Draft NUREG/CR-7114: Methodology for Low Power/Shutdown Fire PRA

End of Comment Period: April 18, 2012

Comment ID	Reviewer	Comments: Comment	Resolution: Response: Accept, Reject, or Accept in Part	Resolution: Report changes to be made
VY-1	Vincent Young (RSC Engineers)	In Section 4.6.3, Step #6 (ignition source counts), it is suggested to add to the existing text that while "the number of countable items (e.g. pumps and electrical cabinets) should remain the same between full-power and LPSD conditions" a check of the full-power counts for items that would be applicable for counting but that were screened from the full-power ignition source counts due to being solely used for shutdown operations and de-energized during power operation (while the component may not be credited in the LPSD PRA model) should be made to avoid missing potential ignition sources in the final LPSD counts. The current wording in Section 4.8.2 provides clear instruction for the potential treatment of de-energized ignition sources during the LPSD analysis, assuming that such an ignition source was carried forward from the counting step to the analysis of its impacts task.		
VY-2	Vincent Young (RSC Engineers)	Table 5: "Zone of Influence (ZOI) and Severity Factor Recommendations" has no entry in the "Recommended Method" column for bin #33 and #37.		
VY-3	Vincent Young (RSC Engineers)	Figure 2: "General Analysis Flow Chart for Task 11 – Detailed Fire Modeling" has flow chart boxes with text that is cut off at the bottom of the box.		
DT-1	Doug Trou (ERIN Engineering and Research, Inc.)	This document is premature and should be withdrawn. A more appropriate course would be for the appropriate Standards Development Organization, in this case the ASME/ANS Joint Committee on Nuclear Risk Management, to first define the requirements that would be part of a draft Standard for low power and shutdown fire PRA, then develop the guidelines to meet those requirements, then pilot those guidelines in an appropriate number of pilots to effectively exercise the technical methods outlined in guidelines and requirements, then revise the draft Standard and guidelines BEFORE issuance of the final guideline document. Failure to follow such a process will lead to the same problems that were introduced when the NRC issued NUREG/CR-6850 prior to (a) a Standard being developed, (b) appropriate piloting, and (c) incorporation of the lessons learned from pilots.		

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NEI-1	NEI	Based on review by industry technical experts in the areas of Fire PRA modeling and Low Power/Shutdown (LPSD) PRA modeling, the draft NUREG, as currently written, does not present a comprehensive, technically sound approach to modeling the risk from internal fires during low power/shutdown (LPSD) operations, and LPSD Fire PRAs do not have a clear regulatory application at this time. NEI therefore recommends that this NUREG not be issued. The industry is particularly concerned about this draft NUREG given recent experiences with NUREG/CR-6850, EPRI 1011989, "Fire PRA Methodology for Nuclear Power Facilities." The document, issued in 2005, detailed methods for modeling risk from internal fires, many of which were still under development and undergoing refinement when the final NUREG was published. Once these methods were published, regulatory expectations for the development and use of Fire PRAs increased substantially, despite industry concerns that the methods discussed in the NUREG were not capable of producing realistic results. This lead to inefficient uses of NRC and industry resources, as licensees expended resources to continuously incorporate new and more realistic fire PRA methods that were not available when NUREG/CR-6850 was published, and the NRC was left to understand constantly evolving methods while simultaneously reviewing licensing applications using the results of Fire PRAs that incorporated them. Nearly seven years later, these methods are still being refined and difficulties associated with using them in regulatory applications continue. To repeat this process by prematurely publishing this NUREG on LPSD Fire PRA would further complicate the technical and regulatory issues being dealt with in At-Power Fire PRAs. While the regulatory lessons learned from the experience of NUREG/CR-6850 raise several major concerns regarding the issuance of this draft NUREG, the technical deficiencies associated with the document itself are also extensive. Many key components of LPSD Fire PRA development, such as HRA quantification, are not addressed and are instead treated as out of scope of the document's purpose. If the methods in this document are used with such limitations, the results will be unrealistic and useless for regulatory applications. The Electric Power Research Institute has submitted detailed comments regarding these technical limitations and their implications, and NEI urges the NRC to strongly consider these issues in deciding whether or not to issue this draft NUREG. It is unclear what the regulatory application for LPSD Fire PRA is at this time, and it is therefore not urgent to issue this NUREG. As outages vary substantially, no plant will be able to define a typical outage and calculate an average core damage frequency, which makes use of an LPSD Fire PRA for regulatory applications extremely difficult. Given the lack of a near-term regulatory need for such a methodology, it would be prudent for the NRC to withdraw this document and continue refining the methods before re-issuing the document for public comment in the future.		
PWR-1	PWR Owners Group	G.1 Complexity of Methods: This is a challenging technical subject since it represents the intersection of two complex risk areas. NUREGICR-7114 is a good start to developing guidance for this subject. However, the document falters in a number of areas, which are provided in the comments below.		
PWR-2	PWR Owners Group	G.2 LPSO Methodology: NUREG/CR-7114 is premature in that there is not a current companion reference for LPSD internal events. Since Fire PRA depends, to a large degree, on an existing internal events PRA, the connection between methodologies (LPSD and Fire) is not clear. A number of the issues listed below are general questions that should be addressed for the LPSD internal events PRA model before adding the additional complication of LPSD Fire PRA. While several NUREGs are available that document LPSD PRAs, they are all dated, do not address some of the broader issues, and do not provide a methodology.		

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PWR-3	PWR Owners Group	G.3 Outage Types: NUREG/CR-7114 seems to assume that refueling outages are the only or most important outage types. However, the issue of outage types should be addressed first, typically as part of a LPSD internal events PRA. Outage types include various types of refueling outages and forced outages during hot standby or cold shutdown. Note that it is possible that, while non-refueling outages may not be important with regard to internal events, they might present special challenges with regard to fire risk.		
PWR-4	PWR Owners Group	G.4 Risk-Informed PRA Applications: For a LPSD PRA (more than an at-power PRA), the configuration risk management application seems to be the dominant application. Other risk-informed applications. need to be identified in order to assess how detailed the modeling needs to be regarding POSs, outage types, etc. Also, the issue of an average versus outage-specific model needs to be addressed.		
PWR-5	PWR Owners Group	G.5 Average LPSD Model versus Outage Specific LPSD Model: An outage-specific model has advantages, especially for Fire PRA, because outage activities that increase fire risk might be identified from the outage schedule and outage planners. In contrast, fire risk from an 'average" outage requires more averaging assumptions, e.g., times and locations during the outage when/where hot work is more or less likely or when/where transient combustibles may accumulate. However, an outage-specific model would be more difficult to address in terms of compliance with RG1.200 and the PRA Standard (Reference 2) (e.g., Does each outage model require a separate peer review?). Also, an outage-specific model does not answer the question: How does shutdown risk compare on average with at-power risk? An average LPSD PRA model would be required for applications such as component or operator action ranking. While this is a general LPSD PRA issue, it raises specific challenges for a Fire PRA (e.g., how are assumptions made about degraded fire barriers?). On the other hand, Fire PRAs do this for at-power risk-making assumptions about average fire risk without identifying specific maintenance alignments at-power that might have increased hot work or transient combustibles. These risks are smeared ('averaged' across the entire at-power cycle) when, in reality, they may be concentrated in a few periods of time.		
PWR-6	PWR Owners Group	G.6 POS Development: NUREG/CR-7114 identifies the possibility of applying Fire PRA to all or a selected set of POSs. While this is appropriate, it is important that the LPSD PRA have a full set of POSs so that the context of the specific POS can be properly understood. Also, note that "at-power" should be treated as a POS, with its own POS fraction of time.		

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PWR-7	PWR Owners Group	G.7 Use of POS Groups: A detailed LPSD PRA may have 20 or more POSs to address important changes to plant configuration, as well as to account for different types of outages. It is not feasible to complete a Fire PRA for each POS. Instead, POSs are grouped according to each specific model element. For example, the grouping of success criteria for a specific system may be in two sets - high decay heat and low decay heat. The initiating event frequencies for LOCAs may be in several groupings, according to RCS pressure. Similarly, for a Fire PRA, POSs may be grouped according to fire program controls and the expected amount of hot work. It is likely that fire program controls in Modes 2 and 3 are essentially the same as in Mode 1. Then, POSs are defined by the collection of modeling elements that may be shared by different groupings of POSs, such that each POS is unique. However, the process for identifying the risk during LPSD is not by assessing risk from one POS at a time, but, rather, by grouping similar elements. Grouping results in subsuming, e.g., modeling the bounding parameter for a group of POSs. This is a more effective way to evaluate risk than screening out POSs.		
PWR-8	PWR Owners Group	G.8 Low Power: Low Power (LP) operation is more similar to at-power than it is to cold shutdown (Modes 4 - 6). The internal events PRA model is essentially the same between LP and at-power, with minor adjustments (e.g., the reactor trip frequency increases, risk from ATWSs decreases). The same EOPs apply during LP and during at power operation. The approach to assessing LP risk is to evaluate the changes from at power that affect risk (i.e.,, a "delta" approach). With regard to fire risk, the plant at LP operation should be essentially identical - the plant is the same with regard to controls of transient combustibles, barriers, hot work, fire emergency procedures etc. A similar "delta" approach should be used for LP Fire PRA - how is LIP different from at-power for issues that would impact fire risk? It is likely that such a 'delta" analysis would find no differences except those issues already identified in the internal events LP delta analysis. This portion of fire risk should be grouped with at-power, not with shutdown. By grouping with shutdown, the fire risk at LP is over-stated, but is understated at shutdown (specifically the calculation of fire ignition frequency, which Is the number of events at 'shutdown" I time at "shutdown").		
PWR-9	PWR Owners Group	G.9 Hot Standby: Similar to LP, hot shutdown (Mode 3) operation is much more similar to at power than it is to cold shutdown (Modes 4 - 6). The internal events PRA model requires more changes, but the accident sequence development is essentially the same. Note that, when the term 'shutdown" is used hereafter (in Comments G1 0 through G1 3), it refers to RCS in "shutdown cooling," typically in Modes 4, 5 and 6.		
PWR-10	PWR Owners Group	G.10 NUREGICR-7114 should consider that most fire emergency procedures are written to address Appendix R requirements, assuming the plant is at-power.		
PWR-11	PWR Owners Group	G.11 Operating Experience: The database of fire events at shutdown should be reviewed more carefully, not Just for fire ignition frequencies, but also for the kinds of events that occur at shutdown. Presumably, fires at shutdown are more frequent, but also more likely to be observed and extinguished by workers in the area. Unique insights and considerations may be identified by reviewing operating experience.		

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PWR-12	PWR Owners Group	G.12 LERF: The consideration of LERF at shutdown is limited by the reduction in source term over time, such that by -15 days, LERF releases may not be possible. This needs to be developed in a LPSD PRA methodology document.		
PWR-13	PWR Owners Group	G.13 Multi-Unit Risk: For sites with multiple units, the dependencies and interconnections may create unique and complex considerations with regard to shutdown risk in general, and fire shutdown risk in particular.		
PWR-14	PWR Owners Group	G.14 The development of such a methodology (as proposed in NUREG/CR-7114) is premature. First, the industry is still struggling with methodological concerns with the Fire PRA to reduce conservatisms. To compound these conservatisms by overlaying LPSD considerations on a Fire PRA is counterproductive, and will cause resources to be expended without a commensurate gain.		
PWR-15	PWR Owners Group	G.15 The development of such a methodology (as proposed in NUREG/CR-7114) is premature for a second reason. The industry has been working on the LPSD PRA Standard for a number of years, and, while close to producing a ballot-ready version, that has not yet concurred. Further, the ballot is sure to be a Trial Use / Pilot Application ballot, for which the LPSD PRA Standard would need to be piloted prior to being officially released as a consensus industry standard. Therefore, until that occurs, it seems inappropriate to suggest a methodology to be used for LPSD PRA without the benefit of an available standard.		
PWR-16	PWR Owners Group	G.16 The development of such a methodology (as proposed in NUREGICR-7114) seems inverted. The premise for a Fire PRA is to build upon an existing at-power internal events PRA. Since the POSs for a LPSD PRA would include 'at-power" as one POS, a more suitable approach for a LPSD Fire PRA would be to start with the LPSD POSs and then overlay the Fire PRA. This is not the approach suggested in the draft NUREG.		

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PWR-17	PWR Owners Group	G.17 The assumptions (G.16) also suggest that such a methodology (as proposed in NUREG/CR-7114) is premature. a. Assumption 1 relies on completing an at-power Fire PRA. Comments G14 and G16 above suggest that this may not be the most pragmatic approach to develop a LPSD Fire PRA. b. Assumption 2 relies on a complete LPSD PRA. Comment G15 suggests that such an analysis, while completed, would be difficult to assess (i.e., determine technical adequacy) without an approved, consensus PRA Standard. c. Assumption 3 indicates that the necessary HRA to support a LPSD Fire PRA is beyond the scope of the draft NUREG. How can a credible LPSD Fire PRA be developed without the use of a suitable HRA methodology? LPSD, in particular, will be more sensitive to human actions (than during at-power operation). The draft NUREG does not suggest that such an HRA approach is being developed or available via another document. Without an HRA methodology, the results of any LPSD Fire PRA will likely be conservative and suspect for use in any risk-informed application. d. Assumption 4 attempts to use the approach and results of the "under-development" FEDB for LPSD fire initiating event frequencies. First, the FEOR is not yet completed; second, there is no justification or rationale as to why the at-power fire frequencies would be applicable during LPSD conditions. As with the HRA methodology, without a credible data set or a methodology to develop a data set, the results of any LPSD Fire PRA will likely be subject to interpretation or, at least, a great deal of uncertainty that would render its usability limited. e. Assumption 5 limits the risk metrics to CDF and LERF. While these metrics may be suitable, there has been considerable discussion about the appropriate risk metrics to use for LPSD states (POSs). CDF and LERF may not provide the appropriate insights, as opposed to time of core uncovery, time to core oxidation, etc., that may be more useful in LPSD conditions.		
PWR-18	PWR Owners Group	G.18 The usefulness of a LPSD Fire PRA must address the issue of a time-averaged model versus a configuration-specific model. Since there is the potential for many unique plant configurations during LPSD, how many can be modeled when considering fire during those POSs? Can a time-averaged model be constructed that will be useful? These questions are related to questions about the LPSD PRA approach that still need to be answered.		
PWR-19	PWR Owners Group	G.19 Draft NUREGJCR-7114 should be reviewed for its use of the terms "at-power' and "full power" to determine (a) if there is a difference in the meaning of these two terms, (b) whether the terms are being used interchangeable (in which case, "at-power" should be used). (c) if the terms are being used consistently with the definitions (of at least "at power') in the PRA Standard, and (d) a definition of one or both terms, as needed.		

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PWR-20	PWR Owners Group	G.20 (Section 4.11.4) Assumptions should not be conservative - they should be best-estimate and identified as important assumptions If they could impact the results. The data and methods involved in Fire PRA for many of the aspects already contain conservatisms that skew results and risk insights. For example (from NUREG/CR-7114, Section 4.11.4): "If the fire brigade is credited, the path between fire brigade equipment and the PAU should be reviewed and the response time adjusted. Longer response times should be used if there is a possibility of maintenance or other activities in the PAUs along the fire brigade's path. Secondary combustibles should be specifically characterized in case of POS that include maintenance activities and plant upgrade. Quantity, type and position of potential combustible materials should be identified. Where in doubt, conservative assumptions should be used and carefully recorded." Conservative assumptions are not limited to Section 4.11.4. Making repeated conservative assumptions will result in wrong and unbelievable results.		
PWR-21	PWR Owners Group	G.21 (Section 4.13) A separate, stand-alone assessment for each postulated POS Is unreasonable and not feasible. Actions should be based on POS states which have a high internal events risk. Many of the POSs will be difficult to define well enough to adequately differentiate their individual risk contributions. The effort should be focused on high plant risk evolutions, like mid-loop, where there is a much higher chance of core damage, rather than focusing on POSs that do not contribute significantly to risk. This comment also applies to all other portions of NUREG/CR-7114 that assume that a separate, stand-alone POS assessment should be completed in support of Fire PRA. The level of detail requested is excessive with no real gain in risk insight - the assessment should focus on functions rather then POSs. The emphasis should be on high risk POS.		
PWR-22	PWR Owners Group	G.22 Section 4.17) It would reduce confusion to have the PRA functions used for the different POSs walked down. The functions would not change for many of the different POS and the redundancy of walking down the exact same conditions for different POS will dilute the attention that should be applied to doing the walkdown correctly and not repeatedly. The major changes in the POS will not be permanent sources and targets, it will be transient combustibles, welding and grinding for planned outage work,		

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PWR-23	PWR Owners Group	G.23 If the approach on NUREG/CR-6850 is taken, the fire CDF during LPSD may be in the range of 1E-01 to IE-02, since just transient combustibles and cutting/welding activities alone will increase by at least an order of magnitude. Additionally, given that alternate means of decay heat removal are unavailable (secondary cooling) for almost all of the outage and that significant safety systems are out of service, the plant has fewer defenses. As a result, some fundamental aspects of the use of NUREG/CR-6850 (Reference 3) need to be looked at again. Applying NUREG/CR-6850 in as outlined in NUREGICR-7114 may not achieve a realistic result and could further discredit this methodology. Specifically, the following LPSD considerations may render NUREG/CR-6850 not applicable: a. Much of the turbine building is in cold shutdown. Can a fire really start? b. Buses are de-energized and pumps are disabled, reducing the fire ignition frequency. c. Many electrical fires occur during testing/maintenance for return to service, which are quickly identified and put out. This would seem to be a special case for outage electrical fires. d. It would seem that actually hot work and transient combustibles are the real fire threat during plant shutdown.		
PWR-24	PWR Owners Group	G.24 Preparation of a LPSD Fire PRA presents a technical challenge to the ability to capture the dynamics of the significant contributors to fire risk. Dynamics relate to: 1) the status of the plant as it transitions from at-power through low power to shutdown, the equipment that is in place, and the transition in the equipment needed and used to perform safety functions through these transitions, 2) the dynamics of the containment as the plant moves from being pressurized through de-pressurization and head removal for fuel offload and reload, 3) vessel inventory as the plants moves through refueling evolutions such as mid-loop, etc.; 4) the dynamics of system operability and availability as the plant works to perform maintenance by removing components and systems from service that impact plant risk by reductions in fire ignition frequency (systems are de-energized) concurrent with equipment unavailability that may concurrently result in some increase to plant risk (this risk is related to the status of the equipment, the ability and timeline needed to return the equipment to service, etc.), and 5) work activities that dynamically shift plant risk by moving and locating transient combustibles in the plant, the movement and locating of ignition sources (for example, the performance of hot work), the impact of increased staffing in the plant improving detection and suppression of fires that may occur, and the dynamics of barriers (doors, penetrations seals, hatches, etc.) that may become impaired for part or all of a work evolution to support outage activities. These dynamics make it difficult to prepare an outage model and likely impossible to provide a realistic assessment of plant risk at any point in time or through a work shift. An outage-specific PRA would likely be required for each outage and based on the work scope and dynamics specific to a given outage an average model would be of little value if the goal to have a model that provides realistic results and meaningful insights.		

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PWR-25	PWR Owners Group	G.25 In general, this guidance appears to be premature and it would seem to be more appropriate in the near-term to consider fire risk during outage periods using qualitative defense-in-depth strategies to ensure that a protective path is available for postulated fire events. The assumptions may have considerable impact on the PRA model as well and the impact seems to be underestimated. Specifically: a. Assumption I identifies that fire ignition sources are predefined by the Fire PRA. and the LPSD PRA should only consider changes that might be associated with LPSD conditions. In terms of equipment and trains that are in and out of service, this represents a significant dynamic input to the LPSD PRA, which will be very difficult to realistically model. b. Assumption 2 is that a LPSD PRA has already been complete - the Fire LPSD guidance is in advance of developing the methods and treatments to support a LPSD PRA. Overlaying results of a fire initiating event (loss of circuits, logic, hot shorts and spurious actuations) onto a LPSD PRA is a very significant task, especially considering difficulties currently faced for Fire PRA such as the consideration of hot shorts - the consideration of hot shorts during at-power conditions is already nearly unlimited without even considering LPSD configurations. c. Assumption 3 identifies the importance of HRA, but the HRA methods are not defined. NUREG/CR-6850 was implemented without developing consensus HRA methods, and, as a result, HRA for Fire PRA is still not consistently implemented. d. Assumption 4 relates to the treatment of fire ignition frequencies to those used for preparing the at-power Fire PRA, providing some room for revision based on plant specific characteristics. There is a significant shift in the types of fires expected during LPSD periods, and this merits a more thorough evaluation and realistic treatment than that suggested in Assumption 4. G.25 (Continuation) These assumptions and limitations are fundamental elements of a credible methodology for LPSD Fire PRAs. Given these assumptions and limitations, this document is more like a "compilation of elements of LPSD Fire PRAs" or a "Fire PRA framework applied to LPSD conditions" than a methodology. The state of NUREG/CR-7114, which is reflective of the state of the industry, indicates that the industry would see a much more significant and near-term benefit if the consideration of fire risk during LPSD was qualitatively considered to provide insights regarding outage scheduling to address equipment needs, alternate equipment and train availability and the review and consideration of potential operator manual action paths. It would be more logical to advance once the industry masters the consideration of fire risk in the 1 OCFRS0.65a(4) risk assessments presently being piloted. A lack of realism in the PRA provides results that are inaccurate and, while conservative models can be developed, would tend to over-emphasize some risk attributes and mask real plant risks by making them seem less important (conservatively calculated risks appear to be more significant than they are as a result of the conservatism applied). Such a lack of realism will surely result given the assumptions and limitations in NUREGICR-7114. This Will only compound conservatisms present in current the Fire PRA methodology.		
PWR-26	PWR Owners Group	G.26 A consensus standard for LPSD PRA is presently being developed. Issuance of a methodology for preparing a PRA without the benefit of a standard seems premature. This can lead to guidance that does not result in realistic assessments and becomes engrained in regulatory tradition without adequate piloting and demonstration (similar to the methodology or NUREG/CR-6850 as applied to NFPA 805).		

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PWR-27	PWR Owners Group	G.27 Walkdowns will not be able to capture the desired data unless these are performed during the work activity, However, since risk insight Is needed to support scheduling, discovery of risk-significant activities while the activity is already in progress is not of benefit to that specific outage,		
PWR-28	PWR Owners Group	S.1 (pages 1-2) As discussed in Comment G8, the boundary between "low power" and "full power" has not been defined. In fact, the current Fire PRA Standard section (Part 4) uses the term "at-power." The PRA Standard offers a definition of 'at-power," but the definition offers its own ambiguities (e.g., "reactor being critical and producing power" -this sounds like Modes I and 2, but where does LIP fit in?).		
PWR-29	PWR Owners Group	S.2 (pages 1-2) Documentation here (and elsewhere in the NUREG) should emphasize the differences from at-power Fire PRA to LPSD Fire PRA for the specific task. For example, for Task I (of NUREG/CR-6850), the documentation should justify why no new fire areas are needed for shutdown.		
PWR-30	PWR Owners Group	S.3 (page 15, 3rd paragraph) This paragraph discusses the case of when "component selection will need to be augmented." However, the example (loss of a redundant train due to fire while the other train is out of service) is not a good example, This example occurs when the refueling cavity is full (when Technical Specifications allow single RHR train operation). However, this does not help to identify additional components. The operating RHR train is important, but there are no additional components that need to be identified because of that unique condition.		

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PWR-31	PWR Owners Group	S.4 page 20, Step 6) The issue of potentially "high consequence" related equipment needs more thought for shutdown. The addition of item (c) does not provide adequate clarity. The "high consequence" events for at-power include high-low interface failures, such as RCS/RHR suction valves spuriously opening, Section 2.5.6 of NUREG/CR-6850 provides such an example. A similar example for shutdown would be helpful (such as, "spurious failure of valve resulting in rapid draindown of the refueling cavity, with the containment hatch off").		
PWR-32	PWR Owners Group	S.5 page 20, Step 6) The new item (c) introduces a term "fuel bundle damage" that may be quite different from "core damage" considered in at-power PRAs. It seems as if this term may include mechanically damaged fuel bundle during transfer from the core to the SFP. This general topic needs to be clarified for shutdown PRA in general, rather than being presented new in NUREG/CR-7114.		
PWR-33	PWR Owners Group	S.6 page 20, Step 6) The new item (c) also includes "in a location outside containment..." This sounds like the SPF, although that was excluded elsewhere. The boundary for shutdown PRA needs to be carefully defined. a. Does it include only fuel in the vessel, only? b. Does it cover fuel in transit from the vessel to the SFP, but still in containment? c. Does it include transit to SFP?		
PWR-34	PWR Owners Group	S.7 (page 22, third paragraph) This paragraph discusses the situation where a fire does not cause damage to any Fire PRA equipment or cable (thus not contributing to fire risk), but during which operators preemptively trip the reactor. NUREGICR-7114 indicates that this event would be captured by the internal events PRA and does not need to be considered in the Fire PRA. It discusses analogous situations which make sense for LP, but not for hot shutdown, cold shutdown, or other non-power modes. Thus, for example, for a fire with the plant in Mode 6 with fuel movement, the operators would likely suspend fuel movement, but they would not transition out of Mode 6.		
PWR-35	PWR Owners Group	S.8 (page 22) Section 4,5 (first paragraph) states that "a separate model may need to be developed for each POS." If a separate model was indeed required for each of 10 to 20 POSs, this project would become extremely costly and almost intractable. In practice, a separate model is created only for groups of POSs, and more likely identifies the differences in fire risk model from one POS group to another.		
PWR-36	PWR Owners Group	S.9 (page 23) Step 1.2 identifies an example of a "special condition" that should be taken into account - an open door of an active electrical cabinet that is normally closed. This may be identifiable for a specific outage (although this may occur only as part of troubleshooting, which would be below the level of detail in an outage plan), but it is unlikely this level of detail would be identifiable for an average outage. This, of course, can occur at power. The process for treating this on an average basis needs to be developed. This applies to a number of other very specific examples identified throughout NUREG/CR-7114 (e.g., temporary cables).		

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PWR-37	PWR Owners Group	S.10 (page 24) The first paragraph discusses the LERF model for the case with the containment open to the atmosphere and claims that "the LERF model could be very simple." However, the ability to Isolate containment must be evaluated - time available, support systems required, environment in containment - to realistically evaluate LERF.		
PWR-38	PWR Owners Group	S.11 (page 25) Table 1 would benefit from an additional column to explain why these fire ignition frequency bins are specific to shutdown conditions.		
PWR-39	PWR Owners Group	S.12 (page 27) Section 4.6.2, the fourth bullet, says "... the ignition frequency is the same among all POSs." Presumably this meant to say "...same among all LPSD POSs." This has two errors. First, "at-power" should be considered as a POS, so "all POSs" means the reactor in any mode (so that the fraction of time in all POSs 1.0). Second, the assumption that ignition frequency is the same among all LPSD POSs improperly models the LP and hot standby POSs as "shutdown" POSs (Modes 4 to 6), when they are in actuality much more like at-power operation. As a result, to the extent that ignition frequencies increase, this overestimates the fire risk in LP and hot standby POSs, but underestimates the fire risk in shutdown POSs.		
PWR-40	PWR Owners Group	S.13 (page 31, first paragraph) The walkdown discussed to Identify shutdown-specific ignition sources would be effective only if it occurred over a number of outages, and at numerous times during each outage. It would be more effective to consult with outage planners, maintenance supervisors, and previous records regarding the occurrence of hot work and transient combustibles.		
PWR-41	PWR Owners Group	S.14 (page 34) Table 3 entries for ICDP and ILERP - The meaning and intent of "CDF with intact trains/system unavailable" are not clear.		
PWR-42	PWR Owners Group	S.15 (page 35) Table 4 provides an interesting proposal for screening criteria, but this is another area that should be addressed by internal events LPSD PRA first. It is not clear what is being screened - fire areas, fire scenarios, POSs, or combinations. The screening would be more appropriate if done by "POS Group," i.e., a group of POSs that shared some community for Fire PRA. The screening of 10% of internal events COF could be extremely low for some POSs.		

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PWR-43	PWR Owners Group	S.16 (page 38, first paragraph) This paragraph discusses the consideration of "de-energized" equipment for some POSs as a factor to determine fire likelihood. Is this equivalent to not counting that piece of equipment? To preserve the total fire ignition frequency for that component, something else needs to increase. This becomes very complex.		
PWR-44	PWR Owners Group	S.17 (page 45) Figure 2 - the text in some of the boxes does not display in the PDF file. Also, the spacing does not provide clear legibility.		
PWR-45	PWR Owners Group	S.18 (page 46, first full paragraph) The discussion of Table 6 notes that 'there are relatively few differences ..." It would be helpful to summarize the differences and the basis for the differences.		
PWR-46	PWR Owners Group	S.19 (page 50) The third bullet suggests that "when in doubt, conservative assumptions should be used ... ' However, there is always some doubt, and the conservative assumption approach is not appropriate for PRA, The objective is to get the best estimate and 'failing conservative" may well mask risk insights and may be nonconservative for some applications.		
PWR-47	PWR Owners Group	S.20 (page 53) The references (7, 8, 9, and 10) do not seem to match the references in Section 5.		
PWR-48	PWR Owners Group	S.21 (page 53) Section 4.12.2, Bullet 4 addresses the issue of human-induced initiating events and the importance of dependencies with subsequent actions. However, it is not clear how this applies to Fire PRA. How could an action that caused the fire impact control room operations? Clearly, the fire would be a challenge, but how does the fact that it was human-induced make subsequent actions more difficult than if this was a hardware-induced fire?		
PWR-49	PWR Owners Group	S.22 (page 53) Section 4,12.2, Bullet 5 addresses the issue of latent failures at shutdown and assumes that the number of these increases at shutdown. Clearly, human failures occur at a higher number during shutdown because there are so many more activities being performed. However, the process of restoring equipment identifies most latent errors. Accordingly, if equipment is maintained during shutdown and then called upon to work, there is high confidence it will perform, without latent failures, because of the maintenance operability test performed at the end of maintenance. (It is true that flood events are more likely at shutdown due to failure to secure system boundaries at the end of maintenance. However, that is not a latent error).		

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PWR-50	PWR Owners Group	S.23 (page 58) Task 16 should emphasize documenting the 'differences" from at-power Fire PRA.		
PWR-51	PWR Owners Group	S.24 (page 58) Task 17 includes the possibility that "separate walkdowns will be necessary in support of each POS." This would require extensive time with questionable value. At most, walkdowns should be performed by POS group. However, the value of walkdowns for shutdown fire risk needs to be carefully examined. It may be much more valuable to interview outage planners and maintenance personnel regarding the kinds of work performed in the past or that might be performed in the future (e.g., opening a cabinet door in a live electrical cabinet for extended time).		
PWR-52	PWR Owners Group	S.25 (page 59) The last bullet says "This walkdown may take place after the LPSD Fire PRA is completed." That is an odd suggestion, to perform a walkdown after the study is done.		
PWR-53	PWR Owners Group	S.26 (page 53, Section 4.12.2) One of the important distinctions for HRA at shutdown versus at-power is that there is no equivalent of "E-0" (the initial EOP for scenarios starting with a reactor trip) - there are, instead, a set of AOPs. The operator must diagnose the Issue to some degree to choose the proper AOP to respond to the event. This is even more so for a fire at shutdown, for which the fire response procedures are not designed.		
PWR-54	PWR Owners Group	S.27 (Section 3) Flooding of the spent fuel pool is a bad example of unique outage configurations; better examples would be large transformer replacements or EDG overhauls.		
PWR-55	PWR Owners Group	S.28 (Section 4.1 Bullet 2, and other places) Fires in inerted containments at-power are analyzed. They usually have no impact since there are limited sources and targets.		
PWR-56	PWR Owners Group	S.29 (Section 4.7) Screening criteria are ambiguous. It may be beneficial to state CDF and LERF as "instantaneous" for the single PAU analysis; this would take the impact of time out of the consideration of screening.		
PWR-57	PWR Owners Group	S.30 (Figure 2) Text is missing in the flow chart Step 2 box		
PWR-58	PWR Owners Group	S.31 (Section 4.12.1) NUREG-1921 (Reference 5) was released in November 2009,		

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PWR-59	PWR Owners Group	S.32 (Section 4.12.2) There should be no increase in the number of pre-initiator events because of an outage. The testing and other factors that would minimize the pre-initiator HEP would remain the same. Many of the credited actions for at-power human errors are performed during outages.		
PWR-60	PWR Owners Group	S.33 (Section 4.14) Reference 13 is incorrect, it should be Reference 12.		
PWR-61	PWR Owners Group	S.34 (Section 4.15) Uncertainties are "addressed" only in that they are identified and evaluated for impacts to the particular application that uses the model.		
EPRI-0	EPRI	Fire PRAs and LPSD PRAs are complex technical analyses. The Merging of the underlying analytical methods presents a significant challenge that requires careful consideration of the applications and current limitations of the methods. Development of Fire PRA Methods is an ongoing activity in which the NRC, EPRI, and industry continue to be engaged and considerable work remains to develop a consensus LPSD PRA Standard with piloted methods. The attached comments address a wide range of technical issues that relate to identifying intended applications, the maturity of the methods and extent to which they constitute a consensus approach, level of detail of the methods, the assumptions that need to be made in performing the analyses, and an appropriate method for integrating fire risk into a LPSD PRA. As a result of the issues that have been identified, EPRI believes significant revision and refinement are necessary for the approach in draft NUREG/CR-7114 to be a practical methodology for application in commercial NPPs. EPRI recommends that draft NUREG/CR-7114 be withdrawn until these improvements can be made. We look forward to further exchangin technical information with the NRC to improve the state-of-the art in the underlying methods required to develop and LPSD Fire PRA methodology.		
EPRI-1	EPRI	As a result of the issues that have been identified, EPRI believes significant revision and refinement are necessary for the approach in draft NUREG/CR-7114 to be a practical methodology for application in commercial NPPs. EPRI recommends that draft NUREG/CR-7114 be withdrawn until these improvements can be made. We look forward to further exchangin technical information with the NRC to improve the state-of-the art in the underlying methods required to develop and LPSD Fire PRA methodology.		
EPRI-1	EPRI	1. Applications and Maturity of Methods: The integration of LPSD and Fire PRAs requires mature guidance in each constituent area. The Fire PRA methodology in NUREG/CR-6850, EPRI/NRC RES Fire PRA Methodology for Nuclear Power Facilities, has a specific application, the risk-informed, performance-based alternative to prescriptive Appendix R fire protection requirements, codified in the NFPA 805. Within the scope of this application are elements containing larger uncertainties and greater conservatisms than are typically encountered in an internal events PRA. After significant iteration, the NUREG/CR-6850 methods are being applied at NPPs, while efforts to make them more realistic continue. For fire PRA, the NFPA 805 application has driven the development of the methods. For LPSD/Fire PRAs, as in any area, it is necessary to understand the objectives of performing the analyses - the intended applications - to ensure that the methodology is developed in a manner that will allow these objectives to be achieved. At present, the dominant application of risk analysis during shutdown conditions is configuration risk management. While the NUREG/CR-6850 methodology provides an existing body of guidance for fire risk assessment at-power, no such guidance document has been developed for LPSD PRAs. In addition, while Fire PRA is included in the ASME/ANR PRA Standard, RA-Sa-2009, an LPSD PRA Standard is still under development. Accordingly, publication of a methodology for LPSD Fire PRA is premature until applications are defined and fundamental guidance for LPSD methods, representing a consensus, is developed.		

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EPRI-2	EPRI	2. Assumptions and Limitations: A methodology document must provide details at a sufficient level for the user to understand how to implement it. Draft NUREG/CR-7114 includes multiple assumptions and limitations that are fundamental to PRA development, with several issues dismissed as "beyond the scope" (e.g., human reliability (HRA) quantification methods). Theses assumptions and limitations involve fundamental elements of a credible methodology for LPSD/Fire PRAs. As written, the assumptions and limitations will likely lead to a high level of conservatism in implementation. In addition, a LPSD PRA uses system success criteria common to the at-power PRA. The conservatisms use of these at-power calculations for system success criteria introduce may be manageable for shutdown conditions. However, these conservatisms inherent in an LPSD PRA would then be compounded by the NUREG/CR-6850 approach, and would likely result in distorted, highly conservative results. For example, the implications of Assumption 2 (Section 2.2) do not seem to have a coherent conclusion, but rather addresses generalities concerning the use of plant operating states (POSs). The lack of detail is clear in the statement, "Methods for the management of the work scope challenge will likely develop through practical application, but cannot be defined a-priori." Assumption 3 (Section 2.2) states that the development of HRA quantification methods for application to LPSD PRA lie beyond the scope of NUREG/CR-7114. HRA is a fundamental element of any PRA and cannot be considered to be "outside the scope" of a credible methodology. Assumption 4 (Section 2.2.) states that "LPSD Fire frequencies are estimated based on past experience in the same manner that fire frequencies were estimated for the RES/EPRI full power fire PRA methodology using the same root database." This might be ana appropriate approach for a pilot study, but is not characteristic of a mature methodology.		

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EPRI-3	EPRI	3. Adaptation of LPSD PRA to fire PRA: The method presented begins with the NUREG/CR-6850 approach and builds the LPSD PRA around it, task by task. This results in an expansive scope of the analysis by not recognizing the similarities between at-power and the low power POSs, and an approach to POS development that minimizes grouping in an effort to be comprehensive. While the analysis needs to consider all relevant information, there are considerations related to POSs and low power modes that can make the modeling more manageable, as described below (see Plant Operating States). In Chapter 3, the term "instantaneous CDF" needs to be defined. This may mean bounding core damage frequency (CDF) for the POS. As decay heat levels change through the POS, the "instantaneous CDF" changes. however, as discussed below, the report seems to minimize grouping of POSs. Section 4.2.2 includes a discussion of possible additions of sequences and equipment. The example presented under sub-item 1, concerning spurious actuation of a high pressure pump while the reactor vessel is closed but in cold shutdown, suggests that this sequence leads directly to a loss of DHR. The example implicitly assumes that all PWRs either have PORVs or rely on them for pressure relief during cold shutdown. This is not the case as PWR plant designs and operating practices vary. Furthermore, for this to result in a LOCA, a relief valve would have to stick open. it is possible that the relief valve could be isolated, ending the LOCA and mitigating the event, without impacting shutdown cooling. 3. (Continuation) Adaptation of LPSD PRA to fire PRA: It is not clear in Chapter 4 if the reported shutdown frequencies are annual frequencies or if they have already been adjusted based on the fraction of time that the plant is in shutdown. In addition, the actions needed to use the frequencies from generic sources are not clear. The useful information in Chapter 4 could be summarized in two paragraphs. Weight the frequencies by the fraction of time in the POS. Do the same tasks as an at-power Fire PRA with the end state of the POS in mind. Instead of the repetition of the at-full power Fire PRA information, examples of the differences would be more appropriate. There is limited discussion of what constitutes a fire that disrupts the POS. In NUREG/CR-6850, all fires are assumed to cause a plant trip. This is highly conservative assumption. In draft Urge/CR-7114, it seems that all fires are assumed to cause a loss of DHR. This takes the NUREG/CR-6850 conservatism to an even higher level. The document should explicitly state what the impacts must be (i.e., the nature of the challenge to the continued availability of DHR or the potential for a loss of inventory that could affect DHR) for a fire to constitute and initiator.		

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EPRI-4	EPRI	4. Plant Operating States: Section 4.5 states the following: " A separate model may need to be developed for each POS. In other words, this task may need to be repeated for each POS separately. If the complete set of LPSD POSs (i.e., the average or typical outages as discussed in Section 3.0 above) is of interest, a separate model should be developed for each POS of the set. Similarly, if a one-of-kind outage is under consideration, the model should reflect the specific conditions of that POS." The method presented for modeling is to adapt POSs to incorporate fire risk. However, a detailed LPSD model may have 20 or more POSs to address important changes to plant configuration, as well as to account for different types of outages. It is not feasible to do a complete Fire PRA for each POS. Instead, the analyst should group POSs according to each specific model element. For example, the grouping of success criteria for a specific system may be in two sets - high decay heat and low decay heat. The initiating event frequencies for LOCAs may be in several groupings, according to reactor coolant system (RCS) pressure. Similarly, for Fire PRAs, POSs may be grouped according to fire program controls and the expected amount of hot work. It is likely that fire program controls in Modes 2 and 3 are essentially the same as in Mode 1. The POSs are defined by the collection of modeling elements that may be shared by different groupings of POSs, such that each POS is unique. But the process for identifying the risk in LPSD is not by assessing risk one POS at a time, but by grouping similar elements. Grouping results in the subsuming of POSs (e.g. modeling the bounding parameter for a group of POSs). This is a more effective approach to evaluating risk than screening out POSs.		
EPRI-5	EPRI	5. Low Power and Hot Standby modes: Low power (LP) operation has more in common with at-power operation than cold shutdown conditions. The internal events PRA model is essentially the same between LP and at-power, with minor adjustments (e.g., the reactor trip frequency increases, anticipated transient without scram (ATWS) risk decreases). The same emergency operating procedures (EOPs) apply at LP as during at-power conditions. The approach to assess LP risk is to evaluate the changes from at-power that affect risk (i.e., a "delta" approach). Fire risk during LP operation should be essentially identical to fire risk during at-power operation - the plant is the same with regard to control of transient combustibles, barriers, hot work, fire emergency procedures etc. A similar "delta" approach should be used for LP/Fire PRA - how is LP different from at-power for issues that would impact fire risk? It is likely that such a "delta" analysis would find no differences except those issues already identified in the internal events LP delta analysis. This portion of fire risk should be grouped with at-power, not with shutdown. By grouping it with shutdown, it over-states the fire risk at LP, but understates it at shutdown (specifically the calculation of fire ignition frequency = number of events at "shutdown"/ time at "shutdown".		

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EPRI-6	EPRI	6. Outage Types and Modeling: One of the technical challenges associated with shutdown PRAs has been defining the boundary conditions of the analysis, given the differences in the scope of maintenance, the differences in scheduling that can arise from one outage to the next, even when the scope of work is similar, and the various types of outages that a plant may enter, e.g., refueling, maintenance, and major equipment changes, such as steam generator replacements. it can be argued that there is no "average outage", which makes calculation of an "average" CDF challenging. In addition, development of an LPSD PRA for specific outages addressing particular maintenance needs (e.g., steam generator replacement or to address an emergent condition requiring significant maintenance) has unique challenges. Development of such a PRA would depend on the development of the outage schedule prior to the specific outage. Following this, the lead time to develop the LPSD PRA could be so significant as to make the task impractical, unless the deviations from an average outage were very limited. If a peer review, with resolution of facts and observations, was desired, this would add tasks to the development of the LPSD PRA for the specific outage. The inclusion of fire makes the technical task of developing the LPSD PRA even more complex. While the methodology presented generally recognizes these factors, it tends to simplify the analysis and seems biased towards a typical refueling outage, or "average outage". However, the application of the methods would vary greatly depending on the type of outage and the configuration presented, which would not only impact the Shutdown internal events modeling, but also the Fire PRA-specific elements of the analysis, such as barrier configurations, cable routing, transient combustibles, and energized equipment. In Fire PRAs developed for at-power conditions, assumptions are made about average fire risk without identifying specific maintenance alignments at power that might have increased hot work or they may be concentrated in a few periods of time. An outage-specific model has advantages, especially for Fire PRA, because outage activities that increase fire risk might be identified from the outage schedule and outage planners. In contrast, fire risk from an "average" outage requires more assumptions in defining the average condition, e.g., times and locations during the outage when/where hot work is more or less likely or when/where transient combustibles may accumulate. For an outage-specific model, it would be difficult to determine the extent to which it meets the requirements of a future LPSD PRA standard. (e.g. does each outage model require a separate peer review?). Also, an outage-specific model does not answer the question of how shutdown risk compares on average with at-power risk. An average LPSD model could be used for applications, such as risk ranking of components or operator actions. While this is a general LPSD issue, it raises specific challenges for Fire PRA (e.g. how does one make assumptions about degraded fire barriers?). A mature methodology needs to address the issues associated with LPSD outages types and the implications of fire included in the PRA.		
EPRI-7	EPRI	7. Procedures: NUREG/CR-7114 outlines a cursory treatment of procedures. To ensure realism, these must be addressed in detail. The at-power EOPs do not have a symptom-based counterpart for shutdown conditions. The implication of this is that operators must diagnose plant conditions to apply the correct abnormal operating procedure (AOP). This is an important distinction for HRA applied to shutdown conditions. In addition, fire emergency procedures are generally written to address 10CFR50, Appendix R Requirements, assuming the plant is at-power.		
EPRI-8	EPRI	8. Spent Fuel and Fuel Bundle Damage: On page 20, high consequence events are discussed as follows: …"for the purpose of the LPSD fire PRA, consideration of potentially high consequence events should be extended to include events where: © one or more related component failures, including spurious operations where at least one failure/spurious operation is induced by a fire that by themselves results in fuel bundle damage either (1) when the reactor vessel and secondary containment structure are open (i.e. no primary or secondary containment) or (2) in a location outside containment to the extent that plant operations associated with the removal of fuel bundles from containment are included in the defined POS(s)." This conflicts with the implications of Assumption 5 on Page 7, which states that alternative end states are outside the scope of this methodology. In addition to being contradictory, this could be interpreted as an expansion of current regulatory requirements to include end states involving fuel bundle damage that use a risk metric other than CDF and LERF.		