



# Palo Verde

Use of NEI 16-08 & NEI 16-06

NRC Public Meeting – Treatment of Mitigating Strategies in Risk Informed Decision Making  
November 15, 2017

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# Palo Verde Generating Station

Example Risk Evaluation Using NEI 16-08

# Example Risk Evaluation Using NEI 16-08

## Deploying Portable 4160V Diesel Generators During A Safety Related Diesel Outage

Description	Benefit Summary
<p>The purpose of this strategy is to use FLEX diesel generators to provide a redundant source of 4160V ac power to either of the emergency busses during evolutions where defense-in-depth to the Medium Voltage ac safety function is challenged, such as a diesel generator outage. The 4160V ac portable generators and the cables to attach to the permanent plant. This strategy will support the 4160V ac electrical distribution system and be used to provide defense-in-depth to the station blackout generator when a safety related diesel is out of service. This will be reflected in the PRA model used for the site's configuration risk management</p>	<p>Risk reduction; Maintenance can be performed while maintaining a green risk window. This strategy will be reflected in the PRA model used for the site's configuration risk management.</p>



# Example Risk Evaluation Using NEI 16-08

Feasibility Assessment	
Element	Description Summary
Identification of all equipment necessary for implementation including permanently installed equipment	Portable equipment necessary to employ the 2MW 4160V ac portable generators includes the generators themselves and the cables connecting the generators to the plant. Permanently installed equipment necessary for implementation includes transfer switches and supply breakers for the 4160V ac busses.
Identify important attributes of the strategy {e.g. pre deployment of equipment, plant modifications, or procurement of additional portable equipment) that need to be established prior to the implementation of the strategy.	Generators are required to be pre-deployed and connected based on timing requirements. Plant modifications exist and all hardware has already been procured.
Is the equipment adequate to meet the proposed strategy?	Generator, cables, and electrical breaker performance capability has been verified to be sufficient for necessary loads. Existing overcurrent protection in the circuit was determined to be sufficient.
Identify any power supply or fuel requirements	Refueling of the generator diesel fuel is required every 12hours.
Can the equipment be deployed, installed, and operated in time to perform the function?	The equipment is pre-deployed and connected to meet necessary time requirements. The system time window is one hour. The necessary actions are proceduralized, uncomplicated and crews are briefed at the start of each shift. Hard Cards are pre-staged for easy to use proceduralized compliance.



# Example Risk Evaluation Using NEI 16-08

Are the conditions within the design capabilities of any support components such as hoses, piping, or valve connections?	Yes. Both the portable cables and installed permanent plant cables are capable of handling the current and output of the portable generators.
If conditions are outside of equipment performance requirements, is there any basis (e.g., margin) to support the use during these conditions?	Not applicable, everything is within equipment performance requirements.
Do connection points and routing paths exist to connect the equipment into the system being supported?	Yes. Deployment paths are located near the connection points and routing of the temporary cables is "skill of the craft". Cables can be routed without interfering with other plant activities.
Identify other required system considerations (e.g. valve alignments, back pressure).	None.
Identify required suction sources (e.g. tank levels/capacity, water quality, and need for strainers).	None.
Identify required instrumentation and control to ensure the functionality of the equipment.	Permanent plant instrumentation exists in the control room to monitor the electrical output of the portable generators once they are connected to the plant. Local instrumentation exists on the portable generators to monitor their operation.
If the portable equipment cannot fully meet the functional requirements, can it be utilized to provide additional margin that may be beneficial?	Not applicable.



# Example Risk Evaluation Using NEI 16-08

Engineering Analysis	
Element	Description Summary
Identify specific engineering documentation references and analysis methodologies (e.g., MAAP, RETRAN, GOthic, CENTS, and battery depletion calculations).	Overcurrent protection has been evaluated and documented in an engineering work order (EWO). Justification for the Equipment Out of Service (EOOS) model changes has been evaluated and documented in the engineering work order as well. EOOS model impact and the incorporation of the 4160V ac portable generators into the PRA model have been evaluated in the EWO.
Are the equipment flowrates and pressures adequate?	Not applicable
Identify the timing for specific operator actions required to implement.	The equipment is pre-deployed and connected to meet necessary time requirements. The system time window is one hour. The necessary actions are proceduralized, uncomplicated and crews are briefed at the start of each shift.
Identify the required mission times	The portable EDG is only being credited to mitigate internal events. Therefore, a mission time of 24 hours is assumed consistent with normal PRA practices.
Are the electrical power requirements satisfied (e.g., voltage, amps and frequency)?	Yes, engineering calculations have been done to ensure requirements are satisfied, they are included in the Engineering Work Order.
Can adequate temperature limits be met?	Not applicable
Is adequate volume and quality of water available?	Not applicable



# Example Risk Evaluation Using NEI 16-08

<p>Can expected environmental parameters for the equipment functionality support the strategy?</p>	<p>The portable generators are deployed on seismic pads. They have been purchased to operate in an external environmental temperature of 130F. No other environmental factors need to be considered.</p>
<p>Is there a refueling plan being implemented to meet the mission time of the strategy?</p>	<p>Refueling of the generator is required as the fuel will last 12 hours. A procedure exists for refueling the portable equipment</p>



# Example Risk Evaluation Using NEI 16-08

Staffing and Training Assessment	
Element	Description Summary
Does the execution of the strategy impact the ability of operators to perform their dedicated duties (e.g. safe shutdown actions, Fire Brigade response, and bcal/offsite communications)?	No. This strategy provides a backup source of ac power as a contingency for loss of normal ac power. No additional actions are required by operators unless an event occurs which requires the use of the portable generator.
What other work groups or departments (e.g. engineering, maintenance, security) directed by operators can perform the actions?	The connections are bolted and have torque requirements so maintenance is required to make the connections. The fire department is needed to perform the refueling of the portable diesel generator when it is operating.
How many personnel are necessary to perform the actions?	Two auxiliary operator are required, one to start both diesels and one to rack in the transfer switch.
Does running portable equipment need to be staffed continuously? If not, at what periodicity do rounds, refueling etc. need to be performed?	Does not need to be staffed continuously. Consumption rates need to be verified periodically so that sufficient time is available for refueling. The tank holds 12 hours of fuel.
Does the execution of the strategy affect the staffing of the other units on site? Is additional staffing required to implement the strategy for multiple units?	No. And the strategy cannot be implemented at multiple units because there are only two 4160V ac generators available.



# Example Risk Evaluation Using NEI 16-08

<p>Can pre-deployment reduce staffing requirements when the strategy is needed to be executed?</p>	<p>The diesels are being pre-deployed to meet the time requirements for their use as a backup to the station blackout (SBO) generators.</p>
<p>Can supplemental personnel be utilized to augment site personnel during the execution of the strategy?</p>	<p>Not applicable.</p>
<p>Are there any changes to training programs required to be implemented?</p>	<p>No changes to the formal training program are required. Existing training on the use of the portable diesels for accident mitigation is sufficient for this application. However, shift lead briefs to each oncoming operating crew are necessary to maintain a heightened awareness of the short time to start the portable diesel generators if needed.</p>



# Example Risk Evaluation Using NEI 16-08

Addressing Unintended Consequences	
Element	Description Summary
Can the strategy create the potential to cause a reactor scram?	No, sufficient overcurrent protection and breaker protection is provided in the circuit to prevent the portable generator from tripping the plant.
Can the strategy create the potential for inadvertent actuation or failure of a system?	No, sufficient overcurrent protection and breaker protection is provided in the circuit.
Does the implementation of the strategy prevent the successful operation of normally required permanently installed plant equipment?	No, because of the way the equipment is connected to the plant, normal equipment is unaffected by the operation of the portable equipment.
Does the equipment meet the scoping requirements of 10CFR50.65(b) (i.e., The Maintenance Rule)?	No, the strategy is not in the EOPs, but in an operations maintenance procedure, referred to from an alarm response procedure (ARP). Also, because of the overcurrent protection breakers, a failure of the portable equipment cannot cause failure of the safety related equipment, or cause a plant trip.
Can the implementation of the strategy impact compliance with plant programs (e.g., FLEX program, 8.5.b, Appendix R, and NFPA-805, barrier control)?	This is not FLEX equipment or B.5.b equipment, so those programs are not impacted. They are not located in a fire area (they are outside) and the combustible fuel could not cause damage to any other plant equipment.
Can the implementation of the strategy impact the effectiveness of the physical security plan?	No, security barriers and security access are unaffected by the pre-deployment of the portable diesel generators.



# Example Risk Evaluation Using NEI 16-08

<p>Are there digital controls on the portable equipment that could impact cyber security? If so, how was that addressed?</p>	<p>There are digital controls, they are not considered as critical digital assets.</p>
<p>Does the implementation of the strategy impact the site emergency plan?</p>	<p>No. There is no special access or egress, no special requirement for use of the generators, or impact on staffing of e-plan personnel. No Emergency Action Levels are affected by deployment of the portable diesel generators.</p>



# NEI 16-06 Evaluation Process

5.1.1 - Scenario Assessment	5.5 - Environmental Challenges
5.1.2 - Function Applicability	7.1 - Initiating Events
5.1.3 - Equipment Capability	7.2 - Accident Sequence Modeling
5.2.1 - Equipment Availability	7.3 - Success Criteria
5.2.2 - Reliability, Testing and Maintenance	7.4 - System Analysis
5.2.3 - Location and Transportation Capability	7.5 - Human Reliability Assessment
5.3 - Time Availability and Margin	7.6 - Data Analysis
5.4.1 - Procedures and Written Instructions	7.7 - Quantification
5.4.2 - Training	7.8 - Large Early Release (LERF) Analysis
5.4.3 - Staffing and Communications	



# Backup Information –

## Example Risk Reduction Evaluation Using NEI 16-06

- Two 2MW 4160VAC portable generators deployed and connected to 4160VAC FLEX distribution box

# 2MW 4.16KV Temporary Generators



# 2MW 4.16KV Temporary Generators



# 4.16KV Bus FLEX Connection



# NEI 16-06 Evaluation Example

Criteria	Evaluation
5.1.2 – Function Applicability	<p>The function met by the portable generators is restoration of a single Class 1E 4160V AC bus given a loss of power to the bus.</p> <p>Supported loads are the same as those supported by a single Station Blackout Generator (SBOG) per the documented engineering evaluation.</p>



# NEI 16-06 Evaluation Example

Criteria	Evaluation
5.1.3 – Equipment Capability	<p>An evaluation was performed by Design Engineering to evaluate the electrical capability of the portable generators to ensure they could meet the PRA mission as defined by the evaluation. Initial fueling of the DGs provides approximately 9 hours of operation, with additional fuel provided by a portable truck under control of the Fire Department. The Fire Department is continuously present at the station and is notified by a step in 40MT-9ZZ01.</p>



# NEI 16-06 Evaluation Example

Criteria	Evaluation
5.2.1 - Equipment Availability	The portable generators must be deployed and installed at the desired unit in order to credit them in the EIOS model. The portable generators are started after installation and prior to crediting their use to confirm availability.



# NEI 16-06 Evaluation Example

Criteria	Evaluation
5.2.2 – Reliability, Testing and Maintenance	Equipment Reliability Engineering Template (ERET) documents the engineering basis for the Palo Verde FLEX program testing and maintenance.



# NEI 16-06 Evaluation Example

Criteria	Evaluation
5.2.3 - Location and Transportation Capability	The portable generators must be deployed and installed at the desired unit in order to credit them in the EOOS model.



# NEI 16-06 Evaluation Example

Criteria	Evaluation
5.3 – Time Availability and Margin	A Human Reliability Assessment (HRA) assessment is documented in an Engineering Evaluation (EE), which demonstrates that the available time (75 mins) is adequate to support employing the portable generators, given that they are initially staged and connected to the FLEX distribution box. There is 15 min of margin based on the HRA.



# NEI 16-06 Evaluation Example

Criteria	Evaluation
5.4.1 - Procedures and Written Instructions	Operators are cued to employ the portable generators by alarm response procedures. Alarm response procedures direct the operator to enter procedure 40MT-9ZZ01, which closes switches/breakers to align the portable generators to the Class 1E bus. The portable generators are stationed with operator aids to provide guidance in starting the generators when directed by procedure.



# NEI 16-06 Evaluation Example

Criteria	Evaluation
5.4.2 - Training	<p>Training, briefings, and walkdowns are provided to the Operators responsible for operating the portable generators. All crews scheduled to be on shift when crediting the generators in EOOS will be given a briefing on the implementing procedure. A designated operator will walk through the operator guide provided for starting and operating the portable generators. Licensed operator continuing training (LOCT) on FLEX strategy implementation is in the LOCT program and the steps for aligning these generators in procedure 40MT-9ZZ01 are the same as in the FLEX procedures.</p>



# NEI 16-06 Evaluation Example

Criteria	Evaluation
5.4.3 – Staffing and Communications	Human Reliability Assessment (HRA) assessment which is documented in the Engineering Evaluation (EE) demonstrates that there are available staff, and their ability to communicate is adequate to employ the portable generators. The HRA is based on operations input.



# NEI 16-06 Evaluation Example

Criteria	Evaluation
5.5 - Environmental Challenges	<p>The portable generators are located on a deployment pad outside the unit. They are not subject to hazards induced from internal floods or fires. They are subject to external hazards induced by weather. A high wind analysis was performed as part of PRA Model Impact 2016-1607 that demonstrated the portable generators would survive wind speeds up to 100 miles per hour. Other external hazards (ex: external flooding) have been screened from further analysis in the Palo Verde PRA. The portable generators are not credited in winds greater than 100 mph, tornado warnings or seismic events.</p>



# NEI 16-06 Evaluation Example

Criteria	Evaluation
7.1 – Initiating Events	<p>An Engineering Evaluation (EE) documents that the portable generators can be modeled as a backup to the Station Blackout Generators (SBOGs). The connection of the portable generators to the class 1E bus requires closure of a manual transfer switch and breaker. All temporary equipment associated with the use of the portable generators is outside safety related structures. Postulated fires from the temporary generators have been evaluated and found to not impact safety related equipment.</p>



# NEI 16-06 Evaluation Example

Criteria	Evaluation
7.2 – Accident Sequence Modeling	An Engineering Evaluation (EE) documents that the portable generators can be modeled as backup to the Station Blackout Generators (SBOGs).



# NEI 16-06 Evaluation Example

Criteria	Evaluation
7.3 – Success Criteria	An Engineering Evaluation (EE) documents that the portable generators can be modeled as backup to the Station Blackout Generators (SBOGs) with the same success criteria.



# NEI 16-06 Evaluation Example

Criteria	Evaluation
7.4 – System Analysis	<p>An Engineering Evaluation (EE) documents that the portable generators can be modeled as backup to the Station Blackout Generators (SBOGs). The postulated Equipment failures associated with use of the portable generators were all evaluated and found to be very small compared to the human reliability failure contribution.</p>



# NEI 16-06 Evaluation Example

Criteria	Evaluation
7.5 – Human Reliability Assessment	<p>An Engineering Evaluation (EE) documents that the Human Reliability Assessment (HRA). The HRA to start and align the portable generators was determined to have a mean value of 0.3 using the EPRI HRA calculator. As the random failure rates are dominated by the magnitude of the HRA, it was decided for modeling simplicity to group the generators, transfer switches, and human action in a single undeveloped event with a value of 0.56. The 0.5 value includes margin to account for the uncertainty associated with both the random failures and the HRA.</p>



# NEI 16-06 Evaluation Example

Criteria	Evaluation
7.6 – Data Analysis	<p>An Engineering Evaluation (EE) documents a quantitative analysis of vendor and industry reliability data pertaining to the portable generators. The failure rates selected for equipment (e.g., portable generators, switches, breakers) were taken from the NRC Reliability and Availability Data System (RADS). The failure rate of the portable generators were assumed to be consistent with station blackout (SBO) diesel generators. The equipment failure rates combined were all very small compared to the calculated human reliability analysis failure probability.</p>



# NEI 16-06 Evaluation Example

Criteria	Evaluation
7.7 – Quantification	<p>An Engineering Evaluation (EE) documents uncertainties associated with the system modeling of the portable generators via sensitivity analyses. The failure rates and their corresponding error factors were determined by data analysis and HRA. The highest error factor for basic events bounded by the undeveloped event is 4.2, which is associated with the fail-to-run failure rate. A single undeveloped event set at <math>5E-1</math> was used in the EOOS model to capture the equipment random failure rates, the HRA, and a safety factor to address uncertainties.</p>



# NEI 16-06 Evaluation Example

Criteria	Evaluation
7.8 - Large Early Release (LERF) Analysis	The portable generators provide an another alternate source for AC power. The existing LERF modeling in the EOOS model is unaffected by adding another alternate power source as a backup to the station blackout generators.



## NEI 16-06 Evaluation Example

Conclusion: The 2MW 4160VAC portable generators deployed and installed meet the evaluation criteria in NRC Regulatory Issue Summary 2008-15 and NEI 16-06 in order to credit in configuration risk assessments.