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SUBJECT: Provides addl anfo re individual plant examination of external events for PVNGS that was requested in ltr to APS dtd 971023.W/15 foldout drawings encl.

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102-04084– WEI/SAB/RMW
February 27, 1998

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Dear Sirs:

Subject: **Palo Verde Nuclear Generating Station (PVNGS)**
Units 1, 2, and 3
Docket Nos. STN 50-528/529/530
Response to Request for Additional Information Regarding Individual Plant Examination of External Events Submittal for the Palo Verde Nuclear Generating Station.

Enclosure 1 provides the additional information regarding the Individual Plant Examination of External Events for PVNGS that was requested in your letter to APS dated October 23, 1997. Please contact Mr. Scott Bauer at (602) 393-5978 if you have any questions or would like additional information regarding this matter. This letter does not make, or imply, any commitments to the NRC.

Sincerely,

Enclosure/Attachment

WEI/SAB/RMW/rlh

A011/1

cc: E. W. Merschoff w/o Attachment
J. W. Clifford
J. H. Moorman w/o Attachment
K. E. Perkins w/o Attachment

Drawings located in [illegible] Files

ENCLOSURE 1

Response to Request for Additional Information

NRC Request 1

Fire

1. The submittal addresses both human intervention and non-intervention aspects of the spurious recirculation actuation signal (RAS) scenario. More detail is needed on this issue as discussed below.

   a. Provide a description of the cable routing carrying the signals contributing to spurious RAS. Identify each compartment and within each compartment, describe the cabling geometry (i.e., number of trays, elevation, orientation, and separation from each other and walls, floors and ceiling). Identify fire sources potentially impacting these cables. Identify the thermal damage criteria used for these cables. If Thermo-Lag is used on these cables, describe how it is credited in the analysis.

   b. Provide an assessment of the operator diagnoses of spurious RAS. How are spurious signals distinguished from real signals? Are there independent instrumentation systems available to help diagnose this situation, and can that cabling be involved in the same fire? What is the cause of the spurious signal generated? (Short to ground? Open circuit cable?) If the operator prematurely isolates the refueling water tank (RWT), how much time is there to correct the situation before the onset of core damage? If the operator error rate is 0.1, what is the core damage frequency (CDF)?

APS Response

1.a.

As described in the PVNGS IPEEE submittal, Section 4.6.3.1, a RAS is only relevant in cases where the fire-induced plant transient leads to the opening of the pressurizer safety valves (PSVs) and the subsequent failure of one or more PSVs to close. This results in a Small Loss-of-Coolant-Accident (LOCA), which requires high pressure safety injection (HPSI) to provide makeup water to the Reactor Coolant System (RCS). If HPSI is successful, eventually the entire contents of the RWT will be used and containment sump recirculation will be required. This section evaluated the potential for a spurious RAS to occur and concluded that either the spurious RAS did not occur or that the operator successfully diagnoses it and responds properly.

Request 1.a. requires information in four areas: 1. RAS cable routing, 2. Potential fire sources that may impact these cables, 3. Thermal damage criteria used to assess these cables, and 4. How Thermo-Lag 330-1 fire retardant material on these cables was credited in the analysis. This information is provided in the following paragraphs.

The cable routing for the RAS instrumentation is very complex. Therefore, APS has provided marked-up conduit and tray drawings as an attachment to this letter that provide a visual indication of the cable routing through the various areas of the units. Notes and deviations in cable routing are identified and shown where differences in cable routing between the units exist. As shown in Table 1 below, the cable routings are color coded to reflect the different Class 1E channels of RWT level instrumentation used in the RAS circuits. The Class 1E powered level indication and control channels are not identified separately because they share the same tray and conduit routing as their respective Channels A or B, Class 1E RWT level channels. Compartment walls are indicated to assist in better visualization of the physical barriers between each compartment. Major potential fire sources are also indicated on these drawings. The RWT instrument vault and the fuel building have no shutdown initiators and were screened from any additional analysis. Therefore, information regarding cable routing through these locations will not be provided. The only other areas that these cables are routed through are the auxiliary and control buildings. The drawings provided identify the cable routing from where the cables enter the auxiliary building up to, but not including, where they enter the main control room.

Table 1

INSTRUMENT	GENERATES RAS	CONTROL RM INDICATION	LEVEL ALARM	COLOR SCHEME
JCHALT0200, Level & Control Ch. A *	NO	YES	YES	NA
JCHBLT0201, Level Ch. B *	NO	YES	YES	NA
JCHALT0203A, Channel A RWT Level **	YES	YES	NO	RED
JCHBLT0203B, Channel B RWT Level **	YES	YES	NO	GREEN
JCHCLT0203C, Channel C RWT Level **	YES	YES	NO	YELLOW
JCHDLT0203D, Channel D RWT Level **	YES	YES	NO	BLUE
BARRIERS	N/A	N/A	N/A	BLACK
FIRE SOURCE	N/A	N/A	N/A	RED Cross- Hatch

* Although Channel B does not have any control functions associated with it, it is referenced with Channel A as a "level indication and control channel" to provide a consistent reference throughout this document.

** The RWT level channels that provide input to the RAS logic are identified as "Class 1E RWT level channel" throughout this document.

The potential fire sources that may impact the RAS cables are identified in the PVNGS IPEEE submittal, Section 4.6.3.2. Since this section of the IPEEE does not explicitly specify which potential fire sources may impact the RAS cables, these sources have been identified on the marked up drawings.

The electrical cables used at PVNGS are IEEE-383 qualified cables. Therefore, the thermal damage criterion considered in the PVNGS analysis is 700 °F., at which point the cables are assumed to fail. This is in accordance with Section 6.3.3.1 of the Fire-Induced Vulnerability Evaluation (FIVE) methodology.

Thermo-Lag 330-1 fire retardant material is not installed on any of the RAS circuitry raceways. Therefore, it is not credited in the analysis.

1.b.

Level indication for the RWT consists of two Class 1E powered level indication and control channels and four Class 1E RWT level channels. A mechanical level gauge is provided locally at the tank. The two Class 1E powered level indication and control channels provide level indication in the main control room and to the remote shutdown panels, but do not provide any input into the generation of a RAS. The Train A powered channel provides control functions to the Chemical and Volume Control System in addition to these level indications. The Train B powered channel does not have any control functions associated with it. The four Class 1E RWT level channels provide level indication in the main control room and will generate a signal to the Engineered Safety Features System (ESFAS) when a low-low level is sensed in the RWT. The ESFAS will generate a RAS when any two-out-of-four Class 1E level channels reach the low-low level setpoint. Train A consists of Class 1E RWT level Channels A and C, while Train B consists of Class 1E RWT level Channels B and D. The four Class 1E RWT level channels produce level signals that are directly proportional to level. Therefore, a loss of signal from the transmitter due to a short-to-ground or open circuit – the actual failure mode is not relevant - would lead to actuation of that channel, a half-leg trip of the ESFAS RAS and a zero indication in the main control room. At least two channels would have to be affected in order to initiate a spurious RAS.

As noted in Section 4.2 of the PVNGS IPEEE submittal, the Appendix R reconstitution analysis safe shutdown fire analysis areas (grouped fire zones) were utilized, where appropriate, to support the FIVE analysis. Section 4.2 also notes that the FIVE analysis was done on a fire zone basis where the analysis areas provided too gross of a grouping of equipment to model with the Probabilistic Risk Assessments (PRA). APS Calculation 13-MC-FP-318, 10CFR50 Appendix R III.G/III.L Compliance Assessment, identifies the components and/or cables of components credited for safe shutdown which may be impacted by a fire within a given fire analysis area. This calculation then allows for the determination of which train of safe shutdown redundant equipment is available to achieve and maintain safe shutdown. If both trains of redundant components are impacted within an analysis area, the function provided by those components is evaluated to determine if it is required. If so, other available means are identified that would achieve the same function. APS Calculation 13-MC-FP-318 reviewed each analysis area to determine which components in a particular analysis area could potentially be impacted by a fire. Based on this review, components that remain available for safe shutdown, or other available means for achieving the same function as that which was lost, were identified. Pertinent information from this calculation was placed into an operating procedure that is readily available to the control room staff in the event of a fire. This procedure focuses on which train (A or B) should be considered as reliable for safe shutdown and the mitigation of spurious actuations. Table 2 on the next page provides a sample of the information that is provided in this procedure and in the calculation.

A review of the fire zones through which the four Class 1E RWT level channels are routed indicates that the fire zones which are most at risk are the main control room and Fire Zones 42D and 52A. Fires in the main control room are adequately addressed in the PVNGS IPEEE submittal. As shown on the marked up conduit and tray drawings provided with this letter, Channels A, B and C Class 1E RWT level channels are routed through Fire Zone 42D. Channels A, C and D Class 1E RWT level channels are routed through Fire Zone 52A.

The Channel A Class 1E RWT level channel is routed through Fire Zone 42D in an overhead cable tray. With the exception of a small portion of conduit routed along the northwest and west walls of this fire zone, the Channel B Class 1E RWT level channel is routed in conduit embedded in the heavy concrete floor of this fire zone. The Channel C Class 1E RWT level channel is routed in an overhead cable tray at the east end of this fire zone. As stated in Section 4.6.3.2 of the PVNGS IPEEE submittal, a load center (LC) and a motor control center (MCC) are the only fixed fire sources of concern for this fire zone. The target of concern is a stack of Train A cable trays, which also contain the Channel A Class 1E RWT level channel. These trays are located approximately nine feet east of the MCC and LC. Using the applicable worksheets from the FIVE methodology, it was determined that the target of concern was not exposed to fires originating from these fixed sources. The transient combustibles control program utilized at PVNGS and frequent plant inspections ensure that transient combustible loads are minimized. Therefore, a fire resulting from a critical transient combustible load is not expected to affect more than one channel of Class 1E RWT level instrumentation in this fire zone.

The Channel B Class 1E RWT level channel conduit and the Channel C Class 1E RWT level channel cable tray were not identified as potential targets due to their locations within the fire area with respect to the MCC or LC. As shown on marked up conduit and tray drawings 13-E-ZAC-015 and 13-E-ZAC-017 provided with this letter, the above-floor portion of the Channel B Class 1E RWT level channel conduit is located along the northwest and west walls of Fire Zone 42D (between horizontal column lines A3 and A4 and vertical column lines AA and AB). The MCC and LC are located between horizontal lines A6 and A7, and vertical column lines AB and AC. The exposed portion of this conduit is not affected from fires originating in the MCC or LC since it is located significantly further away from the MCC and LC than the Train A cable trays. In addition, the exposed conduit and pull box are at a lower elevation than the Train A cable trays, which further lessens the Train B circuits to exposure from fires that may be generated in the MCC or LC.

Table 2

Building	Analysis Area	Fire Zone/ Elev.	Potentially Affected RAS Cables	Potential RAS	Fire Source (from PVNGS IPEEE)	Appendix R	
						SSD Train To Use	13-MC-FP-318 RWT/RAS Appendix R ANALYSIS
Auxiliary Building	XVC	52A/ 120	JCHALT0203A* JCHCLT0203C JCHDLT0203D	YES	4.6.3.2	B	Components lost in this analysis area will not result in unacceptable RWT draw down.
		42D/ 100	JCHALT0203A* JCHBLT0203B# JCHCLT0203C	YES	4.6.3.2	B	
	XVD	52D/ 120	JCHDLT0203D	NO	Screened	A	Redundant Train (A) Class 1E RWT level indication available
		42C/ 100	JCHBLT0203B# JCHCLT0203C	YES	4.6.3.2	A	
	XVIA	42A/ 100	JCHALT0203A JCHCLT0203C	YES	Screened	B	Redundant Train (B) Class 1E RWT level indication available
		47A/ 120	JCHALT0203A JCHCLT0203C	YES	4.6.3.2, 4.7	B	
	XVIIA	47B/ 120	JCHDLT0203D	NO	Screened	A	Redundant Train (A) Class 1E RWT level indication available
		42B/ 100	JCHBT0203B	NO	4.6.3.2	A	
Control Building	IC	86A/ 100	JCHALT0203A* JCHCLT0203C	YES	NONE	B	Redundant Train (B) Class 1E RWT level indication available
	IIC	86B/ 100	JCHBLT0203B# JCHDLT0203D	YES	NONE	A	Redundant Train (A) Class 1E RWT level indication available
	ID and Train C Chase	6A/ 100	JCHCLT0203C	NO	Screened	B	Redundant Train (B) Class 1E RWT level indication available
	IB (Train A Cable Chase)	4A 11A 15A 18A	JCHALT0203A*	NO	NONE	B	Redundant Train (B) Class 1E RWT level indication available
	IIB (Train. B Cable Chase)	4B 11B	JCHBLT0203B#	NO	NONE	A	Redundant Train (A) Class 1E RWT level indication available
	IIG	14/ 120	JCHBLT0203B# JCHDLT0203D	YES	NONE	A	Redundant Train (A) Class 1E RWT level indication available
	IG	20/ 160	JCHALT0203A* JCHCLT0203C	YES	NONE	B	Redundant Train (B) Class 1E RWT level indication available
	IIIA	17/ 140	All	YES	4.6.3.2	B	Control Room Fire, PVNGS Procedure 40AO-9ZZ19

- *=> Also includes circuits for level instrument JCHALT0200 since routing is the same as LT0203A.
- #=> Also includes circuits for level instrument JCHBLT0201 since routing is the same as LT0203B.

The Channel C Class 1E RWT level channel cable tray is located mid-way between vertical column lines AD and AE on drawings 13-E-ZAC-015 and 13-E-ZAC-017. This cable tray exits through the east end of the south wall of Fire Zone 42A. The cable tray then turns east and exits Fire Zone 42D, as shown on drawing 13-E-ZAC-018. The physical distance between this cable tray and the MCC or LC ensures that any fire originating in either of these potential fixed combustible sources will not affect this cable tray.

As shown on the marked up conduit and tray drawing 13-E-ZAC-070 provided with this letter, electrical cables for Class 1E RWT level Channels A, C and D are routed in either conduit or cable trays through Fire Zone 52A. The critical fixed combustible load in this fire zone is a LC that is located approximately 14 feet from the nearest target cable tray. As stated in Section 4.6.3.2 of the PVNGS IPEEE submittal, the applicable worksheets from the FIVE methodology were used to determine that the targets of concern were not exposed to fires originating from this fixed source. In addition, no credible transient fire load could affect the circuit of more than one Class 1E RWT level channel due to the administrative controls that have been implemented at PVNGS.

All of the other fire zones through which two Class 1E RWT level channels were routed were shown to have sufficient physical separation from any credible fixed fire source such that damage to both of the circuits did not occur or that no fixed fire sources existed in the fire zone of consideration. Credible transient combustible loads were evaluated and shown to have a very low probability of affecting more than one circuit at a time. Therefore, at least one reliable train of Class 1E RWT level instrumentation remains available for the operator to use to determine if the RAS actuation is valid when it occurs. In addition, as stated in the IPEEE Section 4.6.3.1, the subject cable trays were shown to have greater than six feet of spatial separation and are protected with fire suppression systems.

As inferred from the PVNGS IPEEE submittal and the marked up conduit and tray drawings provided with this letter, the only fire zone that has two or more Class 1E RWT level channels routed through it that was evaluated using probabilistic techniques was Fire Zone 47A. All of the other fire zones where two or more Class 1E RWT level channels were routed through them were screened in accordance with the FIVE methodology. With the exception of Fire Zones 42D, 47A and 52A, no specific fire modeling or probabilistic evaluations were performed for the other fire zones through which two or more circuits of Class 1E RWT level channels were routed. These fire zones do not contain significant fixed fire sources or the fixed fire source is located such that two or more of the subject cables are not impacted by the fixed fire source. In addition, a fire resulting from a credible transient combustible load was evaluated and shown to have a very low probability of affecting more than one Class 1E RWT level channel at a time. Note that any fire in any fire zone that may potentially impact Class 1E RWT level Channels A or B will also affect the two Class 1E powered level indication and control channels. Level indication and control Channel A is routed through the same raceway as Class 1E RWT level Channel A. Level indication Channel B shares the same raceway as Class 1E RWT level Channel B.

The above discussion demonstrates that a spurious RAS due to a credible fire is highly unlikely. A minimum of two Class 1E RWT level channels would have to be affected by the fire to generate a spurious RAS. If a spurious RAS were to occur, the operator is directed to verify that the RAS is valid. In a fire-initiated event, guidance similar to the information in Table 2, above, is provided to the operations staff to assist in the determination of what channels of instrumentation are to be considered reliable. Station procedures direct the operator to validate the RAS by comparing all channels of RWT level instrumentation to each other, i.e., the channels should read consistently with each other. Channels that have been identified as being potentially impacted by the fire or that have readings that are exceptionally low, high or are erratic are identified as possibly providing information that is questionable. Although not credited in the analysis, the operator will also verify the Class 1E powered, Train A and B containment Engineered Safety Features (ESF) sump level indications to ensure that sufficient level exists in the containment ESF sumps to provide sufficient net positive suction head to the ESF pumps. These circuits have been verified to have adequate separation. Therefore, these circuits are associated with their respective train of safe shutdown equipment. If the reliable safe shutdown train indications indicate that the RAS is valid and sufficient level exists in the containment ESF sumps to provide net positive suction head to the ESF pumps, the operator will then isolate the RWT. Note that the RWT will not isolate automatically on a RAS. If the operator determines that the RAS is spurious, he will take the appropriate actions as defined in station procedures to correct the situation. Simulator training is also provided to the operators such that an incorrect diagnosis by the operator is highly unlikely.

Modular Accident Analysis Program (MAAP) analysis indicates that an actual RAS following an induced LOCA through a PSV would not be expected for approximately 1.9 hours into the event. Operators using the station emergency operating procedures would identify the LOCA and take the appropriate recovery actions. Subsequent operator verification of both the legitimacy and proper execution of the ESFAS actuations (such as a RAS) would bring to the operator's attention the conflicting RWT level indications and the RAS if it were spurious. In the unlikely event the RWT was isolated in response to a spurious RAS and the containment ESF sump inventory was not sufficient to supply net positive suction head to the HPSI pump, the MAAP analysis indicates that core uncovery would not occur until 1.8 hours after the RWT was isolated. This provides sufficient time for the operator to recognize and correct this inappropriate action in accordance with the appropriate emergency operating procedures prior to actual core uncovery occurring. Therefore, as implied in Section 4.6.3.1 of the PVNGS IPEEE submittal, successful response to spurious RAS, or no spurious RAS occurring, is assumed in the analysis due to extensive operator training, use of appropriate station

procedures during event recovery and design features that provide adequate protection of the circuits in question.

In summary, it has been determined that there are no fixed potential fire sources or credible transient combustible fire loads that may induce a spurious RAS in the fire zones of interest. In addition, at least one train of reliable instrumentation remains available to assist the operator in determining the validity of the RAS. As further defense in depth, extensive guidance exists for the operations staff to determine whether or not a RAS is spurious and what the appropriate follow-up actions are that should be taken. Therefore, it is assumed in the analysis that transfer of the ESF pump suctions to the containment ESF sumps is carried out properly and loss of HPSI does not occur.

Question 1.b. asks what the CDF would be if the operator error rate was assumed to be 0.1. As described above, a spurious RAS is not considered to be a credible consequence of a fire. However, if a spurious RAS were postulated to occur along with the LOCA scenario described in Section 4.6.3.1 of the PVNGS IPEEE submittal, an inappropriate operator response to a inadvertent RAS with a stuck open PSV results in core damage. The IPEEE analysis was not constructed to model this scenario due to the fact that a spurious RAS is not considered to be credible. Therefore, APS cannot provide a quantitative answer to this question. However, if an operator non-recovery probability of 0.1 were applied to LOCA sequences that go to unity, the resulting conditional Core Damage Probability (CDP), would be 0.1.

An approximate CDF, based on the assumption of a spurious RAS and an inappropriate operator action, would be equal to the fire ignition frequency of the fire zone in which a fire may cause a spurious RAS, times the conditional CDP (in this case 0.1). Table 2 lists those fire zones for which a spurious RAS could be assumed to occur due to a fire. The fire ignition frequencies for each fire zone of interest are listed in Table 4-4 of the PVNGS IPEEE submittal. However, based on the evaluation described above of the rooms in question, the actual CDF would be much less than that calculated using this approximation.

NRC Request 2

Fire

2. In the second paragraph on page 4-14; additional discussion of the procedure for recovery from loss of off-site power (LOSP) is needed. Please provide the sequence of events and an approximate time-line for the one-hour recovery, allowing time needed for locating personnel and their travel to the required place.

APS Response

It is important to distinguish the type of loss of off-site power events as described in this particular analysis from the more global LOSP as defined in most internal events PRA. The off-site power losses described in this analysis involve the spurious opening of one, or two, 13.8 kV breakers that supply power from the startup transformers to the ESF transformers. In any given cutset, power is lost and then recovered for one train of ESF equipment. A random failure on the other train may prevent a safety function from being met, as stated in the second paragraph on page 4-14. A total loss of off-site power (i.e., the grid or the high voltage switchyard lose all power) is not included in the recovery actions credited in this particular analysis.

The Human Recovery Actions (HRA) developed for both the one- and three-hour recovery actions described in this analysis allow twenty minutes for diagnosis of the event and ten minutes to align and restore auxiliary feedwater after power is restored to the ESF bus. Restoration of auxiliary feedwater requires starting an auxiliary feedwater pump and opening one or two valves to a steam generator, depending on which auxiliary feedwater pump is used. Therefore, thirty minutes remain for the one-hour HRA and 150 minutes remain for the three-hour HRA to perform the required manual local operator actions to restore power to the ESF bus.

The worst case scenario for the one-hour HRA is when the 13.8 kV power supply breakers located in the startup transformer yard require manual local operator action to restore power to the affected ESF bus. This yard is located in the outside plant areas, adjacent to the high voltage switchyard. Three actions are required to disconnect the main control room breaker circuitry from the breaker of interest. One additional action to operate a local control switch is required to close the breaker. A maximum of two breakers would need to be operated to restore power to the affected ESF bus – the operation of the second breaker requires one additional local operator action. The total time required to accomplish these steps is five minutes. Therefore, 25 minutes remain for the operator to be dispatched to, and arrive at, the location where these local actions must be performed.

Transportation is provided to the operator that is assigned to the outside areas (including the startup transformer yard) of the units. The expected travel time for the outside area operator to travel from any plant area to the startup transformer yard is between five and fifteen minutes, depending on the location of the operator when initially dispatched to the startup transformer yard. Therefore, a minimum of ten minutes remains as a contingency to restore power to the affected ESF bus. This scenario bounds the operation of other potentially affected breakers due to the fact that these other breakers are located immediately adjacent to the affected unit. Therefore, the response time for the operator to be dispatched to, and arrive at, the other potentially affected breaker locations is much shorter.

NRC Request 3

Fire

3. Fire zones 46A, 46B, and 46E are all charging pump rooms and are credited with three-hour barriers despite open doorways in each. The consideration of open doorways as vital fire barriers is not consistent with the fire-induced vulnerability evaluation (FIVE) methodology. Provide the analysis of these compartments with the open doorways explicitly included.

APS Response

As stated in the PVNGS IPEEE submittal, Table 4-3, Phase I Screened Fire Compartments, Fire Zones 46A, B and E were screened based on Screening Criterion 2 of the Table. Criterion 2 states "Boundaries that consist of a two-hour or three-hour rated fire barrier *on the basis of barrier effectiveness.*" (emphasis added). In addition, Table 4-3 identifies the assumptions made during the screening process. Assumption 5 of this Table was used to support screening Fire Zones 46A, B and E from further consideration in the analysis. This assumption states that the fire barriers around these zones were considered to be three-hour rated fire barriers despite open doorways in these barriers. This assumption continues to state that the combustible loading in these zones is low and that there are no fire propagation or hot gas layer paths to other compartments. In addition, credit is taken for a deviation to 10CFR50, Appendix R, Section III.G.2, as stated in the PVNGS Updated Final Safety Analysis Report.

Section 2.2, Fire Area, of the FIVE Methodology states that fire area boundaries must be completely sealed with floor-to-ceiling and/or wall-to-wall fire barriers. It continues to state that for fire barriers that are not wall-to-wall or floor-to-ceiling, an evaluation must be performed by a fire protection engineer to assess the adequacy of the fire area boundaries to determine whether they can withstand the fire hazards within the area and protect important equipment in the area from a fire outside the area. APS performed an initial assessment of barrier effectiveness, but did not formally document it. The initial assessment considered the following features for the fire zones under consideration:

Corridor Area, Auxiliary Building Elevation 100'-0", Fire Zone 42C:

a. The top of the open doorway into each charging pump compartment is 7 feet above the floor.
b. The lowest cable tray is 9 feet above the floor (i.e., 2 feet higher than the door).
c. All electrical cables in this fire zone are IEEE-383 qualified cables.
d. The horizontal configuration of the cable trays will limit the rate of fire propagation.
e. There is a large volume of space above the doorways to disperse and cool combustion products.
f. The equivalent fire severity classification for this fire zone is "moderate" (51 minutes). 90% of the combustible loading is due to IEEE-383 qualified electrical cables and Thermo-Lag 330-1 fire retardant material.
g. This fire zone has area wide fire detection.
h. All cable trays in this fire zone that may present an exposure hazard to Fire Zones 46A, B and E have in-tray fire detection and suppression systems.

Charging Pump Rooms, Fire Zones 46A, B and E:

a. There are no fixed combustibles in the entry area or valve gallery of each compartment.
b. There is an additional full height non-rated barrier with all electrical and piping penetrations sealed with high-density elastomer to form a radiological barrier between the entry area and valve gallery of each compartment. An open personnel doorway in this barrier provides access to the pump cubicle.
c. The top of the personnel doorway in this non-rated barrier is approximately 7.5 feet above the floor.
d. A 6-inch concrete curb in the personnel doorway of this non-rated barrier impedes flow of liquids between compartments.
e. Each compartment has low credible combustible loading consisting mostly of lubricating oil for the charging pump.
f. The low combustible loading of each compartment, combined with the high ceiling height, allows for dispersion and cooling of the combustion products such that the formation of a hot gas layer that would propagate from one fire zone into another fire zone is unlikely.
g. Each of these fire zones has area wide fire detection.
h. Each of these fire zones has area wide fire suppression.

Based on the above features of each fire zone under consideration, the initial assessment concluded that these fire zones screened out of further consideration because they satisfied Criterion 2 of the FIVE methodology, i.e., barrier effectiveness was demonstrated. Note that Criterion 6 of the FIVE methodology could also have been used as the screening criteria for these fire zones – automatic fire suppression is installed over combustibles in the exposing compartment.

The following discussion regarding these fire zones provides additional information that supports the initial assessment. The reference drawing for this discussion is Figure 4-1r of the PVNGS IPEEE submittal.

Corridor Area, Auxiliary Building Elevation 100'-0", Fire Zone 42C

Fire Zone 42C is the corridor area located north, east and south of the charging pump rooms (Fire Zones 46A,B and E). This fire zone also includes the corridor area northeast of the charging pump rooms, adjacent to Fire Zone 42B. The floor plan surface area of this fire zone is approximately 4,500 square feet. The ceiling is approximately 18.5 feet above the floor. Area smoke detection is provided throughout this fire zone. The combustible fire loading for this fire zone is moderate.

The fire barrier under consideration is the north wall of the charging pump compartments, located along horizontal column line A7 of Figure 4-1r. This barrier is of heavy concrete construction with the electrical and piping penetrations sealed to an equivalent three-hour fire barrier rating. The open doorways through this barrier into each of the charging pump room entry areas measure three feet wide by seven feet high. Therefore, the tops of these openings are seven feet above the floor. Taking into consideration the ceiling height of this fire zone with respect to the charging pump rooms doorways, a free volume of over 49,000 cubic feet exists for the dispersion of any fire generated hot gasses. Therefore, it is highly unlikely that a hot gas layer would propagate into any of the charging pump rooms.

Located two feet above the charging pump rooms doorways, in Fire Zone 42C, is a horizontal stack of three cable trays. The lowest cable tray is nine feet above the floor. There is an additional horizontal stack of five cable trays approximately midway between column lines A6 and A7. This stack of cable trays runs parallel to column line A7. The lowest cable tray of this stack is 9.5 feet above the floor. The electrical cables in all of these cable trays are IEEE-383 qualified cables and are, therefore, not considered to be ignition sources. The cable trays are also provided with in-tray fire detection and suppression systems. The typical separation distance between sprinkler heads along the cable trays is approximately seven feet. Since the electrical cables are IEEE-383 qualified cables and the tray configurations are in horizontal runs, fire propagation and heat generation would be limited if the fire was somehow sustained. It is expected that any fire in the cable trays will self-extinguish once away from the ignition source due to the IEEE-383 qualified cable jacketing. The cable tray fire suppression system provides added assurance that the affects of a fire in the cable trays would be minimized.

The IEEE-383 qualified electrical cables account for approximately 60% to 75% of the fixed combustible loading for this fire zone, depending on the PVNGS unit being considered. Thermo-Lag 330-1 fire retardant material contributes an additional amount of combustible material such that the combined combustible loading of the electrical cables and the Thermo-Lag 330-1 fire retardant material accounts for approximately 90% of the total fixed combustible loading in Fire Zone 42C for all three units.

As stated in the PVNGS IPEEE submittal, Section 4.6.3.2, the fixed and transient ignition sources for Fire Zone 42C were evaluated. This evaluation concluded that potential fires from the hydrogen recombiners and transient materials resulted in a modified CDF of 1E-6/Rx-yr. Note that the physical location of the hydrogen recombiners is such that a fire from this equipment will not result in a significant exposure fire hazard to the subject cable trays or to Fire Zones 46A, B and E (charging pump rooms).

<u>Charging Pump Rooms, Fire Zones 46A, B and E:</u>

Each charging pump fire zone is made up of three separate areas: the entry area, the valve gallery and the pump cubicle. Entry into each of these fire zones is through the fire barrier that is described above in Fire Zone 42C, i.e., the fire barrier that is the north wall of the charging pump compartments, located along horizontal column line A7 of Figure 4-1r. The ceiling in Fire Zones 46A and B is approximately 18.5 feet above the floor. The ceiling in Fire Zone 46E varies in height between the pump cubicle and the valve gallery/entry area. The pump cubicle ceiling in this fire zone is approximately 18 feet above the floor. The valve gallery/entry area for this fire zone is approximately 13.5 feet above the floor. The floor area for each of the charging pump fire zones is approximately 500 square feet. Therefore, Fire Zones 46A and B each have an available free volume of over 5500 cubic feet of space located between the top of the doorway and the ceiling. The free volume located between the top of the doorway and the ceiling of Fire Zone 46E is over 4100 cubic feet of space. Fire detection and suppression systems are provided throughout all areas of each of these fire zones.

The entry area to each of the charging pump fire zones is immediately south of the fire barrier located along horizontal column line A7. The entry areas are void of any credible fixed combustibles, with the exception of the Chemical and Volume Control System chemical addition pump that is located in the entry area of Fire Zone 46B. This pump is run on an as-needed basis to add chemicals to the Reactor Coolant System for chemistry control. Electrical cables in the entry areas are routed through rigid or flexible conduit and are not considered to be fixed combustible material.

The valve gallery of each of these fire zones is located due south of the entry area. This area is void of combustibles and houses manual valves that are operated via reach rods from the entry area. The concrete wall separating the valve gallery from the entry area is a full height barrier with a doorway offset from the entry doorway to eliminate potential radiation streaming. This open doorway is approximately three feet wide by seven feet high. It has a six-inch high curb at the floor level that impedes any fluids from exiting the valve gallery or charging pump cubicle. This concrete wall is a radiological barrier – therefore, all penetrations through this wall are sealed with high-density elastomer. Although the barrier is not considered fire rated, it does provide substantial fire resistance capability. A floor drain is provided in the valve gallery to direct any leakage to the auxiliary building sump.

The charging pump cubicle is separated from the valve gallery by a partial height wall for shielding purposes. This cubicle, which contains the charging pump, also contains the majority of the combustible material for each of the charging pump fire zones. All electrical cables are routed through rigid or flexible conduit. A floor drain is provided to direct any leakage and/or spills to the auxiliary building sump.

The majority of the combustible materials in the charging pump fire zones is lubricating oil in the charging pump, an equivalent replacement quantity of lubricating oil and Thermo-Lag 330-1 fire retardant material. Maintenance scaffolding with treated wood platforms is also assumed to be in the area for these fire zones. The total amount of the combustible material in each of these fire zones results in a worst case fire severity of approximately thirty minutes.

Maintenance scaffolding is a transient fire load – it is not permanently installed in any of the charging pump fire zones. The Thermo-Lag 330-1 fire retardant material has a very high ignition temperature and will most likely not ignite. Therefore, the most credible combustible material in these fire zones is the charging pump lubricating oil. Assuming that all of the oil in the charging pump and the equivalent replacement quantity were available to be burned at the same time, the heat input from the fire would be approximately 14,240 BTU/Sq.-Ft., or about eleven minutes of fire severity.

Propagation of any fire in one of the charging pump fire zones into any other fire zone is highly unlikely due to the location of the combustible material in the affected fire zone and the physical construction of the charging pump fire zones. In addition, the height of the ceilings in each area will prohibit the formation of any credible hot gas layer that could propagate into other fire zones. The fire detection and suppression systems located throughout each of the charging pump fire zones provides additional assurance that the fire will not propagate to other fire zones.

The above discussion demonstrates that the barrier of concern is effective even though it has open doorways into each of the charging pump compartments. Fire, or a hot gas layer, will not propagate from the charging pump fire zones (Fire Zones 46A, B and E) into any other fire zone, nor will propagation of a fire or hot gas layer from Fire Zone 42C into any of the charging pump fire zones occur. Therefore, using the guidelines of the FIVE methodology, Fire Zones 46A, B and E were appropriately screened from further consideration based on Criterion 2, "Boundaries that consist of a 2-hour or 3-hour rated fire barrier *on the basis of barrier effectiveness*" (emphasis added). Note also that Fire Zones 46A, B and E may be screened from further consideration using Criterion 6 of the FIVE methodology, "Boundaries where automatic fire suppression is installed over combustibles in the exposing compartment on the basis that this will prevent fire spread to the adjacent compartment". Fire Zones 42C, 46A, B and E all have fire suppression installed over the fixed combustibles that represent a credible fire hazard that could allow fire spread into the adjacent compartment. This statement only applies to Fire Zones 42C, 46A, B and E as these fire zones relate to each other.

NRC Request 4

Fire

4. The CDF's of the containment class electrical penetration rooms, 42B and 47A, were reduced by crediting National Electrical Manufactures Association (NEMA)-4 enclosures with fire propagation-limiting characteristics. Since these enclosures do not have these assigned characteristics, please provide the bases for reducing the CDFs.

APS Response

The PVNGS IPEEE, Revision 0, Section 4.6, states that the motor control center (MCC) enclosures for compartments 42B and 47A, Containment Class Electrical Penetration Rooms, are NEMA-4 enclosures. This statement is not correct. These enclosures are actually NEMA-3 enclosures that are rated for outdoor applications. NEMA-3 enclosures do not have any fire protection specifications associated with them, nor are they rated for a direct hose stream.

The NEMA-3 MCC enclosures used in these compartments are non-ventilated, with all cable penetrations sealed with fire retardant foam to prevent water intrusion. Based on this design and application, APS Fire Protection Engineering has determined that any credible fire originating within the MCC will not propagate to other areas outside of the enclosure. Therefore, only the equipment powered by the MCC would be affected by the fire. Since loss of this equipment does not lead to a plant transient, the MCCs are not credible ignition sources as taken in the context of the IPEEE. Note that this fire protection engineering determination reduced the CDF for each compartment by less than 50% and did not result in the screening out of either compartment. Therefore, application of the reduction factors associated with crediting the NEMA-3 enclosures did not materially affect the conclusions of the analysis.

ATTACHMENT

Marked-up Conduit and Tray Drawings