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SUBJECT: Forwards response to RAI re GL 92-08, "Thermo-Lag 330-1 Fire Barriers." Rept re analysis of potential fire exposure,encl.

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10 CFR 50, Appendix R

APS
Commitment. Innovation. Energy.

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102-03894 - JML/SAB/RMW
March 18, 1997

U. S. Nuclear Regulatory Commission
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Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2, and 3
Docket Nos. STN 50-528/529/530
Response to Follow-up Request for Additional Information Regarding Generic Letter 92-08, "Thermo-Lag 330-1 Fire Barriers".

Dear Sirs:

Enclosure 1 provides the information regarding resolution of Thermo-Lag fire barriers that you requested in your letter to APS dated January 21, 1997. Please contact Mr. Scott Bauer at (602) 393-5978 if you have any questions or would like additional information regarding this matter.

Sincerely,

JML/SAB/RMW/mah

cc: J. E. Dyer
K.E. Perkins
J. W. Clifford
K.E. Johnston

Enclosure
Attachment

A029 1/1

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VERIFICATION OF ACCURACY

APS 10 CFR 50.59 Evaluation Log Number 96-00116, SARCN 3643, regarding fireproofing on various cable tray supports.

APS 10 CFR 50.59 Evaluation Log Number 96-00123, SARCN 3645, regarding fireproofing on various HVAC duct supports.

APS 10 CFR 50.59 Evaluation Log Number 96-00268, The Combustibility of Thermo-Lag as the Radiant Energy Shield in Containment.

APS presentation to USNRC, dated February 19, 1997, "PVNGS Thermo-Lag Project Status"

Vendor Package Number A13173, APS Log Number 13-MN-169-A035-1, "Analysis of Potential Fire Exposures to Pressurizer Auxiliary Valve J-CHA-HV-205 and Associated Circuits Currently Protected with a Radiant Energy Heat Shield (REHS)", prepared by IBEX Engineering Services and Hughes Associates, Inc.

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VERIFICATION OF ACCURACY

APS 10 CFR 50.59 Evaluation Log Number 96-00116, SARCN 3643, regarding fireproofing on various cable tray supports.

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	J. H. Hesser	7669	
	S. H. Pittawala	7668	[signature] 3/13/97
	S. B. Koski	7668	[signature] 3/13/97 w/comments.

VERIFICATION OF ACCURACY

Letter dated December 31, 1996, from J. M. Levine to USNRC, letter number 102-03833-JML/SAB/NLT.

Letter dated January 24, 1997, from W. E. Ide to USNRC, letter number 102-03854-WEI/SAB/NLT

COMMITMENTS/ACTION PLAN (Stated or Implied)

NONE

Note: The comment section for each of the actions above should state that this action was committed to the NRC in letter No. ______ dated / / .

The results shown in Table 1 demonstrate the following for fire zone 65:

- No direct flame impingement occurred on the RES.
- The fire plume temperature, including the upper gas layer effect, reached a maximum of 134 ^{0}F.
- The hot gas layer temperature, assuming that the pressurizer cubicle exhaust fans were not running and that the entire surface of all the cable in the cable trays below the pressurizer were involved in the fire, reached a maximum temperature 199 ^{0}F.

The results shown in Table 1 demonstrate the following for fire zone 65:

- No direct flame impingement occurred on the RES.
- The fire plume temperatures reached a maximum of 133 ^{0}F.
- No significant hot gas layer temperatures developed due to the large volume of the containment building.

For all five fire scenarios, the analysis demonstrated that the RES would not be subjected to temperatures sufficiently high to cause combustion of the RES nor was the RES subjected to a radiant heat flux that would approach the RES critical heat flux. This deterministic evaluation concluded that the use of Thermo-Lag as a RES in this application was acceptable.

In summary, the qualitative and quantitative analyses described above demonstrate the acceptability of using Thermo-Lag as the RES for the Train A pressurizer auxiliary spray valve and associated circuits. The design and programmatic fire protection features ensure that the RES would not be exposed to temperatures such that combustion of the RES material would occur in the event of any credible fire. Therefore, the ability to achieve and maintain safe shutdown conditions would not be impacted by any postulated fire scenario. The RES, as designed, meets the intent of 10 CFR 50, Appendix R, Section III.G.2.f.

VERIFICATION OF ACCURACY

APS 10 CFR 50.59 Evaluation Log Number 96-00116, SARCN 3643, regarding fireproofing on various cable tray supports.

APS 10 CFR 50.59 Evaluation Log Number 96-00123, SARCN 3645, regarding fireproofing on various HVAC duct supports.

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COMMITMENTS/ACTION PLAN (Stated or Implied)

NONE

Note: The comment section for each of the actions above should state that this action was committed to the NRC in letter No. ______ dated / / .

CHANGES TO UFSAR

The information provided in the enclosure regarding fireproofing of the HVAC and cable tray supports is the supporting justification for SARCNs 3643 and 3645. These SARCNs will be incorporated into the next revision (rev 9) of the USFAR.

<u>**ENCLOSURE 1**</u>

Response to Request for Additional Information

9703250004

NRC REQUEST 1

Regarding the fire endurance of Thermo-Lag barriers, the licensee states in the December 31, 1996, letter that an engineering evaluation has been conducted, and a 50.59 evaluation has been performed, which concludes that, based on other defense-in-depth fire protection features, Palo Verde Nuclear Generating Station no longer needs to credit the Thermo-Lag barriers installed on heating, ventilation and air conditioning and cable tray supports. Please provide the technical justification, including any appropriate evaluations or analyses, to support your conclusions.

APS RESPONSE

The Thermo-Lag protected supports referred to in this response are not associated with HVAC ducts or cable trays which have been enclosed in Thermo-Lag to achieve compliance with 10 CFR 50, Appendix R. The subject supports are associated with HVAC ducts and cable trays that may penetrate Appendix R fire barriers, but are not required to be protected for safe shutdown concerns.

HVAC Supports

APS installed Underwriter Laboratories (UL) 555 listed fire damper assemblies with fire ratings comparable to the barrier through which the duct penetrated during initial construction of the units. At the time of original installation, the UL 555 standard pertained only to fire damper assemblies mounted in masonry fire barriers. Section 1.10 of that standard stated that the performance of fire damper assemblies in walls, partitions or floors constructed of materials other than those tested were not covered by this standard. Some installations of the fire damper assemblies deviated from the UL 555 standard in that the fire damper assemblies were mounted in barriers constructed of drywall or metal lath and plaster. Therefore, APS committed to fireproofing the first HVAC support on either side of the barrier to ensure barrier integrity in the event of a fire. The hangers were fireproofed with Monokote or Thermo-Lag fireproofing material. The hangers are located in ten different fire zones, associated with six different gypsum board or metal lath and plaster barriers in each unit. The fireproofing material has subsequently been abandoned in place as it is not needed to ensure fire barrier integrity in the event of a fire based on the following analysis.

UL and Southwest Research Institute (SRI) performed ASTM E-119 fire testing on HVAC duct work and supports. The duct system developed for the UL fire tests consisted of a 10" x 10" HVAC 24 gauge galvanized steel duct supported evenly every eight feet by trapeze hangers. The duct joints were taped and not welded or screwed. The trapeze hangers consisted of two - 1/4" diameter threaded rods supporting a 1" x 1" x 1/8" angle iron. The duct hangers were not fireproofed. The system, including a fire damper

assembly, was installed through a standard one-hour gypsum board fire barrier. This testing demonstrated that after exposure to a one-hour ASTM E-119 fire, neither the support steel or duct work of the duct system failed.

The duct system developed for the SRI tests consisted of a 36" x 30" HVAC 22 gauge galvanized steel duct that was supported 6 feet from the barrier by trapeze hangers. The duct joints were designed in accordance with the Sheet Metal and Air Conditioning National Contractors Association guidelines for Joint Types L-2 and T-11. The trapeze hanger consisted of two - 3/8" diameter threaded rods supporting a 2 1/2" x 2 1/2" x 1/4" steel angle. The hanger was not fireproofed. The SRI duct system was installed through a two-hour masonry wall. The testing of this duct system demonstrated that after exposure to a two-hour ASTM E-119 fire, neither the support steel or duct work of the duct system failed.

The fire barriers in question were originally designed and constructed as three-hour fire-rated barriers. These barriers were reclassified as one and two-hour fire-rated barriers during the initial licensing process. Therefore, the construction of these barriers is more substantial than that used in the UL fire tests.

The subject duct systems were designed and constructed to meet either Seismic Category I or IX criteria. The typical installation consists of a minimum 18 gauge duct with all of the joints being either welded or bolted. Stiffeners are provided every four feet on rectangular ducts and every eight feet for circular ducts. The fire damper assemblies and the duct work that penetrates a fire barrier are not supported by the barrier. The hangers on either side of the barrier are designed to support the full load of the duct and the fire damper assembly. Therefore, the subject duct systems are substantially more robust than those used for the UL fire test.

The fire damper assembly is constructed such that the dampers were welded into the damper sleeve first. The damper sleeve's companion angle was then bolted to the companion angle of the duct. The fire barrier was then built around the damper sleeve. After final installation of the plaster or gypsum board, flashing angles were installed at the interface between the duct/damper sleeve and the barrier. The flashing angles were secured to the duct/damper sleeve and not to the barrier itself. This installation method is consistent with both the fire tests and the vendor's details for installing UL fire rated dampers in gypsum board walls.

UL 555 has subsequently been revised to include the installation of fire damper assemblies in gypsum or metal lath and plaster fire barriers. APS has verified that the installed dampers are qualified without the fireproofing on the supports by comparing the as-built configuration of the fire damper assemblies to the guidance provided in the revised UL 555 and by the vendor installation details. In addition, one-hour and two-hour fire testing on duct work demonstrates that the as-built configuration is qualified for use as a one or two-hour fire rated assembly without crediting the fireproofing installed on the

supports. Therefore, fireproofing on these supports has been abandoned in place as it is not needed to ensure fire barrier integrity.

Each fire zone of concern also has existing defense-in-depth fire protection features. Each area is protected by fire detection systems. Any valid fire alarm will result in an immediate response from the on-site fire department. Fire suppression consists of manual fire fighting equipment, area water suppression, cable tray water suppression, CO_2 flooding or Halon flooding. Each zone is protected by one, or more, of these fire suppression methods.

Based on the above information, it has been concluded that the existing duct/damper assemblies, without reliance on the fireproofing of the HVAC supports, will not fail during a postulated fire so as to affect the integrity of the fire barrier.

Cable Tray Supports

During initial construction, APS committed to fireproofing the first cable tray support nearest the fire barrier that the cable tray penetrated whenever the support is located in excess of 24 inches from the face of specific safety-significant fire barriers. This fireproofing was thought to be necessary to maintain structural integrity of the support such that sagging of the cable trays during a postulated fire would be minimized. The integrity of the fire barrier penetration seal may be compromised in this situation due to the additional loads that would be applied to the seal from the sagging cable tray. Subsequent to this commitment, APS has determined that the fireproofing on these supports is no longer necessary and will be abandoned in place. This determination is based on fire tests that were performed for cable tray penetrations and crediting defense-in-depth fire protection features.

The fire barrier penetration seals are qualified in accordance with ASTM E-119. The fire tests typically consisted of a non-fireproofed vertical ladder-type cable tray extending approximately 12 inches into the furnace. The tray was supported by a non-fireproofed tray support. The assembly was then subjected to a three-hour ASTM E-119 fire. The results of this test indicated that the support did not fail, nor was the penetration seal compromised. Additional fire testing (reference Omega Point Test Laboratories Test Report 13890-95676, prepared for NUMARC) has demonstrated that typical cable tray hangers (P1000 and P10001) are able to withstand the effects of an ASTM E-119 one-hour fire test without reliance on any fireproofing material. This testing also demonstrated that the weak link was not the cable tray support, but the cable tray itself. The bottom rungs on the ladder-type cable trays would fail after being subjected to an ASTM E-119 fire for a significant amount of time. Therefore, fireproofing the fire supports would ensure integrity of the supports themselves, but it would not guarantee that the cable tray itself would not fail.

The type of cable tray utilized at PVNGS is the trough-type. This type of tray offers a much more robust construction over the ladder-type trays which were utilized in the fire tests. In addition, seismic considerations required that cable trays be very conservatively supported over their span. A typical cable tray run in the upper elevations of the Control Building is supported every 5 feet. Cable tray runs in other plant areas are supported every 6 feet 6 inches. Cable tray supports were added or verified to be installed within 24" of a fire barrier for those locations where a support could be physically placed. Some locations could not have a support located at this distance from the fire barrier because the cable tray either had a tee or elbow on the section that immediately exited the barrier, or had some other type of obstruction. It is in these instances that the cable tray supports were fireproofed with the intent to prevent cable tray sagging during a postulated fire.

The sections that have a tee or elbow immediately as it exits the barrier have robust construction. The tray sections have a solid bottom, which provides greater structural rigidity over the ladder-type trays that were used in the fire tests. Supports are provided immediately adjacent to the tee or elbow. This structural rigidity and the conservative spacing of the cable tray supports ensures that the fire barrier penetration seal would not fail in the event of a postulated fire.

Most of the fire zones in which the subject supports are located are protected by fire detection and fire protection systems. Activation of the detection or suppression systems results in an alarm in the main control room for the affected zone. Any valid alarm will result in an immediate response from the on-site fire department. Fire suppression consists of manual fire fighting equipment, area water suppression, cable tray water suppression, CO_2 flooding or Halon flooding. Each zone is protected by one, or more, of these fire suppression methods.

The fire testing that has been performed and the existing design and construction of the cable trays and supports demonstrates that the cable trays and supports have sufficient structural integrity to withstand a postulated fire without the benefit of fireproofing the supports. In addition, defense-in-depth fire protection measures provide added assurance that the cable trays or supports will not fail and compromise the penetration seal's integrity in the event of a postulated fire. Therefore, the fireproofing on these supports will be abandoned in place.

NRC REQUEST 2

Regarding the combustibility of Thermo-Lag, the licensee states in the December 31, 1996, letter that a fire protection engineering evaluation has been performed to demonstrate that the radiant energy heat shield for the auxiliary spray valve and associated circuitry in containment meets requirements of Section III.G.2.f of Appendix R to 10 CFR Part 50. This section of Appendix R requires that the radiant energy shields be noncombustible. Thermo-Lag is classified as a combustible material. The information regarding the combustibility of Thermo-Lag was provided to the licensee in Information Notice 92-82, "Results of Thermo-Lag 330-1 Combustibility Testing", dated December 15, 1992, and in Information Notice 95-27, "NRC Review of Nuclear Energy Institute, Thermo-Lag 330-1 Combustibility Evaluation Methodology Plant Screening Guide", dated May 31, 1995. Please provide the technical justification, including any supporting evaluations or analyses, to support the determination that the Thermo-Lag installed inside containment meets the requirements of Section III.G.2.f of Appendix R to 10 CFR Part 50.

APS RESPONSE

10 CFR 50, Appendix R, Section III.G.2.f specifies that a radiant energy heat shield (RES) may be used in lieu of a fire resistive enclosure inside non-inerted containments. This regulation further stipulates that the RES is to be constructed of a non-combustible material. Testing has shown that Thermo-Lag is a combustible material with an ignition temperature of approximately 1000 ^{0}F. APS meets this Appendix R requirement based on qualitative and independent quantitative engineering analyses that demonstrate that the RES for the Train A pressurizer auxiliary spray valve will not be exposed to temperatures in excess of 1000 ^{0}F. Therefore, the RES as designed and installed meets the intent of 10 CFR 50, Appendix R, which is to ensure that that the ability to achieve and maintain safe shutdown in the event of a postulated fire is maintained.

The Appendix R Safe Shutdown Analysis performed by APS assumes that for fires inside containment, specifically fire zones 65 (pressurizer cubicle) and 67A (general area, northwest containment), the Train B pressurizer auxiliary spray valve will be disabled. The Train A auxiliary spray valve will remain operable since the valve and associated circuits are protected with a RES which is comprised of Thermo-Lag and metallic reflectorized insulation. A description of the fire zones and the physical location of the RES is described below and is depicted on Figures 2-1 through 2-11 in Attachment 1.

The Train A auxiliary spray valve is located above the pressurizer, in the pressurizer cubicle, at approximately the 154 ft. elevation. The valve has flex conduit running east from the valve to the east wall of the cubicle where the raceway enters a junction box. A rigid conduit from the junction box runs to the north wall where it turns west and runs for an additional two feet. The conduit then exists the cubicle through the north wall in an embedded conduit. The valve and this portion of the valve's circuit are located in fire

zone 65. Metallic reflectorized insulation is provided for the valve as part of the RES. This insulation has been previously approved for use as a RES. The entire circuit in the pressurizer cubicle (fire zone 65) is enclosed with a Thermo-Lag RES.

Once the circuit exits the north wall of the pressurizer cubicle, it enters fire zone 67A. The north wall of the pressurizer cubicle defines the southern boundary for this fire zone. The Thermo-Lag enclosed conduit exits the pressurizer cubicle at approximately the 154 ft. elevation, runs vertically down the north side of the north wall of the pressurizer cubicle, through two junction boxes, to the 138 ft. elevation. The conduit then turns west and runs horizontally along the north wall of the pressurizer cubicle until the wall turns south. The conduit runs south along the wall, where the RES ends after approximately five feet. The unprotected circuit continues on to the containment electrical penetration, where it exits the containment building.

The following fire mitigation features assure that the RES will not be subjected to temperatures in excess of 1000 ^{0}F, thereby preventing ignition of the RES:

a) Low Fire Loading - the fire loading in both of the affected fire zones is low. The resultant postulated fire size is so small that the RES would not be exposed to temperatures that would be sufficient to cause combustion of the RES. In addition, the spatial separation between the RES and the fixed combustibles is such that any credible fire would not expose the RES to temperatures in excess of 1000 ^{0}F.

b) Fire Protection Features - the existing fire protection features in, or near, these fire zones include smoke detectors at the ceiling level, line-type heat detectors in the cable trays, manual hose stations, portable fire extinguishers and reinforced concrete walls.

c) Fixed Ignition Sources - the lack of fixed ignition sources in both fire zones is such that a fire due to these sources is highly unlikely.

d) Transient Combustible and Ignition Source Administrative Controls - the procedural restrictions for transient combustibles and/or transient ignition sources in either fire zone while the unit is in Modes 1, 2, 3 or 4 ensures that a fire due to these sources is highly unlikely.

e) Ventilation Features and Ceiling Height - these features ensure that a hot gas layer will not form from any postulated fire.

f) Independent Quantification of Potential Fire Effects on the RES - credible fires due to fixed combustibles in the subject fire zones and the resultant exposure to the RES has been quantified in an independent engineering study. This study has determined that the RES would not be subjected to temperatures in excess of 1000 ^{0}F during a postulated fire.

g) Emergency Response Capability - APS maintains a dedicated, on-site, professional Fire Department to respond to fire emergencies.

Each of these fire mitigation features are discussed in detail in the following paragraphs.

a) Low Fire Loading

The Combustible Loading Calculation performed by APS indicates composite fire loadings of 4,879,075 and 70,254,825 BTUs for fire zones 65 and 67A, respectively. These loadings include an additional allowance of 1,200,000 BTUs for transient combustibles. The Combustible Loading Calculation also includes the combustible load from the Thermo-Lag installed in the subject fire zones for the RES. The increased fire loading due to the RES was added to the fire zone loadings as additional conservatism. The total combustible loading, including the increased load due to Thermo-Lag and the allowance for transient materials, was used in the evaluations for the RES.

The fire loading for each of the subject zones results in a zone classification of Low for both zones. The Low classification reflects complete combustion of all combustibles in each zone with no consideration given to spatial separation between distinct groupings of combustibles and the small potential for fire propagation between each group. Any potential increase in fire loadings due to proposed permanent plant changes receive a Fire Protection Engineering review prior to implementation.

Fire Zone 65

The fixed combustibles in zone 65 consist mainly of the pressurizer heater cables located in cable trays within the concrete skirt area below the pressurizer. The total combustible loading is 166 pounds of material. These cable trays are located between the 100 ft. and 110 ft. elevations of the pressurizer cubicle. Therefore, they are at least 44 feet below the RES. The cable trays are not located adjacent to, or above, any likely ignition source. In addition, a fire originating from an electrical fault in the cable trays is not considered credible based on the use of IEEE 383 qualified cables and the use of protection devices on the circuits. Although a fire is highly unlikely in the cable trays, if one did occur, it would not produce a plume or flame height that would reach the RES. A fire in this area would most likely remain within the concrete skirt and not directly expose the rest of the cubicle to flames and/or radiant energy. The hot gases exiting the area below the pressurizer would mix with cooler ambient air and would also transfer heat to the compartment walls. These gases would sufficiently cool prior to reaching the RES such that they would not affect the RES. The additional cooling effects of the cubicle fans were not credited, but provide added assurance that the RES remains unaffected by a fire in the subject cable trays. This assumption is further supported by the independent quantification study as described in a later section of this enclosure.

Fire zone 65 also has combustibles in the form of 24 pounds of PVC jacket on flexible conduit and one pound of lubricating grease in the cubicle cooling fans. The fire loading due to the PVC jacket is considered to be insignificant due to the fact that the amount in any one location is negligible and the PVC is not in one continuous length. There are no fixed ignition sources in proximity to the PVC, nor is self-ignition of a cable within the conduit likely. Therefore, these sources do not constitute a flame propagation path to the RES, nor would they generate a fire that would be large enough to present a hazard to the RES.

The two fan motors are located approximately four feet above the RES. These fans are vane-axial fans, located within a metal bell housing. The fire resulting from a fan overheating and igniting it's lubricating grease would be self-contained. The fan housing will shield the pressurizer cubicle from the fire. In addition, there is sufficient spatial separation from the nearest combustibles such that fire propagation from these materials would not occur.

Fire Zone 67A

The fixed combustibles in fire zone 67A consist mainly of cable in cable trays located above the 80 ft., 100 ft., and 120 ft. elevations. The total combustible loading for these cable trays is 3,519 pounds of material. The combustible loading due to cable trays at elevations of 140 ft. or higher were not considered due to the fact that these cable trays are above the level of the horizontal RES enclosed conduit and are sufficiently separated from the vertical run of the RES conduit such that they do not represent a potential exposure to the RES. Of the cable trays that are of concern, none are attached to the north wall of the pressurizer cubicle (south wall of the fire zone). Therefore, there are no cable trays located directly below the RES.

The cable trays in closest proximity to the RES are located approximately two feet northwest of the RES. A fire originating from an electrical fault in the cable trays is not considered credible based on the use of IEEE 383 qualified cables and the use of protection devices on the circuits. Some of these trays are protected by Thermo-Lag barriers for Regulatory Guide 1.75 physical separation. These cable trays and barriers are even more unlikely to ignite due to the Thermo-Lag having a higher critical heat flux than that of the IEEE 383 cabling. None of the fixed combustibles discussed in this paragraph are located adjacent to, or above, any likely fixed ignition source. Therefore, a fire in these cable trays is not considered to be credible.

The lubricating grease used in the various valves in this fire zone is not considered a credible threat to the RES for several reasons. The grease is difficult to ignite. It has an autoignition temperature of approximately 700 ^{0}F. The grease used in these valves is not openly exposed to potential ignition sources. In addition, no ignition sources which could ignite the grease are in this fire zone. Therefore, a fire due to this source is

which could ignite the grease are in this fire zone. Therefore, a fire due to this source is unlikely. Spatial separation between the valves and the RES provides added assurance that the RES will not be exposed to any fires from this source.

The Combustible Loading Calculation also indicates the presence of 42 pounds of PVC jacket on flexible conduit in this fire zone. The fire loading due to the PVC jacket is considered to be insignificant due to the fact that the amount in any one location is negligible and the PVC is not in one continuous length. There are no fixed ignition sources in proximity to the PVC, nor is self-ignition of a wire within the conduit likely. Therefore, these sources do not constitute a flame propagation path to the RES, nor would they generate a fire that would be large enough to present a hazard to the RES.

Based on the above discussion, it has been concluded that the RES will not be exposed to temperatures in excess of 1000 ^{0}F due to any postulated fire in these zones.

b) <u>Fire Protection Features</u>

The containment building is a multi-level structure that has its primary components separated or enclosed with physical barriers of concrete. The construction of the floors, stairs and walkways is of concrete and/or steel grating. Access to the containment building is limited and controlled during the operation of the units. Because of these controls, transient combustibles and ignition sources are minimized. The lack of credible ignition sources within containment while the unit is operating makes it unlikely that a fire would occur in containment.

The floor, ceiling and walls of fire zone 65 (pressurizer cubicle) are constructed of 2 feet thick reinforced concrete. The fire suppression equipment available in this zone are the hose stations located in fire zone 67A and portable CO_2 fire extinguishers. * Line-type thermal detectors are provided for this fire zone. Activation of these detectors will result in an alarm in the main control room and a response from the on-site fire department.

The primary fire suppression equipment for fire zone 67A (general area, northwest containment) are manual hose stations at each elevation of 80 ft., 100 ft. and 120 ft. and portable CO_2 fire extinguishers. * Fire detection systems consist of smoke detectors and line-type thermal detectors. The smoke detectors are installed throughout the general area. The line-type detectors are installed in each cable tray in this fire zone. Both detection systems, when actuated, provide alarms in the main control room and will result in a response from the on-site fire department.
These fire protection features serve to detect and mitigate the consequences of a postulated fire in these fire zones. Therefore, it is highly unlikely that a fire would start and continue to develop to the point where the RES would be affected.

* The portable extinguishers are removed from containment in Modes 1-4, but would be brought into containment by the fire department on an as-needed basis in the event of a fire in containment.

c) <u>Fixed Ignition Sources</u>

The PVNGS evaluation of fire as an external event indicated that the only significant ignition sources within the containment building are the reactor coolant pumps. These pumps are not located in the two fire zones of concern. There are no potential reactor coolant pump oil leak paths into the fire zones bounding the RES. In addition, there are not any openings in the walls separating the fire zones bounding the RES from the fire zones containing the reactor coolant pumps that would allow the RES to be subjected to the radiant energy from such a fire. Therefore, a fire involving these pumps would not expose the RES to flames or radiant energy.

Field cable runs are not considered ignition sources due to the use of IEEE 383 qualified cables and the use of protection devices on the circuits. A review of industry data did not identify any cases indicating that this cable self-ignited.

Junction boxes are not considered fixed ignition sources because of the solid metal, unvented construction. The junction box construction prevents a fire from propagating outside of the junction box.

There are two fan motors located approximately four feet above the RES. These fans are vane-axial fans, located within a metal bell housing. The fire resulting from a fan overheating and igniting it's lubricating grease would be self-contained. The fan housing will shield the pressurizer cubicle from the fire. In addition, there is sufficient spatial separation from the nearest combustibles such that fire propagation from these materials will not occur. Note also that the heat release rate for motors this size is very low due to the fact that the motor is lubricated with grease, not oil.

d) <u>Transient Combustible and Ignition Source Administrative Controls</u>

There is a potential for transient combustibles to be placed in both fire zones during shutdown maintenance activities. As indicated earlier, however, the PVNGS Appendix R Safe Shutdown Analysis indicates that the pressurizer auxiliary spray valve and the RES protecting it are not required during Modes 5 and 6.

Prior to entry into Mode 4,a visual inspection is performed in accordance with an approved station surveillance procedure in all accessible areas of the containment building which verifies that no loose debris (rags, trash, clothing, etc.) is present in the containment building. This inspection is necessary, in part, to ensure that loose debris which could be transported to the containment sump and cause restriction of the pump suctions during LOCA conditions is identified and removed from the building. All accessible areas of the containment building are inspected prior to establishing containment integrity. This inspection is not required for entries that are made for

inspection, acquiring test data or for normal operations after containment cleanliness has been established for plant operations in Mode 1-4.

The performance of this surveillance procedure ensures that the transient combustibles used during an outage are removed prior to Mode 4 operation. If transient materials or equipment must remain in the containment building, then an engineering evaluation is performed to evaluate the acceptability of leaving these items in the containment building. This engineering evaluation would address any fire protection concerns. Therefore, the cleanliness acceptance criteria established by this surveillance test assures that transient combustibles or ignition sources within the containment building and the subject fire zones are adequately controlled.

e) <u>Ventilation Features and Ceiling Height</u>

Fires from combustibles that are remote from the RES could damage the RES if there is a potential to form a hot gas layer which can bank down and immerse the RES if it is located near the ceiling. The following information demonstrates that the formation of a hot gas layer that could affect the RES is not credible.

Inside the pressurizer cubicle, the RES is located within approximately 7 feet of the ceiling of the pressurizer cubicle. The potential for a hot gas ceiling layer is significantly reduced by the two openings housing 20,000 cfm exhaust fans. These fans operate continuously when the unit is in operation. For a small fire scenario, heat would vent through these openings preventing any hot gas layer from forming and adversely affecting the RES. A fire involving the heater cables located below the pressurizer also would not adversely affect the RES. As stated previously, the hot gases rising from the area below the pressurizer would mix with cooler ambient air and would also transfer heat to the compartment walls. These gases would sufficiently cool prior to reaching the RES such that they would not affect the RES. The additional cooling effects of the cubicle fans were not credited but provide added assurance that the RES remains unaffected by a fire in the subject cable trays.

Outside of the pressurizer cubicle, the RES is located in open areas between the 138 ft. and 154 ft. elevations of the containment building. The containment building general area ceiling height is 206' 6" at the apex of the dome. Therefore, a hot gas layer banking down to these levels is not credible. The height and volume of the containment building general areas would dissipate and cool the hot gases evolving from any postulated fire.

f) Independent Quantification of Potential Fire Effects on the RES

The above qualitative analysis demonstrates that a credible postulated fire would not expose the RES to temperatures in excess of 1000 ^{0}F. Although this conclusion is justified using a number of fire protection features that form APS' defense-in-depth fire protection measures, APS contracted an independent engineering consultant firm to perform a deterministic evaluation, using engineering calculations and computer-based fire models. This evaluation utilized the computer-based fire model CFAST to estimate the upper gas layer buildup and resultant temperatures in fire zone 65. For both fire zones, the analysis took into account the effects of direct flame, plume impingement, radiant energy transfer and the formation of a hot gas layer. The complete evaluation is provided as Attachment 1. A summary of the evaluation is provided in the following paragraphs. Please note that this evaluation was performed with the intent of removing the RES. APS has determined that the RES should remain at this time as a conservative measure to provide additional assurance that the operability of the auxiliary spray valve is maintained in the event of a postulated fire.

This deterministic evaluation assumed five fire scenarios involving the ignition of the fixed combustibles in fire zones 65 and 67A. The fire scenarios involve cable in the cable trays at 100 foot elevation below the pressurizer in fire zone 65 and the cable in cable trays at elevations 108, 110, 133 and 135 feet in fire zone 67A. The results of the credible fixed combustible fires are outlined on the next page in Table 1 and are summarized below.

The results of this study demonstrate the following:

- No direct flame impingement occurred on the RES in either fire zone.
- The fire plume temperature, including the upper gas layer effect, reached a maximum of 134 ^{0}F in fire zone 65. The fire plume temperatures reached a maximum of 133 ^{0}F in fire zone 67A.
- The hot gas layer temperature in fire zone 65, assuming that the pressurizer cubicle exhaust fans were not running and that the entire surface of all of the cable in the cable trays below the pressurizer were involved in the fire, reached a maximum temperature 199 ^{0}F. No significant hot gas layer temperatures developed in fire zone 67A due to the large volume of the containment building.

For all five fire scenarios, the analysis demonstrated that the RES would not be subjected to temperatures sufficiently high to cause combustion of the RES nor was the RES subjected to a radiant heat flux that would approach the RES critical heat flux. This deterministic evaluation concluded that the use of Thermo-Lag as a RES in this application is acceptable.

TABLE 1

Fixed Combustible	Direct Flame Impingement	Fire Plume Temp.	Gas Layer	Radiant Heat
1 Fire Zone 65 - Cables at 100' elev.	NONE (Flame Height = 1.6 feet)	122°F (134°F w/ upper gas layer effects added)	199°F	No separation req'd. Fire source adequate distance away.
2 Fire Zone 67A - Cable trays at 108' elev. minimum.	NONE	109°F	N/A - Due to large volume of Containment.	Fire source adequate distance away.
3 Fire Zone 67A - Cable trays at 110' elev. minimum.	NONE	133°F	N/A - Due to large volume of Containment	Fire source adequate distance away.
4 Fire Zone 67A - Cable trays at 133' elev. minimum.	NONE	RES located outside the Plume.	N/A - Due to large volume of Containment	Fire source adequate distance away.
5 Fire Zone 67A - Cable trays at 135' elev. minimum.	NONE	RES located outside the Plume.	N/A - Due to large volume of Containment	Fire source adequate distance away.

g) <u>Emergency Response Capability</u>

APS maintains a professional Fire Department on-site at all times. The Fire department will immediately respond to fire emergencies.

In summary, the qualitative and quantitative analyses described above demonstrate the acceptability of using Thermo-Lag as the RES for the Train A pressurizer auxiliary spray valve and associated circuits. The design and programmatic fire protection features ensure that the RES would not be exposed to temperatures such that combustion of the RES material would occur in the event of any credible fire. Therefore, the ability to achieve and maintain safe shutdown conditions would not be impacted by any postulated fire scenario. The RES, as designed, meets the intent of 10 CFR 50, Appendix R, Section III.G.2.f.

ATTACHMENT 1