22 points are actually obtained for proper post spectral/waveform analysis. Of the 22 points monitored on this machine only the 4 Main and Booster pump horizontal readings exceed the alert criteria of 0.325 in/sec peak overalls.)

Prior to the fourth ten-year interval, pump vibration was measured in displacement instead of velocity. DAEC has determined measuring pump vibration in velocity for this pump train will provide improved ability to detect degradation, since the normal pump speed is approximately 3600 rpm. DAEC has many years of in-service test data showing that baseline vibrations of 0.4 in/sec represent acceptable pump operation and that vibration levels have not been trending up.

Typical failure modes include:
Sub-synchronous (oil whirl/shaft rub), 1 X Turning Speed (TS) (Misalignment/Unbalance/Looseness), 2XTS (Misalignment), 4XTS Booster pump Vane Pass, 5/6XTS Main Pump Vane Pass, and non-synchronous frequencies generated by rolling element bearings. Of these failure modes, the 1XTS, 2XTS, and Non-synchronous would be more indicative of actual mechanical failure scenarios however influence current overall levels minimally. At each of these four locations the booster pump vane pass is predominant and contributes to greater than 80% of the overall vibration measured. This means that 20% or less is actually from typical mechanical equipment failure modes (1XTS/2XTS/Non-Synchronous). DAEC has conducted thermal growth evaluations and identified misalignment targets for this train. Previous bearing and oil inspections have not identified any historical abnormal indications. 1XTS and 2XTS values are very low indicating excellent alignment/balancing without non-synchronous indications; furthermore vane pass amplitudes have not changed significantly since 1989 baseline data indicating very little, if any, vane or volute degradation. The primary source of these overall numbers is from the booster pump 4XTS and the corresponding acoustical pulsation through the crossover pipe into the Main Pump.

Implementing the alert limit of 0.325 in/sec would require DAEC to constantly have the HPCI pump on accelerated test frequency. The intent of increased test frequency is to closely monitor a pump that is deteriorating from its baseline values. In this case, the pump would be operating at its normal vibration range and no change would be seen. An appropriate alert limit for these vibration data points is 0.500 in/sec. This is based on previous test history, a review of industry data and at the vibration analysis performed.

Relief is requested pursuant to 10CFR 50.55a(a)(3)(i); the alternative testing will provide an acceptable level of quality and safety.

Alternative Testing:

An overall peak vibration alert of 0.5 in/sec will be used for four HPCI Main and Booster Pump horizontal points rather than the code required 0.325 in/sec. Table ISTB-5100-1 required action limit of 0.700 in/sec will be adhered to.

In addition to the normal HPCI pump IST vibration peak overall result, DAEC engineering department personnel will routinely perform post spectral/waveform analysis of the vibration data to ensure no adverse trends toward mechanical degradation go undetected. This nominal increase in the lower alert limit for the alert range of these 4 horizontal points will not affect the operational readiness of the HPCI Main or Booster pump and the OM Code maximum allowable vibration limits for the required action range are being maintained.

The above proposed alternative of DAEC-specified vibration acceptance criteria, together with routine vibration spectral/waveform analysis, with the specified Alert and Required Action Ranges, will result in corrective action on a pump prior to the occurrence of significant degradation.

Status:

This is a new relief Request for DAEC. Monticello has a similar relief previously granted by the NRC.

Pump Relief Request – PR-02

Proposed Alternative for SBLC Pump Vibration Instruments

In Accordance with 10 CFR 50.55a(a)(3)(i)

Systems: Standby Liquid Injection

PUMP: 1P230A AND 1P230B STANDBY LIQUID CONTROL INJECTION PUMPS

Class: 2

Function: To inject liquid poison into the reactor.

Test Requirement: ISTB-3510(e); General, Frequency Response Range; The frequency response range of the vibration measuring transducers and their readout system shall be from one-third minimum pump shaft rotational speed to at least 1000 Hz.

Bases for Relief:

The nominal shaft rotational speed of these pumps is 242 RPM which is equivalent to approximately 4 Hz. Based on this frequency and ISTB-3510(e), the required frequency response range of instruments used for measuring pump vibration is 1.33 to 1000 Hz. Procurement and calibration of instruments to cover this range to the lower extreme (1.33 Hz) is impractical due to the limited number of vendors supplying such equipment and the level of sophistication and cost of the equipment.

These are of a simplified reciprocating (piston) positive displacement design with rolling element bearings, Model Number TD-60, manufactured by Union Pump Corporation. Union Pump Corp. has performed an evaluation of the pump design and has determined that there are no probable sub-synchronous failure modes associated with these pumps under normal operating conditions. Furthermore, there are no known failure mechanisms that would be revealed by vibration at frequencies below that related to shaft speed (4 Hz); thus no useful information is obtained below this frequency nor will indication of pump degradation be masked by instrumentation unable to collect data below this frequency to within tolerance prescribed by IST.

Sub-synchronous peaks are typically associated with sleeved bearing components. These frequencies detect shaft to sleeve rub and oil whirl. The IST requirement for detection to 1/3 turning speed is to detect these failure mode types. However, this Union Pump design utilizes roller bearings which do not have the same failure modes. For a roller bearing design, typical failure is ball or race related and occurs at frequencies greater than turning speed, classified as non-synchronous. As a roller bearing fails, a corresponding change in 1 times turning speed and harmonics indicating excessive looseness and random impacting, not sub-synchronous frequencies, will be seen.

Per the manufacturer, there is no internal gearing in this pump model, therefore the input shaft RPM is also the crank RPM. The instrumentation for measuring vibration must be adequate for accurately assimilating information at this RPM. The significant modes of vibration with respect to equipment monitoring are as follows:

* 1-Times Crankshaft Speed - An increase in vibration at this frequency may be an indication of rubbing between a single crankshaft cheek and rod end, cavitation at a single valve, or coupling misalignment.

* 2-Times Crankshaft Speed - An increase in vibration at this frequency may be an indication of looseness at a single rod bearing or crosshead pin, a loose valve seat in the fluid cylinder, a loose plunger/crosshead stub connection, or coupling misalignment.

* Other Multiples of Shaft Speed or Non-synchronous peaks - An increase in vibration at other frequencies may be indications of cavitation at several valves, looseness at multiple locations, or bearing degradation.

Per the manufacturer, all failure modes that cause vibration in the pump will be at multiples greater than the crank RPM.

Based on the foregoing discussion, it is clear that monitoring pump vibration within the frequency range of 4 to 1000 Hz will provide adequate information for evaluating pump condition and ensuring continued reliability with respect to the pumps' function.

Relief is requested pursuant to 10CFR 50.55a(a)(3)(i); the alternative testing will provide an acceptable level of quality and safety.

Alternative Testing:

Vibration levels of the Standby Liquid Control Pumps will be measured in accordance with the applicable portions of ISTB 3500 with the exception of the lower frequency response limit for the instrumentation (ISTB 3510(e)). In this case the lower limit of the vibration measuring equipment will be 4.00 Hz.

In addition to the normal SBLC pump IST vibration peak overall result, DAEC engineering department personnel will routinely perform post spectral/waveform analysis of the vibration data to ensure no adverse trends toward mechanical degradation go undetected. This lower limit restriction will not affect the operational readiness of the Standby Liquid Control Pumps, and the OM Code maximum allowable vibration limits for the required action range are being maintained.

The proposed alternative will result in corrective action on a pump prior to the occurrence of significant degradation.

Status:

Approval of similar relief was previously granted to DAEC by the NRC in May 29, 1997.

Valve Relief Request – VR-01

Proposed Alternative Test for Excess Flow Check Valves

In Accordance with 10 CFR 50.55a(a)(3)(i)

Systems:

Feedwater Control (45.02)
Residual Heat Removal (49.00)
Core Spray (51.00)
Nuclear Steam Supply Shutoff (58.02)
Reactor Vessel Recirculation (64.01)
Neutron Monitoring (78.01)
Reactor Non-Nuclear Instrumentation (80.00)

Valves:

XFV2119	XFV4457B	XFV4513	XFV4590	XFV4668
XFV2139	XFV4458A	XFV4514	XFV4591	XFV4669
XFV2246A	XFV4458B	XFV4515	XFV4607	XFV4670
XFV2246B	XFV4459A	XFV4516	XFV4608	XFV4671
XFV2246C	XFV4459B	XFV4518	XFV4611	XFV4672
XFV2246D	XFV4460A	XFV4519	XFV4612	XFV4673
XFV2443A	XFV4460B	XFV4528	XFV4637	XFV4674
XFV2443B	XFV4501A	XFV4562	XFV4638	XFV4675
XFV2443C	XFV4501B	XFV4578	XFV4641A	XFV4676
XFV2443D	XFV4503	XFV4579	XFV4641B	XFV4677
XFV4453A	XFV4504	XFV4580	XFV4642A	XFV4678
XFV4453B	XFV4505	XFV4581	XFV4642B	XFV4679
XFV4454A	XFV4506	XFV4582	XFV4643A	XFV4680
XFV4454B	XFV4507	XFV4583	XFV4643B	XFV4681
XFV4455A	XFV4508	XFV4584	XFV4644A	XFV4682
XFV4455B	XFV4510A	XFV4585	XFV4644B	XFV4666
XFV4456A	XFV4510B	XFV4586	XFV4663	XFV4667
XFV4456B	XFV4511	XFV4587	XFV4664	XFV4589
XFV4457A	XFV4512	XFV4588	XFV4665	

Category: C

Class: 1

Function:

Excess flow check valves (EFCVS) specifically designed, by Marotta Scientific Controls Inc., for the DAEC are provided in each instrument process line that penetrates the drywell and is part of the reactor coolant pressure boundary. The excess flow check valve is designed so that it will not close accidentally during normal operation, will close if a rupture of the instrument line is indicated downstream of the valve, can be reopened when appropriate, and has its status indicated in the control room.

An orifice is installed just inside the drywell on each of these instrument lines. The orifice limits leakage to a level where the integrity and functional performance of secondary containment and associated safety systems are maintained, the coolant loss is within the capability of the reactor coolant makeup system, and the potential offsite exposure is substantially below the guidelines of 10 CFR 100. Regulatory Guide 1.11 requested that an additional isolation valve capable of automatic operation be located outside containment on these instrument process lines. At the DAEC, these are the excess flow check valves.

Test Requirement:

2001 Edition and the 2002 and 2003 Addenda of the ASME OM Code.

ISTC-3510 Exercising Test Frequency. Active Category A, Category B, and Category C check valves shall be exercised nominally every 3 months, except as provided by ISTC-3520, ISTC-3540, ISTC-3550, ISTC-3560, ISTC-5221 and ISTC-5222. Power-operated relief valves shall be exercise tested once per fuel cycle.

Basis for Relief:

The excess flow check valve is a simple device: the major components are a poppet and spring. The spring holds the poppet open under static conditions. The valve will close upon sufficient differential pressure across the poppet. Functional testing of the valve is accomplished by venting the instrument side of the tube. The resultant increase in flow imposes a differential pressure across the poppet, which compresses the spring and decreases flow through the valve.

Excess flow check valves have been extremely reliable throughout the industry. Since the time that the EFCVs were added to the DAEC Maintenance Rule Program (1999), no excess flow check valve has failed to close due to actual valve failure (i.e., not related to test methodology). The DAEC Technical Specifications (TS) detail what frequency is required to maintain a high degree of reliability and availability, and provide an acceptable level of quality and safety. In the NRC's Safety Evaluation, which approved the associated TS amendment, the Staff concluded, "Based on the acceptability of the methods applied to estimate the release frequency, a relatively low release frequency estimate in conjunction with unlikely impact on core damage and negligible consequence of a release in the reactor building, we conclude that the increase in risk associated with the licensee's request for relaxation of EFCV surveillance testing to be sufficiently low and acceptable." DAEC requested this relief pursuant to 10CFR50.55a(a)(3)(i) to exercise excess flow check valves at the frequency specified in amended DAEC TS Surveillance Requirement (SR) 3.6.1.3.7.

The NRC's Safety Evaluation also states that the radiological consequences of an unisolable rupture of an instrument line were evaluated in response to Regulatory Guide 1.11, as documented in DAEC UFSAR Section 1.8.11. This evaluation assumed a continuous discharge of reactor water through an instrument line with a ¼ inch orifice for the duration of the detection and cooldown sequence. The assumptions for the accident evaluation do not change as a result of the change in test frequency, and the evaluation in the DAEC UFSAR Section 1.8.11 remains acceptable.

General Electric NEDO-32977-A (Boiling Water Reactor Owners' Group (BWROG) Topical Report B21-00658-01), Excess Flow Check Valve Testing Relaxation, dated November, 1998, (revised through June, 2000) was approved by the Staff on March 14, 2000. NEDO-32977-A provides additional bases for this relief request. The report concludes that the change in the test frequency had insignificant impact on valve reliability, and that the demonstrated reliability of EFCVs coupled with low consequences of EFCV failure provided adequate justification for extending the test interval up to once every 120 months.

Proposed Alternative Test:

Excess flow check valves will be exercised at the frequency specified in the amended DAEC TS Surveillance Requirement (SR) 3.6.1.3.7. The surveillance requirement is to test a representative sample of Excess Flow Check Valves so that each Excess Flow Check Valve is tested at least once every 10 years.

The Excess Flow Check Valves have position indication in the control room. Check valve remote position indication is excluded from Regulatory Guide 1.97 as a required parameter for evaluating containment isolation. The remote position indication will be verified in the closed direction at the same frequency as the exercise test, which will be performed at the frequency prescribed in the amended DAEC TS Surveillance Requirement (SR) 3.6.1.3.7. After the close position test, the valves will be reset, and the remote open position indication will be verified. Although inadvertent actuation of an EFCV during operation is highly unlikely due to the spring-poppet design, the DAEC will verify the EFCVs indicate open in the control room at a frequency greater than once every 2 years.

The failure of an EFCV to isolate would be evaluated per the DAEC corrective action program. The DAEC 10 CFR 50.65 Maintenance Rule Program specifies a performance criteria of less than or equal to 1 maintenance preventable failure to isolate per year on a 3 year rolling average.

Reference:

- DAEC Technical Specification Amendment 230 approved by the NRC on December 29, 1999
- Safety Evaluation by the Office of Nuclear Reactor Regulation of the third 10-year interval inservice inspection plan request for relief regarding excess flow check valve surveillance requirements, Duane Arnold Energy Center, Docket No. 50-331, dated March 28, 2000.