UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 28, 2017

Mr. Robert S. Bement
Executive Vice President Nuclear/
Chief Nuclear Officer
Mail Station 7602
Arizona Public Service Company
P.O. Box 52034
Phoenix, AZ 85072-2034

SUBJECT: PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3 – RELIEF REQUEST NOS. PRR-01, PRR-02, PRR-03, PRR-04, PRR-05, AND PRR-06 FOR USE OF THE PROPOSED ALTERNATIVES IN LIEU OF THE INSERVICE TESTING REQUIREMENTS OF THE ASME OM CODE (CAC NOS. MF9318 THROUGH MF9319, MF9321 THROUGH MF9329, AND MF9331 THROUGH MF9333; EPID L-2017-LLR-0005 THROUGH L-2017-LLR-0010)

Dear Mr. Bement:

By letter dated February 23, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17054D687), as supplemented by letters dated March 10, August 16, and September 29, 2017 (ADAMS Accession Nos. ML17069A319, ML17228A795, and ML17272B033, respectively), Arizona Public Service Company (the licensee), submitted Relief Request (RR) Nos. PRR-01, PRR-02, PRR-03, PRR-04, PRR-05, and PRR-06 for Palo Verde Nuclear Generating Station (PVNGS), Units 1, 2, and 3. The RRs request for approval of the use of alternatives in lieu of the inservice testing (IST) requirements of the American Society of Mechanical Engineers (ASME) Code for Operation and Maintenance of Nuclear Power Plants (OM Code) for the IST program at PVNGS Units 1, 2, and 3.

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) paragraph 50.55a(z)(1), RR PRR-06 proposes an alternative to the requirements of the ASME OM Code for use of vibration-measuring transducers with frequency response from one-third minimum pump shaft rotational speeds at 1,000 hertz (Hz) during Group A and comprehensive IST. The basis for the request is that use of the proposed alternative will provide an acceptable level of quality and safety.

Pursuant to 10 CFR 50.55a(z)(2), RR No. PRR-01 proposes an alternative from the requirements of the ASME OM Code for measurement of the flow rate for Group B testing of essential auxiliary feedwater pumps. RR No. PRR-02 proposes an alternative from the requirements of the ASME OM Code relative to the diesel generator fuel oil transfer pumps suction pressure instrument accuracy. RR Nos. PRR-03 PRR-04, and PRR-05 propose alternatives to the requirements of ASME OM Code for the flow measurement during Group A and Group B testing of the low-pressure safety injection, high-pressure safety injection, and containment spray pumps. The basis for these requests is that the ASME OM Code requirements present an undue hardship without a compensating increase in the level of quality and safety.

The licensee's letter dated February 23, 2017, also included RR Nos. GRR-01 and GRR-02. These RRs were formally withdrawn by the licensee by letter dated March 10, 2017.

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the licensee's submittal and determined that the proposed alternative in RR No. PRR-06 provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). The NRC staff also determined that the proposed alternatives in RR Nos. PRR-01, PRR-03, PRR-04, and PRR-05 provide reasonable assurance that the affected pumps are operationally ready and compliance with the requirements of ASME OM Code would result in hardship or unusual difficulty without a compensating increase in quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(2). The NRC staff further determined that the proposed alternative in RR PRR-02 provides reasonable assurance that the affected pumps are operationally ready and compliance with the ASME OM Code requirement for instrument accuracy is impractical for the diesel fuel oil transfer pumps. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(f)(5)(iii).

Therefore, the NRC staff authorizes alternative requests PRR-01, PRR-02, PRR-03, PRR-04, PRR-05, and PRR-06 for PVNGS Units 1, 2 and 3 for the fourth 10-year IST program interval, which is scheduled to begin on January 15, 2018, and currently schedule to end on January 14, 2028.

All other ASME OM Code requirements for which relief was not specifically requested and approved remain applicable.

If you have any questions, please contact the Project Manager, Siva P. Lingam, at 301-415-1564 or via e-mail at Siva.Lingam@nrc.gov.

Sincerely,

/RA/

Robert J. Pascarelli, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-528, STN 50-529,
and STN 50-530

Enclosure:
Safety Evaluation

cc: Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUESTS PRR-01, PRR-02, PRR-03, PRR-04, PRR-05, AND PRR-06

FOURTH 10-YEAR INTERVAL PUMP AND VALVE INSERVICE TESTING PROGRAM

ARIZONA PUBLIC SERVICE COMPANY

PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3

DOCKET NOS. 50-528, 50-529, AND 50-530

1.0 INTRODUCTION

By letter dated February 23, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17054D687), as supplemented by letters dated March 10, August 16, and September 29, 2017 (ADAMS Accession Nos. ML17069A319, ML17228A795, and ML17272B033, respectively), Arizona Public Service Company (APS, the licensee), submitted Relief Request (RR) Nos. PRR-01, PRR-02, PRR-03, PRR-04, PRR-05, and PRR-06 for Palo Verde Nuclear Generating Station (PVNGS), Units 1, 2, and 3. The RRs request for approval of the use of alternatives in lieu of the inservice testing (IST) requirements of the American Society of Mechanical Engineers (ASME) Code for Operation and Maintenance of Nuclear Power Plants (OM Code) for the IST program at PVNGS Units 1, 2, and 3.

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) paragraph 50.55a(z)(1), "Acceptable level of quality and safety," RR No. PRR-06 proposes an alternative to the requirements of ASME OM Code for use of vibration-measuring transducers with frequency response from one-third minimum pump shaft rotational speeds at 1,000 hertz (Hz) during Group A and comprehensive IST. The basis for the request is that use of the proposed alternative for charging pumps will provide an acceptable level of quality and safety.

Pursuant to 10 CFR 50.55a(z)(2), "Hardship without a compensating increase in quality and safety," RR No. PRR-01 proposes an alternative from the requirements of the ASME OM Code for measurement of the flow rate for Group B testing of essential auxiliary feedwater (AF) pumps. Pursuant to 10 CFR 50.55a(f)(5)(iii), "IST program update: Notification of impractical IST Code requirements," RR No. PRR-02 proposes an alternative from the requirements of the ASME OM Code relative to the diesel generator fuel oil (DGFO) transfer pumps suction pressure instrument accuracy. Pursuant to 10 CFR 50.55a(z)(2), RR Nos. PRR-03 PRR-04, and PRR-05 propose alternatives to the requirements of ASME OM Code for the flow measurement during Group A and Group B testing of the low-pressure safety injection (LPSI), high-pressure safety injection (HPSI), and containment spray (CS) pumps. The basis for these requests is that the ASME OM Code requirements present an undue hardship without a compensating increase in the level of quality and safety for RR Nos. PRR-01, PRR-03, PRR-04 and PRR-05, and impracticality for RR No. PRR-02.

The licensee's letter dated February 23, 2017, also included RR Nos. GRR-01 and GRR-02. These RRs were formally withdrawn by the licensee by letter dated March 10, 2017.

2.0 REGULATORY EVALUATION

Section 50.55a(f), "Preservice and inservice testing requirements," of 10 CFR states, in part, that IST of certain ASME Code Class 1, 2, and 3 pumps and valves be performed in accordance with the specified ASME OM Code and applicable addenda incorporated by reference in the regulations.

Section 50.55a(z), "Alternatives to codes and standards requirements," of 10 CFR states that alternatives to the requirements of paragraph (f) of 10 CFR 50.55a may be used, when authorized by the U.S. Nuclear Regulatory Commission (NRC), if the licensee demonstrates (1) the proposed alternatives would provide an acceptable level of quality and safety or (2) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Paragraph 50.55a(f)(5)(iii) of 10 CFR states, in part, that "[i]f a licensee has determined that conformance with certain Code requirements is impractical for its facility, the licensee must notify the Commission and submit...information to support the determination."

Paragraph 50.55a(f)(5)(iv), "IST program update: Schedule for completing impracticality determinations," of 10 CFR states, in part, that "[w]here a pump or valve test requirement by the Code or addenda is determined to be impractical by a licensee and is not included in the revised inservice test program (as permitted by paragraph [10 CFR 50.55a(f)(4)]), the basis for this determination must be submitted for NRC review and approval not later than 12 months after the expiration of the initial 120-month interval of operation from the start of facility commercial operation and each subsequent 120-month interval of operation during which the test is determined to be impractical."

Paragraph 50.55a(f)(6)(i), "Impractical IST requirements: Granting of relief," of 10 CFR states, in part, that "[t]he Commission will evaluate determinations, under paragraph [10 CFR 50.55a(f)(5)], that code requirements are impractical. The Commission may grant such relief and may impose such alternative requirements as it determines are authorized by law, will not endanger life or property or the common defense and security, and are otherwise in the public interest, giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility."

Based on the above, and subject to the following technical evaluation, the NRC staff finds that regulatory authority exists for the licensee to request and the Commission to authorize the alternatives requested by the licensee.

3.0 TECHNICAL EVALUATION

3.1 Licensee's Alternative Request PRR-01

Applicable Code Requirements

Paragraph ISTB-3300, "Reference Values," (e)(2), states, "Reference values shall be established at the comprehensive pump test flow rate for the Group A and Group B tests, if

practicable. If not practicable, the reference point flow rate shall be established at the highest practical flow rate."

Paragraph ISTB-5122, "Group B Test Procedure," states, in part, that "Group B tests shall be conducted with the pump operating as close as practical to a specified reference point and within the variances from the reference point as described in this paragraph. The test parameter value identified in Table ISTB-3000-1, 'Inservice Test Parameters,' shall be determined and recorded as required by this paragraph."

Paragraph ISTB-5122(b), states, "The differential pressure or flow rate shall be determined and compared to its reference value."

Components for Which Relief is Requested

Table 3.1

Palo Verde Unit	Pump ID	Pump Description	Code Class	Pump Group
Unit 1	1MAFAP01	Essential AF Pump (Turbine-Driven)	3	B
Unit 1	1MAFBP01	Essential AF Pump (Motor-Driven)	3	B
Unit 2	2MAFAP01	Essential AF Pump (Turbine-Driven)	3	B
Unit 2	2MAFBP01	Essential AF Pump (Motor-Driven)	3	B
Unit 3	3MAFAP01	Essential AF (Turbine-Driven)	3	B
Unit 3	3MAFBP01	Essential AF Pump (Motor-Driven)	3	B

The PVNGS Units 1, 2, and 3 fourth 10-year IST program interval begins on January 15, 2018, and is scheduled to end on January 14, 2028. The applicable ASME OM Code edition for the PVNGS Units 1, 2, and 3 fourth 10-year IST program interval is the 2012 Edition.

Component/System Function

In its letter dated February 23, 2017, the licensee states, in part:

> The essential AF pumps supply water to the steam generators during accident. They also may be used to supply feedwater to the steam generators during plant startup and shutdown, although the non-class AF pump normally fulfills that function.

Reason for Alternative Request

In its letter dated February 23, 2017, the licensee states, in part:

> The licensee stated that the ASME OM Code requires to establish the Group B reference point flow rate at the comprehensive test flow rate or at the highest

practical flow rate and to operate the pump at a specified reference point (i.e., fix the flow to a specified value). Measurement of flow is considered a hardship since this is a fixed resistance recirculation path with no flow instrumentation provided. When the pump operates on a minimum flow recirculation (approximately 260 gallons per minute (gpm)), the specified reference point is essentially achieved by the recirculation line's fixed resistance. To establish the fixed resistance, the minimum flow recirculation line contains an administratively controlled locked-throttled drag valve and a locked open manual isolation valve. The drag valve is entirely passive and treated as an orifice. The hand wheels are removed and the valves are locked in position. There [is no operation procedure(s)] that manipulate the valve. There are no maintenance tasks associated with the valve. The use of an ultrasonic flowmeter was evaluated and determined nonviable due to the difficulty in establishing an application-specific 2% calibration on the AF mini-flow piping. Allowing the flow to be remained fixed by the locked-in resistance increases the potential for repeatable test results and degradation monitoring rather than changing the resistance based on ultrasonic flowmeter readout fluctuations. With this understanding, there is little value added in installing ISTB-3510, ["General,"] compliant flow instrumentation in the minimum flow recirculation line to measure the flow. The fixed resistance methodology is repeatable from test to test and accomplishes the same result as if flow were being measured and recorded.

To comply with the ASME OM Code, there are only two practical flow paths available for testing [AFAP01 and AFBP01]. The primary flow path is into the main feedwater lines to the steam generators. The other flow path is the minimum flow recirculation line that recirculates back to the condensate storage tank. The flow path to the steam generators is equipped with flow instrumentation, but the recirculation line is a fixed-resistance circuit with no provisions for flow indication.

Use of the primary flow path at power would inject cold AF into the main feedwater lines. The resulting temperature perturbations could lead to thermal shock/fatigue damage to the feedwater piping and steam generators, and the cooldown of the reactor coolant system could cause undesirable reactivity variations and power fluctuations.

Modifying the minimum flow recirculation line to provide flow indication to meet the ± 2% accuracy requirement (as specified in Table ISTB-3510-1, *Required Instrument Accuracy*) adds little value, since the flow is fixed at approximately 260 gpm and differential pressure is used to monitor degradation. Use of an ultrasonic flow meter and possible adjustment of the fixed resistance introduces the potential for less accurate degradation monitoring than currently employed.

Proposed Alternative

The essential AF pumps are standby pumps that are normally idle during plant operation, except for testing. Little degradation is expected during plant operation when the pumps are idle except for testing. Testing the pumps within ± 20 percent of design flow on a 2-year frequency provides additional information regarding the condition of the pumps. During plant operation, quarterly Group B pump testing for the essential AF pumps listed in Table 3.1 of this safety evaluation (SE) shall be conducted at mini-flow conditions using the minimum flow recirculation line fixed resistance to establish the

specified reference point. Paragraph ISTB-5100, "Centrifugal Pumps (Except Vertical Line Shaft Centrifugal Pumps)," (b)(2) allows the use of the bypass test loops to be used for Group B tests. The PVNGS minimum flow recirculation line is designed to meet the pump manufacturer's operating specifications of approximately 260 gpm. Flow rate will not be measured or recorded. To monitor for degradation, pump differential pressure shall be determined and compared to its reference value and the associated Acceptance, Alert and Required Action Ranges as specified in Table ISTB-5121-1, "Centrifugal Pump Test Acceptance Criteria."

The essential AF pumps listed in Table 3.1 of this SE will be comprehensively tested in accordance with ISTB-5123, "Comprehensive Test Procedure," on a biennial (2-year) frequency as specified in Table ISTB-3400-1, "Inservice Test Frequency," and meet the requirements of Mandatory Appendix V, "Pump Periodic Verification Test Program," as specified in ISTB-1400, "Owner's Responsibility," (d).

NRC Staff Evaluation

The essential AF pumps listed in Table 3.1 of this SE are classified as Group B pumps in accordance with the requirements in ISTB-1400 and ISTB-2000, "Supplemental Definitions." Table ISTB-3400-1 requires that Group B pumps be tested quarterly and biennially. Requirements for the quarterly test are less rigorous than the requirements for the comprehensive pump test. Quarterly Group B essential AF pump tests are normally performed when the plant is operating. Comprehensive essential AF pump tests are performed biennially during an outage, shutdown, or startup. Paragraph ISTB-5122 and Table ISTB-3400-1 state that quarterly tests shall be conducted with the pumps operating at a specified reference point.

The recirculation flow path used for the essential AF pumps listed in Table 3.1 of this SE is a fixed resistance flow path. The flow minimum flow recirculation is designed to meet the pump manufacturer's operating specifications of approximately 260 gpm. There is no flow instrumentation installed in the flow path. The NRC staff considers the installation of flow instrumentation to be an undue burden when compared to the limited benefits gained by the results of the specified quarterly pump tests. During the performance of the quarterly pump testing, pump differential pressure will be measured and trended. This provides a reference value for differential pressure that can be duplicated during subsequent tests. Pump flow rate will not be varied, measured, or recorded during the performance of the quarterly AF pump tests. This methodology provides for the acquisition of repeatable differential pressure during essential AF pump Group B quarterly testing, which is an adequate means of providing reasonable assurance of the operational readiness of the pumps. The performance of pump tests using a noninstrumented recirculation flow path is an acceptable alternative per Position 9 of Generic Letter (GL) 89-04, "Guidance on Developing Acceptable Inservice Testing Programs," provided that comprehensive pump testing is also performed biennially. Biennial comprehensive pump testing requires that essential AF pump differential pressure and flow rate be measured and evaluated together to determine pump hydraulic performance.

Based on the above evaluation, the NRC staff determined that the alternative provides reasonable assurance of the operational readiness of the AF pumps listed in Table 3.1 of this SE and that compliance with the specified ASME OM Code requirement for flow instrumentation would result in a hardship, without a compensating increase in the level of quality and safety.

3.2 Licensee's Relief Request PRR-02

Applicable Code Requirements

The licensee requested relief from the instrument accuracy requirements of the ASME OM Code.

Paragraph ISTB-3510 (a), "Accuracy," states, in part, "Instrument accuracy shall be within the limits of Table ISTB-3510-1."

Table ISTB-3510-1 provides the accuracy limits for the comprehensive pump test (CPT) and preservice test. The accuracy for pressure is ± 2.0 percent for the Group A test and ± 0.5 percent for the CPT and preservice test.

Components for Which Relief is Requested

The licensee has requested to use the proposed alternative described below for the pumps listed in Table 3.2-1 of this SE.

Table 3.2-1

Pump ID	Pump Description	ASME Code Class	ASME OM Pump Group
1MDFAP01	Unit 1 DGFO Transfer Pump A	3	B
1MDFBP01	Unit 1 DGFO Transfer Pump B	3	B
2MDFAP01	Unit 2 DGFO Transfer Pump A	3	B
2MDFBP01	Unit 2 DGFO Transfer Pump B	3	B
3MDFAP01	Unit 3 DGFO Transfer Pump A	3	B
3MDFBP01	Unit 3 DGFO Transfer Pump B	3	B

The PVNGS Units 1, 2, and 3 fourth 10-year IST program interval begins on January 15, 2018, and is scheduled to end on January 14, 2028. The applicable ASME OM Code edition for the PVNGS Units 1, 2, and 3 fourth 10-year IST program interval is the 2012 Edition.

Reason for Alternative Request

The licensee stated that the ASME OM Code requirements for instrument accuracy are impractical for the testing of the pumps listed in Table 3.2-1 and would present a burden if those requirements were imposed, without providing significantly more accurate suction pressure data for evaluating pump degradation.

The DGFO transfer pumps are horizontal centrifugal submersible pumps that operate submerged in the DGFO storage tank. The pumps do not have inlet pressure gauges.

The DGFO storage tank has level instrumentation (DFN-LI-33 and DFN-LI-34) with a calculated loop accuracy of ± 1.5 percent. The instrument reads out in percent of tank level, and this is converted to suction pressure during the pump inservice tests. The calibrated instrument range results in a suction pressure range of 0.2 pounds per square inch gauge (psig) to 4.4 psig. The instrument accuracy of ± 1.5 percent meets the ASME OM Code requirement for Group B pump tests but does not meet the ASME OM Code requirement of ± 0.5 percent for CPTs and preservice tests.

In order to comply with the ASME OM Code requirements for instrument accuracy for DGFO transfer pump suction measurement during CPTs and preservice tests, a redesign and installation of more accurate instrumentation would be required, with minimal benefit.

The DGFO storage tank level instrumentation converts to a full scale range of 4.4 psig, which is slightly greater than the DGFO transfer pump suction pressure reference value (P_r) of 3.8 psig. The full scale range is equal to 1.15 times the suction pressure reference value.

With the 1.5 percent accuracy of the DGFO storage tank level instrumentation, the reading of the suction pressure reference value of 3.8 psig could be between 3.74 psig and 3.85 psig, which is a difference of 0.11 psig. This difference is considered insignificant when monitoring for pump degradation.

Table 3.2-2

Instrument	Range (R)	Accuracy (A)	Range x Accuracy (R x A)	Maximum Variance (R x A x P_r)
ISTB-3510 allowed for CPTs and preservice tests	3 x Pr	± 0.5%	1.5% Pr	1.5% (3.8) = 0.057 psig
Installed Instruments	1.15 x Pr	±1.5%	1.7% Pr	1.7% (3.8) = 0.065 psig

The licensee stated that the current DGFO pump differential pressure reference value varies between 27.7 and 29.1 pounds per square inch differential (psid), with an average value of 28.4 psid. The difference between the ISTB-3510 allowed variance in differential pressure measurement, compared with the variance in the installed instruments, is insignificant when monitoring for pump degradation. As shown in Table 3.2-2 of this SE, the difference is 0.008 psig (0.065 psig – 0.057 psig).

The licensee also stated that Technical Specification (TS) Surveillance Requirement (SR) 3.8.3.1 requires that the DGFO storage tank fuel oil level be maintained at greater than or equal to (≥) 80 percent. The difference between the minimum allowable DGFO storage tank level and the top of the tank is 26.4 inches. The pump suction pressure does not vary by more than 0.7 psig. The licensee reviewed the previous 2 years of test history, and the maximum recorded variance in DGFO transfer pump suction pressure was 0.5 psig. Therefore the pump suction pressure is essentially constant.

Proposed Alternative

For the DGFO transfer pumps listed in Table 3.2-1 of this SE, during the CPTs and preservice tests, pump suction pressure will be measured and recorded using the installed instruments DFN-LI-33 and DFN-LI-34 in the DGFO storage tank.

NRC Staff Evaluation

DGFO transfer pumps listed in Table 3.2-1 of this SE are classified as Group B pumps in accordance with the requirements in ISTB-1400 and ISTB-2000. Paragraph ISTB-3510(a) and Table ISTB-3510-1 require that for the CPT and the preservice test, the pressure instrumentation has an accuracy of ± 0.5 percent.

The pumps are submerged in the DGFO oil storage tank and there are no inlet pressure gauges installed for this pump configuration. The system configuration and design make it impractical to install such gauges for the purpose of conducting IST.

The DGFO storage tank is equipped with level instrumentation (DFN-LI-33 and DFN-LI-34) having a calculated loop accuracy of ± 1.5 percent. The instrumentation reads out in percent of tank level, which is converted to suction pressure during the inservice tests. The calibrated instrument range results in a suction pressure span of 0.2 psig to 4.4 psig. This instrument accuracy does not meet the ± 0.5 percent accuracy as required by Table ISTB-3510-1 for CPTs and preservice tests.

The licensee's TS SR 3.8.3.1 requires that the DGFO storage tank be maintained at ≥ 80 percent capacity, which is verified every 31 days to assure sufficient supply for 7 days of diesel generator full load operation. The difference between minimum allowable tank level and top of the tank is 26.4 inches. Due to the fuel oil level controls, the pumps' suction pressure has little variation. The licensee's review of test history shows that the maximum variance recorded is approximately 0.5 psig. The suction pressure is essentially fixed by the TS level requirements, allowing for very little variation in suction pressure. The installed instrumentation converts to a full-scale range of 4.4 psig, which only slightly exceeds the pump suction reference value of 3.8 psig (full scale equals 1.15 times the reference value).

Considering the existing 1.5 percent accuracy of the level instrument, the reading could be as high as 3.85 psig or as low as 3.74 psig. This results in a 0.11 psig difference in the readings, which is considered insignificant when monitoring for degradation. The existing accuracy is equivalent to the 1.5 percent minimum accuracy allowed by the combination of instrument full-scale range and accuracy as specified in the ASME OM Code, for CPTs and preservice tests. This accuracy provides adequate assurance of operability. Also, the licensee's TS restrict the variance in the pumps' suction pressure to no more than 0.7 psig. The current instrumentation provides sufficient repeatability to allow for an evaluation of the pump hydraulic condition and detect pump degradation.

Based on the above evaluation, the NRC staff has concluded that compliance with the ASME OM Code requirement for instrument accuracy is impractical for the DGFO transfer pumps listed in Table 3.2-1 of this SE. The proposed alternative provides reasonable assurance that the DGFO transfer pumps are operationally ready.

3.3 Licensee's Alternative Request PRR-03

Applicable Code Requirements

The licensee requested an alternative to the Group A testing requirements of the ASME OM Code.

Paragraph ISTB-3300(e)(2) states, "Reference values shall be established at the comprehensive pump test flow rate for the Group A and Group B tests, if practicable. If not practicable, the reference point flow rate shall be established at the highest practical flow rate."

Paragraph ISTB-5121, "Group A Test Procedure," states, in part, "Group A tests shall be conducted with the pump operating as close as practical to a specified reference point and within the variances from the reference point as described in this paragraph. The test parameters shown in Table ISTB-3000-1 shall be determined and recorded as required by this paragraph."

Paragraph ISTB-5121(b), states, "The resistance of the system shall be varied until the flow rate is as close as practical to the reference point with the variance not to exceed +2% or -1% of the reference point. The differential pressure shall then be determined and compared to its reference value. Alternatively, the flow rate shall be varied until the differential pressure is as close as practical to the reference point with the variance not to exceed +1% or -2% of the reference point and the flow rate determined and compared with the reference flow rate."

Paragraph ISTB-5121(c), states, "Where it is not practical to vary system resistance, flow rate and pressure shall be determined and compared to their respective reference values."

Components for Which Relief is Requested

The licensee has requested to use the proposed alternative described below for the pumps listed in Table 3.3.

Table 3.3

Pump ID	Pump Description	ASME Code Class	ASME OM Pump Group
1MSIAP01	Unit 1 LPSI A Pump	2	A
1MSIBP01	Unit 1 LPSI B Pump	2	A
2MSIAP01	Unit 2 LPSI A Pump	2	A
2MSIBP01	Unit 2 LPSI B Pump	2	A
3MSIAP01	Unit 3 LPSI A Pump	2	A
3MSIBP01	Unit 3 LPSI B Pump	2	A

The PVNGS Units 1, 2, and 3 fourth 10-year IST program interval begins on January 15, 2018, and is scheduled to end on January 14, 2028. The applicable ASME OM Code edition for the PVNGS Units 1, 2, and 3 fourth 10-year IST program interval is the 2012 Edition.

Reason for Alternative Request

For a Group A pump test, the ASME OM Code requires the establishment of the Group A reference point flow rate at the CPT flow rate or at the highest practical flow rate, and the operation of the pump as close as practical to a specified reference point (i.e., fix the flow to a specified value). During normal plant operation, the LPSI pumps, with a design flow of 4,200 gpm, cannot develop sufficient discharge pressure to overcome reactor coolant system pressure and allow flow through the safety injection (SI) headers. Therefore, measurement of flow is considered a hardship since the Group A test flow path for the LPSI pumps is a fixed resistance recirculation path with limited capability flow instrumentation provided. The existing flow instrument is a 0 - 5,000 gpm ultrasonic flowmeter with an accuracy of ± 5 percent that

does not meet the ± 2 percent accuracy required in Table ISTB-3510-1. The licensee evaluated using an ultrasonic flowmeter with 2 percent accuracy and determined it was nonviable due to the difficulty in establishing an application specific 2 percent calibration on the minimum flow recirculation line. When the pump operates on minimum flow recirculation at a flow rate of approximately 180 gpm, the specified reference point is essentially achieved by the recirculation line's fixed resistance. The minimum flow recirculation line contains a flow orifice and a normally open motor-operated valve and solenoid isolation valve that establish the fixed resistance. A fixed resistance line allows the flow to remain constant and increases the potential for repeatable test results and degradation monitoring rather than changing the resistance based on flow meter readout fluctuations. With this understanding, there is little value added by replacing the existing flowmeter, or installing ISTB-3510 compliant flow instrumentation in the minimum flow recirculation line to measure flow. This fixed resistance methodology is repeatable from test to test and accomplishes the same result as if flow were being measured and recorded.

Modifying the minimum flow recirculation line to provide ASME OM Code-required flow indication accuracy of ± 2 percent adds little value since the flow is fixed at approximately 180 gpm and differential pressure is used to monitor degradation. Use of an ultrasonic flow meter and possible adjustment of the fixed resistance introduces the potential for less accurate degradation monitoring than currently employed.

Proposed Alternative

The LPSI pumps are normally used to provide shutdown cooling flow during shutdown operations, and they are occasionally used for recirculating the refueling water tank when the plant is at power. During plant operation, quarterly Group A pump testing for each LPSI pump shall be conducted at minimum flow conditions using the minimum flow recirculation line with fixed resistance to establish the specified reference point. Paragraph ISTB-5100(b)(1) allows the use of bypass test loops to be used for Group A tests. In accordance with ISTB-3300(e)(2), the flow rate will be established at the highest practical flow rate of 180 gpm. Flow rate will not be measured or recorded. To monitor for degradation, pump differential pressure shall be determined and compared to its reference value and the associated Acceptance, Alert and Required Action Ranges as specified in Table ISTB-5121-1. Vibration measurement will be conducted during the Group A tests in accordance with ISTB-3540, "Vibration."

In response to a request for additional information (RAI) dated September 29, 2017, the licensee stated that the proposed flow rate of 180 gpm is below the manufacturer's minimum continuous stable flow of 2,400 gpm. The licensee further stated that in response to NRC Bulletin 88-04, "Potential Safety-Related Pump Loss," its letter 161-04032 dated July 1, 1991 (Legacy Accession No. 9107120005) stated, in part: "The vendor's evaluation of the Safety Injection pumps indicated that the specified miniflow rates are below the minimum continuous stable flow point; however, the vendor never intended and recommends against running the pumps on miniflow for extended periods of time. At PVNGS, administrative controls and operating procedures are such that the Safety Injection pumps are not operated for extended periods of time at miniflow in accordance with the vendor technical manual recommendations." It is also stated that "Ingersoll-Rand verified the Safety Injection miniflow rates are sufficient to ensure no pump damage from low flow operation for short periods of time."

The licensee stated that under the IST program, the LPSI pump Group A test procedure limits the pump operating time based on flow rate. Operation at the 180 gpm miniflow rate is limited to 1 hour, providing margin to the vendor guidance. The vendor's minimum flow rate for safe

operation is 100 gpm for 1 hour. The licensee's operators ensure that the pump run-time limits are met during the Group A testing at the minimum flow condition.

In accordance with Table ISTB-3400-1, a CPT, in accordance with ISTB-5123, will be performed on each LPSI pump every 2 years. Also, the pumps will meet the requirements of Mandatory Appendix V as specified in ISTB-1400(d).

Since the LPSI pumps are used infrequently, little degradation is expected during plant operation when the pumps are not used except for limited operations and testing. Testing the pumps at the CPT flow rate on a 2-year frequency, and also satisfying Mandatory Appendix V, provides additional information regarding the condition of the pumps.

The licensee stated that this alternative request is a resubmittal of NRC-approved third 10-year interval PRR-03, which was based on the ASME OM Code-2001 Edition through the OMB 2003 Addenda. This fourth 10-year interval request is based on the ASME OM Code 2012 Edition. There have been no substantive changes to this alternative, to the ASME OM Code requirements or to the basis for use, which would alter the previous NRC SE conclusions.

NRC Staff Evaluation

The LPSI pumps listed in Table 3.3 of this SE are classified as Group A pumps in accordance with the requirements in ISTB-1400 and ISTB-2000. Table ISTB-3400-1 requires that Group A pumps be tested quarterly and biennially. Requirements for the quarterly Group A test are less rigorous than the requirements for the biennial CPT. The quarterly Group A tests for the LPSI pumps are normally performed when the plant is operating. The CPTs are performed biennially during an outage, shutdown, or startup. Paragraph ISTB-5121 and Table ISTB-3400-1 state that quarterly tests shall be conducted with the pumps operating at a specified reference point.

The recirculation flow path used for the LPSI pumps for the Group A tests is a fixed resistance flow path. There is limited capability flow instrumentation installed in the flow path. The NRC staff considers the installation of flow instrumentation to be an undue burden when compared to the limited benefits gained by the results of the specified quarterly pump tests. During the performance of the quarterly pump testing, pump differential pressure will be measured and trended. This provides a reference value for differential pressure that can be duplicated during subsequent tests. Pump flow rate will not be varied, measured, or recorded during the performance of the quarterly Group A tests. This methodology provides for the acquisition of repeatable differential pressure during LPSI pump Group A quarterly testing, which is an adequate means of providing reasonable assurance of the operational readiness of the pumps. The flow rate of for the Group A tests will be approximately 180 gpm, which is below the manufacturer's minimum continuous stable flow. However, the pump manufacturer's minimum flow for safe operation is 100 gpm for less than 1 hour, and the licensee is limiting the pump operation at 180 gpm to 1 hour, which is acceptable. Also, a CPT will be performed biennially, and the requirements of Mandatory Appendix V will be satisfied. A biennial CPT requires that LPSI pump differential pressure and flow rate be measured and evaluated together to determine pump hydraulic performance.

Based on the above evaluation, the NRC staff determined that the alternative provides reasonable assurance of the operational readiness of the LPSI pumps listed in Table 3.3 of this SE and that compliance with the specified ASME OM Code requirement for flow instrumentation would result in a hardship, without a compensating increase in the level of quality and safety.

3.4 Licensee's Alternative Request PRR-04

Applicable Code Requirements

Paragraph ISTB-3300(e)(2), states, "Reference values shall be established at the comprehensive pump test flow rate for the Group A and Group B tests, if practicable. If not practicable, the reference point flow rate shall be established at the highest practical flow rate."

Paragraph ISTB-5122 states, in part, that "Group B tests shall be conducted with the pump operating as close as practical to a specified reference point and within the variances from the reference point as described in this paragraph. The test parameter value identified in Table ISTB-3000-1 shall be determined and recorded as required by this paragraph."

Paragraph ISTB-5122(b), states, "The differential pressure or flow rate shall be determined and compared to its reference value."

Paragraph ISTB-5122(c), states, in part, that "System resistance may be varied as necessary to achieve a point as close as practical to the reference point. If the reference point is flow rate, the variance from the reference point shall not exceed +2% or -1%."

Components for Which Relief is Requested:

Table 3.4

Palo Verde Unit	Pump ID	Pump Description	Code Class	Pump Group
Unit 1	1MSIAP02	HPSI Pump A	2	B
Unit 1	1MSIBP02	HPSI Pump B	2	B
Unit 2	2MSIAP02	HPSI Pump A	2	B
Unit 2	2MSIBP02	HPSI Pump B	2	B
Unit 3	3MSIAP02	HPSI Pump A	2	B
Unit 3	3MSIBP02	HPSI Pump B	2	B

The PVNGS Units 1, 2, and 3 fourth 10-year IST program interval begins on January 15, 2018, and is scheduled to end on January 14, 2028. The applicable ASME OM Code edition for the PVNGS Units 1, 2, and 3 fourth 10-year IST program interval is the 2012 Edition.

Component/System Function

In its letter dated February 23, 2017, the licensee stated, in part:

> The HPSI pumps provide high-pressure coolant injection of borated water into the reactor coolant system (RCS) under accident conditions. They also provide flow for long-term cooling and flushing to prevent boron precipitation."

Reason for Alternative Request

In its letter dated February 23, 2017, the licensee stated in part:

> The ASME OM Code requirements to establish the Group B reference point flow rate at the highest practical flow rate and operate the pump at a specified reference point (i.e., fix the flow to a specified value) is considered a hardship since this is a fixed resistance recirculation path of approximately 170 gallons per minute (gpm), which is measured by limited capability permanent plant flow instrumentation. The installed flowmeter is on a common recirculation line to the Refueling Water Tank. This instrumentation is a 0-5000 gpm ultrasonic flowmeter with ± 5% accuracy and does not meet the ± 2% instrument requirements of Table ISTB-3510-1, *Required Instrument Accuracy*, for pump testing. The use of an ultrasonic flowmeter with 2% accuracy was evaluated and determined to be nonviable due to the difficulty in establishing an application specific 2% calibration on the SI mini-flow piping. To establish the fixed resistance, the minimum flow recirculation line contains a flow orifice and a normally open motor-operated valve and solenoid isolation valve. Allowing the flow to remain fixed by the orifice resistance increases the potential for repeatable test results and degradation monitoring rather than attempting to change the resistance based on ultrasonic flowmeter readout fluctuations. When the pump operates on minimum flow recirculation, the specified reference point is essentially achieved by the fixed resistance.
>
> With this understanding, there is little value added in replacing the existing 0-5000 gpm, ± 5 percent ultrasonic flowmeter, or adding instrumentation that meets ISTB-3510(a), *Accuracy,* requirements. The fixed resistance methodology is repeatable from test to test and accomplishes the same result as if flow were being measured and recorded.
>
> ...
>
> The HPSI pumps are categorized as Group B. During normal operation, the HPSI pumps are generally in standby except for pump testing. Pump 1MSIBP02, 2MSIBP02 and 3MSIBP02 are used occasionally to recharge the SI tanks. Minimal degradation is expected during plant operation with this limited use. Thus, the alternate testing will adequately monitor these pumps to ensure continued operability and availability for accident mitigation.
>
> Modifying the minimum flow recirculation line to provide flow indication to meet the ± 2% accuracy requirement as specified in Table ISTB-3510-1 adds little value since the flow is fixed and differential pressure is used to monitor degradation.

Proposed Alternative

In its letter dated February 23, 2017, the licensee stated in part:

> During plant operation, quarterly Group B pump testing for the HPSI pumps [listed in Table 3.4] shall be conducted at mini-flow conditions using the minimum flow recirculation line fixed resistance of approximately 170 gpm to establish the specified reference point.
>
> [Paragraph] ISTB-5100(b)(2) allows the use of the bypass test loops to be used for Group B tests. The PVNGS minimum flow recirculation line is designed to meet the pump manufacturer's operating specifications. The flow rate through the loop is established at the highest practical flow rate of approximately 170 gpm in accordance with ISTB-3300(e)(2). Flow rate will not be measured or recorded. To monitor for degradation, pump differential pressure shall be determined and compared to its reference value and the associated Acceptable and Required Action Ranges as specified in Table ISTB-5121-1, *Centrifugal Pump Test Acceptance Criteria*.

In response to an RAI by letter dated September 29, 2017, the licensee stated that the proposed flow rate of 170 gpm is below the manufacturer's minimum continuous stable flow of 225 gpm. The licensee further stated that the HPSI pump quarterly Group B test procedure limits pump operating time based on flow rate. Operation at 170 gpm mini-flow rate is limited to 1 hour, providing margin to the vendor guidance. The manufacturer's minimum flow for safe operation of less than 1 hour is 85 gpm. Operators ensure pump run-time limits are met during quarterly testing at minimum flow conditions. The licensee's procedures reflect awareness that HPSI pump minimum recirculation flow lines are sized to allow pump operation on a time-limited basis. Mini-flow test flow rates are greater than the manufacturer-specified minimum flow for safe operation for a minimum duration.

The HPSI pumps listed in Table 3.4 of this SE will be comprehensively tested in accordance with ISTB-5123 on a biennial (2-year) frequency as specified in Table ISTB-3400-1 and meet the requirements of Mandatory Appendix V as specified in ISTB-1400(d).

The HPSI pumps listed in Table 3.4 of this SE are infrequently used pumps. Minimum degradation is expected during plant power operation when the pumps are idle, except for limited operations and testing. Testing the pumps at the comprehensive pump flow test flow rate on a 2-year frequency, while satisfying Mandatory Appendix V, provides additional information regarding the condition of the pumps.

NRC Staff Evaluation

The HPSI pumps listed in Table 3.4 of this SE are classified as Group B pumps in accordance with the requirements in ISTB-1400 and ISTB-2000. Table ISTB-3400-1 requires that Group B pumps be tested quarterly and biennially. Requirements for the quarterly test are less rigorous than the requirements for the comprehensive pump test. Quarterly Group B HPSI pump tests are normally performed when the plant is operating. Comprehensive HPSI pump tests are performed biennially during an outage, shutdown, or startup. Paragraph ISTB-5122 and Table ISTB-3400-1 state that quarterly tests shall be conducted with the pumps operating at a specified reference point.

The recirculation flow path used for the HPSI pumps listed in Table 3.4 of this SE is a fixed resistance flow path. There is limited capability flow instrumentation installed in the flow path. The NRC staff considers the installation of flow instrumentation to be an undue burden when compared to the limited benefits gained by the results of the specified quarterly pump tests. During the performance of the quarterly pump testing, pump differential pressure will be measured and trended. This provides a reference value for differential pressure that can be duplicated during subsequent tests. Pump flow rate will not be varied, measured, or recorded during the performance of the quarterly HPSI pump tests. This methodology provides for the acquisition of repeatable differential pressure during HPSI pump Group B quarterly testing, which is an adequate means of providing reasonable assurance of the operational readiness of the pumps. The performance of pump tests using noninstrumented recirculation flow path is an acceptable alternative per Position 9 of GL 89-04, provided comprehensive testing also performed biennially. The flow rate for the Group B tests for 1 hour will be approximately 170 gpm, which is above the manufacturer's minimum flow for safe operation for 1 hour, and the pump will not be subjected to dead head conditions during the tests. The biennial comprehensive pump testing requires that HPSI pump differential pressure and flow rate be measured and evaluated together to determine pump hydraulic performance.

Based on the above evaluation, the NRC staff determined that the alternative provides reasonable assurance of the operational readiness of the HPSI pumps listed in Table 3.4 of this SE and that compliance with the specified ASME OM Code requirement for flow instrumentation would result in a hardship, without a compensating increase in the level of quality and safety.

3.5 Licensee's Alternative Request PRR-05

Applicable Code Requirements

Paragraph ISTB-3300(e)(2), states, "Reference values shall be established at the comprehensive pump test flow rate for the Group A and Group B tests, if practicable. If not practicable, the reference point flow rate shall be established at the highest practical flow rate."

Paragraph ISTB-5121 states, in part, that "Group A tests shall be conducted with the pump operating as close as practical to a specified reference point and within the variances from the reference point as described in this paragraph. The test parameters shown in Table ISTB-3000-1 shall be determined and recorded as required by this paragraph."

Paragraph ISTB-5121(b) states, "The resistance of the system shall be varied until flow rate is as close as practical to the reference point with the variance not to exceed +2% or -1% of the reference point. The difference pressure shall then be determined and compared to its reference value. Alternatively, the flow rate shall be varied until the differential pressure is as close as practical to the reference point with the variance not to exceed +1% or -2% of the reference point and the flow rate determined and compared with the reference flow rate."

Paragraph ISTB-5121(c), states, "Where it is not practical to vary system resistance, flow rate and pressure shall be determined and compared to their respective reference values."

Components for Which Relief is Requested:

Table 3.5

Palo Verde Unit	Pump ID	Pump Description	Code Class	Pump Group
Unit 1	1MSIAP03	CS Pump A	2	A
Unit 1	1MSIBP03	CS Pump B	2	A
Unit 2	2MSIAP03	CS Pump A	2	A
Unit 2	2MSIBP03	CS Pump B	2	A
Unit 3	3MSIAP03	CS Pump A	2	A
Unit 3	3MSIBP03	CS Pump B	2	A

The PVNGS, Units 1, 2, and 3 fourth 10-year IST program interval begins on January 15, 2018, and is scheduled to end on January 14, 2028. The applicable ASME OM Code edition for the PVNGS Units 1, 2, and 3 fourth 10-year IST program interval is the 2012 Edition.

Component/System Function

In its letter dated February 23, 2017, the licensee stated, in part:

> The CS pumps deliver borated water to the containment spray headers, providing containment cooling and pressure control during accident condition. The CS pumps can also be lined up to provide flow for shutdown cooling.

Reason for Alternative Request

In its letter dated February 23, 2017, the licensee stated, in part:

> The ASME OM Code requires the Group A reference point flow rate to be established at the comprehensive pump test flow rate if practicable or at the highest practical flow rate, and to operate the pump at a specified reference point (i.e., fix the flow to a specified value). It is considered a hardship to meet this requirement since this is a fixed resistance recirculation path of approximately 190 gallons per minute (gpm) with limited capability permanent plant flow instrumentation.
>
> The installed instrumentation is a 0-5000 gpm ultrasonic flowmeter with ± 5% accuracy and does not meet the 2% instrument requirements of Table ISTB-3510-1, *Required Instrument Accuracy*, for pump testing. The use of an ultrasonic flowmeter with 2% accuracy was evaluated and determined nonviable due to the difficulty in establishing an application specific 2% calibration on the SI mini-flow piping.
>
> To establish the fixed resistance the minimum flow recirculation line contains a flow orifice and a normally open motor-operated valve and solenoid isolation valve. Allowing the flow to remain fixed by the orifice resistance increases the potential for repeatable test results and degradation monitoring rather than attempting to change the resistance based on ultrasonic flowmeter readout fluctuations. When the pump operates on minimum flow recirculation, the specified reference point is essentially achieved by the fixed resistance. With

this understanding, there is little value added in replacing the existing 0-5000 gpm, ± 5% ultrasonic flowmeter, or adding instrumentation that meets ISTB-3510(a), *Accuracy*, requirements. The fixed resistance methodology is repeatable from test to test and accomplishes the same result as if flow were being measured and recorded.

The normal CS flow path cannot be used for testing the CS pumps without spraying down the inside of the containment building and risking damage to important equipment. The reactor coolant system (RCS) injection portion of the shutdown cooling flow path cannot be used for testing during plant operation because the CS pumps are unable to develop sufficient discharge pressure to overcome RCS pressure.

The minimum-flow recirculation flow path is a fixed resistance circuit containing a flow-limiting orifice capable of passing only a small fraction (approximately 190 gpm) of the design flow (3890 gpm). The permanent plant 0-5000 gpm, ± 5 percent accuracy, flow instrumentation (permanently mounted ultrasonic flowmeter) has only limited capability, and does not meet the Table ISTB-3510-1 flow rate accuracy requirement for ±2%. This instrumentation is on a common recirculation line to the Refueling Water Tank. A larger recirculation flow path is available; however, this requires an alternate line up and the same limited capability flow instrument exists in this portion of the recirculation line.

The larger recirculation flow path is capable of carrying higher flow, but routine surveillance testing at less than the full flow reference value is not practical because of the pump rumble range (1800-2800 gpm). Testing in or near the rumble range is not practical because of the potential for equipment damage. Testing at flow rates above the rumble range (> 2800 gpm) is not practical because flow velocities in the recirculation piping would exceed the design criteria.

The CS pumps are categorized as Group A since they are normally used to provide shutdown cooling flow during shutdown operations. This infrequent use is expected to result in minimal degradation during plant operation. Thus, the alternate testing will adequately monitor these pumps to ensure continued operability and availability for accident mitigation.

Modifying the minimum flow recirculation line to provide flow indication to meet the ± 2% accuracy requirement as specified in Table ISTB-3510-1 adds little value since the flow is fixed and differential pressure is used to monitor degradation.

Proposed Alternative

In its letter dated February 23, 2017, the licensee stated, in part:

> During plant operation, quarterly Group A pump testing for the CS pumps [listed in Table 3.5 of this SE] shall be conducted at mini-flow conditions using the minimum flow recirculation line fixed resistance of approximately 190 gpm to establish the specified reference point. [Paragraph] ISTB-5100(b), *Bypass*

Loops, subparagraph (1) allows the use of the bypass test loops to be used for Group A tests. The flow rate through the loop is established at the highest practical flow rate of approximately 190 gpm in accordance with ISTB-3300(e)(2). Flow rate will not be measured or recorded. To monitor for degradation, pump differential pressure shall be determined and compared to its reference value and the associated Acceptable and Required Action Ranges as specified in Table ISTB-5121-1, *Centrifugal Pump Test Acceptance Criteria*. Vibration measurement will be conducted quarterly in accordance with ISTB-3540, *Vibration*.

In response to an RAI by letter dated September 29, 2017, the licensee stated that the proposed flow rate of 190 gpm is below the manufacturer's minimum continuous stable flow of 2100 gpm. The licensee further stated that the CS pump quarterly Group A test procedure limits pump operating time based on flow rate. Operation at 190 gpm mini-flow rate is limited to 1 hour, providing margin to the vendor guidance. The manufacturer's minimum flow for safe operation of less than 1 hour is 150 gpm. Operators ensure pump run-time limits are met during quarterly testing at minimum flow conditions. The APS procedures reflect awareness that CS pump minimum recirculation flow lines are sized to allow pump operation on a time-limited basis. Mini-flow test flow rates are greater than the manufacturer-specified minimum flow for safe operation for a minimum duration.

The CS pumps listed in Table 3.5 of this SE will be comprehensively tested in accordance with ISTB-5123 on a biennial (2-year) frequency as specified in Table ISTB-3400-1, and meet the requirements of Mandatory Appendix V as specified in ISTB-1400(d).

The CS pumps listed in Table 3.5 of this SE are infrequently used pumps. Little degradation is expected during plant power operation when the pumps are idle, except for limited operations and testing. Testing the pumps at comprehensive pump test flow rate on a 2-year frequency, while satisfying Mandatory Appendix V, provides additional information regarding the condition of the pumps.

NRC Staff Evaluation

The CS pumps listed in Table 3.5 of this SE are classified as Group A pumps in accordance with the requirements in ISTB-1400 and ISTB-2000. Table ISTB-3400-1 requires that Group A pumps be tested quarterly and biennially. Requirements for the quarterly test are less rigorous than the requirements for the comprehensive pump test. Quarterly Group A CS pump tests are normally performed when the plant is operating. Comprehensive CS pump tests are performed biennially during an outage, shutdown, or startup. Paragraph ISTB-5122 and Table ISTB-3400-1 state that quarterly tests shall be conducted with the pumps operating at a specified reference point. The normal CS flow path cannot be used for testing the CS pumps without spraying down the inside of the containment building and risking damage to important equipment. The RCS injection portion of the shutdown cooling flow path cannot be used for testing during plant operation because the CS pumps are unable to develop sufficient discharge pressure to overcome RCS pressure.

A larger recirculation flow path is available for the CS pumps. However, this flow path requires an alternate lineup and the same limited capability flow instrument exists in this portion of the recirculation line. The larger recirculation flow path is capable of carrying higher flow, but routine surveillance testing at less than the full flow reference value is not desirable because of high pump vibration that occurs in this flow range (1800-2800 gpm). Testing in or near this flow

range is not desirable because of the potential for pump damage due to high vibration. Testing at flow rates above 2800 gpm is not desirable because flow velocities in the recirculation piping would exceed the design criteria.

The minimum flow recirculation flow path used for the CS pumps listed in Table 3.5 of this SE is a fixed resistance flow path. The flow in this path is approximately 190 gpm. There is limited capability flow instrumentation installed in the flow path. The NRC staff considers the installation of flow instrumentation to be an undue burden when compared to the limited benefits gained by the results of the quarterly pump tests. During the performance of the quarterly pump testing, pump differential pressure will be measured and trended. This provides a reference value for differential pressure that can be duplicated during subsequent tests. Pump flow rate will not be varied, measured, or recorded during the performance of the quarterly CS pump tests. This methodology provides for the acquisition of repeatable differential pressure during CS pump Group A quarterly testing, which is an adequate means of providing reasonable assurance of the operational readiness of the pumps. The performance of pump tests using a noninstrumented recirculation flow path is an acceptable alternative per Position 9 of GL 89-04, provided that comprehensive pump testing is also performed biennially. The flow rate for the Group A tests for 1 hour will be approximately 190 gpm, which is above the manufacturer's minimum flow for safe operation for 1 hour, and the pumps will not be subjected to dead head conditions during the tests. Biennial comprehensive testing requires that CS pump differential pressure and flow rate be measured and evaluated together to determine pump hydraulic performance.

Based on the above evaluation, the NRC staff determined that the alternative provides reasonable assurance of the operational readiness of the CS pumps listed in Table 3.5 of this SE and that compliance with the specified ASME OM Code requirement for flow instrumentation would result in a hardship, without a compensating increase in the level of quality and safety.

3.6 Licensee's Alternative Request PRR-06

Applicable Code Requirements

Paragraph ISTB-3510(e), "Frequency Response Range," states, "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."

Components for Which Relief is Requested:

Table 3.6

Palo Verde Unit	Pump ID	Pump Description	Code Class	Pump Group
Unit 1	1MCHAP01	Charging (CH) Pump A	2	A
Unit 1	1MCHBP01	CH Pump B	2	A
Unit 1	1MCHEP01	CH Pump E	2	A
Unit 2	2MCHAP01	CH Pump A	2	A
Unit 2	2MCHBP01	CH Pump B	2	A
Unit 2	2MCHEP01	CH Pump E	2	A
Unit 3	3MCHAP01	CH Pump A	2	A
Unit 3	3MCHBP01	CH Pump B	2	A
Unit 3	3MCHEP01	CH Pump E	2	A

The PVNGS, Units 1, 2, and 3 fourth 10-year IST program interval begins on January 15, 2018, and is scheduled to end on January 14, 2028. The applicable ASME OM Code edition for the PVNGS Units 1, 2, and 3 fourth 10-year IST program interval is the 2012 Edition.

Component/System Function

In its letter dated February 23, 2017, the licensee stated, in part:

> The positive displacement CH pumps perform a safety function to provide charging flow from the volume control tank, refueling water tank, or spent fuel pool to the reactor coolant system (RCS) for emergency boration and RCS pressure control (with auxiliary pressurizer spray).
>
> These pumps also provide flow for RCS makeup, RCS boron and chemical control, and reactor coolant pump seal injection (non-safety functions).

Reason for Alternative Request

In its letter dated February 23, 2017, the licensee stated, in part:

> The CH pumps are of a single-acting reciprocating (three-piston) positive displacement design; model number NP18-3.1 TFS, manufactured by Gaulin Corporation. The nominal shaft rotational speed of the CH pumps is 199 revolutions per minute (rpm), which is equivalent to approximately 3.3 Hz. Based on this frequency and ISTB-3510(e), the required frequency response range of instruments used for measuring pump vibration is to be 1.1 to 1,000 Hz.

The ASME OM Code requires the use of vibration-measuring transducers with frequency response from one-third minimum pump shaft rotational speeds to at least 1, 000 Hz during Group A and comprehensive pump testing.

In its letter dated February 23, 2017, the licensee also stated, in part:

> PVNGS has determined there are no mechanical degradation scenarios where only a sub-synchronous vibration component would develop on the CH pumps. Potential sub-synchronous and synchronous vibrations evaluated are as follows:
>
> a) Oil whirl, which presents itself at frequencies below the rotational frequency of the pump (0.38X - 0.48X, where X equals the rotational frequency of the pump), is not applicable to the PVNGS horizontal, triplex, reciprocating charging pumps. These pumps have high reciprocating loads within their journal bearings, which prevents the oil whirl phenomena.
>
> b) A light rub/impact could generate a vibrational component at a frequency below the pump's rotational frequency (e.g., 0.5X (99.5 rpm)), but would normally generate a harmonic vibrational component that would present either as an integer or half-integer multiple of the running speed of the pump. (e.g., a light rub vibration occurring at 0.5X, where X equals the rotational frequency of the

pump, could also produce a vibrational component that could be measured at integer multiples of the original frequency (i.e., 1X, 1.5X, 2X, etc.), and would, thus, be identified in the calibrated range of the equipment.).

c) A heavy rub generates increased integer values of multiple running speed components, as well as processing the 1X phase measurement. In either case, the overall vibration level would still show an increase from both the attenuated sub-synchronous and 1X vibration components.

d) Looseness in the power train would likely be identified through the measurement of a vibrational component(s) found at frequencies that are multiples of the pumps rotational frequency. (i.e., 1X and 2X, where X equals the rotational frequency of the pump).

PVNGS has many years of CH pump operating experience (OE) that supports the preceding analysis that there is no mechanical degradation scenario where only a sub-synchronous vibration component would reveal pump degradation.

PVNGS has determined that relative to the charging pumps, the significant modes of vibration, with respect to equipment monitoring, are as follows:

1-Times Crankshaft Speed (1X) – 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 (2X) – 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 – An increase in vibration at other frequencies may be an indication of cavitation at several valves, looseness at multiple locations, or bearing degradation.

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 monitoring vibration at frequencies below those related to shaft speed (3.3 Hz.).

Based on the foregoing discussion, it is clear that monitoring pump vibration within the frequency range of 3 to 1000 Hz will provide adequate information for evaluating pump condition and ensuring continued reliability with respect to the pumps' function.

Proposed Alternative

In its letter dated February 23, 2017, the licensee stated, in part:

> Vibration levels of the CH pumps [listed in Table 3.6 of this SE] will be measured in accordance with the applicable portions of ISTB-3500, "Data Collection," with the exception of the lower frequency response limit for the instrumentation (ISTB-3510(e)). In this case, the lower response limit for the vibration measuring equipment will be 3 Hz.
>
> In addition to measurement of the ASME OM Code-required normal CH pump IST peak vibration, PVNGS will routinely perform post spectral/waveform analysis of the vibration data to ensure no adverse trends toward mechanical degradation go undetected.

NRC Staff Evaluation

The licensee requests an alternative to the frequency response range requirements for the CH pumps listed in Table 3.6 of this SE. Paragraph ISTB-3510(e) of the ASME OM Code requires that the frequency response range for vibration measuring transducers and their readout system shall be from one-third of the minimum pump shaft rotational speed (1.1 Hz) to at least 1,000 Hz.

The licensee proposes to use its existing instrumentation with a range of 3 Hz to 1,000 Hz. These pumps are piston, positive-displacement pumps with rolling-element bearings. The pump manufacturer informed the licensee that this type of pump has no sub-synchronous failure modes. Furthermore, there are no known failure mechanisms that would be revealed by vibration at frequencies below those related to shaft speed (3.3 Hz). The licensee states that, based upon the absence of a credible failure mode, no useful information will be obtained by testing below the 3 Hz frequency nor will any indication of pump degradation be masked by instrumentation unable to collect data below frequency.

The licensee identified the frequencies where high vibration would provide an indication of pump degradation as a one time (1X) pump running speed, (2X) pump running speed, and multiples of pump running speed. The types of problems that could be encountered at these frequencies were also identified. The frequency spectrum of the signals generated is characteristic of each pump and constitutes a unique pattern. Analysis of the pattern allows identification of vibration sources, and monitoring of change over time permits evaluation of the mechanical condition of the pump.

The licensee states that there is no probable sub-synchronous failure modes associated with these CH pumps under normal operating conditions. Furthermore, there are no known failure mechanisms that would be revealed by monitoring vibration at frequencies below those related to shaft speed (3.3 Hz).

Consistent with the NRC staff position in Section 5.4 of NUREG-1482 Revision 2, "Guidelines for Inservice Testing at Nuclear Power Plants," and based on the forgoing discussion, the NRC staff finds that monitoring pump vibration within the frequency range of 3 to 1,000 Hz will provide adequate information for evaluating pump condition and ensuring continued reliability with respect to the pumps' function, and that the information gained at the low frequency response (i.e., less than 3 Hz) does not apply for the bearing design of these pumps.

Based on the above evaluation, the NRC staff determined that the alternative provides an acceptable level of quality and safety.

4.0 CONCLUSION

As set forth above, the NRC staff finds that the proposed alternative described in alternative request PRR-06 provides an acceptable level of quality and safety for pumps listed in Table 3.6. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1) for alternative request PRR-06. Therefore, the NRC staff authorizes alternative request PRR-06 for PVNGS Units 1, 2 and 3 for the fourth 10-year IST program interval, which is scheduled to begin on January 15, 2018, and currently schedule to end on January 14, 2028.

As set forth above, the NRC staff determined that for alternative requests PRR-01, PRR-03, PRR-04, and PRR-05, the proposed alternatives provide reasonable assurance that the affected pumps listed in Table 3.1 (RR PRR-01), Table 3.3 (RR PRR-03), Table 3.4 (RR PRR-04), and Table 3.5 (RR PRR-05) are operationally ready and compliance with the requirements of ASME OM Code would result in hardship or unusual difficulty without a compensating increase in quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(2). Therefore, the NRC staff authorizes RRs PRR-01, PRR-03, PRR-04, and PRR-05 for PVNGS Units 1, 2 and 3 for the fourth 10-year IST program interval, which is scheduled to begin on January 15, 2018, and currently schedule to end on January 14, 2028.

As set forth above, the NRC staff finds that the proposed alternative described in alternative request PRR-02 provides reasonable assurance that the DGFO transfer pumps are operationally ready for those listed in Table 3.2-1. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(f)(5)(iii) for alternative request PRR-02. Therefore, the NRC staff authorizes alternative request PRR-02 for PVNGS Units 1, 2 and 3 for the fourth 10-year IST program interval, which is scheduled to begin on January 15, 2018, and currently schedule to end on January 14, 2028.

All other ASME OM Code requirements for which relief was not specifically requested and approved in the subject requests remain applicable.

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Date: December 28, 2017

SUBJECT: PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3 – RELIEF REQUEST NOS. PRR-01, PRR-02, PRR-03, PRR-04, PRR-05, AND PRR-06 FOR USE OF THE PROPOSED ALTERNATIVES IN LIEU OF THE INSERVICE TESTING REQUIREMENTS OF THE ASME OM CODE (CAC NOS. MF9318 THROUGH MF9319, MF9321 THROUGH MF9329, AND MF9331 THROUGH MF9333; EPID L-2017-LLR-0005 THROUGH L-2017-LLR-0010) DATED DECEMBER 28, 2017

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