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SUBJECT: Informs of signficant radiological problems encountered in field of reactor coolant pump stellite content, per Insp Rept 50-528/86-08.

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MEMORANDUM FOR: G. W. Knighton, Director, Project Directorate V, Division of Reactor Project III, IV, V and Special Projects
L. J. Cunningham, Chief, Radiation Protection Branch, NRR/PRPB

FROM: F. A. Wenslawski, Chief
Emergency Preparedness and Radiological Protection Branch, Region V

SUBJECT: PALO VERDE REACTOR COOLANT PUMP STELLITE CONTENT

REFERENCE: INSPECTION REPORT NO. 50-528/86-08, SECTION 3, WASTE SYSTEMS, LIQUID, INSPECTION OF MARCH 3-7, 1986

The referenced Inspection Report documented the first report of licensee's concerns related to the antimony content of reactor coolant pump (RCP) bearings and RCP stellite wear rings. Subsequent reports document increasing primary system contamination with Sb-122/124 and licensee's efforts to remove the contaminants. Modified bearings were obtained and installed in Unit 3 before initial criticality and in Unit 1 during the first refueling outage. Unit 2 RCP bearings will be replaced during the first refueling outage.

During the Unit 1 refueling (October 1987 - January 1988), the RCP impellers were removed for antimony decontamination prior to shaft removal because of the shaft cracking problem. Concurrent with the opening of the primary system, the licensee found a significant increase in the number of Co-60 particles identified during surveys. Some of the particles contained millicurie quantities of Co-60.

Examination of the impellers disclosed significant damage to the stellite wear rings or surfaces (see attached Attachment 1). The licensee reported that the stellite had been plasma arc deposited on the impeller base metal in a layer approximately 0.012 inches thick. The upper surface was 12 inches in diameter and 4 inches wide. The lower surface was 28 inches in diameter and about 4 inches wide. The licensee described the damage as follows:

- The complete loss of the upper wear surface on one pump.
- The loss of 3 or 4, 1-inch diameter blisters in another area.
- The loss of a 4-inch strip, 3/4 to 1 inch wide.
- The loss of small chunks or chips from one of the lower surfaces.

Seven of the eight impellers in service in Units 1 and 2 were coated with stellite by KSB, the RCP manufacturer. One of the Unit 1 and all the Unit 3 pumps were coated with stellite by Cleveland Hardfacing. The Unit 1 impeller which lost all of the upper stellite surface was the unit coated by Cleveland Hardfacing.

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During the Unit 1 outage, it was determined that the upper stellite wear ring/surface was not required and it was removed from all the Unit 1 impellers. In addition, the width of the lower wear ring/surface was reduced to approximately 2 inches. A project is presently underway to identify a suitable replacement surfacing material to be used on the impellers. It is believed that this project will permit corrective action to be taken on the Unit 2 impellers during the first refueling presently scheduled for February-March 1988.

When the presence of stellite on the impellers first became known to the licensee's radiation protection staff, they requested but did not press for prompt corrective action in the belief that the stellite would adhere to the base metal and not contribute a significant source of cobalt target material. Experience has shown that the stellite is a significant source for the production of Co-60. One particle, recovered from a steam generator, was 9 millicuries. This one particle exhibited a contact dose rate of approximately 4500 rad/hr (See Attachment 2).

The licensee's radiation protection staff has notified their management that they believe that these particles present a potential threat to the health and safety of plant workers. Management responded by noting the previously mentioned partial removal of the stellite from Unit 1 impellers, stated that replacement surfacing was being investigated and establishing a schedule for stellite removal:

Unit 1 - Next time impellers are removed
Unit 2 - Refueling - February 1988
Unit 3 - Refueling - 1989

Licensee management concluded that the stellite removal was desirable but not feasible at this time.

Licensee management has agreed to submit a report on the stellite problem to the Region V office following the inspection of the Unit 2 impellers during the February-March 1988 refueling outage.

The purpose of this memorandum is to keep you informed of significant radiological problems encountered in the field. In addition, if there are other instances of degraded stellite applications, an Information Notice or vendor inspection involvement might be appropriate.

Original Signed
F. A. Wenslawski, Chief
Emergency Preparedness and
Radiological Protection Branch

Attachments:
As Stated.

JAN 25 1988

cc w/attachments:
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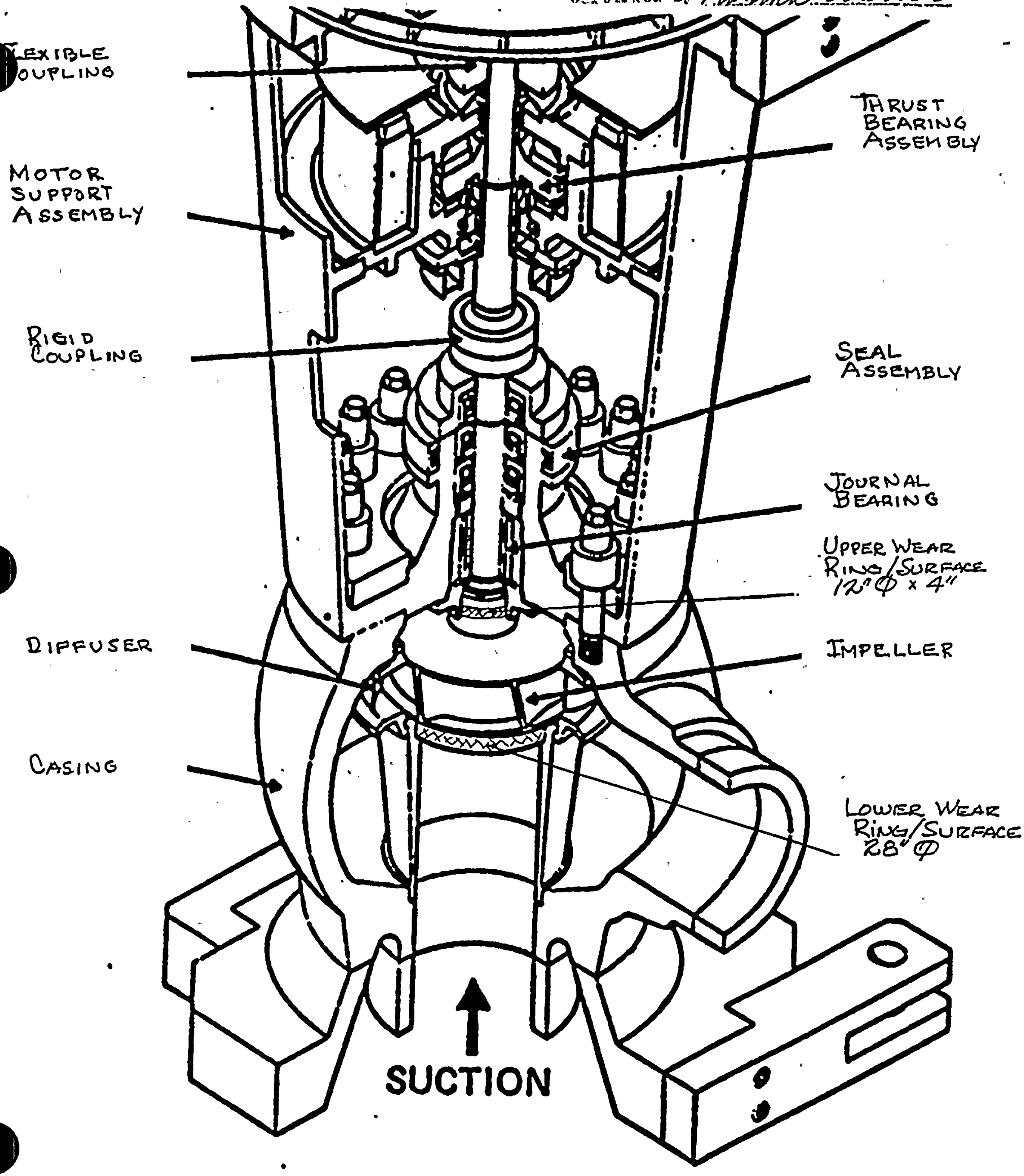

ATTACHMENT 1

DESIGNATED ORIGINAL

Arizona Nuclear Power Project

Certified By

ID#:	215-00473-GDP/DM/JBS	Prepared by: Signature	
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File: 87-002-419.04

SUBJECT: Postulated Exposure Assessment From Co-60 Chips Recently Found During Unit 1 Outage Work

On October 20, 1987, during outage work in Unit 1, a spot of high activity contamination was found during routine hot particle surveys of the #2B Reactor Coolant Pump 100' elevation platform. The contamination was localized, removed from the work area, and appropriately placed in shielded storage by Radiation Protection Staff. Preliminary dose rate measurements indicated a 20 R/hr gamma component on contact with the source.

Support Staff isolated the contamination as a discrete particle measuring 600 - 750 microns in diameter. The particle activity was quantified by gamma spectral analysis using a collimated HPGe detector at 12 feet (free air) from the source. The efficiency calibration was performed using a standard source at the same source to detector geometry. This analysis indicated ~9.2 mci of Co-60 (Attachment A).

In the interest of providing a relative assessment of the radiological implications associated with potential direct personnel exposure involving this particle, several evaluations were performed.

Beta Skin Dose Estimate

1. Calculational assessment of direct skin exposure assuming skin contact and no self-absorption:

$$9193\ \mu ci \times 4.314\ \frac{R - cm^2}{\mu ci - hr} = 39{,}659\ Rad/hr/cm^2$$

where: 9193 µci = particle activity (Co-60)

$$4.314\ \frac{R - cm^2}{\mu ci - hr} = \text{Dose conversion factor for Co-60}$$

2. Using the computer code "Varskin", a value of 37,900 Rad/hr was obtained (Attachment B).

Note: The dose rates above are at a depth of 7 mg/cm^2 in tissue.

D

ATTACHMENT 2

These Beta dose rates correspond to ≈11 Rad/sec delivered to the skin in a postulated direct skin exposure incident.

Although it is permissible to average doses from particles over an area of 1 cm^2, Attachment B shows that the true Beta dose delivered is 3.89 E+06 Rad/hr over a basal cell area of .0098 cm^2.

Gamma Skin Dose Estimate

The gamma skin dose component was estimated using instrument readings in combination with calculational techniques. The results were 889 $R/hr/cm^2$ at a tissue depth of 7 mg/cm^2.

Direct Measurement Comparisons

In an attempt to relate the calculated values to direct measurement results, comparisons were also performed. These measurements are not ideal since the extrapolation chamber used has an active surface area greater than 1 cm^2. Therefore, measurements must be made at some distance and normalized to contact readings (7 mg/cm^2 depth).

The particle was isolated under 20 mg/cm^2 plastic, affixed to a phantom, and placed at a distance 10 cm from the detector surface. Combined Beta and gamma dose rate measurements resulted in a value of 1.77 Rad/hr at 10 cm. This value was then normalized.

$$1.77 \text{ Rad/hr} \times 650 = 1150 \text{ Rad/hr at } 20 \text{ mg/cm}^2$$

where: 650 = correction factor for air absorbtion and distance

This value of 1150 Rad/hr was then corrected to 7 mg/cm^2 tissue depth:

$$\frac{1150 \text{ Rad/hr}}{e^{-(105.4)(0.013)}} = 4527 \text{ Rad/hr}$$

where: 105.4 = attenuation coefficient (μ)
0.013 = density thickness (gms/cm^2)

This value is not absolute since this approach did not involve ideal measurement assessment conditions. The difference between calculational results obtained from gamma spectral analysis and these from extrapolation measurements would indicate that a significant amount of the beta dose component is being attenuated through self-absorption by the particle itself.

Synopsis

This particular discrete particle illustrates the dose rate potential associated with hot particle contamination. During the period when this report was being prepared, another Co-60 chip was found. The relative magnitude of its postulated characteristics indicate potentials on the order of 6 times the magnitude of the particle involved in this paper. Due to the minute size and inverse square properties involved, surface dose rates fall off very rapidly with increasing distance. In addition, most available instrumentation will severly underestimate true particle dose rates simply by design and because of geometry considerations.

GDP/DM/RDM/JBS/kdf

Distribution:

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