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WILLIAM F. CONWAY
EXECUTIVE VICE PRESIDENT
NUCLEAR

102-02464/WFC/TRB/DLK
March 30, 1993

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station P1-37
Washington, DC 20555

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2, and 3
Docket Nos. STN 50-528/529/530
Reply to Notice of Deviation 50-528/93-03-01
File: 93-070-026

Arizona Public Service Company (APS) has reviewed NRC Inspection Report 50-528, 529, 530/93-03 and the Notice of Deviation, dated March 1, 1993. Pursuant to the provisions of 10 CFR 2.201, APS' response is enclosed. Enclosure 1 to this letter is a restatement of the Notice of Deviation. APS' response is provided in Enclosure 2.

Separate from this letter, APS is forwarding a copy of the containment high-range monitor calibration procedure and the calibration data sheets used to develop the (AM-241) internal transfer source acceptance criteria.

Should you have any questions, please contact Thomas R. Bradish at (602) 393-5421.

Sincerely,

W F Conway

WFC/TRB/DLK/rv

Enclosures:
1. Enclosure 1 - Restatement of Notice of Deviation
2. Enclosure 2 - Reply to Notice of Deviation

cc: J. B. Martin
J. A. Sloan

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ENCLOSURE 1

RESTATEMENT OF NOTICE OF DEVIATION 50-528/93-03-01

NRC INSPECTION CONDUCTED

JANUARY 11, 1993 THROUGH JANUARY 15, 1993

AND

FEBRUARY 10, 1993 THROUGH FEBRUARY 12, 1993

INSPECTION REPORT NOs. 50-528, 529, AND 530/93-03

RESTATEMENT OF NOTICE OF DEVIATION 50-528/93-03-01

During an NRC inspection conducted on January 11-15, and February 10-12, 1993, a deviation of your Updated Final Safety Analysis Report (UFSAR) was identified. In accordance with the "General Statement of Policy and Procedure for NRC Enforcement Action," 10 CFR Part 2, Appendix C, the deviation is listed below:

Palo Verde Updated Final Safety Analysis Report (UFSAR) Chapter 11.5 committed the licensee to follow the recommendations found in NUREG-0737, which requires that containment high-range monitors be calibrated in situ in accordance with Table II.F.1-3.

Contrary to the above, the licensee's current practice of using a "keep alive" Americium (Am) source to calibrate the containment high-range monitors does not meet the recommendations found in NUREG-0737. Specifically, the use of an internally mounted Am-241 source to perform an in situ calibration is characteristic of a "source check" and not a primary calibration using the radionuclides, external to the detector, that cover the expected range and energy response defined in Table II.F.1-3 of NUREG-0737.

ENCLOSURE 2

REPLY TO NOTICE OF DEVIATION 50-528/93-03-01

NRC INSPECTION CONDUCTED

JANUARY 11, 1993 THROUGH JANUARY 15, 1993

AND

FEBRUARY 10, 1993 THROUGH FEBRUARY 12, 1993

INSPECTION REPORT NOs. 50-528, 529, AND 530/93-03

REPLY TO NOTICE OF DEVIATION 50-528/93-03-01

Reason for the Denial

APS denies Notice of Deviation 50-528/93-03-01.

The Notice of Deviation takes exception to the use of an internally mounted Americium (Am-241) source to calibrate the containment high-range radiation monitors with the following statement:

> "Specifically, the use of an internally mounted Am-241 source to perform an in situ calibration is characteristic of a "source check" and not a primary calibration using the radionuclides, external to the detector, that cover the expected range and energy response defined in Table II.F.1-3 of NUREG-0737."

Table II.F.1-3 of NUREG-0737, however, does not specifically recommend the in situ calibration fulfill the requirements of a primary calibration procedure or the use of an external source, nor does it exclude the use of an internal source. It merely provides that "in situ calibration for at least one decade below 10R/hr shall be by means of a calibrated radiation source."

As shown below, APS' transfer calibration procedure verifies detector accuracy and operability through the use of a transfer radiation source, and is fully consistent with NUREG-0737 and APS' commitment in the UFSAR to "follow the recommendations" therein. APS' transfer calibration procedure is essentially the procedure specified by the equipment manufacturer to comply with the NUREG-0737 requirements, and it is consistent with the transfer calibration methodology used by the two other major manufacturers of containment radiation monitors.

The basis for APS' position that its calibration procedure is consistent with the recommendations of NUREG-0737 can be explained by examining the following areas:

- the differences between primary and transfer in situ calibrations, and the ability of the transfer calibration source to serve as a "calibrated radiation source" satisfying the recommendations of NUREG-0737

- the dual role of the Am-241 source and the specific procedural requirements imposed that allow it to be used as a transfer calibration standard; and

- the principles of ion chamber operation that allow the use of an internally mounted alpha emitter (Am-241) to demonstrate the accuracy and functionality of an ion chamber used to measure external beta/gamma radiation.

Primary vs. Transfer Calibration

APS disagrees with the NRC position that the in situ calibration should fulfill all the requirements of a primary calibration. APS' specific position regarding primary and in situ calibrations is based upon a standard methodology currently in development by the industry. The following five part process is developed from the draft ANS/ANSI 5.9 Standard (formerly ANS 6.8.1, 6.8.2, and 5.7.2) currently in review. Note, this standard is used for reference only since it is still in the review cycle.

1) Electronic Alignment - In the case of containment high-range area monitors, this consists of setting detector operating voltage and performing an electronic calibration of the detection channel using a suitable pico amp current source. This methodology is described in NUREG-0737 recommendations.

2) Energy Calibration - Since collection efficiency of an ion chamber depends on ion density, and not on how the ionization is produced, the linearity characteristics of the ion chamber should be independent of the type or spectrum of the radiation involved (provided that the intensity of the radiation field is reasonably uniform over the volume of the ionization chamber). Furthermore, since ion chambers of a particular design can be manufactured so that they are essentially identical, this calibration can be

performed on a "type" basis. For the containment high-range monitors, this calibration was performed to demonstrate a sensitivity to photon energies as low as 60 KeV and an essentially flat response of the detection system in terms of exposure rate in the incident photon energy range of 0.1 to 3.0 MeV. The energy calibration was performed as part of the primary calibration and is documented in "Report of Calibration, Model KDA-HR Ion Chamber Detector (P/N 824636-001)", Kaman Report Number: K-82-70-U(R).

3) Linearity Testing - This consists of exposing the detector to widely spaced points in its measurement range and verifying linear response. For containment high-range detectors, this test is accomplished for exposure rates through 10^7 R/hr on a type basis for the same reasons explained above. Linearity testing was performed as part of the primary calibration and is documented in "Report of Calibration, Model KDA-HR Ion Chamber Detector (P/N 824636-001)", Kaman Report Number: K-82-70-U(R). Every subsequently manufactured detector that is purchased is tested through 10^3 R/hr. When these detectors are purchased, calibration data documenting this test is supplied with the detector. This methodology follows the guidance recommended in NUREG-0737 and later clarified by

4) Primary Calibration - For containment high-range detectors, this consists of exposing the detector in an NIST (formerly NBS) traceable gamma radiation field and establishing the output of the detector in terms of R/hr/amp referenced to a particular isotope (generally, Cesium (Cs-137) or Cobalt (Co-60)). This part of the calibration was performed in conjunction with the linearity testing described above. Therefore, each detector installed in the field undergoes a primary calibration (exposure through 10^{3} R/hr) before it is shipped by the manufacturer to ensure correct response.

5) Transfer Source Testing - This test consists of exposing the detector to a source that will serve as a transfer standard to ensure proper operation at subsequent field in situ calibrations. The response to the transfer calibration source observed during the primary calibration is correlated to the expected response in the field. As long as the responses are similar, the detector is expected to respond to radiation in the field as it did during the primary calibration. The transfer calibration source becomes a "calibrated source" when it is linked to the primary calibration by this method. The transfer source is used only as a link of traceability to the

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1 Letter dated August 16, 1982, from D. G. Eisenhut, USNRC, to Regional Administrators, "Proposed Guidance for Calibration and Surveillance Requirements for Equipment Provided to Meet Item II.F.1, Attachments 1, 2, and 3, NUREG-0737"

primary calibration and need not be NIST traceable. In the case of the containment high-range monitor, the manufacturer records each detector response to the internal Am-241 source observed during linearity and primary calibration testing (through 10^3 R/hr) performed at the factory. This information is supplied with every detector. The Am-241 source response measured and recorded as part of the primary calibration forms the link between the primary calibration and subsequent field calibrations making the Am-241 acceptable as a transfer calibration source.

While all parts of the calibration process discussed above are important to quantify the performance characteristics of the detector, not all of the parts are required to be repeated in the field to verify detector accuracy and operability. For containment high-range detectors, only electronic alignment and verification of the correct transfer source response are necessary to ensure that the monitor is functioning accurately for its intended purpose when it is installed in the field. Therefore, an in situ calibration need only consist of an electronic alignment and transfer source response verification. The remaining parts of the calibration may be performed by the manufacturer at the factory.

All three major US manufacturers of containment high-range area monitoring systems follow this calibration methodology and utilize a transfer calibration method to verify that the detector and monitor are functioning accurately after field installation. Palo Verde Nuclear Generating Station is no exception.

By way of comparison, Victoreen Instrument Corporation follows the methodology as stated establishing traceability to the primary calibration through the use of a modified version of the Victoreen Field Calibration Kit (FCK). The Victoreen FCK consists of a Cs-137 source mounted in a shielded holder that fixes the detector to source geometry. The FCK is not directly NIST traceable in terms of exposure rates. Traceability is linked only to the source response observed during the primary calibration.

GA/Sorrento Electronics uses a similar method in the form of their RT-11 calibrator. Again, a Cs-137 source in a shielded holder is used. The holder is subsequently hung on the side of the detector in a known geometry. The RT-11 is not NIST traceable in terms of exposure rate. Traceability is only linked to the primary calibration.

Although other manufacturers decided to utilize external transfer calibration sources, Kaman elected to use an internal source. The Palo Verde Nuclear Generating Station calibration method is essentially the method prescribed by the original equipment manufacturer (Kaman) with tighter tolerances applied to the transfer source response. In this case, the transfer calibration source consists of an Am-241 source mounted in a fixed location within the detector itself. This source is present at all times and its output is directly traceable to the primary calibration of the detector.

In summary, an in situ calibration does not need to meet all of the requirements of a primary calibration. That is, NUREG-0737 did not recommend an in situ "primary

calibration". Instead, NUREG-0737 only recommended that the detector's response be verified with a "calibrated source". All three major manufacturers of containment high-range monitors utilize a transfer calibration methodology to accomplish this requirement and to routinely assess detector performance in the field. NUREG-0737 does not specify the use of an external transfer source nor does it prohibit the use of an internal transfer source. Therefore, the use of any transfer source, mounted externally or internally, is appropriate provided that it is traceable to the factory calibration and that it satisfactorily demonstrates the detector and monitor are functioning accurately after field installation.

Dual Role of Am-241

APS disagrees with the NRC position that the use of the internal source response as part of the in situ calibration "is characteristic of a "source check" and not a primary calibration using the radionuclides, external to the detector, that cover the expected range and energy response defined in Table II.F.1-3 of NUREG-0737."

As discussed above, an in situ calibration is not the same as the factory primary calibration. NUREG-0737 does not recommend an in situ "primary calibration."

With respect to the use of Am-241 as a "check source", APS agrees with the NRC that the Am-241 is utilized as a check source to verify detector operability during continuous

operation. The containment high-range monitor utilizes the continuous current response generated by the internal source to detect detector failure (i.e., a loss of detector signal). However, this is only one application for using the internal source. PVNGS calibration procedures require the Am-241 source response fall within a prescribed range (± 30%) of the response recorded during the primary calibration. Under this application, the calibration method used at PVNGS is not characteristic of a "source check". A "source check", as defined in the Standard Technical Specifications, is "a qualitative assessment of channel response when the channel sensor is exposed to a source of increased radioactivity." The use of the internal source response in the PVNGS calibration procedures is a quantitative assessment that is directly traceable to the primary calibration. As such the PVNGS calibration procedure constitutes a "calibration" and not a "source check". This is consistent with the transfer calibration methodology discussed above.

Use of Alpha Emitter to verify Ion Chamber Operation

An ion chamber detects radiation via its interaction with gas contained within the chamber. This interaction produces ions and electrons in an electric field that eventually are detected as a current response between the detector's electrodes. The type of gas in the detector, the type of radiation, or the energy of the radiation does not greatly effect the energy dissipation per ion pair produced by the interaction between the radiation and the gas. In other words, the energy dissipation of fast electrons and alpha particles is

essentially the same, and the amount of energy deposited within the chamber is proportional to the number of ion pairs formed (ion density) by the interaction of the radiation with the gas.[2] Therefore, collection efficiency of the ion chamber depends on ion density produced within the chamber, and not on how the ionization originated.

The overall detector sensitivity to external radiation is a function of the mechanical design of the ion chamber (i.e., construction material, wall thickness, detector diameter, etc.). Since ion chambers of a particular model can be manufactured so that they are essentially identical with respect to mechanical design, the practice of type testing detectors becomes applicable. This is the basis for performing energy response and linearity testing through 10^7 R/hr in order to quantify response characteristics for a particular model of detector rather than repeat the test on each detector manufactured. Therefore, as long as the detectors are manufactured to the same mechanical design, the only parameters that can effect the ion collection efficiency within the chamber is the fill gas, its purity, fill pressure, and operating voltage.

Performing an electronic alignment and subsequent linearity testing through 10^3 R/hr on each detector manufactured ensures that the mechanical design of the detector and parameters affecting ion collection efficiency are consistent with that of the detectors that were type tested for linearity and energy response. As part of this factory test, the

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2 Knoll, Glenn F., Radiation Detection and Measurement, John Wiley and Sons, New York, NY, 1979 (pages 152-153).

response to the internal alpha source is recorded and the information is used later in subsequent field calibrations. When the detector is calibrated in the field it undergoes an electronic alignment and verification of its recorded response to the transfer calibration source (Am-241). The field test not only verifies that the ion collection efficiency of the detector has not changed but also verifies that the response of the detector is not affected by any inaccuracy of the electronic components used to measure the detector output or by any factor that could challenge connector and signal cable integrity. Because the detector mechanical design has already been verified in the laboratory and is not altered by field installation, it is not necessary to reverify the mechanical design by performing an in situ calibration in a known radiation field. Since ion collection efficiency within the chamber is independent of the type or energy of the radiation, either an alpha, beta, gamma, or beta/gamma source may be used to produce the ionization. Therefore, the use of an internally mounted alpha source rather than an external beta/gamma or gamma source can be used to test the parameters that affect ion collection efficiency within the chamber and operating characteristics of the monitor.

The use of a high activity beta/gamma or gamma source mounted externally in close proximity to the detector is not an adequate test to verify the mechanical design of the detector with respect to overall energy response because of the highly variable radiation fields. To test the overall energy response of an ion chamber detector, the detector should be exposed in a known radiation field that is relatively uniform with respect to the internal dimensions of the detector. Therefore, the use of an external transfer calibration

source under these circumstances provides no advantage over the use of an internal Am-241 source. The same information regarding detector performance can be obtained from either type of source. In fact, the use of a high activity external source can induce a non conservative bias in the response if back scatter (a phenomenon caused by the interaction of the radiation with structures and equipment located near the detector) is not quantified or measured. The use of the internal Am-241 source eliminates back scatter effects.

Finally, NUREG-0737 recommends that the response of the detector be checked at one point below the range of 10 R/hr. The detector response from the internal Am-241 source produces a current that is within the range of 1E-11 to 5E-11 amps. Based on the detector efficiency of 1E+11 R/hr/amps, this response is equivalent to a response in the range of 1 to 5 R/hr. Therefore, the current response falls within the range recommended in NUREG-0737.

Corrective Actions Taken and Results Achieved

APS has reviewed Chapters 11.5 and 18 of the UFSAR, and the calibration recommendations made for containment high-range monitors in NUREG-0737. Chapter 11.5 of the UFSAR does not specify, in detail, the calibration methods employed by APS to meet the general guidance found in Table II.F.1-3 of NUREG-0737. This condition may have led to the confusion which resulted in the issuance of NOD 50-528/93-03-01.

Corrective Actions That Will Be Taken To Avoid Further Deviations

No action is required. Nevertheless, to avoid any future confusion, APS will provide additional details in the UFSAR regarding the methods used to calibrate RU 148 and RU 149.

Date When Full Compliance Will Be Achieved

APS has been in full compliance. The change to the UFSAR discussed above will be included in the next annual update due March 1994.