SPLB Comments Based on Review of NUREG/CR-6850,
EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities

All page #s refer to pages in Volume 1.

xiii. Fire Risk Re-Quantification Study
PRA ~~analysis~~ *(multiple times)*
a stable ~~a~~ basis

xvi-xvii. Titles of Tasks do not exactly match chapter headings in Vol.2. Use of the letter "B" in the transfer gate may be confusing in light of there also being Support Task B in the same diagram - suggest a different letter or symbol

xxiii. CCF - the use of this acronym for anything other than common-cause failure will create confusion - suggest KKF
CDF - Core Damage Frequency

1-5. PRA ~~analysis~~

1-7. PRA ~~analysis~~
its original development

2-2 - 2-3. Titles of Tasks do not exactly match chapter headings in Vol.2

3-1. Methodology for ~~on~~ conducting

3-2. PRA ~~analysis~~

3-6. HRA ~~analysis~~

3-10. the Appendix R SSD list, ~~that~~ supporting

3-11. in most IPEEEs (e.g., circuit
EPRI and RES Technical Development Teams
NFPA 805, in particular, requires ~~need~~ consideration

All page #s refer to pages in Volume 2, Chapter 1, e.g., “1" indicates “1-1.”

3, 1.4.2	Change “Plan views of different buildings in the plant” to “Plan and elevation views of different buildings in the plant.”
3, 1.5.1	Change “Such buildings will likely screen in total” to “Such buildings will likely screen.”
6, 2nd bullet	Change “a well sealed concrete wall” to “a concrete wall.”
9, item 1	“etc.” should not be used. List all characteristics instead of using “etc.”
9, 1.5.4, 3rd bullet	Delete the word “Provide”
9, 1.5.4, 4th bullet	Delete the word “Document”.

All page #s refer to pages in Volume 2, Chapter 2, e.g., “1" indicates “2-1.”

3, last paragraph	Move the parenthesis after the word “pump” to after the word “alarm.”
4, 1st paragraph	Explain what is meant by “etc.” after the word “triples.”
7	Add Loss of DC Power as an Accident Sequence Type in Table 2-1.
16, 2nd bullet	Change “1/10th” to “1/10.”
18, 1st bullet	Delete the comma after the word “above.”
19, 2.5.6	Add “to” after the word “due.” Delete “to” in item 1.(a).
21, 1st bullet	Location should include the elevation and column lines.

All page #s refer to pages in Volume 2, Chapter 3, e.g., “1" indicates “3-1.”

1, 3.1, 1st sentence	Change “necessitate” to “necessitates.”
1, 3.1, last paragraph	Change “detailed circuit analysis” to “detailed circuit failure analysis.”
6, 3.5, last sentence	This sentence does not make sense.
8, 3.5.1.3, Item 1	The sentence “In this situation, it is recommended that some amount of detailed circuit analysis be conducted as a part of cable selection to minimize the number of cables requiring.” does not make sense.
8, 3.5.1.3, Item 1	In the next to the last sentence, change “and up-to-date” to “and is up-to-date.”
8, 3.5.1.3, Item 5	Change “3-foot” to “3-feet” and “5-foot” to 5-feet.”
9, 3.5.2.1, Item 2	Change “To what extend” to “To what extent.”
10, 3.5.2.1, Item 3	Change “Number of component” to “Number of components.”
10, 3.5.2.1, Item 7	Past non-conservative assumptions, with no simultaneous failures, should also be revisited.
11, 3.5.2.2, Item 2	Change “a cables failure” to “a cable’s failure.”

All page #s refer to pages in Volume 2, Chapter 4, e.g., “1" indicates “4-1.”

1, 4.3.1	Change “a set of compartments are” to “a set of compartments is.”
3, last paragraph above bullets	Change “plant physical configuration” to “physical plant configuration.”

All page #s refer to pages in Volume 2, Chapter 5, e.g., “1" indicates “5-1.”

7. For unavailable trains (as represented by their major components), some PRAs incorporate average test/maintenance (T/M) unavailabilities, i.e., average train unavailabilities derived from plant-specific data. Rather than set these values to 1.0 if unaffected by the fire, it would be appropriate to leave them at their nominal T/M values since the fire may or may not occur when the train is out-of-service for maintenance. An “a priori” setting of these failures to 1.0 or TRUE would overestimate the ICDP and ILERP for a fire initiator that does not affect those trains per se.

All page #s refer to pages in Volume 2, Chapter 6, e.g., “1" indicates “6-1.”

2	The 37 bins cited in Table 6-1 do not appear to be all inclusive. For example, some plants have gas turbines instead of diesel generators. In the FP SDP, frequencies are listed in Table A4.1 for gas turbine generators, but not in NUREG/CR-6850 Table 6-1.
3	Revise “Generic Freq” in table to be “Generic Freq/Plant” since this is a per-plant number.
6, step 6.4.3	“at least one walkdown” expand this to say, “at least one walkdown of the entire plant” since this appears to be the scope of the walkdown.
6, step 6.4.3	it is unclear what areas of the plant requires walkdown, for example are administrative areas required to be walked down? What about domestic water pump rooms, should these areas which may contain numerous large pumps be considered in the count? Also, SBO diesels, they may be either within the protected area or outside the protected area.
7, step 6.5.1	first bullet, gasoline is not typically stored in a nuclear plant, replace with diesel fuel.
7, step 6.5.1	second bullet, where is the percentage of time that an ignition source is functioning used? For example, a diesel and emergency pumps are nearly never used. Where would these be considered. If there are only a few types of equipment where the “time functioning” factor is used, spell it out here. Analysts may spend time collecting “time functioning” information for equipment to develop a factor that is not used.
9, step 6.5.2	last paragraph in 6.5.2, if this is saying not to use plant fire numbers to lower the plant fire frequency, then state so explicitly.
13, step 6.5.6	3rd paragraph, the term ‘inaccessible areas’ is used. All plant areas should be accessible. If this means that for analysis it is not reasonable to allow access to an area, for example, containment during operation, then describe the area as something other than ‘inaccessible.”
13, Step 6.5.6	4th paragraph, electronic databases may not provide accurate information for number of electrical cabinet sections without additional information. For example, it may be accurate for 4160V cabinets since there is typically one 4160V cabinet per section. But, 480V cabinets may have 2 to 5 switchgear per section, which may make the database misleading.
14, Step 6.5.6	Bin 8 Bullet, are TSC, Security, and SBO diesels included in the plant diesel count?

14, Step 6.5.6	Bin 9 Bullet, should outdoor compressors be counted?
14, Step 6.5.6	Bin 14 Bullet, Shouldn't 5 HP motors be excluded since they are excluded for pumps?
15, Step 6.5.6	Bin 15 Bullet, 4.6kV switchgear should be 4.16kV. Also, electric cabinet voltages may even be as high as 6kV. Is it intended that greater than 4.16 kV be excluded?
15, Step 6.5.6	Bin 18 Bullet, junction boxes should not be apportioned to as a ratio of cable. Many cable spreading rooms have a lot of cable, but since they have few conduits, have few junction boxes. For example, a pump room may have no exposed cables but may have as many junction boxes as a cable spreading room. Also, it is unclear why junction boxes are included in the count when wall mounted electrical cabinets are excluded. There is a lot more going on in a wall mounted electrical cabinet than in a typical junction box.
16, Step 6.5.6	Bin 28, after bullet, If splattering could occur, it could easily bypass the barriers between transformers and cause secondary fires. What is the basis for crediting shielding?

All page #s refer to pages in Volume 2, Chapter 7, e.g., “1" indicates “7-1.”

1. Step 2 - Quantify large early release frequency (LERF) Model

2. ... on dominant compartments while ~~minimizing~~ ensuring that the risk contribution of screened compartments is minimal (thereby justifying their screening) ...

4-5. ... CDFs ~~frequencies~~ ...

5. Under Task 7D in Table 7-1, should “Updates to the fire ignition frequencies developed in Task 6" be included among the inputs?

6-7. ... LERFs ~~frequencies~~ ...

7. ... models to calculate fire-induced ~~LERF/~~CLERP for each compartment ...

8. ... the basis for exclusion s~~S~~hould be documented ...

9. ... CDFs ~~frequencies~~ ... LERFs ~~frequencies~~ ... ICDPs ~~probabilities~~ ... lLERPs ~~probabilities~~ ...

All page #s refer to pages in Volume 2, Chapter 8, e.g., “1" indicates “8-1.”

8, Step 8.4.2	Add, Elevation drawings of rooms and equipment, following equipment layout drawings

All page #s refer to pages in Volume 2, Chapter 9, e.g., “1" indicates “9-1.”

6	In the note at the bottom of the page, change “Fire PRA Component Selection” to Fire PRA Components Selection.”
11, 3rd Bullet	Change “to occur in manner” to “to occur in a manner.”
11, 6th Bullet	Change “each cable need be analyzed” to each cable needs to be analyzed.”

All page #s refer to pages in Volume 2, Chapter 10, e.g., “1" indicates “10-1.”

1. methodology necessitates an analysis

3. and Task 14 ~~12~~, Quantification of Fire Risk

8. Acronym CCF normally stands for common-cause failure. Suggest not using for cable configuration factor as it is quite confusing (use KKF)

10. Uncertainty bands of ±50% are suggested for cables with >15 conductors in Appendix V. This should be reflected here as well.

All page #s refer to pages in Volume 2, Chapter 11, e.g., “1" indicates “11-1.”

2	In Equation 11-1, change $P_{ns,k'}$ to $P_{ns,k.}$
3-5	The titles for Steps 11.2, 11.4, 11.6, 11.7, and 11.8 do not agree with the titles in Figure 11-1.
12, 11.4.1	First sentence, change “The input” to “The inputs.”
13, 11.4.2	Change “Focused waldown of the unscreened compartments is” to Focused walkdowns of the unscreened compartments are.”
13, 11.4.2	Last sentence, change “In addition to focused walkdown” to “In addition to focused walkdowns.”
4, 11.5	In number 1, change compartments to compartment.
18	In the first sentence, change the step in the parenthesis from 4.a to 5.a.
21	In the first sentence of the second paragraph, change “depends” to “depend.”
22, 4th Bullet	Change “the user needs specify” to “the user needs to specify.”
23, 11.5.1.7.3	In the second line, change “fuels” to “fuels’.”
27, 11.5.1.8.1	In the first line, change “analysis it to assess” to “analysis is to assess.”
28, 1st Bullet	In the second line, change “the system arrive” to “the system to arrive.”
30	Below equation 11.5, change “The approach is assumes” to “The approach assumes.”
37	Change “For cabinets with open an back” to “For cabinets with an open back.”
41	Change “It is strongly recommended that single compartment” to “It is strongly recommended that a single compartment.”
43	In the third paragraph, change “all exposed compartments regardless the number” to “all exposed compartments regardless of the number.”

All page #s refer to pages in Volume 2, Chapter 12, e.g., “1" indicates “12-1.”

3. operators may face in various fires

All page #s refer to pages in Volume 2, Chapter 13, e.g., “1" indicates “13-1.”

2, 13.3.1, 3rd paragraph	Change “in an NPP.” to “in a NPP.”
3, 13.3.2, 3rd paragraph	Change “...may be compromised. (Systems could include local sprinkler systems, and features could include manual hose stations.)” to “ may be compromised (Systems could include local sprinkler systems, and features could include manual hose stations).”
4, 13.3.4, 1st paragraph	Change “one or more fire suppression system” to “one or more fire suppression systems.”
7, 13.6.3, last paragraph	Change “supplies that used in” to “supplies that are used in.”

All page #s refer to pages in Volume 2, Chapter 14, e.g., “1" indicates “14-1.”

2. “General Task Objectives and Approach” discusses “fire scenario frequencies,” but it is not clear whether what is meant here is just the fire ignition frequency or the {fire ignition frequency * growth factor (if any) * non-detection probability * non-suppression probability * propagation probability (if any) * probability of component damage due to fire}, i.e., the fire-induced damage portion of the fire risk equation. I suspect the latter, since the fire is not of interest unless it induces component damage, and all these factors must contribute in order for a fire “scenario” to have the same influence in an accident sequence as a non-fire initiator.

2. CDFs ~~frequencies~~

3-4. Similar comments to above on “fire scenario frequencies.” Likewise on CCDPs ~~probabilities~~, CDFs ~~Frequencies~~, LERFs ~~frequencies~~ and CLERPs ~~probabilities~~.

4. ... the probability distributions representing ~~of~~ epistemic uncertainties ...

5. Fire PRA ~~analysis~~

All page #s refer to pages in Volume 2, Chapter 15, e.g., “1" indicates “15-1.”

3. ... as Fire PRA task execution progresses, and as new information ...

4. Possible strategies include (...):

4. Identifying a base case as the best estimate model ~~and/or~~ with data values and performing a sensitivity analysis ...

4. This assembly should decide which uncertainties will be addressed ...

5. ... taking advantage of the results of the Fire PRA ~~as they are iterated upon~~ at each iteration ... affect the results or the understanding of the results.

5. ... it is not expected that uncertainty analyses will be performed on screened out portions of the model/results ... TRUE, BUT SENSITIVITY CONSIDERATIONS MAY BE APPROPRIATE (SEE UNCERTAINTY SECTIONS IN CHAPTERS 4 AND 7 ON SCREENING)

All page #s refer to pages in Volume 2, Chapter 16, e.g., “1" indicates “16-1.”

3, Table 16-1	Under “Detailed Fire Modeling-Multicompartment,” add a period after results.
3, Table 16-2	Under “Scoping Analysis,” change “scooping” to “scoping.”
3, Table 16-2	Under “Sensitivity Analysis,” change “final results of each cases” to “final results of each case.”

All page #s refer to pages in Volume 2, Chapter 17, e.g., “1" indicates “17-1.”

1, 17.1, 2nd paragraph	Change “involve common set of steps” to “involve a common set of steps.”
2, bullet items	Be consistent. Some items end with a period, some items end with a comma, some items end with no punctuation. All should end the same.
3, 17.3, 1st paragraph	Change “course a fire risk analysis” to “course of a fire risk analysis.”
5, Table 17-1, Item 7, 2nd column	Change “sever vibration” to “severe vibration.”

All page #s refer to pages in Volume 2, Chapter 18, e.g., “1" indicates “18-1.”

1, 18.1	Change “fire PRA project of this type necessitate” to “fire PRA project of this type necessitates.”
1, Footnote	Change “throughout these procedure” to “throughout this procedure.”
2, 18.3.1, last paragraph	Change “Fire PRA equipment and cable selection tasks” to “Fire PRA component and cable selection tasks” to agree with the title of Task 2.

All page #s refer to pages in Volume 2, Chapter 19, e.g., “1" indicates “19-1.”

2. CCDP is conditional not only on fire initiator but also on non-detection/non-suppression of the fire, etc. Generally, it is conditional on all aspects specific to the fire (ignition, detection/suppression, severity) and any damage done to components directly by the fire. Only the non-fire-induced failures and aspects remain for the CCDP

2. Ceiling Jet. Refers to the relatively rapid gas flow~~s~~ ....

2. Circuit Failure and Fault Mode have the same definitions. If this is the intention, then why draw a distinction? Just combine as Circuit Failure/Fault Mode.

2. CLERP. Similar comments as above for CCDP.

3. Conditional Core Damage Probability (CCDP). See above. Also, this definition should only appear once, i.e., the acronym should not be assigned a separate entry on page 2.

3. Core Damage Frequency (CDF) is the product of CCDP, fire initiator, non-detection/non-suppression, fire severity, fire-induced component failures, etc. These latter items are not part of CCDP, which addresses only non-fire-induced failures. See previous comments.

3. Enclosure. An enclosure is a room ...

3. Equipment Failure Response Report. ... fire damage to its ~~associated~~ related power, control, or instrumentation cable. (Avoid using the term “associated” unless in same context as “associated circuit.”)

4. Fire PRA Database ... Fire PRA ~~analysis~~, ...

6. Influence factor (occupancy) ... temporary, etc. ...

7. Influence factors. Move this definition so that it precedes those for the specific influence factors. Also, delete reference to “work package” and refer to “analysis” or something similar.

7. LERF. See previous comment on CDF - LERF is not just the product of fire initiator and CLERP.

7. Lower layer. Under Ceiling Jet, “gases” was spelled “gasses” - be consistent (check spelling in other definitions as well).

8. Operator (in HRA context). Remove duplication.

8. Performance shaping factor (PSF) ... such as visibility, toxic fumes, and smoke~~,~~.

8. Planning (in HRA context). The human process of selecting~~,~~ a strategy and the appropriate procedures(s), and ...

9. Raceway ... pull boxes, junction boxes (see also Via, Cable).

9. Add definition of “Risk,” preferably taken from ASME RA-Sa-2003.

9. Safe Shutdown (SSD) Systems and Equipment ... and components within the framework of 10 CFR 50 Appendix R ~~of 10 CFR Part 50 framework~~ ...

9. Screening analysis ... the probability of a significant accident ~~or~~ and its consequences (i.e., the risk).

9. Screening criteria ... the probability of an accident ~~or~~ and its consequences (i.e., the risk).

9. Smoke layer ... two-zone model formulation (see also Upper Layer).

10. Surrogate event ... of fire initiators or fire-induced failures.

11. Upper layer ... two-zone model formulation (see also Smoke Layer).

All page #s refer to pages in Volume 2, Appendix A, e.g., “1" indicates “A-1.”

2, Item 3	The phrase “time sinks” does not make sense.
5, A.3.1, 2nd bullet	The parenthesis at the end of the section does not make sense.
5, A.3.1, 3rd bullet	In the last sentence, change “Tthis” to “This.” Also, the parenthesis at the end of the sentence does not make sense.

All page #s refer to pages in Volume 2, Appendix B, e.g., “1" indicates “B-1.”

No Comments

All page #s refer to pages in Volume 2, Appendix C, e.g., “1" indicates “C-1.”

1. ... and present the mean, standard deviation, 5^{th}, 50^{th} and 95^{th} percentiles ...

1. The classification of fire events is further divided into power and low-power operation ... – There is no evidence of this division in Table C-1 or C-3.

2. No attempt has been made to estimate the number of fire~~s~~ events that EPRI has been unable to collect. – Is this acknowledged underestimation at least somewhat accounted for in the uncertainty (error factor on distribution) on the fire ignition frequencies?

2. ... personal styles in event reports also influence~~s~~ the level of ...

3. ... specifically for Bayesian analysis ...

4-6. Not being familiar with the R-Dat program, does the column in Table C-1 “EF for EF” add anything, considering it just repeats the “EF” column?

7. ... ignition source (see ~~for~~ further discussions below) ...

8. ... would be classified as non-severe ... (2 occurrences)-

9. ... prompt suppression, including, in particular, continuous fire watches.

13. Table C-3 appears without any introduction or discussion in the preceding (or succeeding) text. While the reader can deduce what the table intends to convey, it would be better if some discussion were provided.

All page #s refer to pages in Volume 2, Appendix D, e.g., “1" indicates “D-1.”

1. ... CDF ~~frequency~~ ... (2 occurrences)

1. ... in the United States is ~~of~~ on the order of 1.0E-06/yr or higher ...

1. ... LERF ~~frequency~~ ... (2 occurrences)

1. ... and all other Internal Events Initiating Events are set to 0.0 ...

1. ... temporary change risk criteria~~a~~on documented in ... (2 occurrences)

All page #s refer to pages in Volume 2, Appendix E, e.g., “1" indicates “E-1.”

1. ... is the probability that fire ~~ignition~~ progression/development would include certain ...

1. Step 2 - should the midpoint value of the discretized bin be assumed as the damaging HRR?

3-10. Table E-2 appears to use values other than the midpoint as the “point value” for some bins. This difference should be explained.

All page #s refer to pages in Volume 2, Appendix F, e.g., “1" indicates “F-1.”

1, F.1	Here Figure F-1 is called “Fixed Ignition Source Form.” However, on page 2, Figure F-1 is called “Walkdown and Severity Factor Calculation Form.” The form name should be the same in both places.
3, 2nd bullet	Change “Appendices E and G provides” to “Appendices E and G provide.”
6, Figure F-3, 3rd box	Change “Dmage Criteria” to “Damage Criteria.”

All page #s refer to pages in Volume 2, Appendix G, e.g., “1" indicates “G-1.”

1 In the fourth line from the bottom, change “presented have is based” to “presented is based.”

10 In the second paragraph, change “should include estimate” to “should include an estimate.”

12 In the first paragraph, change “fuel package the most closely” to “fuel package that most closely.”

25 Second Bullet, change “tightly bundles cables” to “tightly bundled cables.”

29 Second Bullet, change “could exhibit heat release rate” to “could exhibit a heat release rate.”

34 First Bullet references Figure G-19. It seems that this should be Figure G-22.

All page #s refer to pages in Volume 2, Appendix H, e.g., “1" indicates “H-1.”

3, Section H.1.3	Second line, change “The decision will hinge on the whether or not” to “The decision will hinge on whether or not.”
4, Section H.1.3	In the last paragraph, the first sentence needs to be changed. As it is written, it makes no sense.

All page #s refer to pages in Volume 2, Appendix I, e.g., “1" indicates “I-1.”

1, 6th Bullet from the top of page	Change “An MOV” to “A MOV.”
8	In the first paragraph, fourth line, change “Table I-4, below provides” to “Table I-4, below, provides.”

All page #s refer to pages in Volume 2, Appendix J, e.g., “1" indicates “J-1.”

1. CCF - the use of this acronym for anything other than common-cause failure will create confusion - suggest KKF

7. “How well does the formula predict the test data?” - Two examples are given (31/80 spurious actuation probability for a seven-conductor cable; 11/44 spurious actuation probability for a one-conductor cable). Are these the only cases, or are there more? Either way, it should be stated since the implication with the formulas is that several data points exist and the various formulas were tried until the ones selected yielded acceptable values compared to multiple (i.e., certainly more than two) experimental results. If other comparisons exist, perhaps a table comparing actual with predicted results would be helpful.

All page #s refer to pages in Volume 2, Appendix K, e.g., “1" indicates “K-1.”

3. The probability for the intercable short (0.06) is not directly read from Table 10-1, since an intercable hot short w/o CPT is not listed there. What apparently is implied is that either: (a) the M/C intercable w/o CPT is 0.1 times the M/C intracable w/o CPT (i.e., 0.1 * 0.6); or (b) the M/C6M/C intercable w/o CPT is twice that of the M/C6M/C intercable with CPT, (i.e., twice the midpoint [0.03] of the range of 0.01-0.05). Since this is the first example of use of Table 10-1, at least a footnote explaining how this 0.06 term was obtained is needed.

11. When calculating CCF_{SO2}, it appears the assumption is that the first short (SO1) has removed two of the five cables as candidates for the second short, reducing the value of TC from five to three. This is an important point in assessing the dependency in this example, and at least a footnote describing the calculation would be helpful. Otherwise, the reader is left wondering why the different values for TC between the SO1 and SO2 calculations.

18. Table K-5 should be located before Section K.6 to avoid confusion.

All page #s refer to pages in Volume 2, Appendix L, e.g., “1" indicates “L-1.”

3, Section L.2	Change “Using this, definition the frequency” to “Using this definition, the frequency.”

All page #s refer to pages in Volume 2, Appendix M, e.g., “1" indicates “M-1.”

12	Last paragraph, second line says “the temperature rise in the room is in the order of degrees C.” Add a number in front of degrees C.
16, Section M.6.1.1	In the second paragraph, change “According to the approach on provided” to “According to the approach provided.”

All page #s refer to pages in Volume 2, Appendix N, e.g., “1" indicates “N-1.”

3, Section N.1.2, 1st item under 1st bullet	Change “1970s, 1980s and 1980s” to “1970s, 1980s and 1990s.”
5, Section N.2.2	Change “10% of BWRs Hydrogen Recombine Frequency” to “10% of BWR’s Hydrogen Recombiner Frequency.”
6, Section N.2.3	Sixth paragraph, fifth line, add a period after the word “impingement.”
P6, Section N.2.3	Sixth paragraph, tenth line, change “excess flow valve on control panel release hydrogen” to “excess flow valve on the control panel that released hydrogen.”
7, Section N.2.3.1	Fourth bullet, change “Leaking flange leak” to “Leaking flange.”

All page #s refer to pages in Volume 2, Appendix O, e.g., “1" indicates “O-1.”

No Comments

All page #s refer to pages in Volume 2, Appendix P, e.g., “1" indicates “P-1.”

3. The first entry under the Detection column in Table P-1 should read Continuous Fire Watch, for consistency with discussion that follows the table

4. ... Note that at this point, automatic detection and suppression systems are assumed effective for ...

4. Scenario J in Fig. P-1 assumes failure of prompt detection, prompt suppression, and automatic detection, but then credits successful automatic suppression when neither prompt nor automatic detection has occurred. In other words, it produces the same OK result as Scenario F, where automatic detection is credited. Is automatic detection irrelevant for successful automatic suppression as the event tree seems to imply?

5. ... or in-cabinet detectors are credited (for an in-cabinet initiated fire) ...

5. ... because halon systems usually depends on a smoke ...

5. ... The probability of automatic suppression failure is the unreliability times plus (Boolean sum) the unavailability ...

5. ... smoke detectors, the probability of automatic detection failure should also be also multiplied added (Boolean sum) ...

6. ... is calculated by summing (Boolean) the unreliability and unavailability ...

6. ... using the suppression time reported in the FEDB ...

6. ... As mentioned above (for automatic fire suppression systems [under Pr{failure fire brigade}] or elsewhere?), events suppressed by fixed fire suppression system only ...

8. ... add 5 minutes to the time available for detection, i.e., reduce the time to detect the fire (t_{det}) by 5 minutes.

12. ... The availability is the compliement of the unavailability ...

12. ... in the calculation, the unreliability of the system (what goes here?) unnecessary.

12. ... A generic fault tree is provided to assist ... – There is no fault tree provided.

12. ... to continuously indicate if trouble exists), the results ...

13. ... water suppression system is in the compartment or use of ...

13. The probability of no suppression is calculated by summing the probabilities ...

13. ... These ~~three~~ four branches (or sequences) represent scenarios where the fire is not suppressed by the fire brigade. (In the case of Scenario N, the fire brigade's failure results from a failure of manual detection such that the brigade does not even attempt to suppress the fire.)

15. The previous comment regarding Sequence J in Fig. P-1 also applies to Fig. P-4

15. In Sequence L in Fig. P-4, 0.16 should be 0.15

All page #s refer to pages in Volume 2, Appendix Q, e.g., “1" indicates “Q-1.”

No Comments

All page #s refer to pages in Volume 2, Appendix R, e.g., “1" indicates “R-1.”

1, Section R.1	First paragraph, third line, change “cables types” to “cable types.”
1, Section R.	First paragraph, fifth line, change “six inches of the rack” to “six inches off the rack.”
5, Note at the top of the page	Change “five” to “fire” in the first and second lines.
5, Section R.4.2	The second sentence in the first paragraph after the three equations needs to be modified because it does not make sense as it is written.
8, Section R.4.2.2	All of the five bullets should be black, not some black and some gray. In the last bullet, change “1 minutes” to “1 minute.”

All page #s refer to pages in Volume 2, Appendix S, e.g., “1" indicates “S-1.”

No Comments

All page #s refer to pages in Volume 2, Appendix T, e.g., “1" indicates “T-1.”

5, 1st line	Change “Of the 13 meters tests” to “Of the 13 meters tested.”
11, Section T.2.2.1.2	Third line, change “and addition level of analysis” to “an additional level of analysis.”

All page #s refer to pages in Volume 2, Appendix U, e.g., “1" indicates “U-1.”

No comments.

All page #s refer to pages in Volume 2, Appendix V, e.g., “1" indicates “V-1.”

1. ... in whether the equipment list, and hence the model, contains all the necessary ...

4. It is recommended the above uncertainties be dealt with through a quality review ...

8. Uncertainty bands of ±50% are suggested for cables with >15 conductors. This should be reflected in Chapter 10 as well.

9. While the post-fire HRA has the same types of uncertainties as other HRAs, are the magnitudes of these uncertainties inherently larger, or is this implicit in the use of the performance shaping factors? If inherently larger, should there be some discussion here?

9. Whether the detailed HRAs ~~analyses~~ and subsequent ...

All page #s refer to pages in Volume 2, Appendix W, e.g., “1" indicates “W-1.”

2	The first sentence says “The data fields highlighted in blue on Figures W-1 and W-2...” There are no data fields highlighted in blue in these figures (in the hard copy).
3, Section W.2	In the third line, change “are an important elements” to “are important elements.”
3, Section W.2	In the sixth line, change “it is possible than some valves” to “it is possible that some valves.”
4, Table W-1	Consider adding Manual damper to the list of options for Equipment Type.
5, Table W-1	There is no Equipment Failure Code for the Failure Description “Erroneous Indication.”

Review Comments on Draft NUREG /CR-6850 Developed by the NRC Office of Nuclear Regulatory Research and Electric Power Research Institute (EPRI)

Fire PRA Methodology for Nuclear Power Facilities
Volume 2: Detailed Methodology

Principal Contributor Naeem Iqbal NRR/DSSA/SPLB

General Comments

The draft NUREG should use dual units throughout the document, i.e., first SI units with English units in brackets. The NRC's metrication rules require the use of metric units for all measures, followed by the English equivalents in parentheses. For example, on page 8-2 the value of temperature is provided in SI units only while on page 8-7 temperature value is provided in English units.

Draft NUREG should list nomenclature used in the text.

All appendices require equation numbering.

Specific Comments

Chapter 8 - Scoping Fire Modeling (Task 8)

The draft NUREG should include a reference of cable damage criteria in the text and Table 8-2 on page 8-10.

Chapter 11 - Detailed Fire Modeling (Task 11)

The draft NUREG should provide a discussion on maximum expected fire scenarios (MEFS) and limiting fire scenarios (LFS) in Chapter 11 reference to the NFPA 805, Appendix C.

Page 11-1. Why are single compartment fire scenarios separated from the MCR fire scenarios?

Page 11-12 in Section 11.3.7, Assumptions, First Bullet. In this assumption, the analysis is limited to a single fire occurring at any given time; this is not a valid assumption. Often fire in one compartment spreads to an adjacent compartment very rapidly, resulting in multiple fires.

Page 11-25. Explain why exposure temperature of 25 °C above the threshold has been selected for cable failure to occur in a matter of minutes.

Page 11-25. Discuss very high temperature or heat flux levels in which cable damage may occur in a matter of seconds. Provide levels of temperature and heat flux in the discussion.

Page 11-31. In the second paragraph provide reference to the “review of the Control Room fire events.”

Page 11-35, Section 11.5.1.1.7, Step 7.b. Why were only three fire scenarios identified in the control room? There may be more than three fire scenarios in a control room fire.

Appendix G - Appendix for Chapters 8 and 11, Heat Release Rates

This appendix should use the abbreviation HRR throughout the text.

This appendix should use the abbreviation NPP throughout the text.

Equation G-1 should be provided in its corrected form in accordance with the SFPE Handbook of Fire Protection Engineering, 3rd Edition, 2002. A reference should also be provided in the text and in the reference section.

Figure G-1 should label the four stages of fire as described in the text.

Page G-3. Provide a complete reference for the Fire PRA Implementation Guide (FPRAIG).

Page G-3. Provide a complete reference for NUREG-1742 in the reference list.

Table G-1, "Recommended HRR Values for Electrical Fires." The title should be "Recommended HRR Values for Electrical Fires **without Electrical Energy**."

Table G-2, "Recommended HRR Values for Electrical Fires." The title should be "Recommended HRR Values for Electrical Fires **without Electrical Energy**."

Table G-2 represents profiles by averaging the growth times and steady burning durations from the Sandia cabinet experiments. This table should clarify that these tests were conducted without electrical energy and that fire growth was based on burning of cable bundle(s) only (specify cable type) and affected by cabinet ventilation (cabinet door open/closed). The table should also include the Test No. from the Sandia cabinet experiments.

Page G-7. The first paragraph discuss a t^2 function representing the growing phases of the fire. This function need to be discussed in more detail as to why growth of a cable fire is represented by this equation. Also, the equation should be derived step by step in SI units.

Table G-4 on page G-9 should refer to the original data source.

Table G-5 on page G-11 should refer to the original data source.

Table G-6. Replace NUREG-4527 by NUREG/CR-4527.

Table G-8 referred to EPRI TR-100443, so include this reference in Section G.8. The reference column of Table G-8 should refer to original data sources.

Pages G-25 to G-36. Provide discussions with correct Figure references.

Appendix H - Appendix for Chapters 8 and 11, Damage Criteria

The draft NUREG should include a reference to cable damage criteria in the text and in Table H-1 on page H-1.

Table H-2 on Page H-2. Provide a reference in the column “ignition/Damage Parameter Set to be Used.”

Appendix L - Appendix for Chapter 11, Mail Control Board Fires

This Appendix should include a correlation for estimating the maximum centerline temperature of a fire plume Currently this Appendix presents only a plume temperature calculation when a target is away from the fire.

Appendix M - Appendix for Chapter 11, High Energy Arcing Faults

Section M.1, “Introduction,” should discuss in detail the findings from the NRC research report, “Operating Experience Assessment Energetic Fault in 4.16 kV to 13.8 kV Switchgear and Bus Ducts That Caused Fire in Nuclear Power Plants 1986-2001" (ML021290358).

Appendix N - Appendix for Chapter 11, Hydrogen Fires

The Title of this appendix should be **Hydrogen Fires and Explosions.**

On Page N-12, define TNT-equivalent.

Page N-12, provide a Table N-3 reference.

Appendix O - Appendix for Chapter 11, Turbine Generator Fires

This appendix should include a detailed discussion on turbine generator fire modeling using computer models, e.g., “Numerical Fire Modeling of a Turbine Hall,” International Association for Fire Safety Science (IAFSS), Proceedings of 2nd International Symposium, June 13-17, 1988, Tokyo, Japan, Hemisphere Publishing Corporation, New York, Wakamatsu, T.; Hasemi, Y.; Sekizawa, A.; Seeger, P. G., Editors, pp. 771-779, 1989.

Appendix R - Appendix for Chapter 11, Cable Fires

Page R-1 should include a reference to the IEEE-383 fire test standard.

Page R-3, Section R.3, should include a reference for the equation.

Page R-4, Table R-1, should include a reference for the data source.

Page R-5, Section R.4.1.2. Provide the original source of the flame spread rates on cable. Provide references in the discussion.

Page R-6. Replace Table P-1 with Table R-1.

Page R-6. The last paragraph referred to the fire test involving 14 filled horizontal cable trays. Provide the original reference for the fire testing.

Page R-8, Section R.4.2.2. Provide a basis/reference for cable exposure time.

Appendix S - Appendix for Chapter 11, Fires Propagation to Adjacent Cabinets

On Page S-1, replace (NUREG 4527) with (NUREG/CR-4527).

This Appendix should include an approach presented in Appendix D to the NEI NFPA 805 Implementation Guide for electrical fire propagation to adjacent cabinets.

Appendix T - Appendix for Chapter 11, Smoke Damage

No Comments.

**SPSB Comments Based on Review of NUREG/CR-6850,
EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities**

General:
(1) While the two electronic .pdf files for the subject document text appear to display correctly on the computer monitor, varying results were noted when the pages were sent to a printer. Some printed text was compressed/overwritten which also appeared to vary depending on the type of printer selected.

(2) During the development of several Phase 3 fire analysis reviews within SPSB, NUREG/CR-6850 was cited by the contractor support as the reference for specific data sets, such as fire frequencies and severity factors. The values cited in these reviews do not appear to be directly taken from NUREG/CR-6850, but from the database that was used to develop the NUREG. Is the database going to be released for either general use or internal-NRC use? Without access to the database, we are put in an untenable position of trying to justify numbers, contained in NRC analyses, to NRC management and licensees for which we and the licensees have no ability to trace and understand the application of these values from the NUREG/CR-6850 database to the Phase 3 products.

Specifics:
(1) The examples of fixed ignition sources on page 8-7 that are subject to high energy arcing faults lists equipments at 480V or higher. Appendix M to NUREG/CR-6850 and the Fire Protection Significance Determination Process (FP SDP) both indicate that this condition applies to equipments at 440V or higher.

(2) The updated guidance to the FP SDP for electronic components, provided by Sandia National Laboratory to SPSB in mid-September 2004, indicated failure thresholds of 0.25 BTU/ft^{2}s and 150F. It was noted that NUREG/CR-6850 on pages 8-10 and H-6 states 0.25BTU/ft^{2}s and 200F for these failure thresholds. Discussions with Steve Nowlen (SNL) confirmed that 150F failure temperature was the correct value. NUREG/CR-6850 needs to be updated on pages 8-10 and H-6.

(3) On page 11-30, just below Equation 11-5, it states, “Appendix T provides a simplified approach to evaluated Equation 11-5.” Appendix T does not appear to be the correct reference since that appendix is related to smoke damage.

(4) The cable spread rules in NUREG/CR-6850 on page R-8, specifically when the first tray is ignited, are not consistent with the guidance in the FP SDP. Again, the FP SDP appears to be correct and NUREG/CR-6850 needs to be updated on page R-8.

Subject: Gareth Parry Comments on NUREG/CR-6850

Volume 2, Chapter 7: Quantitative Screening

On page 7-2 , first full paragraph, the phrase " focusing on the dominant fire compartments" is found. The word "dominant" became an issue in endorsing the ASME Standard. The word dominant has been replaced by significant. The word significant is defined in combination with an object, so, a significant accident sequences is defined as (more or less, with Y=95 and X=1): one of the set of sequences, defined at the functional or systemic level, that, when rank-ordered by decreasing frequency, aggregate to Y% of core damage frequency, or that individually contribute more than X% of core damage frequency. Even though PRA practitioners have been using the term dominant for years, for the most part I believe that the what they had in mind was more the concept behind the word significant as defined above. I recommend using the term significant rather than dominant, except where the meaning is "the most significant." This is probably a more general comment, as I'm sure the term is used elsewhere.

Table 7-2:

The screening criterion for a compartment is CDF<[highest fire ignition frequency]*[CCDP for case where the general plant transient internal initiating event is set to 1.0 and ...]. The text points to Appendix D as a basis, where the discussion argues that a total fire induced CDF of 1E-06 can be regarded as very small. The formulation of the cumulative screening criterion attempts to scale this to the plant specific CDF using a factor of 10% for the fire induced CDF. The development of the criterion for individual fire compartments is not clear.

- What does the highest fire ignition frequency refer to? Higher with respect to what? I did a quick search but did not find the term in Section 6, though I may have missed it.

- What is the justification for combining the highest fire ignition frequency with arguably the lowest CCDP to set the screening criterion?

While the use of screening criteria may be acceptable for an evaluation of CDF/LERF, it may not be appropriate for all applications. In particular, applications that lead to modifications to the CCDP/CLERP or an increase in the frequency of damaging fires may need to be revisited. There should perhaps be a note to this effect.

Volume 2, Chapter 12: Post-fire Human Reliability Analysis

General Comment: The chapter is a good discussion of PSFs, but has relatively little guidance on quantification, which is inevitable given the stated aim to be HRA methodology neutral. However, it might have been helpful to have more guidance on how these PSF can be dealt with, particularly with respect to uncertainty. For example, the time of day is identified as an aleatory uncertainty. This could be dealt with in two ways: include that as an event on the event tree and develop different HEPs, or more likely it would be dealt with implicitly, with the HEP being the weighted sum of the HEPs for the x number of time intervals. I think there is some discussion along these lines in the HRA Good Practices Document, NUREG-1792. If this is true, a reference to that document would, as a minimum, help.

Page 12-12: A minor editorial comment: While it would be helpful to have the involvement of people with knowledge or experience of how people behave during fires, it's not clear that fire fighter trainers are particularly helpful. They might have good insights on how fire-fighters are affected by conditions, but their tasks are very different from those of the operators.

Volume 2, Chapter 15: Uncertainty and Sensitivity Analysis

Chapter 15 provides a description of a traditional uncertainty analysis task. It provides very little in the way of insight into what was learned from the requantification study. For example, section 15.5.3, documents a number of objectives (page 15-5) which include: "identify which uncertainties will be grouped together .... ", and " identify issues that will be treated in a sensitivity analysis and specify sensitivity analysis cases". Weren't there any conclusions from the requantification study regarding these issues? Appendix V, which supports this chapter provides no additional insight.

Volume 2, Appendix U: Uncertainty Analysis - Technical Bases

This appendix is well written and clear. However, in the paragraph on the top of page U-5, the sentence following that which begins "Given a source and combustible are present ..." is, in my opinion, incorrect. The prior sentence identifies conditions that are unknown, e.g., environmental conditions *at the time*. This particular example is surely aleatory in nature, and since this variability is not modeled explicitly in the fire model it would be implicit in the fire ignition probability. The second example, "whether conditions are suitable for spontaneous ignition," might be either aleatory or epistemic. If it is reflective of a condition that can change from time to time it is aleatory, if it is more a reflection of the fact that we can't determine that, given the nature of the location, whether spontaneous ignition could or could not occur, it would be epistemic. In this case however, the probability distribution would be binary.

Volume 2, Appendix V: Discussion of Individual Task Uncertainties

Most of the discussion in Appendix V addresses issues such as: completeness, level of detail, whether approximations are appropriate (related to level of detail), and whether methods have been applied correctly. The strategy given to address these "not-quite and largely unquantifiable uncertainties," i.e., use quality reviews, is certainly appropriate. However, most of this is not what is traditionally called uncertainty in the context of a PRA uncertainty analysis. This term is typically reserved for addressing the degree of belief that a particular model is more credible than another model, or to address the uncertainty in parameter values. However, there is relatively little guidance on how to address these uncertainties, that are traditionally dealt with in uncertainty analysis. For example, there is no discussion on "developing multiple models for an issue" (page 15-4), unless it's covered in the individual chapters or Appendixes (in which case it would help to have cross-references). In addition, there is not much guidance in the HRA chapter on characterizing the uncertainty.