



UNITED STATES  
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

April 27, 2000

Mr. D. N. Morey  
Vice President - Farley Project  
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Company, Inc.  
Post Office Box 1295  
Birmingham, Alabama 35201-1295

SUBJECT: JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 & 2: SECY-99-182  
"ASSESSMENT OF THE IMPACT OF APPENDIX R FIRE PROTECTION  
EXEMPTIONS ON FIRE RISK" (TAC NOS. MA8524 AND MA8525)

Dear Mr. Morey:

We request your comments on a Sandia National Laboratories limited-scope study of the core damage frequency (CDF) impact of Appendix R exemptions at Farley Units 1 and 2. SECY-99-182 from William D. Travers to the Commissioners (Enclosure 1) addressed the impact of cumulative Appendix R fire protection exemptions on fire risk. The staff, with Sandia National Laboratories support, performed a limited-scope study looking at the CDF impact of Appendix R exemptions at nine plants including Farley Units 1 and 2 (Enclosure 2). This study found that the cumulative risk impact at Farley could be potentially significant. For Farley, this result was based on the cumulative impact of individual exemptions, each of which was determined to be potentially risk significant. These results were based largely on available information from your Individual Plant Examinations for External Events submittals.

The second bullet in the Conclusions section of SECY-99-182 states that the staff will undertake the following actions as a follow-up to this limited-scope study:

Pursue the potentially risk significant exemptions at Farley and Robinson to assess the significance of the potentially risk-significant exemptions identified in this study. This will involve interactions with the licensee to confirm data used and judgments made in the study. If the exemptions are found to be sufficiently risk significant to justify a plant-specific backfit, the staff will pursue with the licensee improvements to the plant's fire protection program to reduce the risk.

D. N. Morey

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Please review the limited-scope study and send us your comments on the data assumptions and conclusions in the study. Please let me know within 30 days from receipt of this letter when you can submit the requested information. You can contact me at (301) 415-1423 if you have any questions about this request.

Sincerely,

A handwritten signature in black ink, appearing to read "L. Mark Padovan". The signature is fluid and cursive, with the first name "L." and last name "Padovan" clearly distinguishable.

L. Mark Padovan, Project Manager, Section 1  
Project Directorate II  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

Docket Nos. 50-348 and 50-364

Enclosures: As stated

cc w/encl: See next page

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## POLICY ISSUE (Information)

July 9, 1999

SECY-99-182

FOR: The Commissioners

FROM: William D. Travers /s/  
Executive Director for Operations

SUBJECT: ASSESSMENT OF THE IMPACT OF APPENDIX R FIRE PROTECTION  
EXEMPTIONS ON FIRE RISK

### PURPOSE:

In a Staff Requirements Memorandum (SRM) on SECY 98-058, dated June 30, 1998, the staff was directed to "closely examine plants whose individual plant examinations for external events (IPEEEs) show fire protection vulnerabilities to gain a thorough understanding of the particular risk contributors. In evaluating those facilities, consideration is to be given to the cumulative effects of exemptions to current regulations to ensure that an adequate level of fire protection is maintained. The staff is directed to report to the Commission the results of lessons learned from the IPEEE efforts." In addition, in another SRM dated April 1, 1999, the staff was directed as follows: "when assessing the effect of exemptions to Appendix R, the staff needs to consider the cumulative effect of exemptions at a particular plant." The purpose of this paper is to summarize the results of a limited scope analysis investigating the potential core damage frequency (CDF) impact of exemptions to Appendix R.

### BACKGROUND:

Appendix R to 10 CFR Part 50 applies only to plants operating before January 1, 1979. When it promulgated Appendix R, the Commission recognized that there would be plant conditions and configurations where strict compliance with the prescriptive fire protection features specified in Appendix R would not significantly enhance the level of fire safety already provided by the licensee. Therefore, in cases where a fire hazard analysis could adequately demonstrate that alternative fire protection features provided an equivalent level of fire safety to that required by Appendix R and satisfied the underlying purpose of Appendix R, the licensee

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Enclosure 1



could apply for an exemption from the prescriptive requirements of Appendix R. Thus, the exemption process provided a means of allowing flexibility to meet the performance objectives of Appendix R through alternative means.

For plants that began operation after January 1, 1979, guidance for the plants' fire protection programs is provided in Branch Technical Position (BTP) CMEB 9.5-1. For these newer plants, the staff approved "deviations" from the guidance during the licensing process. Since Appendix R requirements are included in BTP CMEB 9.5-1, this paper uses the term "exemptions" to refer to both BTP CMEB 9.5-1 deviations as well as Appendix R exemptions.

The staff has granted and continues to grant exemptions on the basis that the alternative fire protection strategies proposed provide an adequate level of fire safety and satisfy the underlying purpose of the regulation. However, this does not ensure that the fire risk associated with the alternative strategies is equal to that associated with a compliance-based strategy. Indeed, exemptions may represent relaxations in requirements (e.g., the lack of an automatic fire suppression system in an area where such a system is prescribed by the regulation). Thus, it is possible that the granting of exemptions could result in some increase in fire risk.

The Office of Nuclear Reactor Regulation's FIREDAT database contains information on NRC-approved exemptions; a recent summary is provided in NUREG-1521 (Draft). NUREG-1521 shows that almost 90 percent of the non-schedular exemptions (i.e., exemptions not associated with the schedule-related requirements of Appendix R) are associated with the requirements for fire protection of safe shutdown capability (see Appendix R, Sections III.G and III.L); a substantial fraction of these are associated with the requirements for protection of redundant trains of post-fire safe shutdown systems (see Section III.G.2). It should be noted that there is considerable variability in the scope of some of the exemptions. For example, some exemptions cover multiple fire areas while others cover specific elements in a single area.

#### DISCUSSION:

The original Quad Cities IPEEE submittal identified fire protection vulnerabilities. Quad Cities also has over 30 exemptions to Appendix R, and the question has been raised as to whether or not the exemptions contributed significantly to the plant's fire risk. Commonwealth Edison has since notified the staff that they are revising the Quad Cities IPEEE, and on the basis of the re-analysis, they stated that the Appendix R exemptions have a negligible contribution to the plant's fire risk. However, the staff has not yet received the revised IPEEE and is currently unable to confirm this conclusion.

To provide additional information to the Commission, the staff, with contractor support, performed a limited scope study looking at the CDF impact of Appendix R exemptions at nine plants representing a total of 13 units. The plants were selected on the basis that the fire-induced CDFs reported in the plants' IPEEE fire analyses are high compared to other IPEEE submittals. The plants included in this study are Calvert Cliffs Unit 1, Dresden Units 2 and 3, Farley Units 1 and 2, Kewaunee, Palisades, Robinson Unit 2, St. Lucie Units 1 and 2, Summer, and Turkey Point Units 3 and 4. The total number of exemptions examined in this study is 169, and the number of exemptions per plant varied from 2 to 54. The question addressed is: On the basis of what we know now regarding plant-specific fire risk, do any exemptions (or sets of exemptions) have the potential to significantly affect CDF?

Based largely on available documentation for the IPEEE submittals, the results of this limited scope study indicate that out of the 169 exemptions for the nine plants, most have a small or very small impact on CDF. Only five of the exemptions are potentially risk significant <sup>1</sup>(three at Dresden Units 2 and 3 and two at Farley Units 1 and 2). Of the remaining 164 exemptions, 143 have a small or very small impact on fire risk, and 21 have an indeterminate risk impact. Additional discussion on the approach, results and conclusions of this study is included in an attachment to this paper.

There are, of course, uncertainties in these results stemming from the use of the IPEEEs (which were aimed at licensees identifying vulnerabilities and gaining an appreciation of severe accident behavior at their plants, and not necessarily at accurate CDF estimates); from the information contained in the available documentation (many of the submittals contain insufficient information to allow definitive assessments of CDF impact); from the variability in quality of the IPEEEs from plant to plant; and from weaknesses in the IPEEEs themselves (there are gaps in the current state of the art of fire risk assessments which limit their ability to confidently deal with a number of key fire safety issues). Even with these limitations, the IPEEEs provide the best information readily available to address questions about the potential risk significance of Appendix R exemptions.

#### CONCLUSIONS:

The results of this study show that a simple count of the number of exemptions at a given plant provides little or no direct insight into the potential risk significance of exemptions at that plant. Similarly, a comparison of the number of exemptions between plants does not provide a reliable indication of the relative risk significance of exemptions at each plant.

With respect to the impact of individual exemptions, the results of this study have shown that a large majority (about 85 percent) of the Appendix R exemptions that were examined had a small or very small impact on plant CDF.

The two overall conclusions of the study discussed above should be considered robust. However, given the nature of this limited scope study, the plant-specific results discussed below for potentially risk-significant and indeterminate exemptions should be considered preliminary pending more detailed evaluation.

Five exemptions at two plants (Dresden and Farley) were found to be potentially risk significant. The risk significance of 21 exemptions could not be determined because the IPEEE lacked sufficient detail to assess their risk significance.

With respect to the cumulative effect of exemptions, this study found that the cumulative risk impact at three of the nine plants could be potentially significant. For two of these plants (Farley and Dresden), this result was based on the cumulative impact of individual exemptions, each of which was determined to be potentially risk significant. The third plant (Robinson) had exemptions that were considered, on an individual basis, to have a small impact on several fire areas; however, taken together, the CDF contributions for the impacted areas may be

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<sup>1</sup> As discussed in the attachment, a "potentially risk significant" exemption is one which may have led to a CDF increase equal to or greater than  $1 \times 10^{-5}$  per reactor year.

potentially significant. Four other plants in this study had a small or very small cumulative effect. The cumulative effect for the two remaining plants could not be determined with any degree of confidence because of the nature of the indeterminate individual exemptions for those plants.

As a follow-up to this limited scoping study, the staff will undertake the following actions:

- Commonwealth Edison has informed the staff that it will revise and resubmit the Quad Cities and Dresden IPEEEs. The staff will therefore review the risk significance of the Dresden and Quad Cities exemptions when the revised IPEEEs are submitted to the staff.
- Pursue the potentially risk significant exemptions at Farley and Robinson to assess the significance of the potentially risk-significant exemptions identified in this study. This will involve interactions with the licensee to confirm data used and judgments made in the study. If the exemptions are found to be sufficiently risk significant to justify a plant-specific backfit, the staff will pursue with the licensee improvements to the plant's fire protection program to reduce the risk.
- Continue to perform research to close gaps in the current state of the art in fire risk analysis methods and tools, including tools to provide a better understanding of the risk from main control room (MCR) fires. (Additional discussion on the risk significance of MCR fires is included in the attachment to this paper.)
- Collect additional information to assess the risk significance of a number of non-MCR exemptions whose impact is currently indeterminate.
- Include the identification and assessment of potentially risk-significant exemptions for plants not included in this study as part of the scope of the IPEEE follow-up program. The insights learned from this scoping study will be used to screen the exemptions, so that all exemptions will not have to be reviewed.

These activities will be prioritized and carried out consistent with available NRC resources.

In addition, the staff intends to encourage licensees to make future exemption requests risk-informed. That is, licensees will be encouraged to use the guidelines of Regulatory Guide 1.174 to develop their exemption requests. The exemption request should discuss whether or not the exemption affects a fire area or plant equipment that is a dominant fire risk contributor for the plant. If such an area or equipment is affected by the exemption, the request should provide an adequate basis, using Regulatory Guide 1.174, as to why the exemption is justified. Any procedure or hardware changes that were made subsequent to the IPEEE submittal that affect the exemption request should also be discussed. If licensees choose not to provide a

The Commissioners

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risk-informed submittal, the staff may request additional information or may choose to independently assess the exemption's risk. This approach is consistent with the staff's recommendation in SECY-98-300.

original /s/ by

William D. Travers  
Executive Director  
for Operations

Attachment: Assessment of the Impact of  
Appendix R Fire Protection Exemptions on  
Fire Risk

## **Assessment of the Impact of Appendix R Fire Protection Exemptions on Fire Risk**

### Approach

This study is based on the review of non-schedular exemptions that have been granted at nine nuclear plants representing a total of 13 units. The plants were selected on the basis that the fire-induced core damage frequencies (CDFs) reported in the plants' Individual Plant Examination of External Events (IPEEE) fire analyses are high compared to other IPEEE submittals. The plants included in this study are Calvert Cliffs Unit 1, Dresden Units 2 and 3, Farley Units 1 and 2, Kewaunee, Palisades, Robinson Unit 2, St. Lucie Units 1 and 2, Summer, and Turkey Point Units 3 and 4.<sup>2</sup> The total number of exemptions examined in this study is 169, and the number of exemptions per plant varied from 2 to 54.

One additional plant, Quad Cities, also reported a high fire-induced CDF estimate. However, the licensee is currently revising its IPEEE fire analysis. Because this revised analysis has not yet been submitted to the staff, Quad Cities has not been included in this study. Commonwealth Edison is also in the process of revising the IPEEE fire analysis for Dresden. Changes to the IPEEE might also result in changes to the plant-specific results for Dresden that are presented in this paper.

This study is based primarily on a review of each of the exemptions for the nine plants and on risk insights gained through an examination of the corresponding IPEEE fire analysis. The study has attempted to address both the quantitative and qualitative risk implications of the exemptions. The quantitative implications relate to the quantification of fire risk as represented by the fire-induced CDF. This was determined by assessing the potential reduction in CDF that might have resulted if the licensee had adopted a compliance-based strategy (i.e., met the prescriptive requirements of Appendix R) rather than selecting an alternative method to meet the underlying purpose of Appendix R. Qualitative risk implications relate to the impact that exemptions may have had on fire protection defense in depth (i.e., on the elements of fire prevention, fire detection and suppression, and protection of plant safe shutdown equipment).

The fire areas or zones impacted by a given exemption were compared to those cited in the IPEEE. If the impacted area or zone was reported to have an insignificant CDF contribution in the IPEEE, and if the fire protection-related phenomena or features cited in the exemption appear to have been considered in the IPEEE analysis, then the exemption itself was generally found to have a very small risk impact. On the other hand, if the impacted area was identified in the IPEEE as a significant CDF contributor, or the phenomena or features cited in the

exemption were not included in the IPEEE fire analysis, the exemption was examined in greater detail to determine whether or not it could have an impact on the quantification of CDF. If such

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<sup>2</sup>This study generally relies upon the fire-induced CDFs reported in the IPEEEs. In the cases of Summer and Turkey Point, total fire CDFs were not reported in the submittal. For these cases, the staff developed estimates of the total fire CDF by summing the sequence frequencies for the dominant contributors provided in the submittals.

an impact was determined to exist, then attempts were made to estimate the potential magnitude of the risk reduction that might be realized if a compliance-based strategy had been implemented rather than seeking an exemption. In a number of cases, the attempts were unsuccessful because of: (a) a lack of sufficient detailed information in the IPEEE submittal, or (b) weaknesses in the current fire risk assessment state of the art (especially with respect to the assessment of main control room fires). For these cases, the associated exemptions were classified as having an indeterminate impact.

In ranking the direct CDF impact of specific exemptions, four risk-impact categories were identified: potentially significant risk impact, small risk impact, very small risk impact, and indeterminate.<sup>3</sup> A potentially significant exemption is defined as one that may have led to a CDF increase equal to or greater than  $1 \times 10^{-5}$ /reactor-year. An exemption with a small risk impact is defined as one that potentially resulted in an increase in CDF between  $1 \times 10^{-6}$ /ry and  $1 \times 10^{-5}$ /ry. (Note that if a quantitative CDF estimate could not be made but it could be concluded with a reasonable level of confidence that the exemption was not potentially significant, then the exemption was generally ranked as having a small risk impact.) Those exemptions found to have had a CDF impact of less than  $1 \times 10^{-6}$ /ry were classified as having a very small risk impact. (In some cases a qualitative judgment was employed in making this assessment.) An indeterminate exemption is one that may or may not have a significant risk impact, but for which a CDF increase could not be established with any degree of confidence.

An assessment of the cumulative effect of exemptions on fire risk was done for each plant. In addition to considering each exemption individually, an attempt was made to assess the cumulative effect of all the exemptions for a particular plant. However, for some cases in which plants had indeterminate exemptions, the cumulative effect of exemptions could not be determined with any degree of confidence.

## Results

The nature, number, and significance of the exemptions granted varied significantly from plant to plant. The results of this study show that a simple count of the number of exemptions at a given plant provides little or no direct insight into the potential risk significance of exemptions at that plant. Similarly, a comparison of the number of exemptions between plants does not provide a reliable indication of the relative risk significance of exemptions at each plant. In large part this can be attributed to plant-to-plant differences in the scope of the exemptions themselves. In some cases, several individual exemptions for a given plant covered very specific features in a single fire area. In other cases, a single exemption impacted as many as 22 separate fire areas in the plant.

With respect to the impact of individual exemptions, the results of this study have shown that a large majority (143) of the 169 Appendix R exemptions that were examined had a small or very

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<sup>3</sup>This classification of risk significance was selected to correspond to the categories for CDF acceptance guidelines in Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis."

small impact on plant CDF.<sup>4</sup> Five exemptions were found to be potentially risk significant. That is, had these exemptions not been granted, and the plant had not selected an alternative method to achieve compliance with NRC fire protection requirements, the estimated fire CDF in some or all of the impacted areas could have been reduced on the order of  $1 \times 10^{-5}/\text{ry}$ . The risk significance of the remaining 21 exemptions could not be determined. Table 1 provides a tabulation of the categorization of all 169 exemptions for the nine plants in this study.

| Table 1: Number of exemptions in each risk impact category.   |                       |                         |                            |                   |                   |                        |
|---|-----------------------|-------------------------|----------------------------|-------------------|-------------------|------------------------|
|   | Total # of Exemptions | Potentially Significant | Indeterminate              |                   | Small Risk Impact | Very Small Risk Impact |
|   |                       |                         | Relating to General Issues | Lack of MCR Fixed |                   |                        |
| Calvert Cliffs 1  | 5                     | -                       | -                          | -                 | 1                 | 4                      |
| Dresden 2&3   | 11                    | 3                       | 2                          | 1                 | 3                 | 2                      |
| Farley 1&2  | 54                    | 2                       | 2                          | -                 | 3                 | 47                     |
| Kewaunee  | 3                     | -                       | -                          | 1                 | -                 | 2                      |
| Palisades   | 5                     | -                       | -                          | 1                 | -                 | 4                      |
| Robinson  | 13                    | -                       | 1                          | 1                 | 5                 | 6                      |
| St. Lucie 1&2   | 40                    | -                       | 4                          | 2                 | 2                 | 32                     |
| Summer  | 2                     | -                       | -                          | -                 | -                 | 2                      |
| Turkey Point 3&4 <sup>1</sup>   | 36                    | -                       | 4                          | 2                 | -                 | 30                     |
| All 9 Plants  | 169                   | 5                       | 13                         | 8                 | 14                | 129                    |
| <sup>1</sup> The Turkey Point exemptions considered here are those that were in effect at the time of the IPEEE fire analysis. Since then several significant fire protection related plant improvements have been made, and a new set of exemptions has been granted. A number of the original exemptions considered in this study have been superseded by this new set of exemptions, and certain of the plant improvements would impact the assessment made in this study. |                       |                         |                            |                   |                   |                        |

The five potentially risk-significant exemptions impacted two of the nine plants, Farley and Dresden. Both of the potentially significant exemptions at Farley related to lack of fixed

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<sup>4</sup>Additional detailed information is provided in a June 1999 letter report from Sandia National Laboratories (SNL), "An Assessment of the Impact of Appendix R Fire Protection Exemptions on Fire Risk."

automatic fire suppression and lack of one-hour fire barriers. The areas impacted are cable penetration/cable vault areas which were identified in the licensee's IPEEE as being significant contributors to fire CDF. Assuming that fire suppression and fire barriers had been installed, the IPEEE estimates of the CDF contribution for each fire area would likely have been reduced substantially.

Each of the three potentially significant exemptions at Dresden related to a lack of fixed automatic suppression, and two cited a lack of fixed detection as well. Each of the three impacted one or more areas identified in the IPEEE as significant or dominant contributors to fire CDF. Again, assuming that fire suppression had been installed in the impacted areas, the IPEEE estimates of the area CDF contribution would likely have been reduced significantly.

The impact of 21 out of 169 exemptions could not be determined from the information used in this study. For 13 of these 21, the IPEEE lacked sufficient detail to assess their risk significance. The remaining eight related to the lack of fixed suppression in the main control room (MCR). These were ranked as indeterminate because of the inherent uncertainty in current MCR fire risk evaluations (i.e., the assessment of the additional benefit that might be realized by installation of fixed automatic suppression). The fire risk research program is currently developing the tools to provide a better understanding of the risk from MCR fires.

With respect to the cumulative effect of exemptions, this study found that the cumulative risk impact at three of the nine plants could be potentially significant. For two plants (Farley and Dresden), this result was based on the cumulative impact of individual exemptions that were determined to be potentially risk significant. The third plant, Robinson, had exemptions that were considered to have a small impact on several fire areas; however, taken together, the CDF contributions for the impacted areas may be potentially significant. Four other plants in this study had a small or very small cumulative effect. The cumulative effect for the two remaining plants could not be determined with any degree of confidence because of the nature of the indeterminate individual exemptions for those plants.

Appendix R exemptions may impact the nature or source of the dominant plant fire CDF scenarios and the extent to which fire risk mitigation is dependent on various aspects of fire protection defense in depth. Several common areas of impact were identified; they include the following:

- *Manual versus Fixed Automatic Suppression:* The single most common "class" of exemption in this study involved the lack of fixed fire suppression systems (e.g., fire sprinkler systems) in fire areas containing redundant trains of safe shutdown equipment. With no fixed fire suppression in place, the impacted plants are more dependent on automatic fire detection and manual fire fighting. All of the potentially risk-significant exemptions identified in this study included a lack of fixed fire suppression. (Note that the lack of fixed fire suppression by itself does not necessarily imply a large CDF impact because many risk-insignificant exemptions also involved the lack of automatic fire suppression.)
- *Lack of Separation and Absent Fire Barriers:* Several exemptions were related to cases in which fire barriers are required by Appendix R but not installed. In these cases, there is a shift from passive protection of one train of safe shutdown equipment as a means of ensuring plant safety to active methods, including fire prevention, minimizing fire



hazards, prompt intervention, and alternative shutdown or manual recovery. When these cases are encountered in conjunction with a lack of fire suppression, the exemption is generally found to be potentially risk significant.

- *Reliance on Manual Recovery Actions To Overcome Damage to Redundant Trains:* Many of the exemptions were granted in part on the basis that procedures would be established to take manual actions to regain control of components and systems. In these cases there is a clear shift away from passive/active protection of one safe shutdown path and towards manual recovery of lost systems and equipment through operator actions. This also implies a heightened reliance on administrative controls (for the associated plant procedures) and on personnel performance and training. Depending on the number, complexity, and time required for the manual actions, this type of exemption could be risk significant.

In general, exemptions that applied to the following circumstances were found to have only a small or very small risk impact:

- Exemptions related to combustibles in areas having greater than 20 feet of physical separation of redundant trains, if the overall fire sources are minimal and/or the area has at least partial fire detection and suppression.
- Exemptions related to the lack of fixed automatic fire suppression and one train of equipment (usually cables) protected by a one-hour fire rated barrier, if the overall fire sources are minimal, fire detection is present, and manual fire fighting equipment and personnel are available.
- Exemptions related to barriers lacking specific fire rating, for example, major structural members (walls, ceilings, floors) and various openings in these members that are not protected by fire-rated closure devices, if there is evidence of a substantial fire barrier.
- Exemptions for lack of fixed emergency lighting if portable lighting is available.

### Limitations

One of the most significant limitations of this study is reliance on the IPEEE fire submittals as the primary basis for developing risk insights. This study utilized the IPEEEs in a manner that goes beyond the original intent of the IPEEE process. The objectives of the IPEEE were for licensees to identify potential plant vulnerabilities and gain an appreciation of severe accident behavior at each plant. In the case of fire, most licensees have applied simplified methods of analysis. Further, with very few exceptions, the NRC's IPEEE review process has considered only the IPEEE submittal itself with no attempt to validate the accuracy of the licensees' detailed findings or CDF estimates. Also, any improvements or changes that licensees have made since the performance of each IPEEE were not included in this study. The only exceptions are changes that were identified in the IPEEE submittal itself and that were credited in the IPEEE fire analysis. For many of the exemptions that were found to have very small risk impact, the findings were based entirely on low CDF values (less than  $10^{-6}$ /reactor-year) for the impacted fire areas as reported in the IPEEE.

Another limitation concerns the limited detail available in the information that was used in this study. The initial assessments were completed based on (1) abstracts from the FIREDAT database<sup>5</sup> of the rationale used by the staff to grant the exemption and (2) insights gleaned from the corresponding IPEEE submittal. (It should be noted that most licensees did not explicitly address exemptions in their IPEEE submittals.) Following the initial assessment, those exemptions identified as potentially risk significant or risk indeterminate were re-examined in greater detail (i.e., using the NRC staff safety evaluation for the corresponding exemptions). In two cases (Farley and Turkey Point), additional information, based on discussions with cognizant NRC staff, was factored into the assessment. No site visits or follow-up discussions with plant personnel were undertaken.

In order to characterize the risk impact of the exemptions with a high level of confidence, details of the fire area impacted by the exemption may be needed. In cases where the IPEEE submittals did not provide this level of detail, or the quantitative tools did not exist, judgment was used to assess the risk significance of the exemptions. This judgment was based upon knowledge and insights gained from performing and reviewing other fire risk studies, including the IPEEE submittals, a broad understanding of current fire PRA-related literature, and experience in the performance and interpretation of fire safety experiments.

Even with the above limitations, the IPEEEs provide the best information readily available to address questions about the potential risk significance Appendix R exemptions. The overall conclusions of the study (i.e., only a small fraction of the Appendix R exemptions have a potentially significant impact on plant risk; there is no direct correlation between the number of exemptions and the risk significance of exemptions at a plant) should be considered robust. However, given these limitations, the plant-specific results for potentially risk-significant and indeterminate exemptions should be considered preliminary pending more detailed evaluation.

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<sup>5</sup>The Office of Nuclear Reactor Regulation's FIREDAT database contains information on NRC-approved exemptions; a recent summary is provided in NUREG-1521 (Draft).

D. N. Morey

- 2 -

April 27, 2000

Please review the limited-scope study and send us your comments on the data assumptions and conclusions in the study. Please let me know within 30 days from receipt of this letter when you can submit the requested information. You can contact me at (301) 415-1423 if you have any questions about this request.

Sincerely,

/RA/

L. Mark Padovan, Project Manager, Section 1  
Project Directorate II  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

Docket Nos. 50-348 and 50-364

Enclosures: As stated

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**An Assessment of the Impact of Appendix R  
Fire Protection Exemptions on Fire Risk**

**A Letter Report to the USNRC**

**Final Report**

**June 7, 1999**

**Prepared by:  
Steven P. Nowlen, Sandia National Laboratories  
Dr. Mardy Kazarians, Kazarians and Associates**

**Prepared for:  
U.S. Nuclear Regulatory Commission  
Office of Research  
Probabilistic Risk Assessment Branch  
USNRC JCN W-6733**

**Enclosure 2**

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# Sandia National Laboratories

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June 7, 1999

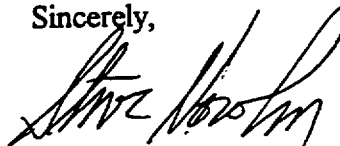
Mr. Ed Chow  
MS 10 E 50  
RES/DRAA/PRAB/SB  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555

Dear Mr. Chow, Ed,

Subject: Appendix R Exemption Risk Impact Final Report

Enclosed are five copies of the final letter report documenting the results of nine case studies to assess the fire risk impact of Appendix R exemptions based on insights from the IPEEE fire analyses. The study was completed under Task 4, "Insights," of the IPEEE Fire Analysis Screening Review Program (JCN W-6733). Delivery of this final report represents the last milestone in this particular subtask.

Sincerely,



Steven P. Nowlen  
Accident and Consequence  
Analysis Department 6413

1 Enclosure (5 copies): *An Assessment of the Impact of Appendix R Fire Protection Exemptions on Fire Risk*, Final Report, June 7, 1999.

Copy to:

USNRC/RES/PRAB - Alan Rubin

USNRC/RES/PRAB - Nathan Siu

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## ABSTRACT

This report documents the results of a scoping study of the impact of USNRC granted exemptions and/or deviations to the 10 CFR 50 Appendix R fire protection regulations on nuclear power plant fire risk.<sup>1</sup> The study is based on the examination of granted exemptions for a selected set of nine plants and risk insights gleaned from the corresponding Individual Plant Examination for External Events (IPEEE) submittals. The plants were chosen based on the fact that they had reported IPEEE fire-induced core damage frequency (CDF) estimates that are relatively high in comparison to that reported by other licensees. For each plant, the study examines each of the Appendix R exemptions that has been granted by the USNRC and assesses the potential impact that each exemption might have had on the plant's reported fire CDF. In addition, the cumulative effect of all the exemptions at each plant is examined. In total, 169 exemptions are examined. Of these 5 exemptions at two plants were found to be potentially significant. An additional 21 exemptions at various plants were found to be risk indeterminate of which eight relate to lack of fixed suppression in the main control room. The remaining 143 exemptions (approximately 85% of those examined) are ranked as having a small (14) or very small (129) risk impact.

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<sup>1</sup>CFR refers to the U.S. Code of Federal Regulations.

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## EXECUTIVE SUMMARY

### E.1 Introductory Remarks

This report documents the results of a scoping study to determine whether or not USNRC-approved exemptions<sup>2</sup> to the 10CFR50 Appendix R fire protection requirements have had a significant impact on fire risk at commercial nuclear power plants. The study has attempted to address both the quantitative and qualitative risk implications of each exemption at each plant in the study group. The quantitative implications relate to the actual quantification of fire risk as represented by the fire-induced core damage frequency (CDF). Specific quantitative CDF change assessments for individual exemptions are made only for those exemptions found to be potentially risk significant. Quantitative estimates of the cumulative effect are also made for exemptions found to be of either small or very small risk impact (the terms "small" and "very small risk impact" are defined below). Qualitative risk implications relate to the impact that exemptions have had on fire protection defense in depth which is achieved through a combination of fire prevention, fire detection/suppression, and protection of plant safe shutdown capability.

### E.2 The Plant Sample Group

This scoping study is based on an examination of granted exemptions at nine specific plants representing a total of 13 units. The plant sample group was selected solely on the basis that the Individual Plant Examination for External Events (IPEEE) fire analysis for each of these nine plants reported<sup>3</sup> fire-induced core damage frequency (CDF) values that are relatively high in comparison to other licensee IPEEE submittals. The plants in the sample group are Calvert Cliffs Unit 1<sup>4</sup>, Dresden Units 2 and 3, Farley Units 1 and 2, Kewaunee, Palisades, Robinson Unit 2, St. Lucie Units 1 and 2, Summer, and Turkey Point Units 3 and 4. The total number of exemptions examined in this study is 169, and the number of exemptions per plant varied from 2 to 54.

One additional plant, Quad Cities, also reported a relatively high fire-induced CDF estimate in comparison to other licensees. However, the licensee at Quad Cities is currently revising its IPEEE fire analysis, and is performing its own self-assessment of the risk impact of Appendix R exemptions. Because these licensee studies are not yet available, Quad Cities has not been

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<sup>2</sup>Appendix R applies specifically to plants granted operating licenses before January 1, 1979. Such plants may request an "exemption" to the specific compliance features set forth in Appendix R. Plants licensed after that time may commit to meeting the Appendix R requirements as a part of their licensing basis, and may then seek approval for "deviations" from those requirements. The sample group includes both pre- and post-Appendix R plants. For convenience, both "exemptions" and "deviations" will be referred to in this report as exemptions.

<sup>3</sup>Note that for St. Lucie, Summer, and Turkey Point, the licensee did not report a total fire-induced CDF value. In these cases the total fire CDF was inferred by the IPEEE review team by summing the individual contributors reported in the IPEEE.

<sup>4</sup>While Calvert Cliffs is a multi-unit site, there are no exemptions identified for Unit 2.

included in this study. It is also noted that the same licensee is also in the process of revising the IPEEE fire analysis for Dresden. This study has been based on the original Dresden submittal. Changes to the IPEEE might also result in changes to the exemption significance results presented in this report.

In the case of Turkey Point, this study has considered those exemptions that were granted to the licensee during the original plant Appendix R compliance efforts (during the 1980s). This does represent the status of the plant as of the time that the IPEEE fire analysis was performed.<sup>5</sup> However, in more recent years (1996-98) the plant fire protection program has undergone significant changes. As of 1998 the USNRC approved a new set of Appendix R exemptions that supercede a number of the previous exemptions [Ref. 2,3]. This process included consideration of several plant fire protection upgrades. Hence, the results for Turkey Point represent a historical plant perspective that is no longer an accurate representation of the plant as it exists today.

### E.3 Methodology

In ranking the direct CDF impact of specific exemptions four categories are used; namely, potentially significant, indeterminate, small, and very small. These categories are defined as follows:

- A potentially significant exemption is an exemption that may have led to CDF increases equal to or greater than  $1 \times 10^{-5}$ /reactor-year ( $1E-5$ /ry). This corresponds to Region I as presented in Figure 3 of Regulatory Guide (RG) 1.174 [Ref. 1].
- An indeterminate exemption is an exemption for which there are indications of a potentially significant risk impact, but for which a direct CDF contribution could not be established with any confidence. Exemptions that are found to have led to CDF increases of less than  $1E-5$ /ry are not categorized as risk indeterminate even if the actual CDF change cannot be quantified with confidence.
- An exemption with a small risk impact is an exemption that potentially resulted in an increase in CDF between  $1E-6$ /ry and  $1E-5$ /ry. This corresponds to Region II as defined in Figure 3 of RG 1.174. Note that if a quantitative assessment of CDF cannot be made, but within a reasonable level of confidence it is concluded that the exemption is not potentially significant, then the exemption is generally ranked as having a potential small risk impact.

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<sup>5</sup>The licensee submitted a fire risk analysis in June 1991 as a part of the IPE. This same study was cited as the IPEEE fire analysis. The USNRC review of the IPEEE was completed in February 1996. The more recent staff reviews were documented in October and December 1998.

- Those exemptions found to have led to a CDF increase of less than  $1E-6/ry$  are classified as having a very small risk impact. This corresponds to Region III as defined in Figure 3 of RG 1.174. Again, qualitative judgement may be employed in making this assessment.

This study is based primarily on examination of each of the granted exemptions for the nine plants in the sample group and on risk insights gained through an examination of the corresponding IPEEE fire analysis.<sup>6</sup> The fire areas or zones impacted by a given exemption are compared to those cited in the IPEEE study. The area/zone IPEEE CDF contribution is taken as an initial indication of the potential risk significance of an exemption. The exemption and IPEEE are then examined to determine whether or not the licensee's alternate compliance strategy cited in the exemption (1) relates to issues that are typically considered as contributing factors in a fire risk assessment, (2) is considered in the IPEEE analysis, and (3) has had some impact on fire CDF quantification. Attempts are then made to assess the potential risk reduction that might be realized assuming that the exemption was not granted and that the licensee implemented a compliance strategy consistent with those outlined in Appendix R. This assessment relies on a combination of quantitative and qualitative factors. In many cases the judgement of the authors plays an important role in the final risk significance ranking. In two specific cases, supplemental information beyond the IPEEE and the original exemption documentation (the Staff Evaluation Report) is considered:

- In the case of Farley, discussions with cognizant USNRC staff have been incorporated into the final categorization of six specific exemptions.
- In the case of Turkey Point, information developed by the USNRC staff in its review of recent licensee exemption requests was considered in the ranking of four original plant exemptions impacting certain areas of the turbine building [Ref. 2,3].

#### E.4 Findings Relating to the Direct CDF Impact of Individual Exemptions

This study finds that some Appendix R exemptions are potentially risk significant. However, the study also finds that most exemptions are not risk significant. Approximately 85% of the sample group were ranked as having a small or very small risk impact. Table E.1 summarizes the CDF impact findings. Of the 169 Appendix R exemptions examined in this study, it is concluded that five are potentially risk significant. That is, had the plants chosen one of the specific compliance strategies outlined in Appendix R rather than the alternative compliance strategy specified in the exemptions, the estimated fire CDF in some or all of the impacted areas would likely have been reduced by at least  $1E-5/ry$ . These exemptions impacted two of the nine plants; namely, Farley and Dresden.

- Both of the potentially significant exemptions at Farley relate to lack of fixed automatic fire suppression and lack of one-hour fire barriers. The areas impacted are cable

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<sup>6</sup>Documents considered for each plant are referenced in the corresponding appendix.

penetration - cable vault areas (areas 1-034 and 1-035), apparently for Train A and Train B respectively. These areas are identified in the IPEEE as significant contributors to fire CDF ( $2.9E-5/ry$  and  $1.6E-5/ry$  respectively as compared to a total fire-induced CDF of  $1.6E-4/ry$ ). Assuming that fire suppression and fire barriers had been installed, the IPEEE estimates of the CDF contribution for each fire area would likely have been reduced substantially. While definitive estimates are not possible, it is likely that each would have been reduced from significant to very small CDF contributors.

| Table E.1: Number exemptions in each risk impact category.  |                       |                         |  |                               |                   |                        |
|---|-----------------------|-------------------------|--|-------------------------------|-------------------|------------------------|
|   | Total # of Exemptions | Potentially Significant | Indeterminate                            |                               | Small Risk Impact | Very Small Risk Impact |
|   |                       |                         | Other than Lack of MCR Fixed Suppression | Lack of MCR Fixed Suppression |                   |                        |
| Calvert Cliffs 1  | 5                     | -                       | -  | -                             | 1                 | 4                      |
| Dresden 2&3   | 11                    | 3                       | 2  | 1                             | 3                 | 2                      |
| Farley 1&2  | 54                    | 2                       | 2  | -                             | 3                 | 47                     |
| Kewaunee  | 3                     | -                       | -  | 1                             | -                 | 2                      |
| Palisades   | 5                     | -                       | -  | 1                             | -                 | 4                      |
| Robinson  | 13                    | -                       | 1  | 1                             | 5                 | 6                      |
| St. Lucie 1&2   | 40                    | -                       | 4  | 2                             | 2                 | 32                     |
| Summer  | 2                     | -                       | -  | -                             | -                 | 2                      |
| Turkey Point 3&4 <sup>1</sup>   | 36                    | -                       | 4  | 2                             | -                 | 30                     |
| All 9 Plants  | 169                   | 5                       | 13                                       | 8                             | 14                | 129                    |
| <sup>1</sup> The Turkey Point exemptions considered here are those that were in effect at the time of IPEEE fire analysis (circa 1991). |                       |                         |  |                               |                   |                        |

Each of the three potentially significant Dresden exemptions relates to lack of fixed automatic fire suppression, and two cite a lack of fixed fire detection as well. Each of the three impacts one or more areas identified in the IPEEE as significant or dominant contributors to fire CDF. Again, assuming that fire suppression had been installed in the impacted areas, the IPEEE estimates of the area CDF contribution would likely have been reduced significantly. Likely, the areas would have been found to be very small, rather than significant, CDF contributors.

In addition, 21 exemptions remain classified as risk indeterminate. Seven of the nine plants have at least one indeterminate exemption. These are summarized as follows:

- Eight of the indeterminate exemptions relate to the lack of fixed suppression in the main control room (MCR). These are uniformly ranked as indeterminate given the inherent uncertainty in current MCR fire risk estimates and in the additional benefit that might be realized by installation of fixed automatic suppression.
- In the case of Turkey Point, four of the six indeterminate exemptions impact areas in the turbine building that were screened in the IPEEE analysis. They are ranked as risk indeterminate based on information provided in USNRC staff reviews of more recent licensee exemption requests [Ref. 2,3]. The new set of Turkey Point exemptions does supercede these four exemptions. Hence, this finding is limited to a historical perspective of the plant as it existed at the time of the IPEEE fire analysis.
- The nine remaining indeterminate exemptions impact Dresden, Farley, Robinson, and St. Lucie. These exemptions could not be assessed due to a lack of relevant information in the IPEEE submittal. In some cases it appears that the IPEEE submittal does not address the alternate compliance strategy cited in the exemption; hence, the results of the IPEEE are questioned. As noted in Section E.7, this study is utilizing IPEEE submittals in a manner that goes beyond the original intent of that process.

#### E.5 Findings Relating to Cumulative CDF Impact

An assessment of the cumulative CDF impact is performed for each plant individually. As noted above, seven of the nine plants in the sample group have indeterminate exemptions. Six plants have indeterminate exemptions for lack of fixed suppression in the MCR. These exemptions are not explicitly considered in the assessment of cumulative impact. Five plants have indeterminate exemptions relating to other matters (i.e., unrelated to lack of fixed suppression in the MCR), and the discussions below provide a nominal assessment of the potential impact of these exemptions. The resolution of indeterminate exemptions may change the cumulative CDF impact. Therefore, for those plants where the cumulative CDF impact is ranked as either very small or small, if there are indeterminate exemptions, there is a potential for the cumulative CDF impact to change. The cumulative impact findings for each plant are summarized as follows:

Calvert Cliffs 1 has a total of five exemptions.<sup>7</sup> Of the five, only two are found to have had a potential discernible impact on plant fire CDF (CAL-03, and 05). Overall, as a result of the exemptions, one impacted scenario has the potential for a small risk contribution and there are several impacted scenarios whose cumulative CDF contribution is very small. Hence, it is concluded that for Calvert Cliffs the Appendix R exemptions have had, at most, a small cumulative impact on fire risk.

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<sup>7</sup>Note that Calvert Cliffs 2 had no identified exemptions

Dresden has a total of 11 exemptions that are ranked in all four risk significance categories. It seems that most of the fire areas at Dresden identified in the IPEEE submittal as significant CDF contributors (CDF in excess of  $1E-5/ry$ ) are impacted by an exemption. The cumulative impact of the exemptions at Dresden is found to be potentially significant. This derives primarily from the three exemptions ranked as potentially significant. The contribution from the three indeterminate exemptions may also be potentially significant.

Farley has a total of 54 exemptions ranked in all four risk significance categories. It is concluded that exemptions may have had a potentially significant cumulative impact on fire risk at Farley. This cumulative impact derives from a combination of the risk impact of three potentially significant exemptions and the potential cumulative impact of the 50 small and very small category exemptions.

Kewaunee has just three exemptions. None of these was ranked as potentially significant, and only one, relating to lack of fixed fire suppression in the MCR, was ranked as indeterminate. Putting aside the question of MCR fire suppression, it is found that exemptions at Kewaunee have had, at most, a very small cumulative impact on fire risk.

Palisades has five exemptions. None of these was ranked as potentially significant, and only one, relating to lack of fixed fire suppression in the MCR, was ranked as indeterminate. Putting aside the question of MCR fire suppression, it is found that exemptions at Palisades have had, at most, a very small cumulative impact on fire risk.

Robinson has 13 exemptions, none of which taken individually were found to be potentially significant. However, a cumulative risk impact is postulated. Given, in particular, the potential impact of the three indeterminate exemptions (HBR-06, 08, and 12), it is concluded that the cumulative risk impact of the exemptions at Robinson is, in the judgement of the authors, potentially significant.

Summer has only two exemptions, and both are ranked as having a very small risk impact. It is concluded that Appendix R exemptions have had, at most, a very small cumulative impact on plant fire risk at Summer.

St. Lucie has 40 exemptions. The cumulative impact of exemptions that can definitively be assessed is found to be small. There is, however, a potentially significant cumulative impact as a result of, in particular, four indeterminate exemptions that cannot be assessed.

Turkey Point had 36 exemptions at the time of the IPEEE fire analysis. Given the information provided in recent USNRC Staff documents, the cumulative risk impact of exemptions at Turkey Point as they existed at the time of the IPEEE fire analysis was likely potentially significant. This finding is based primarily on the authors judgement regarding the four indeterminate turbine building exemptions. It is again noted that new



exemptions have superseded a number of the exemptions considered in this study, and that the licensee has implemented a number of fire protection program improvements that would impact the risk significance of the exemptions. This study has not included consideration of either the new set of exemptions nor the associated plant improvements.

#### E.6 Findings Relating to Qualitative Risk Impacts

Qualitative risk impacts relate to shifts in the nature or source of the dominant plant fire CDF scenarios, and to the extent to which fire risk mitigation is dependent on various aspects of the fire protection defense in depth. Note that fire protection defense in depth is defined as a fire protection program that provides for the prevention of fires, effective detection and suppression of those fires that do occur, and protection of safe shutdown components important to safety. Several common areas of impact were identified including the following:

- *Manual versus Fixed Automatic Suppression:* The single most common “class” of exemptions are those involving the lack of fixed fire suppression systems (e.g., fire sprinkler systems) in fire areas containing redundant trains of safe shutdown equipment. With no fixed fire suppression in place, the impacted plants become more dependent on manual fire fighting. All of the identified potentially significant exemptions include this feature as a part of the exemption.
- *Lack of Separation and Absent Fire Barriers:* Several cases are noted in which fire barriers are nominally required but not installed. In these cases, there is a shift from passive protection of one train of safe shutdown equipment as a means of ensuring plant safety to fire prevention, minimizing fire hazards, prompt intervention, and alternate shutdown or manual recovery. These cases often are encountered in conjunction with a lack of fire suppression as well. It is these latter cases that are generally found to be most significant.
- *Reliance on Manual Recovery Actions to Overcome Damage to Redundant Trains:* It is noted that many of the exemptions were granted in part on the basis that procedures would be established to take manual actions to regain control of components and systems. Plants including such exemptions are Farley, Robinson, and Dresden. In these cases there is a clear shift away from passive/active protection of one safe shutdown path and towards manual recovery of lost systems and equipment through operator actions. This also implies a heightened reliance on administrative controls (for the associated plant procedures) and on personnel performance and training.

#### E.7 Other General Findings

One general finding of this study is that a simple count of the number of exemptions at a given plant provides little or no direct insight into the potential risk significance of plant exemptions. Similarly, a comparison of the number of exemptions between plants will not provide a reliable

indication of the relative risk significance of exemptions at each plant. In large part this can be attributed to plant-to-plant differences in the approach to exemption requests. In some cases it was noted that several individual exemptions were sought by a given plant for, in effect, the same feature and alternate compliance strategy with each individual exemption addressing one specific fire area. In other cases, it was found that a single exemption impacted as many as 23 separate fire areas and as many as 91 fire zones<sup>8</sup> having similar features and alternate compliance strategies. There was also considerable apparent redundancy noted among the exemptions at certain plants. That is, in some cases there was more than one exemption citing essentially the same features in the same plant areas. Given these observations, it is concluded that simple counting of the exemptions provides no insights.

Another general finding of this study relates to the potential application of IPEEE studies to future risk-informed decision making processes. In one case in particular, Turkey Point, it was found that the IPEEE submittal had not fully addressed fire hazards present in the turbine building. While the licensee had screened all of the turbine building areas as risk-insignificant, based on other USNRC staff documentation, it would appear that the turbine building does, indeed, contain risk significant fire areas. Several other cases were noted where nominally important fire areas (areas with high screening CCDF values) were ultimately screened on low CDF but where the IPEEE submittal provided little or no detail regarding how the cited CDF reductions were achieved. While the authors have nominally accepted the results as accurate representations of the risk contribution in these cases, further review would be desirable if the results are to be used as input into any future regulatory decisions. The use of IPEEEs in risk-informed regulatory processes goes beyond the intent of the IPEEE process. Further, the IPEEE submittal review process has focused on the question of whether or not that original intent has been met. Hence, more detailed reviews of the IPEEE submittals may be required to support the application of those studies to risk-informed regulatory processes.

#### E.8 Limitations

This study is intended as a scoping study only. The single most significant limitation to this study is reliance on the IPEEE submittals as the primary basis for development of risk insights. This study is utilizing the IPEEE submittals in a manner that goes beyond the original intent of the IPEEE process. The level of detail regarding fire risk included in the IPEEE submittals was found, in general, to be insufficient to allow the risk impact characterization of the exemptions with a high level of confidence. In general, it is assumed that the IPEEE fire analyses are accurate and complete representations of the plant fire risk.

Other specific limitations to this study are summarized as follows:

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<sup>8</sup>Note that a fire zone is generally a subset of a fire area. Most IPEEE fire studies were based on fire zone rather than fire area analyses.

- Information used in this study is limited in scope. The study has generally been based on a review of exemption summaries for each exemption in the sample group, the corresponding IPEEE fire analysis submittal, and, for potentially significant and indeterminate exemptions, USNRC Staff documentation prepared during the exemption review and approval process.
- While quantitative screening criteria are used to define the risk significance of each exemption, the methods used to establish the risk significance of an exemption are primarily qualitative in nature and ultimately rely heavily on the judgement of the authors.
- No specific attempts were made to capture a “representative” set of plants in the study group. As noted above, each plant in the sample group has reported a relatively high fire-induced CDF compared to other licensees. Hence, given reliance on the IPEEE findings as the basis for risk insights, the sample group is considered the most appropriate possible.
- Any plant improvements or changes made since the performance of each IPEEE have not been included in this study. The only exception would be changes that were identified in the IPEEE submittal itself and that were credited in the IPEEE fire analysis.

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## 1. Introduction

### 1.1 Objective

The objective of the study is to perform a scoping examination of the impact that USNRC-approved exemptions<sup>9</sup> to the 10CFR50 Appendix R fire protection requirements have had on the fire risk at commercial nuclear power plants. In particular, the study is attempting to answer two questions:

1. "Have Appendix R exemptions resulted in increases in fire risk as measured by the fire-induced core damage frequency (CDF), and if so, how significant is that CDF increase?"
2. "Have Appendix R exemptions resulted in a significant shift in the degree to which plants rely on various fire protection defense in depth features? Expressed another way, have the Appendix R exemptions led to a significant shift in the source or nature of the dominant fire CDF contributors?"

The first question, in essence, asks what is the quantitative impact of Appendix R exemptions on plant fire risk as measured by fire-induced CDF. Limitations of the IPEEE submittals made it difficult to obtain detailed and defensible answers to this question for many of the exemptions. The second question is qualitative in nature and is intended, in part, to offset this limitation. It is also intended to address certain aspects of the risk-informed regulatory process as currently defined by the USNRC. In particular, Regulatory Guide (RG) 1.174 requires that the USNRC staff consider safety margin and defense in depth in addition to CDF and Large Early Release Frequency (LERF). This second question considers, in particular, defense in depth questions.

### 1.2 Plants Analyzed

This study has separately examined the exemptions granted to nine plants representing a total of 13 units. The plants in the study group were selected based on the fact that their IPEEE reported fire CDF estimates that are relatively high in comparison to the CDFs reported by other licensees. In each case the reported fire-induced CDF is near or above the subsidiary safety goal of  $1\text{E}-4/\text{ry}$ , which applies to total plant CDF from all sources. Table 1.1 lists the nine plants in the study group. The number of exemptions identified for each plant, and the total plant fire-induced CDF as reported in the IPEEE submittal are also given in Table 1.1. The total number of exemptions

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<sup>9</sup>Appendix R nominally applies only to plants granted operating licenses before January 1, 1979. Such plants may request an "exemption" to the specific compliance features set forth in Appendix R. Plants licensed after that time may commit to meeting the Appendix R requirements as a part of their licensing basis, and may then seek approval for "deviations" from those requirements. The plants in the study group include both pre- and post-Appendix R plants. For convenience, both "exemptions" and "deviations" will be referred to in this report as exemptions.

addressed in this study is 169. Other pertinent information for each of the nine plants is provided in Table 1.1.

| Table 1.1: List of Plants Examined. |                  |                   |                                  |
|-------------------------------------|------------------|-------------------|----------------------------------|
| ID <sup>1</sup>                     | Plant            | No. of Exemptions | Reported Fire CDF <sup>2,3</sup> |
| A                                   | Calvert Cliffs 1 | 5                 | 7.3E-5 / 1.1E-4                  |
| B                                   | Dresden 2&3      | 11                | 2.5E-4 / 2.8E-4                  |
| C                                   | Farley 1&2       | 55                | 1.6E-4                           |
| D                                   | Kewaunee         | 3                 | 9.8E-5                           |
| E                                   | Palisades        | 5                 | 2.0E-4                           |
| F                                   | Robinson 2       | 13                | 2.2E-4                           |
| G                                   | St. Lucie 1&2    | 40                | 1.9E-4 / 1.2E-4*                 |
| H                                   | Summer           | 2                 | 4.1E-4*                          |
| I                                   | Turkey Point 3&4 | 36                | <2E-4*                           |

1. The 'ID' letter corresponds to the appendix that discusses the individual exemptions in detail.
2. Taken from IPEEE submittal; multiple values represent results for sister units (lower unit number first)
3. An '\*' indicates that the total fire CDF was not reported by the licensee but was inferred by the USNRC IPEEE reviewers by summing the sequence frequencies for the dominant contributors.

One additional plant, Quad Cities, also reported a relatively high fire-induced CDF estimate in comparison to other licensees in its IPEEE submittal. However, the licensee at Quad Cities is currently revising its IPEEE fire analysis, and is performing its own self-assessment of the risk impact of Appendix R exemptions. Because these licensee studies are not yet available, Quad Cities has not been included in this study.

It is also noted that the same licensee is also in the process of revising the IPEEE fire analysis for Dresden. This study has been based on risk insights obtained from the original Dresden submittal. Changes to the IPEEE fire analysis for Dresden might also result in changes to the exemption significance results presented in this report.

Finally, in the case of Turkey Point the plant fire protection program has undergone substantial changes since the time of the IPEEE fire analysis that have not been considered in this study. This study has considered exemptions granted to the licensee during the original plant Appendix R compliance efforts (during the 1980s). This does represent the status of the plant as of the time that the IPEEE fire analysis was performed.<sup>10</sup> As of 1998 the USNRC approved a new set of Appendix R exemptions that supercede a number of the previous exemptions [Ref. 2,3].

<sup>10</sup>The licensee submitted a fire risk analysis in 1991 as a part of the IPE. This same study was cited as the IPEEE fire analysis. The USNRC review of the IPEEE was completed in February 1996. Recent staff reviews were documented in October and December 1998.



For Turkey Point, the approval process associated with the new exemptions included consideration of several plant fire protection upgrades including fire barrier upgrades and installation of additional fixed fire detection and suppression systems. Hence, the results for Turkey Point represent a historical perspective of the plant as it existed at the time of the IPEEE analysis, but this perspective is no longer an accurate representation of the plant as it exists today.

### 1.3 General Methodology

The following four steps describe the overall methodology applied in this study:

- Step 1: The exemptions for each of the plants are "binned" (grouped) to characterize the general nature of each exemption. Two sets of binning categories are used to characterize (1) the plant areas impacted by the exemption and (2) that step within a general fire risk assessment that would be impacted by the exemption. It has been observed that a fire risk assessment is a process by which plant features which contribute to fire protection defense in depth are quantitatively weighed and assessed against fire-induced threats to the plant's safe shutdown capability. Hence, the second binning category also reflects that aspect of fire protection defense in depth that is impacted by each exemption.
- Step 2: The information provided in the exemption summaries provided by the NRC staff is compared to the information available in the IPEEE submittal. The following topics are considered in this step: matching of the fire zones or fire areas impacted by the exemption to those considered in the IPEEE submittal; the relevant features of the fire zone or fire area; the safe shutdown equipment and cables that could potentially fail from a fire; the nature and significance of fire and fuel sources; the fire initiation frequency; the conditional core damage probability (CCDP); and the core damage frequency (CDF). Based on this information, each exemption is placed in one of four risk significance binning categories. The categories reflect the potential for a decrease in the CDF assuming that the exemption had not been granted and the licensee had instead made some modifications that are consistent with the explicit compliance approaches set forth in Appendix R. The following four risk impact ranking categories are used:
  1. **Potentially Significant:** This category is assigned to those exemptions with the potential to have increased plant fire risk significantly. In this study, a significant risk impact is defined as an increase in the fire-induced CDF of  $10^{-5}$ /reactor-year ( $1E-5$ /ry) or higher. This criterion corresponds to Region I as presented in Figure 3 of Regulatory Guide (RG) 1.174 [Ref. 1].
  2. **Indeterminate:** This category includes exemptions for which there are indications of a potentially significant risk impact, but for which a direct CDF contribution could not be established with any confidence. Note in particular that if it is concluded that an exemption has led to CDF increases of less than  $1E-5$ /ry, then that exemption would not be categorized as risk indeterminate even if the actual CDF change cannot be quantified with confidence.



3. **Small:** An exemption with a small risk impact is an exemption that potentially resulted in an increase in CDF between  $1\text{E-}6/\text{ry}$  and  $1\text{E-}5/\text{ry}$ . This corresponds to Region II as defined in Figure 3 of RG 1.174. Note that if a quantitative assessment of CDF cannot be made, but within a reasonable level of confidence it is concluded that the exemption is not potentially significant, then the exemption is generally ranked as having a potential small risk impact.
4. **Very Small:** Those exemptions found to have had a CDF impact of less than  $1\text{E-}6/\text{ry}$  are classified as having a very small risk impact. This corresponds to Region III as defined in Figure 3 of RG 1.174. Again, qualitative judgement may be employed in making this assessment. This group will also include exemptions found to have had no discernible impact on fire risk. That is, this study finds that many exemptions relate to issues that would not typically be considered as significant factors in a modern fire risk analysis (e.g., operator actions inside containment, or a two hour versus three hour fire barrier element in a fire zone with minimal fire hazards present). These exemptions are also ranked as having a very small risk impact.

- **Step 3:** Those exemptions that were initially ranked in the potentially significant and indeterminate risk impact categories in Step 2 are analyzed further. This second level of analysis includes consideration of additional documentation relevant to the exemption. In particular, the USNRC Staff evaluation reports as cited in the exemption summaries were obtained for review. The objectives of this step are (1) to the extent possible, resolve the indeterminate cases, and (2) quantify the CDF implications of exemptions identified as potentially risk significant.

- **Step 4:** As a final step, the cumulative impact of the Appendix R exemptions at each individual plant is assessed. The CDF reduction realized by postulating full implementation of the Appendix R compliance features are assessed for each exemption identified as potentially risk significant and for all of the small and very small category exemptions taken as a group. Note that the CDF reduction estimates contain large uncertainty due primarily to limitations in the available documentation in the IPEEE submittal.

#### 1.4 Limitations

This study is intended as a scoping study only. It is observed that the nature, number, and significance of the granted exemptions vary significantly from plant to plant.

The single most significant limitation to this study is reliance on the IPEEE submittals as the primary basis for development of risk insights. This study is utilizing the IPEEE submittals in a manner that goes beyond the original intent of the IPEEE process. The objectives of the IPEEE process are for licensees to identify potential plant vulnerabilities and gain an appreciation of severe accident behavior at each plant. In the case of fire, most licensees have applied simplified

methods of analysis. Further, with very few exceptions, the IPEEE review process has considered only the IPEEE submittal itself and has not delved into the supporting documentation. This study has considered information that is not being considered in the IPEEE review process (i.e., documentation associated with the exemptions). Comparison of these documents has, in a few cases, led to some indications of apparent inconsistencies between conditions cited in the IPEEE and those cited in the corresponding Staff Evaluation Report (SER). No attempts have been made to fully resolve these inconsistencies.

The level of detail regarding fire risk included in the IPEEE submittals was found, in general, to be insufficient to allow the risk impact characterization of the exemptions with a high level of confidence. In some cases the risk contributions of the areas identified as risk significant appear inconsistent with the information provided in the exemption documents or in other USNRC staff evaluation documents. The following provides two opposing examples of this:

- At Farley there were four fire areas in particular that were identified in the IPEEE submittal as dominant contributors to total plant fire CDF. These four areas are impacted by a total of six exemptions.<sup>11</sup> However, it is found that the exemptions had no discernible impact on fire risk. Given that the exemption documents cite a lack of redundant safe shutdown equipment within any one of the impacted fire areas, the basis for the IPEEE fire analysis finding of dominant CDF contributions remains unclear. There is not enough information in the documentation reviewed in this study (the IPEEE and SER) to resolve these apparent inconsistencies.
- At Turkey Point, at least four exemptions in the original plant exemption set impacted large areas of the turbine building (exemptions TUR-02, 14, 15, and 16 impacting fire areas 79, 84, and 89). In the IPEEE fire analysis, the entire turbine building was screened out as an insignificant fire risk contributor. However, recent USNRC staff evaluations have been performed in conjunction with the Thermo-Lag<sup>12</sup> resolution efforts and in conjunction with a new set of licensee exemption requests [Ref. 2,3]. Based on this new information it is clear that the IPEEE submittal, which was completed in 1991, did not fully address the fire hazards associated with the turbine hall. Hence, despite the finding of insignificant CDF contribution cited in the IPEEE submittal, these exemptions have been ranked as risk indeterminate. (Lacking an alternate basis for assessing CDF contribution of the impacted areas, there is no basis for quantitatively assessing the risk significance of these exemptions.)

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<sup>11</sup>The six exemptions appear to be rather redundant and all address essentially the same feature, doors that lack a specific listing as fire rated doors.

<sup>12</sup>Thermo-Lag is a trademark product of Thermal Science Inc. which has been widely used by the U.S. nuclear industry to construct 1-hour and 3-hour protective fire barrier envelopes for cable trays and conduits. The product has been the focus of considerable staff attention over the past five years due to issues raised regarding the reliability of the original qualification tests conducted to demonstrate its fire performance.

In general, it is assumed that the IPEEE fire analyses are accurate and complete representations of each plant's fire risk. Only in a few cases have the results of an IPEEE fire analysis been questioned. These are noted in both the associated appendices, and in the discussion of plant specific results. No attempt has been made to access IPEEE "second tier" supporting information. As a result, the authors are faced with several situations where definitive assessments of the CDF impact of a given exemption can not be made. This is generally due to a lack of sufficient detail regarding the fire analysis (e.g., fire modeling assumptions, postulated fire sources, fire intensities, proximity of critical targets to specific fire sources, how local fire barriers are treated, credit given for manual and/or automatic suppression in a given scenario, etc.).

Other specific limitations to this study include the following:

- Information used in this study is limited in scope. The initial assessments were completed based on (1) exemption summaries provided by the USNRC staff that include a short summary of the rationale used by the staff to grant the exemption,<sup>13</sup> and (2) insights gleaned from the corresponding IPEEE submittal. Following this initial assessment those exemptions identified as potentially risk significant or risk indeterminate were re-examined in some detail. For these exemptions additional documentation, primarily the corresponding NRC staff evaluation reports, was collected and considered. In only two cases, Farley, Turkey Point, St. Lucie, and Dresden was additional information factored into the assessment of the risk significance of the exemptions (as noted above).
- While quantitative screening criteria are used to define the risk significance of each exemption, the methods used to establish the risk significance of an exemption are primarily qualitative in nature and ultimately rely heavily on the judgement of the authors. Together, the two authors of this study have expertise gained through the performance of multiple PRAs, the review of numerous other fire risk studies including the IPEEE submittals, a broad understanding of current PRA-related literature, and experience in the performance and interpretation of fire safety experiments. This knowledge has been used to estimate the potential impact of each exemption on the CDF contribution of scenarios reported in the IPEEE that can be associated with the exemption. In the detailed discussions provided in the appendices any assumptions made in the assessment of risk impact are generally identified as "points of uncertainty."
- No specific attempts were made to capture a "representative" set of plants in the study group. As noted above, each plant in the sample group has reported a relatively high fire-induced CDF compared to other licensees. Hence, given reliance on the IPEEE findings as the basis for risk insights, the sample group is considered the most appropriate possible.

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<sup>13</sup>The exemption summary information was taken from an internal USNRC/NRR exemption data base called FIREDAT. The data base was prepared by a contractor and has not been validated by the USNRC staff.

In postulating specific compliance strategies that would eliminate the need for the exemption, the most direct compliance strategy is assumed and no consideration has been given to the associated implementation costs.

- As noted above, the CDFs reported in the IPEEE submittals are generally used directly and without question as indicators of the risk importance of the impacted fire areas or zones. For many of the exemptions ranked in the small and very small impact categories the finding is based entirely on low CDF values for the impacted fire areas/zones as reported in the IPEEE. In these cases it has been noted that the findings of this study are sensitive to the robustness of the IPEEE analysis itself.
- It is observed that, in general and for the sample group in particular, the fire IPEEE studies have been based on point estimates of fire CDF with little or no consideration of uncertainties. This may influence the estimation of potential risk reductions that might be realized assuming that individual exemptions had not been granted.
- Any plant improvements or changes made since the performance of each IPEEE have not been included in this study. The only exception would be changes that were identified in the IPEEE submittal itself and that were credited in the IPEEE fire analysis. This is a known factor in the assessment of Turkey Point in particular. Since completion of the Turkey Point IPEEE fire analysis, several significant fire protection related plant improvements have been made and a new set of exemptions (not considered in this study) has been granted [Ref. 2,3]. A number of the original exemptions (considered in this study) have been superseded by this new set of exemptions, and certain of the plant improvements would impact the assessment made in this study.

## 1.5 Organization of this Report

The initial exemption binning process, a summary of its results, and related insights are presented in Section 2. A plant-by-plant summary of the exemptions and risk impact findings for the nine plants in the sample group are provided in Section 3. Insights related to common groups of exemptions and commonly encountered exemption features are discussed in Section 4. Section 5 provides a summary of the study findings. Appendices A through I provide the worksheets that were developed for each of the 169 exemptions (the assignment of appendices to the nine plants is provided in Table 1.1).

## 2. Summary of Initial Exemption "Binning" Results

In this section, the insights gained from binning the exemptions by (1) the affected location (plant area/zone) and (2) the step(s) of a typical fire risk assessment impacted by the exemption are discussed. These are the results of Step 1 as defined in the discussion of general methodology in Section 1.3.

### 2.1 Overview

From the information provided in Table 1.2, it can be observed that the sample group is dominated by older plants, most having started construction in the late 1960's. In all, the study group covers 13 units. Of the 13 units, 11 were licensed before January 1, 1979 and are directly subject to Appendix R compliance. The remaining two units (Farley 2, and St. Lucie 2) were licensed after January 1, 1979 and are subject to Appendix R compliance by virtue of the plant licensing basis.

The study group includes only one BWR (Dresden). This can be attributed, at least in part, to the average age of the nine plants. In the early years of the industry, there were more PWR units in operation than BWR. It has also been noted that BWRs generally report lower CDF values than PWRs.

It is also interesting to note that the number of exemptions varies significantly from plant to plant. In the selected group, Summer had the fewest exemptions, just 2, and Farley had the most, 54. No clear pattern has been established to characterize these differences. Together, three of the plants (Farley, St. Lucie, and Turkey Point representing 6 units) account for 131 of the 169 exemptions (approximately 77%). Each of the remaining 6 plants in the selected group had 13 or less exemptions per plant.

In considering the number of exemptions at a given plant it should be noted that each plant appears to have taken a somewhat unique approach to grouping (or not grouping) similar exemptions. In some cases, we encountered several individual exemptions that deal with a common condition in different fire areas. This is observed, for example, at Farley. There are approximately 14 exemptions citing lack of fire rating for essentially identical fire doors in various plant areas. All 14 of these exemptions are found to have had no discernible impact on fire risk because the doors were tested and met the performance criteria of a fully rated three hour fire door. In other cases, we encountered single exemptions that impacted several (as many as 23) individual fire areas. For example, two exemptions at Dresden impact a total of 45 fire areas (DRS-03 and -04). In a second case at Calvert Cliffs, one exemption (CAL-03) impacts two

fire areas that together represent a total of approximately 91 IPEEE fire zones.<sup>14</sup> Hence, a simple count of the exemptions provides little useful information and can be misleading.

## 2.2 Exemption "Binning" Categories

The exemptions are "binned" based on two factors: location (plant area) and the steps of a typical fire risk assessment. Both factors can provide nominal insights regarding the risk significance of the exemption.

The location factor is based on the plant physical area that is impacted by the exemption. This provides some initial indication of the importance of the exemption based on the nominal fire risk importance of a given plant area. Also, it can provide some insights regarding the types of locations for which licensees had difficulty in achieving the compliance strategies set forth in Appendix R. For example, typically the containment is not an important fire CDF contributor in a PWR. Therefore in the authors judgement, an exemption impacting a PWR containment is unlikely to have significant impact on fire CDF. Such insights are only used as a general guide. Exceptions do exist and are considered. The following categories have been used for the location factor as the "Location Binning Category":

- Containment
- Cable tunnel (long, narrow compartments where there are only cables)
- Cable vaults (including the cable spreading room (CSR))
- Main control room (MCR)
- Switchgear room
- Diesel Generator area
- Turbine building
- Battery room
- Relay room
- Pump room
- General process area
- Intake Structure

The analysis step binning factor is based on that aspect of the fire risk assessment process that is impacted by the exemption. While the steps in a fire PRA can be categorized in many different ways depending on the exact methodology being employed, the following nominal listing of the steps in a fire PRA has been used to bin the exemptions in this study:

- Preliminary plant review (PPR):
  - identification of risk important plant systems and components (Eq&Sys)

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<sup>14</sup>Recall that a fire area is a region fully bounded by barriers with a fire rating of at least two, and more commonly three, hours. A fire area may be subdivided into many fire zones. Most IPEEE fire analyses were based on fire zone assessments rather than fire area assessments.

- development of the plant systems/risk models (Risk Mod)
- definition of physical fire areas and fire zones (Zone Def)
- mapping of components and systems to specific fire zones (Mapping)
- Fire hazards assessment (FHA):
  - identification of fire hazards and fire sources (Sources)
  - fire growth and damage modeling (Grw&Dmg)
  - fire detection and suppression analysis (Det/Supp)
  - fire compartment interaction analysis (FCIA)
- Risk Quantification (RQ):
  - systems impact analysis (Sys. Impact)
  - human reliability analysis (HRA)
  - mitigation and recovery analysis (Recov.)
  - uncertainty analysis (Uncert.)

### **2.3 Results of Exemption Initial Binning Process**

Each exemption has been assigned to one or more of the binning categories of the two factors discussed above. The details of these results are provided in the Appendices. Table 2.1 summarizes the results of binning for the location factor by actual numbers and by percentages. Tables 2.2 presents similar information for binning by the fire risk analysis step factor. (Because of their length, the tables appear at the end of Section 2.)

Note that each exemption may impact more than one area and/or more than one aspect of the PRA analysis. This is noted in particular in the binning by impacted area. Many of the exemptions specifically apply to multiple fire areas. Therefore, adding up the individual entries in each table may result in a number greater than the total number of exemptions for a given plant and/or for the study group as a whole.

### **2.4 Insights Drawn from the Initial Binning Process**

The percentages presented in the tables cannot be extrapolated to characterize either the number nor the fraction of exemptions in a larger body of plants that would fall into any given category. However, beyond the simple numerical results of the binning process, some observations can be made regarding the nature of the exemptions reviewed. These include the following:

- There is no distinct common pattern among the plants in terms of areas of the plant impacted by the exemptions. It can be said each plant is somewhat unique in terms of the areas for which exemptions are requested or in terms of fire protection defense in depth feature impacted (presented through the fire PRA categories).
- About 40% of the exemptions address areas of the plant that are labeled as general process area. This is a "catch all" category that captures all those areas that either could not be clearly defined in generic terms or do not fall within other more clearly defined

categories. It must be added that general process areas do not include any part of the administration related buildings.

- The second tier of most commonly cited areas includes the containment and pump rooms.
- The third tier of most commonly cited areas includes cable tunnels and the intake structure.
- The first three tiers of most commonly cited areas represent close to 90% of the exemptions.
- All but one of the plants in the sample group had one or more exemptions that impacted fire areas within containment. Many of these related to lack of fixed fire detection and/or suppression, lack of proper oil collection system for the RCPs, and lack of emergency lighting. A smaller number relate to intervening combustibles and lack of separation.
- Six of the nine plants in the sample group included at least one exemption impacting the main control room. In particular, each of these six plants included an exemption for the lack of automatic fixed fire suppression in the MCR.
- Relatively few exemptions, approximately 7 of the 169, impacted the turbine building. These included one exemption each at Dresden and Robinson and five exemptions at Turkey Point.<sup>15</sup> It is commonly noted that for many plants there is little or no Appendix R equipment and cables housed in the turbine building. These exemptions clearly illustrate that exceptions to this observation do exist. In particular for Dresden, the turbine hall also serves as a safe shutdown area and does contain a substantial number of important cables and components.
- None of the exemptions address the cable spreading room. For three of the nine plants, an area somewhat similar to the cable spreading room is impacted, although these are characterized as cable vaults.
- Battery rooms and relay rooms are two areas that are impacted by only a small number of exemptions.
- By far the most common impact with regard to the steps in a fire PRA is observed in the "Fire Hazard Analysis" grouping. In particular, many of the exemptions studied are related to the Appendix R separation criteria and requirements for fixed automatic

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<sup>15</sup> At Dresden, the one exemption actually covered lack of fixed fire suppression and/or detection in 22 fire areas within the turbine building. For Turkey Point there are several areas identified in the exemptions and in the IPEEE as "outdoor areas." However, based on discussions with the NRC Staff, many of these areas are actually part of the turbine building which happens to be only partially enclosed. Hence, these exemptions are classified as impacting the turbine building in this study.



detection and suppression. These exemptions are generally binned in the "FHA-Grw&Dmg" and "FHA-Det/Supp" categories respectively. Over half of all exemptions (60%) are categorized into these two categories.

- The single most common class of exemptions in the sample group related to fire areas which contain multiple safe shutdown trains, but are not provided with automatic fixed fire detection and/or suppression systems. In all, about half of the exemptions analyzed in this study related to a lack of detection and/or suppression (lack of suppression is cited more commonly than lack of detection, although many exemptions cited a lack of both detection and suppression). These exemptions are typically accepted by the USNRC on the basis of (1) a perceived minimal fire hazard, (2) availability of manual fire fighting, (3) existence of an alternate means of safe shutdown, or (4) a combination of these factors.
- The second most common class of exemptions related to a lack of adequate separation and/or a lack of 1-hour fire barrier protection. These are generally placed in the "FHA - Grw&Dmg" impact group. These exemptions are typically accepted by the USNRC on a basis similar to the four bases cited immediately above for exemptions involving a lack of fixed detection and/or suppression. For this group additional consideration is commonly given to (5) availability of significant train separation that fell short of the requirements, or (6) separation that met or exceeded the requirements but included some modest level of intervening combustibles.

**Table 2.1: Summary of Binning Results by the Location Factor**

2.1a: Based on the simple count of exemptions:

|                            | All | CAL | DRS | FAR | KEW | PAL | HBR | STL | SUM | TUR |
|----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Containment                | 29  | 2   | 1   | 1   | 1   | 1   | 3   | 11  |     | 9   |
| Cable tunnel               | 15  |     |     | 13  | 1   |     |     | 1   |     |     |
| Cable vaults               | 11  |     |     | 4   |     |     | 1   | 6   |     |     |
| Main control room          | 12  |     | 3   |     | 1   | 1   | 1   | 4   |     | 2   |
| Switchgear room            | 12  |     | 1   | 8   |     | 1   |     | 2   |     |     |
| Diesel Generator area      | 9   |     |     | 4   |     |     | 1   | 2   |     | 2   |
| Turbine building           | 6   |     | 1   |     |     |     | 1   |     |     | 4   |
| Battery room               | 1   |     |     |     |     |     |     | 1   |     |     |
| Relay room                 | 4   |     | 1   |     |     | 1   |     | 2   |     |     |
| Pump room                  | 23  |     |     | 2   |     |     | 5   | 7   |     | 9   |
| General process area       | 69  | 2   | 5   | 22  |     | 2   | 3   | 21  | 2   | 12  |
| Intake Structure           | 13  | 1   | 1   | 5   |     |     | 3   | 2   |     | 1   |
|                            |     |     |     |     |     |     |     |     |     |     |
| Total Number of Exemptions | 169 | 5   | 11  | 54  | 3   | 5   | 13  | 40  | 2   | 36  |

2.1b: Based on the percentage of exemptions in the sample group:

|                       | All | CAL | DRS | FAR | KEW | PAL | HBR | STL | SUM  | TUR |
|-----------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|
| Containment           | 17% | 40% | 9%  | 2%  | 33% | 20% | 23% | 28% |      | 25% |
| Cable tunnel          | 9%  |     |     | 24% | 33% |     |     | 3%  |      |     |
| Cable vaults          | 7%  |     |     | 7%  |     |     | 8%  | 15% |      |     |
| Main control room     | 7%  |     | 27% |     | 33% | 20% | 8%  | 10% |      | 6%  |
| Switchgear room       | 7%  |     | 9%  | 15% |     | 20% |     | 5%  |      |     |
| Diesel Generator area | 5%  |     |     | 7%  |     |     | 8%  | 5%  |      | 6%  |
| Turbine building      | 4%  |     | 9%  |     |     |     | 8%  |     |      | 11% |
| Battery room          | 1%  |     |     |     |     |     |     | 3%  |      |     |
| Relay room            | 2%  |     | 9%  |     |     | 20% |     | 5%  |      |     |
| Pump room             | 14% |     |     | 4%  |     |     | 38% | 18% |      | 25% |
| General process area  | 41% | 40% | 45% | 41% |     | 40% | 23% | 53% | 100% | 33% |
| Intake Structure      | 8%  | 20% | 9%  | 9%  |     |     | 23% | 5%  |      | 3%  |

**Table 2.2 Summary of Binning Results by the Fire PRA Factor**

2.2a: Based on the simple count of exemptions.

|                          | All | CAL | DRS | FAR | KEW | PAL | HBR | STL | SUM | TUR |
|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Preliminary Plant Review |     |     |     |     |     |     |     |     |     |     |
| PPR : Eq&Sys             | 2   |     | 1   |     |     |     | 1   |     |     |     |
| PPR : Risk Mod           | 0   |     |     |     |     |     |     |     |     |     |
| PPR : Zone Def.          | 0   |     |     |     |     |     |     |     |     |     |
| PPR : Mapping            | 0   |     |     |     |     |     |     |     |     |     |
| Fire Hazard Assessment   |     |     |     |     |     |     |     |     |     |     |
| FHA : Sources            | 8   | 1   | 2   |     |     |     | 1   | 2   |     | 2   |
| FHA : Grw&Dmg            | 76  |     |     | 47  | 1   | 2   | 4   | 9   |     | 13  |
| FHA : Det/Supp           | 85  | 1   | 9   | 32  | 2   | 3   | 5   | 10  | 1   | 22  |
| FHA : FCIA               | 34  | 2   |     | 7   |     |     | 1   | 18  |     | 6   |
| Risk Quantification      |     |     |     |     |     |     |     |     |     |     |
| RQ : Sys Impact          | 0   |     |     |     |     |     |     |     |     |     |
| RQ : HRA                 | 10  | 1   | 1   |     |     |     | 3   | 2   | 1   | 2   |
| RQ : Recov.              | 3   |     | 1   |     |     |     | 1   |     | 1   |     |
| RQ : Uncert.             | 0   |     |     |     |     |     |     |     |     |     |

2.2b: Based on the percentage of exemptions in the sample group.

|                            | All | CAL | DRS | FAR | KEW | PAL | HBR | STL | SUM | TUR |
|----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Preliminary Plant Review   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| PPR : Eq&Sys               | 1%  |     | 9%  |     |     |     | 8%  |     |     |     |
| PPR : Risk Mod             |     |     |     |     |     |     |     |     |     |     |
| PPR : Zone Def.            |     |     |     |     |     |     |     |     |     |     |
| PPR : Mapping              |     |     |     |     |     |     |     |     |     |     |
| Fire Hazard Assessment     | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| FHA : Sources              | 5%  | 20% | 18% |     |     |     | 8%  | 5%  |     | 6%  |
| FHA : Grw&Dmg              | 45% |     |     | 87% | 33% | 40% | 31% | 23% |     | 36% |
| FHA : Det/Supp             | 50% | 20% | 82% | 59% | 67% | 60% | 38% | 25% | 50% | 61% |
| FHA : FCIA                 | 20% | 40% |     | 13% |     |     | 8%  | 45% |     | 17% |
| Risk Quantification        | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| RQ : Sys Impact            |     |     |     |     |     |     |     |     |     |     |
| RQ : HRA                   | 6%  | 20% | 9%  |     |     |     | 23% | 5%  | 50% | 6%  |
| RQ : Recov.                | 2%  |     | 9%  |     |     |     | 8%  |     | 50% |     |
| RQ : Uncert.               |     |     |     |     |     |     |     |     |     |     |
| Total Number of Exemptions | 169 | 5   | 11  | 54  | 3   | 5   | 13  | 40  | 2   | 36  |

### 3. Overview of Plant Exemptions and Risk Impact Findings

#### 3.1 Introductory Comments

The subsections below provide summary discussions of the risk significance analysis results for each of the nine plants in the study group. Detailed discussions of each exemption for each plant are provided in the appendices which accompany this report. Each appendix “steps through” each exemption for a given plant. The presentation structure for each exemption in the appendices includes the following sub-sections:

- Plant: This is the plant and, if specified, unit the exemption applies to.
- Exemption #: This is an identifier number assigned to each exemption as a part of this study. This identifier is used throughout this report as the primary means of referencing a given exemption. Each identifier includes a three-letter abbreviation of the plant name, and a sequential number (e.g., KEW-01 is the first Kewaunee exemption). The order of the exemptions is taken as that obtained from a full print of exemptions for each plant as delivered by FIREDAT. Nominally, FIREDAT appears to order exemptions chronologically based on the date of acceptance.
- Document Accession #: This is an exemption identifier provided by the FIREDAT summary data base. It corresponds to the reference numbers for the supporting documents at NRC.
- Exemption Description: This is a summary description of the exemption taken directly from the exemption summary provided by the USNRC staff from the data base FIREDAT for use in this study.
- Location Binning Category: This entry is defined in Section 2.
- PRA Step Binning Category: This entry is defined in Section 2.
- Potential for CDF Reduction: This is the final assessment ranking of the risk/CDF significance of the exemption (potentially significant, indeterminate, small, or very small risk impact).
- Analysis: This is a discussion of the exemption risk/CDF implications, relevant plant features that mitigate the impact, and CDF change results assuming implementation of an alternate compliance strategy that is consistent with those set forth in Appendix R. Included, where available, is a discussion of IPEEE analysis findings for the areas impacted by the exemption.
- Points of Uncertainty: This section discusses any factors that complicated the analysis of risk impact of the exemption, prevented a definitive assessment of the exemption, and/or contributed to a reduced level of confidence in the assessment findings.
- Relevant IPEEE Citations: This section identifies where in the IPEEE information specifically related to the fire zone/area addressed by the exemption was identified during the study. Some general discussion of the IPEEE findings is also provided. Note that this is not intended as an exhaustive discussion of relevant IPEEE information, but rather, as a pointer to relevant IPEEE information.

The subsections below summarize the information from each appendix. The discussion for each plant includes (1) a general discussion of the exemptions and the bases used to assess significance, (2) an assessment of the cumulative impact of all of the exemptions on fire risk/CDF at each plant, and (3) a discussion of any qualitative risk impacts noted during the analysis.

### 3.2 Calvert Cliffs 1

#### 3.2.1 Summary of Exemption Analysis Findings

Calvert Cliffs 1 had five exemptions. Note that while Calvert Cliffs is a dual unit site, there were no exemptions identified for Unit 2. All five are ranked individually as having had a very small risk impact. The five Calvert Cliffs 1 exemptions were assessed as follows:

- CAL-01, and -02 both deal with elements in certain fire barriers that are not fire rated. In both cases the un-rated elements are water tight doors. These are found to have had no discernible impact on fire risk based on (1) fire tests by the license show the watertight doors represent substantial barriers, (2) the potential for a fire of sufficient severity (intensity and duration) to challenge the doors is very small, and (3) the IPEEE included a detailed multi-zone fire analysis and the impacted area combinations are screened.
- CAL-03 deals with lack of fixed suppression systems in two fire areas (representing a large number of individual fire zones). This exemption is found to have had at most a very small risk impact based largely on the IPEEE findings which screened all of the impacted fire zones and zone combinations. This finding is sensitive to the robustness of the IPEEE analyses.
- CAL-04 is related to the capacity of the reactor coolant pump (RCP) oil collection system inside containment. This is a common class of exemptions that are found to have had a very small risk impact as discussed in Section 4.6 below.
- CAL-05, deals with use of hand-held emergency lighting in lieu of fixed emergency lighting inside containment. This exemption is found to have had no discernible impact on fire risk because no operator recovery actions inside containment are modeled in the IPEEE.

#### 3.2.2 Cumulative Impact of Exemptions

As noted above Calvert Cliffs 1 has a total of five exemptions. Of the five, three relate to plant features that would not be considered as discernable factors in a typical fire risk assessment. The remaining two exemptions are found to have led to a very small impact on plant fire CDF. The cumulative impact implications for these two exemptions is summarized as follows:

- Exemption CAL-03, ranked as having a very small risk impact, addresses lack of fixed suppression in two, apparently, very large fire areas (fire areas 10 and 11). Together, the two areas represent 91 individual fire zones in the IPEEE analysis. However, even

summing the CDF for all of the analyzed zones yields a total CDF contribution of less than  $1\text{E-}6/\text{ry}$  (approximately  $9.8\text{E-}7/\text{ry}$ ). Hence, the net risk impact has been, at most, very small based on the IPEEE findings.

- Exemption CAL-05 relates to the RCP oil collection system. This exemption is deemed to have, at most, a potential small CDF impact.

In summary, as a result of the exemptions, one impacted scenario has the potential for a small risk contribution and there are several impacted scenarios whose cumulative CDF contribution is very small. Hence, it is concluded that for Calvert Cliffs the Appendix R exemptions have had, at most, a small cumulative impact on fire risk.

### 3.2.3 Qualitative Risk Impact

For Calvert Cliffs 1, no qualitative risk changes of a significant nature are identified. Exemption CAL-03 does shift reliance for fire suppression from automatic fixed systems to the manual fire brigade. However, none of these cases is considered risk significant.

## 3.3 Dresden Units 2 and 3

### 3.3.1 Summary of Exemption Analysis Findings

Dresden has eleven Appendix R exemptions, and each exemption applies to both Units 2 and 3. Of these, three are found to be potentially significant, three are found to be risk indeterminate (including one related to lack of fixed suppression in the MCR), three are found to have had a small risk impact, and the remaining two exemptions are found to have had a very small risk impact. Of the eleven exemptions, nine relate to lack of separation and/or fixed fire suppression systems. The other two exemptions relate to lack of alternate shutdown capability for the MCR and for two crib houses.

The three Dresden exemptions found to be potentially significant are summarized as follows:

- **DRS-01: *Lack of suppression and detection in three zones*** - This exemption impacts several zones including in particular the MCR and two switchgear areas. In the MCR the exemption is found to be risk indeterminate as discussed in Section 4 below. In one of the two switchgear rooms, zone 1.1.1.4, the exemption is found to be potentially significant based largely on the significant CDF contribution for the zone cited in the IPEEE. It would appear that a substantial CDF reduction might be realized had the exemption not been granted and fixed fire suppression and detection had been installed. A nominal potential risk reduction of on the order of 0.05 (1/20) for the impacted zone is postulated. This would reduce the CDF contribution from the IPEEE reported value of  $1.78\text{E-}5/\text{ry}$  to below  $1\text{E-}6/\text{ry}$ . Hence this room would screen rather than representing a significant CDF contributor. This estimate is highly uncertain, however, given the manner in which the licensee has quantified fire CDF, in particular, the CDF contribution of

transient and self-ignited cable fires appears to have been assessed very conservatively while other fire sources have largely screened.

- **DRS-04: *Lack of fixed suppression and/or detection in 22 turbine building zones*** - This exemption impacts several of the dominant CDF contributors identified in the IPEEE. Ultimately it was found that many of these zones do have partial suppression coverage and there would be little risk benefit to be gained by extending the existing coverage. However, in Zone 7.0.A.1 there is no suppression coverage; hence, there is a potential for significant risk benefit if the suppression were installed. The potential CDF gain is similar in nature to DRS-01 and similar limitations apply. The IPEEE reported CDF for this zone is  $1.04\text{E}-5/\text{ry}$ . Elimination of the exemption would likely reduce this contribution well below  $1\text{E}-6/\text{ry}$ . It is also noted that DRS-04 impacts a second significant CDF contributor; namely, area 8.2.6.A. However, this area has partial sprinkler coverage, and the potential for risk reductions due to extension of the system could not be determined. For this area the exemption is found to be risk indeterminate.

- **DRS-10: *Lack of fixed fire suppression in two areas of the reactor building*** - The fire zones impacted by these exemptions are 1.1.1.2, and 1.1.1.3. (Note that DRS-08 also impacts these same fire zones, but relates specifically to intervening combustibles. It appears that lack of suppression is the more risk significant issue in these zones.) The two impacted fire areas are analyzed in detail in the Dresden IPEEE. Ultimately both 1.1.1.3 and 1.1.2.3 are found to have CDF contributions in excess of  $1\text{E}-5/\text{ry}$  ( $5.06\text{E}-5/\text{ry}$  and  $2.34\text{E}-5/\text{ry}$  respectively). Both fire areas are cited as containing a significant selection of safe shutdown equipment and substantial fire sources. In general the licensee analysis concluded that fires of substantial duration were required to cause critical damage. Hence, installation of a fire suppression system in these areas would be expected to substantially reduce fire CDF. The potential risk gains are similar in nature to those described in DRS-01 and similar uncertainties apply. It is likely that had the exemption not been granted the fire areas would have screened with CDFs below  $1\text{E}-6/\text{ry}$  rather than remaining as significant CDF contributors.

The three exemptions categorized as risk indeterminate are described as follows:

- **DRS-02: *Lack of alternate shutdown in the event of a MCR fire*** - This exemption addresses the plant's approach to post-fire recovery in the case of an MCR fire. The specific exemption cites loss of hot and cold shutdown capability and the inability to effect repairs within 72 hours. While a recovery procedure was developed and approved by the USNRC Staff, it appears that the recovery procedures involve numerous and potentially complicated human actions to pull and replace fuses, trip circuit breakers, and manipulate transfer switches. In the IPEEE analysis there is no discussion of these required actions. It does not appear that a detailed human reliability analysis (HRA) was performed to address the conditions cited in the exemption. The MCR did survive screening and several specific fire scenarios were considered. However, the final estimated contribution to fire CDF is small ( $1.66\text{E}-6/\text{ry}$ ) and the MCR is not a significant contributor to the total plant CDF ( $>2\text{E}-4/\text{ry}$ ). On this basis one might nominally conclude that the exemption was not risk significant. However, given that the analysis does not appear to have

considered the cited conditions, and given that the same effects may also result from fires in the cable spreading room and relay room as well, there appears to be a strong basis for questioning the findings of the IPEEE. Given these uncertainties, this exemption is ranked as risk indeterminate.

- **DRS-03: *Lack of fixed suppression in three reactor building zones*** - This exemption impacts three risk significant fire zones in the reactor building. Of these two are already impacted by DRS-01 and DRS-10, each of which is already found to be potentially significant. The third zone is 1.1.2.3 which has an IPEEE CDF contribution of  $2.34E-5/\text{ry}$ . However, the area is protected by partial sprinkler coverage, and the potential risk reductions to be gained by extending the coverage cannot be determined. This is because the IPEEE does not state how fire suppression was credited nor what fire sources are, or are not, covered by the partial suppression system. Hence, in the context of this one fire area, the exemption is found to be risk indeterminate.

- **DRS-11: *Lack of fixed suppression in the MCR*** - This is a common class of exemptions. See discussion in Section 4.

The remaining five exemptions were found to have either a small or very small risk impact. These are summarized as follows:

- **DRS-05, -06, -09: *Lack of fixed fire suppression*** - These three exemptions relate to lack of fire suppression in various plant areas. DRS-05, and -06 are found to have a very small risk impact based on the fact that the impacted fire areas are apparently screened from the IPEEE analysis as risk insignificant. DRS-09 is found to have had, at most, a small risk impact based largely on protection of the redundant cables in the room by a 1-hour fire barrier. However, there appears to be some potential for additional very small risk reductions had fire suppression been installed in the impacted areas. The findings on these exemptions assume the IPEEE has appropriately considered and screened the impacted areas.

- **DRS-07: *Intervening combustibles in two crib houses*** - This exemption addresses the presence of intervening combustibles between redundant safe shutdown trains in two plant fire areas. The exemptions cites a potential for severe fires to result in loss of the safe shutdown capability. The IPEEE submittal does not specifically address the crib houses. The exemption documents do state that the area is protected by fixed fire suppression systems and appears to conclude that all of the fire sources have a limited fire spread potential. Given the descriptions provided in the exemption documents, some analysis of these areas would have been expected in the IPEEE, and the areas would nominally be expected to survive an area screening analysis. Largely on this basis, the exemption is found to have a potential for a small risk impact despite the lack of treatment of these areas in the IPEEE.

- **DRS-08: *Intervening combustibles*** - This exemption impacts four zones including two that are also impacted by DRS-10 involving lack of suppression. This exemption focuses on th



question of intervening combustibles (whereas DRS-10 related to lack of fixed suppression). The IPEEE cites substantial damage times and limited fire spread potential in the impacted fire zones, so it would appear that the presence of intervening combustibles was not a significant factor in the risk assessment. The other two impacted zones are not risk significant based on the IPEEE reported CDF. Hence, the exemption is found to have had, at most, a small impact on fire risk.

### 3.3.2 Cumulative Impact of Exemptions

Dresden has a total of 11 exemptions that are ranked in all four risk significance categories. It seems that most of the fire areas at Dresden identified in the IPEEE submittal as significant CDF contributors (CDF in excess of  $1E-5/\text{ry}$ ) are impacted by an exemption. These exemptions do cite alternate compliance strategies relating to phenomena or features typically identified as contributing factors in fire risk assessments. This includes in particular fixed suppression, fixed detection, and reliance on manual recovery/repair actions. The cumulative risk impact for Dresden is summarized as follows:

- The most obvious risk impact is related to the three potentially significant exemptions (DRS-01, 04, and 10). As stated above, these exemptions impact fire zones identified in the IPEEE submittal as significant contributors to fire CDF (zones 1.1.1.3, 1.1.1.4, and 7.0.A.1). In each case this study finds that had the Appendix R compliance strategies been implemented in lieu of the exemption, the impacted zones would likely have been found to be very small rather than significant CDF contributors. The CDF contribution for these zones represents about 20% of the total Unit 3 fire CDF and about 10% of the total Unit 2 fire CDF.
- Three exemptions are ranked as risk indeterminate (DRS-02, 03, 11). In addition, two of the three significant exemptions also have an indeterminate impact on certain fire areas (DRS-01 and 04). These five exemptions impact several fire areas identified in the IPEEE as significant CDF contributors. Hence, the cumulative impact of these exemptions may also be significant.
- A number of plant fire areas impacted by exemptions may have led to small risk increases. Given that there are only a small number of impacted areas, the cumulative impact for these cases is also deemed to be small.
- Two exemptions (DRS-05 and 06) are ranked as having a very small impact and are also found to have had no discernible cumulative impact on fire risk.

In summary, the cumulative impact of the exemptions at Dresden is found to be potentially significant. This derives primarily from the three exemptions ranked as potentially significant. There is a potential for the contribution from the three indeterminate exemptions to also be potentially significant.

### 3.3.3 Qualitative Risk Impact

Dresden has a relatively large number of zones in both the Turbine Building and Reactor Building impacted by exemptions for lack of fixed fire suppression. In many cases partial fixed suppression coverage is provided. In these areas the exemptions were typically found to have either a small or very small risk impact with only one exception (see discussion of DRS-04 above). Most of the risk significant fire areas identified in the IPEEE are in these two buildings and were indeed impacted by these exemptions. For those areas where fixed fire suppression is completely lacking, the plant has shifted the focus of fire suppression from fixed fire suppression systems to the manual fire brigade. Also, one layer of defense in depth has been lost; namely, automatic fire suppression capability.

In the case of the main control room, it would appear that the Dresden MCR abandonment safe shutdown method is dependent on operators implementing numerous manual recovery actions to mitigate fire damage. The cited operations appear to be both numerous and complex in nature, and are intended to overcome the possibility of control circuit failure, fuse failures and potential spurious operations due to fires in the MCR. To overcome such faults manual actions must be taken that require pulling fuses, replacing fuses, manually operating disconnect switches, tripping circuit breakers, shedding non-safety loads for buses, and transferring control circuits to emergency control stations. It would appear that the IPEEE analysis has not explicitly considered the risk implications of the required actions.

### 3.4 J. M. Farley, Units 1 and 2

#### 3.4.1 Summary of Exemption Analysis Findings

J. M. Farley Units 1 and 2 have a total of 54 exemptions between them. Of the 54 exemptions 12 address both units, 26 address Unit 1 only, and 17 address Unit 2 only. Ultimately many of the Unit 2 exemptions are found to be combinations of, or duplicates of, exemptions that had already been addressed for similar areas of Unit 1. Of the 54 exemptions, two are found to be potentially significant, two are found to be risk indeterminate, six are found to have had a small risk impact, and 44 are found to have had a very small risk impact.

Due to the relatively large number of exemptions at Farley, and due to commonality between many of the exemptions, the discussion of exemption analysis findings will focus on the types of areas impacted, those exemptions impacting CDF dominant fire areas, and general groupings of exemptions.

Exemptions ranked as potentially significant or risk indeterminate are summarized as follows:

- *Potentially significant exemptions* – The two exemptions identified as potentially significant (FAR-32 and -35) each impacts a fire compartment identified as significant fire CDF contributors in the IPEEE subarea. Each cites a lack of fixed fire suppression and a lack of 1-

hour fire barriers to protect redundant cables. In general, the need for 1-hour barriers clearly indicates the presence of redundant safe shutdown equipment (mostly cables in these cases) that lacks proper separation (either closer than 20 feet or with intervening combustibles). It is concluded that implementation of plant modifications that would eliminate the need for these exemptions would lead to a measurable decrease in the CDF. Given the information in the submittal it is difficult to quantify the impact with any certainty. However, it would appear that in each case the potential for risk reductions is substantial (see further discussion in under cumulative impact below).

- *Unclad raceway supports* - Exemption FAR-53 is relatively unique and states that cable raceways protected by 1-hour fire barriers lacked protection for the raceway supports in 23 fire areas. A similar exemption was encountered at St. Lucie (STL-26). The NRC staff evaluation focused on the potential for the unclad supports to fail in a fire causing collapse of the raceways, and this is justifiably found to be highly unlikely. However, the lack of protection on the supports also introduces the potential path for heat to bypass the thermal protection and enter the protected envelope. This can lead to very early failure of the protective envelope depending on how far out from the envelope the supports are protected (if they are protected at all) and on the exposure fire intensity. This is not addressed in the exemption summary provided by the NRC, and discussions with the cognizant NRC staff reveal that this was not considered at the time the exemption was approved. The impacted fire areas are not identified in the information reviewed for this study. However, even if the areas were known to this study the risk significance could not be assessed because the IPEEE does not describe how the barriers were credited in the fire analysis. For this reason, the exemption is found to be risk indeterminate.

- *Lack of barriers and Fixed Suppression in Intake Structure* - The exemption documentation for FAR-42 cites that all ten service water pumps are housed in a common area with little separation. However, it would appear that the IPEEE only considered a potential loss of one train (the on-service train) of service water. The basis for this is unclear. Given the risk importance of the impacted systems, and apparent lack of treatment of the cited factors in the IPEEE, this exemption is ranked as risk indeterminate.

The remaining exemptions are all ranked as having a small or very small risk impact. These include the following groups of exemptions:

- *Non-Compliant Fire Doors* - There are several exemptions (approximately 14) related to fire doors that do not comply with NFPA standards. The doors are equipped with removable transoms to facilitate movement of equipment (see for example FAR-38). The removable transom violates the NFPA fire door listing standard. However, the manufacturer provided a statement to support the exemptions citing that, in effect, except for the fact that the transom is removable, the doors would be fire-rated. The USNRC concurred with this view. This study also finds these exemptions to have had no discernible impact on fire risk because the doors would be treated as, in effect, rated fire doors in a typical risk assessment. Hence, these exemptions were ranked as having, at most, a very small risk impact.

- *Other un-rated or missing fire barriers* - Similar findings are also noted for an additional 12 exemptions related to un-rated or missing fire barriers. These generally related to small openings, un-rated fire doors or hatches, and unqualified penetrations seals. All are found to have a very small risk impact based largely on the IPEEE findings of low CDF contributions in the multi-compartment analysis and/or a lack of fuel loads and fire sources sufficient to challenge the barriers that are provided.

- *Exemptions impacting fire areas with high screening CCDF values* - Nearly half of the exemptions at Farley (FAR-08, -09, -13 through -16, -21, -22, -26, -27, -31, -32, -33, -37 through -40, -44 through -47, -49, -51, and -52) impact fire areas cited in the IPEEE as having relatively large screening CCDF values assuming loss of all equipment in the room (typically about 0.05, but ranging from 0.02 to 0.08). The relatively high screening CCDF values indicate a potential risk importance for these compartments. The conclusion that these exemptions have only a very small risk impact is based entirely on the licensee's final IPEEE CDF results in that each area is found to be an very small CDF contributor (i.e., less than  $1E-6/ry$ ). The robustness of these conclusions is dependent entirely on the robustness of the IPEEE analysis.

### 3.4.2 Cumulative Impact of Exemptions

Farley has a total of 54 exemptions ranked in all four risk significance categories. The cumulative risk impact of the exemptions at Farley is summarized as follows:

- The most important contribution to the cumulative impact at Farley comes from the exemptions ranked as potentially significant (FAR-32 and 35). Two areas of Unit 1 (1-034 and 1-035), identified in the IPEEE submittal as significant CDF contributors, are impacted. Had the exemptions not been granted, and had suppression and 1-hour fire barriers been installed, the areas would likely have been reduced from significant to very small CDF contributors. Area 1-034 represents about 19% of the total fire CDF with "Train A on-service" and 1-035 represents about 10% of the Unit 1 total fire CDF with "Train B on-service." Hence, similar cumulative risk reductions for Unit 1 would likely have been realized had the exemptions not been granted; that is, 10-19%.
- Two exemptions are ranked as indeterminate (FAR-42 and 53). Both relate to questions that were apparently not considered in the IPEEE fire analysis. Hence there is no basis for assessing the risk impact of these exemptions.
- Of the remaining 50 exemptions, three are found to have had a small risk impact and 47 are found to have had a very small impact. When taken together, the cumulative risk impact of these 50 exemptions is found to range between small and potentially significant. A definitive assessment is not possible based on the information provided in the IPEEE submittal. The assessment is based on a three-tiered examination of this set of 50 exemptions:

- Approach 1: Exemptions ranked in the small impact category have a maximum estimated potential CDF contribution of  $1E-5/ry$  each. Exemptions ranked in the very small impact category have a maximum potential CDF contribution of  $1E-6/ry$  each. Given three small and 47 very small category exemptions, the maximum potential cumulative risk contribution is approximately  $7.7E-5/ry$ . This could be a significant cumulative impact.
- Approach 2: Approach 1 is an upper bound estimate of the cumulative impact. If individual scenarios could be assessed in further detail, there would almost certainly be some reduction in each exemption's CDF contribution as compared to these bounding values. If, on average, the reduction is assumed to be one order of magnitude, the cumulative impact would then be estimated as  $7.7E-6/ry$ . This would be considered a small cumulative impact.
- Approach 3: A large number of the small and very small category exemptions impact fire scenarios that have, apparently, been analyzed in detail by the licensee in the IPEEE analysis.<sup>16</sup> These scenarios are considered those where the potential risk reductions can be most clearly quantified. Summing the impacted scenarios yields a CDF contribution of approximately  $1.8E-5/ry$  for Unit 1 and  $1.3E-5/ry$  for Unit 2. Assuming a potential for at least one order of magnitude reduction for each impacted scenario (based on the judgement of the authors), the risk reductions would be found to be potentially significant for each unit.

In summary, it is concluded that the exemptions have a potentially significant cumulative impact on fire risk at Farley. This cumulative impact derives from a combination of the risk impact of three potentially significant exemptions and the potential cumulative impact of the 50 small and very small category exemptions.

### 3.4.3 Qualitative Risk Impact

Of the 54 exemptions at Farley, 14 call for reliance on manual operator actions to achieve safe shutdown in the event of severe fires in various areas of the Auxiliary Building (AB). Each of these exemptions falls into one of three general categories; (1) lack of fixed fire suppression combined with the absence of 1-hour fire barriers for redundant cables (eight cases), (2) lack of

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<sup>16</sup>This analysis is based on the sum of the CDF contribution for scenarios impacted by exemptions FAR-09, 15, 16, 21, 22, 26, 27, 33, 37, 38, 39, 40, 44, 45, 47, 49, 51, 52 which are all in the very small ranking category, and FAR-41 and 50 which are both in the small ranking category. The other impacted scenarios were only analyzed in the IPEEE at the equivalent of a screening level and have not been included in this approach.

fire suppression and the presence of un-rated fire barrier elements between fire areas (general hatches and bulkheads, two cases), and (3) fire barriers between areas that contain un-rated elements (doors and hatches, four cases). Exemptions in the latter two categories are uniformly found to be of small or very small risk impact. However, these 14 exemptions imply that the ability to achieve safe shutdown is assured by manual recovery/repair of fire damaged systems rather than through passive/active protection of one shutdown train. The combinations of required actions include the following "action sets":

- Recovery of one main steam atmospheric relief valve, transfer relays for the PORV, PORV block valves, and reactor head vent valves.
- Manual control of instrument air to allow recovery of one PORV.
- Recovery of PORVs, reactor head vent valves, isolation RCS, pressurizer sample line valves, alignment of CCW heat exchangers, and re-establishing charging pump miniflow.
- Recovery of PORVs, transfer relays for PORVs, MSIVs, RWST charging pump suction valves, main steam atmospheric relief valves, and establishing CST level indication.
- Recovery of charging line isolation valve control, PORVs and block valves, and main steam atmospheric relief valves.
- Manual operation of AFW, recovery of charging pump mini-flow and PORVs, and initiation of RCS charging through the boron injection tank.
- Manual actions to regain charging pump mini-flow, establish RCP seal injection, isolation of RCS and pressurizer sample lines, control of one main steam atmospheric relief valve, recovery of PORVs and reactor head vent valves, and initiating RCS charging through the boron injection tank.
- Manual control of one main steam atmospheric relief valve and monitoring of boron concentration utilizing the RCS sampling system.

Some of the action sets appear relatively numerous and complex. It is not uncommon to encounter a need for manual recovery actions in the event of MCR, cable spreading room, or relay room fires. Indeed, this is the express purpose of the alternate shutdown capability. For Farley these actions may be required for fires in a variety of plant areas.

A second qualitative impact is noted with respect to Farley's reliance on manual detection and suppression of fires in lieu of passive barriers, fixed detection and fixed automatic suppression. In all, 33 of the 54 Farley exemptions relate to lack of one or more of these features. These 33 exemptions shift the burden for fire suppression in areas housing multiple trains of safe shutdown equipment from fixed automatic systems to manual intervention. Because most also cite a lack of

passive 1-hour barrier protection for redundant cables, prompt intervention in fires also becomes more critical. The combination both a lack of barriers and fixed automatic suppression places a substantial burden on the fire brigade to quickly and effectively respond to plant fires.

### 3.5 Kewaunee

#### 3.5.1 Summary of Exemption Analysis Findings

Kewaunee has only three Appendix R exemptions. Two were ranked as having a very small risk impact, and one is ranked as risk indeterminate (related to lack of fixed suppression in the MCR). Note that these results are considered independently robust, and are not significantly dependant on the robustness of the licensee IPEEE submittal. Given the small number of exemptions, each is summarized as follows:

**KEW-01: *Lack of Separation Inside Containment*** - This exemption is found to have had, at most, a very small risk impact. This is based primarily on (1) the IPEEE considered containment fire CDF and found it to be insignificant, and (2) the lack of credible fire sources and fuel loads of sufficient magnitude to cause redundant train damage.

**KEW-02: *Lack of Fire Suppression in the Shield Building*** - This area acts much like a cable tunnel in terms of the risk implications. The exemption in question relates to lack of a fixed fire suppression system. Hence, the plant is reliant on detection and manual fire suppression for fires impacting this area. In the IPEEE analysis the shield building is not analyzed in detail and is not identified as a fire CDF contributor. There are no fixed fire sources in the area other than the cables themselves, although given the plant vintage (circa 1974 start of operation), self-ignited cable fires should likely be postulated. A conservative bounding analysis shows that the worst case fire CDF for this area is on the order of, at most,  $1E-5/ry$ , and a detailed analysis would likely reduce this estimate even given lack of fixed fire suppression. Hence, it is concluded that this exemption has had, at most, a very small impact on fire risk.

**KEW-03: *Lack of Fixed Suppression in the MCR*** - This is a common class of exemptions. See Section 5 below for further discussion.

#### 3.5.2 Cumulative Impact of Exemptions

At Kewaunee, there are three exemptions. Two (KEW-01 and 02) are ranked as having a very small risk impact. These two impact areas (containment and part of the shield building) that were qualitatively screened in the IPEEE fire analysis indicating very small potential risk contributions. The third exemption was ranked as risk indeterminate and deals with lack of suppression in the MCR. Putting aside the question of MCR fire suppression, it is found that exemptions at Kewaunee have had no cumulative impact on fire risk.

### 3.5.3 Qualitative Risk Impact

In the case of KEW-02, the exemption shifts the burden for suppressing fires in the shield building from reliance on a fixed fire suppression system to reliance manual fire brigade response. No other qualitative risk impacts are noted.

## 3.6 Palisades

### 3.6.1 Summary of Exemption Analysis Findings

Palisades Nuclear Plant has five exemptions. Three of the five address lack of fixed fire suppression in certain fire areas and the other two address lack of 20 feet horizontal separation. The fire zones addressed in these exemptions include the control room, the containment and other general process areas. No exemptions are found to be potentially significant. One, PAL-01, relates to lack of fixed suppression in the MCR and is found to be risk indeterminate. Given the small number of exemptions, each is summarized as follows:

- PAL-01: *Lack of Fixed Suppression in the MCR* - This is a common class of exemptions. See Section 5 below for further discussion.
- PAL-02 and -03: *Lack of Fixed Suppression in the Safeguards Panel Room and in two areas of the Reactor Building (respectively)* - This safeguards panel room serves as the location for the remote shutdown panels. It also houses two 480V MCC panels. In the IPEEE this room is analyzed in some detail and is found to have a very small CDF contribution ( $3.5E-8/\text{ry}$ ). Similarly, the reactor building areas impacted by PAL-03 are also found to have very low CDF contributions. Primarily on this basis, these two exemptions are found to have a very small risk impact.
- PAL-04: *Lack of Adequate Cable Separation Inside Containment* - In this case the exemption cites that there is 75 feet of horizontal separation, but that the separation area is not completely free of combustibles. Given the substantial separation and the low probability of a fire of sufficient magnitude and duration to damage the redundant trains, this exemption is found to have, at most, a very small risk impact.
- PAL-05: *Lack of Adequate Cable Separation in the Containment Air Room* - It is inferred that this area contains only a limited number of instrument cables and that alternate shutdown paths are available. This area is not addressed in the IPEEE analysis, implying that the area was likely screened. Ultimately, given that only a limited subset of the instrumentation cables would be lost, the lack of separation is found to have, at most, a very small risk impact.

Note that the analyses for exemptions PAL-02, -03, and -05 are dependent primarily on the CDF contributions for the impacted areas cited in the IPEEE submittal or, in the case of PAL-05



an assumption that the IPEEE has considered and appropriately screened the fire area. Hence, the robustness of these conclusions is sensitive to the findings of the IPEEE.

### 3.6.2 Cumulative Impact of Exemptions

There are five exemptions at Palisades. Of these, four were ranked as having a very small risk impact. Even summing all of the scenarios potentially impacted by these four exemptions results in a CDF contribution of less than  $1\text{E}-6/\text{ry}$ . The final exemption (PAL-01) was ranked as risk indeterminate and deals with lack of suppression in the MCR. Putting aside the question of MCR fire suppression, it is found that exemptions at Palisades have had, at most, a very small cumulative impact on fire risk. This finding is sensitive to the findings of the IPEEE.

### 3.6.3 Qualitative Risk Impact

Exemptions PAL-02 and PAL-03 have shifted the burden for fire suppression from fixed automatic suppression systems to the manual fire brigade for the impacted areas. The impacted areas are not, however, risk significant based on the IPEEE.

## 3.7 H.B. Robinson

### 3.7.1 Summary of Exemption Analysis Findings

H.B. Robinson was granted thirteen Appendix R exemptions. Of these, two are found to be risk indeterminate (including one related to lack of fixed suppression in the MCR), five are found to have a small risk impact, and the remaining six are found to have a very small risk impact.

The two indeterminate exemptions are summarized as follows:

- HBR-01: *Lack of Fixed Suppression in the MCR* - This is a common class of exemptions. See Section 4 below for further discussion.
- HBR-03: *Lack of Detection, Suppression, Separation, and Alternate SD Capability* - This exemption impacts the service water pump area in the intake structure. In the IPEEE the area is identified as fire zone G/29. The screening CCDP assuming loss of all equipment in the area (i.e., both service water pumps) is cited as  $2.75\text{E}-2$  and the screening CDF is  $3.16\text{E}-4$  assuming a nominal fire frequency and loss of both pumps. In the final analysis the potential for loss of both pumps is apparently dismissed, and the area is found to have a very small risk contribution (on the order of  $1\text{E}-6/\text{ry}$ ). However, based on a description of the configuration of these pumps relative to one another, there appears to be a reasonable basis for questioning the IPEEE results for this fire area. Hence, the exemption is ranked as risk indeterminate.

The remaining exemptions are all ranked as either small or very small risk impact. These are summarized as follows:

- HBR-02: *Lack of Suppression, Barriers and Loss of Cold Shutdown* - This exemption impacted the RHR pump room. However, since only the cold shutdown capability is lost, this exemption is found to have a very small risk impact.
- HBR-04: *Under-Qualified Penetration Seals* - This exemption impacted a cable vault area. The seals in question are 2-hour rated, but 3-hour rated seals are nominally required. The exemption is found to have, at most, a very small risk impact based on the low probability of a fire that would challenge the seals.
- HBR-05: *Inadequate RCP Oil Collection Capacity* - This is a common class of exemptions. See Section 4 below for further discussion.
- HBR-06: *Lack of Detection in Fire Zones 12 and 13 and Lack of Suppression and Alternate Shutdown Capability in the Auxiliary Building* - This exemption appears to impact several fire zones including at least two that are identified as nominally risk important in the IPEEE. However, these two zones in particular did have detection and at least partial suppression available. Based on the results of the IPEEE, which cites that some of the impacted areas have CDF contributions just below  $1E-5/ry$ , this exemption is found to have, at most, a small risk impact. This finding is, however, sensitive to the findings of the IPEEE.
- HBR-07: *Lack of Detection and Suppression* - This exemption impacted fire areas or zones that are all found in the IPEEE to have low screening CCDP and low CDF values. Hence, the exemption is found to have, at most, a very small risk impact.
- HBR-08: *Lack of Detection/Suppression in Fire Area 'G'* - This exemption impacts several individual fire zones including G/29 which is the subject of HBR-03 as discussed above. Other than G/29, there are only two zones nominally identified as risk important. These two zones do include detection and at least partial suppression and are ultimately screened on low CDF. These results appear to be robust; hence, the exemption is found to have, at most, a small risk impact.
- HBR-09: *Lack of Separation Inside Containment* - Containment fires are qualitatively screened in the Robinson IPEEE by direct reference to the FIVE methodology. On this basis, the exemption is found to have, at most, a very small risk impact. However, it is not clear that the licensee has assessed the potential for loss of multiple trains of redundant instrumentation; hence, the finding is sensitive to the findings of the IPEEE.
- HBR-10, -11, and -13: *Lack of Emergency Lighting* - Three exemptions relate to a lack of emergency lighting in various plant areas. HBR-13 is found to have a very small risk impact because it specifically impacts containment, and no recovery actions in containment were credited in the IPEEE. For HBR-10 and -11, several other plant areas are impacted. There may be some risk impact, but this cannot be clearly established based on the IPEEE because little information

on recovery actions is provided. These two exemptions were ranked as having a potential small risk impact based on the CDF contribution of the impacted areas.

- **HBR-12: *Intervening Combustibles in the CCW Pump Room*** - This room is cited in the screening analysis as having a CCDP assuming loss of all equipment in the room of  $8.58\text{E}-02$  and a screening CDF of  $7.38\text{E}-4$ . Hence, the room is nominally very important. There is, however, no detailed analysis of this area provided. The exemption rationale provided by the NRC staff states that the area has a low fuel load, some 1-hour barriers are installed, and detection is available. However, it would appear that fixed suppression is not available. Based on the apparent screening of the area from the IPEEE, this exemption is found to have a potential for, at most, a small risk impact. However, this finding assumes that the area was appropriately analyzed and found to have a small CDF contribution in the IPEEE.

Note that for two of the exemptions in particular (HBR-06 and -12), the finding of a small risk impact is based entirely on the results of the IPEEE analysis. Hence, these findings are only as robust as the IPEEE itself. In the case of one exemption, HBR-03, there appears to be a strong basis for questioning the IPEEE results, hence, the exemption is found to be risk indeterminate.

### 3.7.2 Cumulative Impact of Exemptions

There are 13 exemptions at Robinson, none of which were found to be potentially significant. Several of the exemptions relate to issues that would not be considered as contributing factors in a fire risk assessment and are found to have little or no discernible impact on plant fire risk. However, for other exemptions, a cumulative risk impact is postulated. These cases are summarized as follows:

- One exemption ranked as risk indeterminate (HBR-03) impacts a fire area that was found in the IPEEE fire analysis to be a very small CDF contributor. However, the area contains redundant service water pumps located in close proximity to one another. From the IPEEE submittal it can be inferred that the licensee has assumed that multiple pumps cannot be lost due to a single fire. This assumption has not been explicitly discussed in the IPEEE, but appears critical to the licensee finding of very small CDF contribution. Given the rather high CDF ( $3\text{E}-4/\text{ry}$  assuming a nominal fire frequency and loss of all pumps) obtained in the screening phase of the fire analysis, and give that there is no basis given for dismissing the potential for loss of multiple pumps in the final quantification, the risk impact remains indeterminate, but may be potentially significant. However, no definitive assessment of potential risk reductions is possible.
- One exemption (HBR-06) cites lack of fixed fire suppression in several fire zones in the Auxiliary Building (fire area A). While individually the potential risk reductions for the impacted areas are found to be small, the cumulative impact of the CDF contributions for the impacted areas taken together is potentially significant.

- Two additional exemptions are ranked in the small impact category (HBR-08 and 12). The total CDF contribution for the two impacted areas is approximately  $9E-6/ry$ . Had the exemptions not been granted these scenarios would have likely been reduced from small to very small CDF contributors. Hence the cumulative impact of these two exemptions taken together also ranks as potentially significant.

Hence, given in particular the potential impact of exemptions HBR-06, 08, and 12, it is concluded that the cumulative risk impact of the exemptions at Robinson is potentially significant.

### 3.7.3 Qualitative Risk Impact

A number of exemptions at Robinson have shifted the responsibility for fire suppression from fixed suppression systems to the manual fire brigade (e.g., HBR-01, -02, -03, -06, -07, and -08). This has impacted a number of plant areas both within the plant structure and in outdoor areas. Three of these exemptions have also shifted the burden for fire detection from fixed systems to manual detection (e.g., HBR-03, -06, -08).

In one case, HBR-02, cold shutdown capability may be lost and require repair. In another case, HBR-03, the exemption states that alternate shutdown capability may be lost, and it is not clear how safe shutdown would be achieved.

## 3.8 St. Lucie 1 and 2

### 3.8.1 Summary of Exemption Analysis Findings

St. Lucie has a total of 40 exemptions for both units; sixteen are associated with Unit 1, and 24 with Unit 2. Of the 40 exemptions none are found to be potentially significant, but six are found to be risk indeterminate; four relating to topics other than fixed suppression in the MCR (STL-05, -09, -19, and -20) and two related to lack of fixed suppression in the MCR (STL-10 and -12). Of the other 34 exemptions, two are found to have a small risk impact, and 32 are found to have a very small risk impact.

Due to the relatively large number of exemptions at St. Lucie, and due to commonality between many of the exemptions, the analysis findings will be presented for groups of exemptions rather than for each individual exemption. In particular, many of the exemptions deal with similar situations either in various areas of one unit, or between the two units. Exemptions that impacted fire CDF dominant areas will also be discussed.

The exemptions identified as risk indeterminate will be discussed first. In some cases these are grouped with other small or very small impact exemptions that are similar in nature. Note that in each indeterminate case, the most significant factor in our inability to reach definitive conclusions is the lack of sufficient information, or a lack of relevant discussions, in the IPEEE submittal.

- (STL-05 and -20): *Un-rated hatch covers* - These two exemptions address hatch openings in 3-hour rated fire barriers (floor/ceiling) that are assumed to be closed with non-combustible but un-rated covers. STL-05 applies to Unit 2, and STL-20 applies to similar conditions in Unit 1. These two exemptions are found to be risk indeterminate. The major points of uncertainty that prevent a definitive assessment are (1) the IPEEE submittal does not mention the existence of these hatches and therefore, it is not clear whether they were included in the fire analysis or and (2) at least some of the impacted areas do appear to contain risk significant equipment. In general, the combustible loading of the areas below the hatch is cited as small so the likelihood of a fire that can overcome the cover and damage cables and equipment above should also be small. Another mitigating factor is the fact that the areas above the hatch are protected by automatic suppression systems. These features will substantially reduce the likelihood of a large fire and the resulting CDF. However, a more concise conclusion would require some understanding of the equipment that might be damaged given a large fire. In this case the cables and equipment that are immediately above the hatches are of particular importance. Further, it is not clear how often the hatches are left open versus closed with the non-rated covers. Hence, no defensible conclusions regarding risk significance can be drawn.

- *Lack of Fixed Suppression and/or Detection Coverage*: A number of exemptions relate to lack of fixed fire suppression (STL-09, -14, -15), or lack of both fixed fire detection and fixed fire suppression (STL-16, -17). In most cases these exemptions are found to have a very small risk impact based in large part on the IPEEE results (in particular, STL-14 and -16 are sensitive to the IPEEE findings). In the case of STL-09 the exemption is found to be risk indeterminate. This exemption addresses lack of an automatic fire suppression system in eight separate areas in Unit 2. The impacted areas include Switchgear rooms, hallways, a component cooling area, a steam tunnel, and the intake structure. Of the impacted areas, only one is identified in the IPEEE as having a potentially significant CDF contribution. This is the Hallway to the Division B Fan Room El. 43' which appears to house more than one train of safe shutdown equipment. The IPEEE provided very little information on this area, hence, the CDF implications could not be assessed.

- (STL-10, -12): *Lack of Fixed Suppression in the MCR* - This is a common class of exemptions uniformly ranked as risk indeterminate. See discussion in Section 4 for further discussion.

- (STL-19): *Lack of 3-hour rated fire barrier between personnel area and hold up tank area* - This exemption impacts Unit 1, and is somewhat of an anomaly. The areas impacted by the exemption would not normally be expected to be risk significant. However, the exemption documentation states that there are redundant trains of equipment located within the two adjacent zones. In this case, there is a doorway between the two rooms that has no door. Hence, there is no substantial physical impediment to the flow of heat and fire products from one room to the other. The IPEEE has not provided any detail regarding how these two areas were assessed, although one of the two areas is identified in the IPEEE as risk significant (the personnel area).

Given the lack of detail in the IPEEE, the exemptions risk significance cannot be determined, and the exemption is ranked as risk indeterminate.

For the other exemptions at St. Lucie, it is concluded that the risk impact was either small or very small. These included the following groups:

- *Un-rated or Missing Barriers:* Several exemptions (18) deal with un-rated or missing fire barriers or barrier elements between adjacent fire areas. In particular, five exemptions deal with lack of 3-hour fire barrier (STL-01, -02, -04, -18, -25), four deal with un-rated penetration seals (STL-28, -29, -37, -38), two deal with un-rated watertight doors (STL-22, -27), three deal with lack of fire rated seals, dampers and/or doors in walls (STL-24, -34, -39), three deal with partial fire walls (STL-06, -08, -13), and one deals with a lack of a fire barrier in a case involving greater than 20 feet of separation (STL-07). Of these, only STL-04 is ranked as having a potentially small risk impact. All of the rest are found to have a very small risk impact. This is based on consideration of (1) the IPEEE results for the impacted areas, (2) combustible fuel loading, (3) the significance of fire sources, (4) fire protection features that are available, (5) whether the area is indoors or outdoors, (6) the existence of some substantial barriers to the spread of fire and fire products, and/or (7) the potential for, and impact of, room-to-room fire spread.

- (STL-21, -30): *Inadequate RCP Oil Collection Capacity* - This is a common class of exemptions. See discussion in Section 4 for further discussion.

- (STL-26): *Un-Clad Supports on Clad Conduits* - On first examination, this exemption appears quite similar to FAR-54 (see discussions in 3.4.2 above). However, further examination reveals one substantial difference. Discussions with the cognizant USNRC/NRR staff indicate that the barriers are made of Thermo-Lag and were installed in accordance with then current manufacturer guidelines. Those guidelines did establish a requirement to clad the structural supports for at least nine inches specifically to address the "thermal short-circuit" issue. The exemption deals with the lack of cladding from that point to the ultimate point where the supports are anchored. Hence, it is concluded that for St. Lucie the only issue of concern for this exemption was, indeed, structural collapse. Given this perspective, the exemption is found to have, at most, a very small risk impact.

Note that for two exemptions in particular, STL-14 and -16, the finding of a very small risk impact is based entirely on the results of the IPEEE analysis and conclusions of low CDF impact in the affected areas.

### 3.8.2 Cumulative Impact of Exemptions

For St. Lucie there are 40 exemptions. The cumulative risk impact of the exemptions is summarized as follows:

- There are 34 exemptions ranked in the small and very small risk impact groups. Many relate to issues that would not typically be considered as discernible factors in a fire risk assessment. Even a very conservative assessment of the potential risk impact would find the cumulative impact of these exemptions to be, at most, small.
- There are four exemptions ranked as risk indeterminate (STL-05, 09, 19, and 20). Each relates to issues not addressed in the IPEEE. There is no basis for assessing the risk impact of these exemptions. However, there is a potential that the cumulative impact of these exemptions might be significant.

For St. Lucie the cumulative impact of exemptions that can definitively be assessed is found to be small. There is, however, some potential for a significant cumulative impact as a result of, in particular, four indeterminate exemptions that cannot be assessed. Hence, the overall impact of the exemptions remains indeterminate.

### 3.8.3 Qualitative Risk Impact

Several exemptions cite a lack of fire suppression and/or fire detection. These exemptions do shift the responsibility for fire detection and suppression from fixed automatic systems to plant personnel and manual intervention as has been discussed for other plants in the sample group.

Several exemptions are identified related to missing, partial, or un-rated fire barriers and barrier elements (seals, doors, dampers). While most of these are found to have a very small risk impact, they do shift the burden for plant safety from passive fire barrier protection to fire prevention, minimizing fire hazards, and rapid intervention. The cases identified as indeterminate relate to situations that were apparently not addressed in the IPEEE so the potential risk impact is unknown.

## 3.9 V. C. Summer

### 3.9.1 Summary of Exemption Analysis Findings

There are only two exemptions for Summer, and both are found have a very small risk impact. The two exemptions are summarized as follows:

- SUM-01: This exemption cites lack of fixed fire detection in certain plant areas. The exact areas that are impacted remains unclear, but this was not considered critical to our finding of a very small risk impact. The exemption documentation states that the rooms do not contain safety related equipment susceptible to fire damage. Further, fire detection is possible by a variety of automatic devices outside the area. Hence, the fire CDF associated with these fire zones should be very small and therefore, the added protection afforded by an automatic fire suppression system is deemed to be of minimal impact on risk.

- SUM-02: This exemption cites that a fire in those areas where all channels of T-cold are located would have some effect on control room operators. Since there will be other parameters available, operators would be capable of monitoring the conditions of the core, the steam generators and primary cooling loop. Since the control room itself would not be affected by a fire in the fire zones where loss of T-cold may occur, it is deemed that the protection of a redundant set of T-cold related cables in the four rooms would have little impact on core damage frequency.

Note that these results are not sensitive to the IPEEE findings and are considered independently robust.

### 3.9.2 Cumulative Impact of Exemptions

There are only two exemptions at Summer, and both are ranked as having a very small risk impact. Only a very limited number of fire scenarios are impacted, and the total risk contribution of these scenarios is also found to be very small. Hence, for Summer, it is concluded that Appendix R exemptions have had, at most, a very small cumulative impact on plant fire risk.

### 3.9.3 Qualitative Risk Impact

There are no significant qualitative risk implications identified for Summer.

## 3.10 Turkey Point Units 3 and 4

### 3.10.2 Summary of Exemption Analysis Findings

There are 36 exemptions identified for Turkey Point Units 3 and 4. Of these exemptions 20 address both units, 9 address Unit 3, and 7 address Unit 4. Of the exemptions six are found to be risk indeterminate including two relating to lack of fixed fire suppression in the MCR. The remaining 30 exemptions are all found to have a very small risk impact. It is also noted that the exemptions are rather repetitive. Many individual exemptions deal with similar issues for different areas, and/or deal with identical issues for corresponding areas in the two sister units.

Given the relatively large number of exemptions, the discussion here will focus on general groups of exemptions and related insights. The findings are summarized as follows:

- *Indeterminate exemptions in the Turbine Building:* There are four specific exemptions that were ranked as risk indeterminate based on recent USNRC/NRR staff activities (TUR-02, -14, -15, and -16). The impacted areas are all in the Turbine Building. In the IPEEE the entire Turbine Building was screened. However, based on recent staff fire protection evaluations [Ref. 2,3], it is clear that the IPEEE did not fully address the fire hazards present in these areas. Lacking an alternate basis for assessing the CDF contributions for the impacted areas, these four exemptions are ranked as risk indeterminate.



- *Sensitivity to IPEEE Findings:* Several exemptions are found to have a very small risk impact based entirely on the CDF estimates provided in the IPEEE (including TUR-01, -03, -04, -06, -09, -12, -19, -20, -21, -22, and -36). The robustness of these conclusions is sensitive to the findings of the IPEEE.
- *RCP Oil Collection Capacity (TUR-11, -32):* This is a common class of exemptions. See Section 5 below for further discussion.
- *Lack of Fixed Suppression in the MCR (TUR-09, -30):* This is a common class of exemptions uniformly ranked as risk indeterminate. See Section 5 below for further discussion.
- *Lack of Fixed Emergency Lighting (TUR-10, -31):* In this case, both of these exemptions relate to emergency lighting inside containment. As in other similar cases, the risk impact of containment lighting is found to be very small based on the fact that the IPEEE does not credit any recovery actions inside containment.
- *Lack of Detection and/or Suppression:* At least 14 exemptions at Turkey Point deal with the lack of fixed detection and/or suppression systems. This includes the four Turbine Building exemptions ranked as risk indeterminate. For the other ten cases, a finding of very small risk impact is based, at least in part, on the cited IPEEE results of a low CDF contribution for the impacted area.

### 3.10.2 Cumulative Impact of Exemptions

At the time of the IPEEE fire analysis, Turkey Point had a total of 36 exemptions, among which there appears to be considerable redundancy (multiple exemptions citing the same features and alternate compliance strategy in the same plant areas). The cumulative impact of the exemptions as the plant existed at that time is summarized as follows:

- There are 30 exemptions ranked as having a very small risk impact. The majority of these deal with issues that would not typically be considered as contributing factors in a fire risk assessment and are found to have had no discernible impact on fire risk. For the others (in particular TUR-01, 04, 06, and 07) the cumulative risk impact is found to be, at most, small.
- There are 4 exemptions ranked as risk indeterminate (TUR-02, 14, 15, and 16) based on information provided in staff evaluation reports associated with more recent exemption requests by the licensee [Ref. 2,3]. As noted above, the exemptions considered in this study are those that were originally granted by the USNRC and reflect the state of the plant at the time of the IPEEE fire analysis. However, in the IPEEE fire analysis, the licensee has screened the impacted areas (the turbine building) so there is no basis for quantitatively estimating the numerical CDF impact. However, given the information

provided in the new staff evaluations, in the judgement of the authors, it is likely that the cumulative impact of these four was potentially significant.

In summary, it is considered likely that the cumulative risk impact of exemptions at Turkey Point as they existed at the time of the IPEEE fire analysis was potentially significant. This finding is based primarily on the judgement of the authors regarding the four indeterminate turbine building exemptions. It must again be noted that new exemptions have superseded a number of the exemptions considered in this study, and that the licensee has implemented a number of fire protection program improvements that would impact the risk significance of the exemptions. This study has not included consideration of either the new set of exemptions nor the associated plant improvements.

### 3.10.3 Qualitative Risk Impact

Several exemptions cite a lack of fixed fire detection and/or fixed fire suppression in areas containing multiple trains of safe shutdown equipment. This implies that the burden for fire detection and suppression shifts from fixed automatic systems to manual intervention as has been noted at other plants.

A number of cases are also noted that involved missing or un-rated fire barrier elements (penetration seals, doors, etc.). In particular for the cases where barriers have not been provided between redundant trains, the mitigation of fire risk becomes dependent on fire prevention, minimizing fire sources, and rapid intervention in fires that do occur, rather than reliance on a protected safe shutdown train. This also has been encountered at other plants in the sample group.

## **4. Broad Insights Regarding General Classes of Exemptions**

### **4.1 Overview**

This chapter provides a discussion of broad insights gained through this study. In particular, based on the sample group, many of the exemptions cite similar plant features and compliance strategies. Indeed, it was found that relatively few of the exemptions are truly unique and that most fall into one of several broad groups. The following is a list of exemption features that are found commonly among the 169 exemptions reviewed in this study.

- Lack of fixed automatic fire suppression:
  - in general plant areas that contains redundant trains
  - in the main control room (MCR)
- The potential loss of safe shutdown equipment being mitigated by reliance on human actions rather than passive/active protection of one shutdown path
- Non-compliant physical separation of unprotected redundant trains:
  - by less than 20 feet
  - by more than 20 feet, but with intervening combustibles
- Non-compliant fire barriers:
  - Substantial but unqualified fire barriers
  - Missing or partial fire barriers
- Lack of emergency lighting system
- Under-designed reactor coolant pump (RCP) oil collection system

Each of these is discussed in the following subsections.

### **4.2 Lack of Fixed Fire Suppression**

Almost half of the exemptions in the sample group address lack of either fixed automatic fire suppression, fixed fire detection, or both systems. These exemptions can be divided into two groups; those that address lack of automatic suppression system in the MCR and those that address other parts of the plant. These two groups are discussed separately below.

#### **4.2.1 Lack of Fixed Fire Suppression in General Areas**

The single most commonly encountered class of exemption are those related to lack of fixed fire suppression in general plant areas. These are cases where a fire area contains redundant safe shutdown equipment trains, but an exemption is sought for the requirement to install a fixed automatic fire suppression system. These are generally cited as falling under Appendix R sections III.G.2 or III.G.3. Approximately half of the exemptions in the sample group fell into this class.

In very general terms, the lack of a fixed automatic fire suppression system shifts the burden for fire suppression from an automatic system to the manual fire brigade. A fire risk analysis will

typically assume a minimum brigade response time of at least 10-20 minutes in general plant areas. For remote or inaccessible plant areas, response times of 30 minutes or more might be postulated. In comparison, a fixed suppression system is typically assumed to operate in well under five minutes in most cases. Hence, the lack of fixed fire suppression nominally allows more time for a fire to grow unchecked and increases the probability of more extensive fire damage for a given scenario. However, an assessment of the CDF contribution must also consider the fire sources that are present, the nature of the fuel sources present (arrangement, type, quantity, and proximity to exposure fire sources), the potential existence of cable "pinch points," the proximity of critical targets to the fire sources, the availability of other passive protection features (such as local fire barriers), and the vulnerability of the critical equipment.

There are three common bases upon which these exemptions are sought and/or granted. The assessment of risk significance for these exemptions depends on which of these bases is used to justify a particular exemption. These bases and our approach to assessment are summarized as follows:

- The majority of cases cited that one train of equipment (usually cables) is protected by a one-hour fire barrier system (typically a local fire wrap). In these cases the exemptions are typically sought/granted based on existing automatic fire detection, minimal fuel loading, a lack of significant fire source hazards (either altogether or in close proximity to the critical equipment), and availability of manual fire fighting equipment and personnel. The assessment of these cases concluded that exemptions granted on this basis had only a small or very small risk impact. A one-hour fire barrier does provide a substantial level of protection under a range of fire conditions. Further, the fact that the fire areas contain minimal fuel loads and minimal source fire threats also implied that fires severe enough to challenge these fire barriers would be very unlikely. Finally, the presence of fire detection and manual fire fighting make it unlikely that a fire would burn unchecked for a sufficient period of time to challenge the barriers. Examples include DRS-05 and FAR-10.
- A second subset of this class of exemptions cited no local fire barrier protection, but did cite that there is substantial separation of the redundant trains well in excess of the nominal twenty-foot requirement of Appendix R. In some cases this separation might include some minimal amounts of intervening combustibles. These exemptions typically impacted very large fire areas (such as areas in the reactor building or within containment). This sub-class also cited minimal fuel loading in the area, minimal fire source hazards (either for the area as a whole or in close proximity to the critical equipment), and the availability of fixed detection and manual suppression. Our assessment of this sub-class found these exemptions to have a very small risk impact. With a very large fire area and substantial separation it would take a very large fire burning unchecked for a long time to lead to damage to the redundant trains. Given the configuration cited in these cases, this is deemed to be very unlikely. Examples include DRS-08.

- A third subset of this class of exemptions proved to be more problematic. This subclass cited lack of 1-hour barriers between redundant trains and lack of fixed automatic fire suppression system. Several of these impacted fire zones that the IPEEE identified as risk significant (i.e, high CDF). These exemptions are generally granted on the basis of either an overall low fuel load and minimal-to-modest fire source hazards, or the existence of fixed detection and extensive manual suppression capability. Several also cited manual actions that could be taken to overcome fire damage. This class of exemptions is ranked as having either a small or very small risk impact if information could be found in the IPEEE that addresses the specific fire zone or area and the corresponding CDF is small (i.e., less than  $1E-5/ry$  or  $1E-6/ry$ ). Otherwise, the exemption is ranked as either potentially significant or risk indeterminate. Those exemptions that addressed risk significant fire zones are generally categorized as potentially significant. Examples include exemptions FAR-19, FAR-20 and FAR-23.

#### 4.2.2 Lack of Fixed Automatic Suppression in the MCR

A second commonly encountered class of exemptions deals with the lack of fixed automatic fire suppression specifically in the MCR. Most of the plants in the sample group (six of nine) had specific exemptions for the lack of a fixed fire suppression system in the MCR, and based on the IPEEE submittals it would appear that none of the remaining three plants actually has such systems installed. Indeed, in the experience of the authors, fixed fire suppression in the MCR is quite rare.

Ultimately, this particular class of exemptions is found to be risk indeterminate. Factors that would tend to minimize the risk significance of fixed automatic fire suppression in the MCR include the following:

- The MCR is continuously manned; hence, it is generally assumed that operators will quickly intervene in any fires that do occur. Indeed substantially greater credit is commonly given to prompt manual intervention in MCR fires than is given to fires in most any other areas of the plant. The installation of an automatic fixed fire suppression system would, therefore, not result in the same level of CDF reduction as would be observed in other areas. In particular, one could not assume that the manual and automatic systems are substantially independent, rather, there are dependencies that must be considered, and these would reduce the potential risk benefit (including, for example, issues of coincident timing).
- There is also a potential for undesirable impacts related to an automatic fire suppression system that can offset the benefits gained from installing such a system. In most plant areas these concerns can be addressed with relative ease, however, in the MCR such concerns would be very difficult to address. An automatic fire suppression system may cause additional damage induced by the suppressant itself. Further, the inadvertent

discharge potential must also be considered. In considering the currently available approaches to fixed suppression the following consideration would apply:

- Much of the equipment housed in the MCR would be vulnerable to water damage so use of water may not be desirable.
- Carbon Dioxide based systems would present serious habitability concerns that would need to be carefully assessed.
- Halon-based systems are subject to suppressant availability problems due to Halon's status as an ozone depleting fluorocarbon compound; hence, Halon does not represent a viable long-term solution.

Thus, plants would need to either consider advanced and unproven methods of fire suppression (such as water mist systems or the Halon replacements), or make extensive plant modifications to contain and control suppressants once they are discharged.

However, the authors acknowledge that alternate arguments can be made for a significant risk reduction potential. This includes the following points:

- While there have been a small number of minor MCR fires, there is yet to be a significant and challenging fire in a nuclear power plant MCR. Hence, the real likelihood of a serious MCR fire remains uncertain.
- The residual CDF from MCR fires derives primarily from those fire scenarios that are assumed to remain un-suppressed for some substantial period of time (several minutes). If this residual CDF is significant (i.e. greater than  $1E-5/ry$ ) then a potential for significant risk reductions as defined in this report must be acknowledged. Fixed automatic fire suppression systems may be one way to achieve these risk reductions.

A general consensus regarding the significance of residual MCR fire risk has not truly formed. Current thinking reflects a dichotomy of opinion. Most risk analysts will acknowledge the potential for MCR fires to be risk significant. In particular, a fire of sufficient severity to cause MCR abandonment would present a serious challenge to the safe shutdown capability of most plants. However, the actual risk significance of MCR fires remains a point of significant debate.

Another limitation that prevents a clear resolution of these exemptions is the fact that, in general, treatment of MCR fires in the IPEEE analyses has been relatively weak, particularly with regard to abandonment scenarios and the resulting procedures for post-fire safe shutdown. This is an area of analysis that continues to develop, and continues to be a focus of controversy. A majority of the IPEEE submittals have identified the MCR as a significant contributor to fire CDF.

Given the uncertainties associated with the CDF contribution of the MCR itself, and the observed weaknesses in the IPEEE's treatment of MCR fires in general and MCR abandonment scenarios in particular, the authors find these exemptions to be risk indeterminate. It is beyond the scope of this effort to resolve these issues.

#### **4.3 Lack of Fully Compliant Redundant Train Separation**

##### **4.3.1 Separation of at least Twenty Feet with Intervening Combustibles**

The second most commonly encountered general class of exemptions deal with cases where there is some separation between redundant trains within a fire area, but either the intervening space did contain some combustibles or the distance did not comply with Appendix R requirements. This was cited as a factor in close to half of the exemptions in the sample group.

In general, these exemptions are sought/granted on the basis of (1) minimal quantities of intervening combustibles, (2) minimal overall fuel loads in the impacted area, (3) minimal fire source threats, (4) substantial existing separation, (5) existence of fixed detection and suppression, or (6) a combination of these five factors.

In cases where the area is either partly protected by automatic suppression systems, the area is very large, or the area is open (e.g., there is no ceiling) the exemptions are uniformly determined to have a very small risk impact. In other cases the combination of minimal fuel loads, minimal fire source hazards, and substantial existing separation led us to conclude that the likelihood of fires of sufficient magnitude and duration to damage both redundant trains is very small. Examples include exemption DRS-07.

##### **4.3.2 Separation by less than Twenty-Feet**

Several exemptions address lack of 20 feet of separation between redundant trains, and the majority of these exemptions address the containment. For the containment, in the majority of cases it is concluded that the exemptions have, at most, a very small risk impact. Examples include exemption PAL-04. However, indeterminate ranking is assigned if it is suspected that there could be a pinch-point of a critical set of cables. Those cases found to be potentially significant or risk indeterminate generally involved lack of fire barriers and/or a lack of fire suppression as well. These cases are discussed in Section 4.2.

#### **4.4 Barriers Lacking Specific Fire Rating**

Another commonly encountered class of exemptions are related to substantial barriers that lacked a specific fire rating. These are typically associated with major structural members (walls, ceilings, floors) and various openings in these members that are not specifically fire rated. Several different cases are encountered, and each had a somewhat unique basis for assessment of the risk significance. These include the following:

- Several exemptions cited the use of watertight doors with no specific fire rating. In general, these exemptions are generally sought/granted on the basis of a low area fuel load. These exemptions are uniformly judged to have a very small risk impact. These doors are quite substantial, being made of steel, and include a very substantial latching

mechanism far in excess of a typical rated fire door system. Breaching such a door would require a quite severe fire of long duration in close proximity to the door, and such fires are uniformly found to be very unlikely in the impacted fire areas. Examples include exemption CAL-01 and CAL-02.

- Some cases were encountered involving valve stems that passed through a wall between a high-radiation area and a low-radiation area. These are specifically designed to allow for manual operation of valves without the need to enter the high-rad area. The construction features made it clear that there is little or no space between the valve stem and the bushings provided to guide the stem through the wall. Hence, the spread of flames or significant quantities of smoke or heat through these penetrations is considered very unlikely. Further, because the valves, valve stems, and valve handles are all of non-combustible metal materials, there is little chance that secondary ignition would occur on the unexposed side of the barrier. These cases are also ranked in the very small risk impact category. Examples include FAR-07.
- Several exemptions cite reliance on partial walls or a partial shield between redundant equipment in lieu of a full fire wall. In these cases the contents and configuration of the compartment are examined. The potential for formation of a hot layer and the resulting damage potential played a major role in our assessment of these exemptions. In all cases encountered in this study the exemptions are ranked as having a very small risk impact because there are no cables or other combustibles near the ceiling that might lead to fire spread past the partial barrier, the critical targets are located at floor level meaning that hot layer or plume damage is unlikely, and/or it is an open area (i.e., no ceiling or no walls) so that a hot layer cannot form. Examples include STL-06, 07 and 08.

#### 4.5 Lack of Emergency Lighting

Several plants in the study group had exemptions for a lack of fixed emergency lighting within the containment or other plant locations. Examples include exemptions CAL-05, TUR-10 and -31, and HBR-10, -11, and -13. In all cases, the licensee has portable lighting available. The only potential CDF implication of this class of exemptions is the possibility that the failure probability would increase for operator recovery actions that might be required inside impacted areas. The assessment of these exemptions was somewhat different depending on the areas impacted.

- *Inside Containment:* Exemptions that cited a lack of fixed emergency lighting inside containment were uniformly ranked as having a very small risk impact. This is because, to the knowledge of the authors, no fire risk assessment had ever credited operator recovery actions inside containment. Hence, the existence or lack of fixed emergency lighting would not be considered as a discernible factor in a typical risk assessment.
- *In General Plant Areas:* The question of emergency lighting in general areas of the plant is a bit more problematic to assess. Most fire risk analyses will credit some operator



recovery actions that take place outside the MCR. Fixed emergency lighting is intended, at least in part, to support operators in the performance of such actions. The lack of fixed emergency lights may adversely impact or delay operators in their attempts to perform these recovery actions. However, in the cases encountered in this study, the IPEEEs provided very little or no information regarding the development of human error probability (HEP) values associated with human recovery actions. None made any specific mention of the lighting available as a part of the recovery analysis. In the judgement of the authors, the lack of fixed emergency lighting would have, at most, a small risk impact. Hence, these exemptions were uniformly ranked in the small impact category.

#### 4.6 RCP Oil Collection System Capacity

A total of four of the nine plants in the study group had exemptions related to an inadequate capacity for the Reactor Coolant Pump (RCP) oil collection system. In each case there is a collection system available, but the system can only handle the full inventory of oil in one pump rather than the full inventory of all pumps.

Discussions with the NRC staff revealed that typical design practice is to place the collection tank remote from the RCPs themselves and outside the biological shield wall (but within containment). Further, if an overflow were to occur, the oil would spill to the containment floor in the area of the tank (not the RCPs), and would then flow to the containment sump.

For these exemptions to have any impact on plant fire risk one must postulate the simultaneous failure of more than one pump leading to an oil spill whose volume exceeds the available collection capacity. Further, one must postulate that the oil overflows the collection tank, pools in an area that might threaten safe shutdown equipment, and is actually ignited. The only credible scenario the might lead to simultaneous loss of more than one RCP is an earthquake. However, the RCP pumps and the associated oil collection system are designed to withstand a safe-shutdown earthquake (SSE). It would, therefore, require an earthquake that exceeds the SSE to cause failure. This, in itself, is a low probability event.

Overall, it would require a combination of a number of low probability events to even result in a fire actually being initiated; namely, occurrence of an earthquake greater than the SSE, simultaneous failure of more than one RCP including release of the full inventory of oil, and ignition of the oil spilled at the tank location or into the containment sump. This, however, is simply the equivalent of a fire event frequency. For the fire to be risk significant we must also consider the potential for equipment damage due to the fire that goes beyond the damage already realized by the earthquake itself, and the availability of alternate shutdown paths. Given these cascading factors, it is considered extremely unlikely that any such scenarios would lead to CDF contributions of  $1E-5$ /ry or higher. Hence, the exemptions are not considered to be potentially significant. In the opinion of the authors, it is likely that any such scenarios would have CDF

contribution of less than  $1E-6/ry$ . Hence, the exemptions were uniformly found to have a very small risk impact.

#### 4.7 Reliance on Human Actions to Overcome Equipment Damage

A number of exemptions address areas/zones where loss of safe shutdown cables and equipment would require operators to manipulate controls or equipment at several locations within the plant to achieve safe shutdown. In certain cases this is cited specifically in the context of overcoming potential hot shorts or other electrical faults. Examples include exemptions DRS-02 and FAR-09. In the case of Dresden, the exemption deals specifically with fires in the MCR. At Farley, however, the manual actions are relied upon for fires in several plant areas and appear as factors in several of the exemptions (see discussion in Section 3.4.3).

Reliance on manual actions to repair/recover damaged systems may result in a significant potential shift in the level of defense in depth available. In particular, there is a shift from the passive/active protection of one train of safe shutdown equipment to reliance on repairs and manual recovery actions. Thus, a substantial layer of defense in depth may be eroded.

In the specific case of Dresden, the actions cited were numerous and complex (e.g., pulling of specific fuses and replacement of others, isolation of non-safety loads from critical buses, manually operating disconnect switches, tripping circuit breakers, and manipulation of transfer switches). Further, it did not appear that the IPEEE analyzed these operator actions to assess the potential risk significance.

For Farley, the actions were generally cited in conjunction with various exemptions whose focus was on other fire protection features. In each case, the cited actions were generally fewer in number and less complex than those cited at Dresden (for example, recovery of a specific valve or set of valves). However, the actions were required for a broader range of fires in a number of plant areas. It was also not clear for Farley that the IPEEE considered the risk implications of the need to perform these actions.

For exemptions that cited manual actions to overcome fire damage, the IPEEE submittal is scrutinized carefully to ascertain that manual actions and the specific scenarios are addressed. In general the treatment of human actions has been noted as an area of weakness in many IPEEE submittals. A risk indeterminate ranking may be assigned if the IPEEE submittal does not provide sufficient information regarding the postulated manual actions, and if it appears that an assessment of those actions would be critical to a full understanding of the risk implications. In some cases, a potentially significant designation may result based entirely on other factors cited in the exemption especially if a risk significant fire area is impacted.

## 5. Summary of Findings and Conclusions

### 5.1 Direct CDF Risk Implications

The results of the exemption risk significance ranking for individual exemptions in the sample group overall and for each plant in the sample group are summarized in Table 5.1. Recall that in this ranking four categories are identified; namely, potentially significant, risk indeterminate, small risk impact, and very small risk impact. A potentially significant risk impact is defined as a potential CDF increase of  $10^{-5}$ /ry or greater given that the exemption was granted as compared to the likely CDF had the licensee implemented the compliance strategies outlined in Appendix R. A small risk impact is defined as a potential risk increase between  $10^{-6}$ /ry and  $10^{-5}$ /ry, and a very small risk impact is defined as a risk increase of less than  $10^{-6}$ /ry. Indeterminate exemptions are those exemptions for which there is an indication of a potentially significant risk impact, but for which there was not sufficient information available (generally in the IPEEE) upon which to base a more definitive assessment of the actual risk impact.

Table 5.1: Number exemptions in each risk impact category.

|   | Total # of Exemptions | Potentially Significant | Indeterminate                            |                               | Small Risk Impact | Very Small Risk Impact |
|---|-----------------------|-------------------------|--|-------------------------------|-------------------|------------------------|
|   |                       |                         | Other than Lack of MCR Fixed Suppression | Lack of MCR Fixed Suppression |                   |                        |
| Calvert Cliffs 1  | 5                     | -                       | -  | -                             | 1                 | 4                      |
| Dresden 2&3   | 11                    | 3                       | 2  | 1                             | 3                 | 2                      |
| Farley 1&2  | 54                    | 2                       | 2  | -                             | 3                 | 47                     |
| Kewaunee  | 3                     | -                       | -  | 1                             | -                 | 2                      |
| Palisades   | 5                     | -                       | -  | 1                             | -                 | 4                      |
| Robinson  | 13                    | -                       | 1  | 1                             | 5                 | 6                      |
| St. Lucie 1&2   | 40                    | -                       | 4  | 2                             | 2                 | 32                     |
| Summer  | 2                     | -                       | -  | -                             | -                 | 2                      |
| Turkey Point 3&4 <sup>1</sup>   | 36                    | -                       | 4  | 2                             | -                 | 30                     |
| All 9 Plants  | 169                   | 5                       | 13                                       | 8                             | 14                | 129                    |
| 1. The Turkey Point exemptions considered here are those that were in effect at the time of the IPEEE fire analysis (circa 1991). |                       |                         |  |                               |                   |                        |

It is concluded that some Appendix R exemptions do hold the potential to have resulted in significant risk increases as defined in this study. Of the 169 Appendix R exemptions independently examined in this study it is concluded that five are potentially risk significant. These cases impact Farley and Dresden and are summarized as follows:

- The two potentially significant exemptions at Farley relate to lack of fixed automatic fire suppression, lack of one-hour fire barriers, and in one case lack of fixed detection as well. Each impacts an area identified in the IPEEE as a significant contributor to fire CDF. In each case it is found that had the exemptions not been granted, these dominant CDF contributors would have been reduced substantially. Given the information available in the IPEEE submittal, it is not possible to quantify the actual CDF reduction for any of the exemptions. It is, however, likely that each of the impacted fire scenarios would have been reduced to, at best, visible but no longer significant CDF contributors (i.e., the CDF estimates for each impacted area would have likely dropped well below  $1E-5/ry$  and possibly below  $1E-6/ry$ ).
- The three potentially significant Dresden exemptions also relate to lack of fixed automatic suppression, and two cite a lack of fixed detection as well. Each of the three impacts one or more areas identified in the IPEEE as significant or dominant contributors to fire CDF. In particular three dominant/significant CDF contributors are impacted substantially. Overall, it is estimated that for the impacted scenarios, the CDF reductions would be on the order of at least 0.05 (1/20) assuming installation of fixed automatic suppression systems. Hence, it is likely that the impacted scenarios would have become, at best, visible but no longer significant CDF contributors.

In addition, there are 21 exemptions ranked as indeterminate. For each of these indeterminate exemptions there is some indication of a potentially significant risk impact, but the actual risk impact cannot be clearly determined based on the information reviewed in this study. Of these 21, eight relate specifically to the lack of fixed suppression in the MCR. These exemptions were uniformly classified as risk indeterminate based primarily on a lack of consensus regarding the residual risk associated with MCR fires. The remaining thirteen indeterminate exemptions deal with various issues and remain indeterminate due primarily to a lack of sufficient information, or relevant discussions, in the IPEEE submittal. The indeterminate exemptions generally relate to physical phenomena such as suppression, detection, fire barriers, and/or human factors issues related to repair and recovery. These aspects of the analysis are often presented in only sparse detail in the IPEEE submittals. Others relate to issues that do not appear to have been addressed in the IPEEE, and therefore, lack a basis upon which to assess the risk importance.

It is also concluded that most exemptions have had either a small or very small impact on fire risk. In all, approximately 85% of the exemptions were ranked in these two categories (143 of 169). Included in the exemptions ranked in the very small impact group were a number of exemptions that are found to have had no discernible impact on fire risk at all. This subset of exemptions cite plant features or issues that would not be considered as discernible factors in a typical risk

assessment. In many cases, the determination of a small or very small risk impact was based largely or entirely on the cited CDF results for the impacted areas/zones in the IPEEE. In these cases, the findings are sensitive to the findings of the IPEEE.

## 5.2 Findings Relating to Cumulative CDF Impact

An assessment of the cumulative CDF impact is performed for each plant individually. The results are summarized in Table 5.2. As noted above, seven of the nine plants in the sample group have indeterminate exemptions (six plants have indeterminate exemptions for lack of fixed fire suppression in the MCR and five plants have indeterminate exemptions relating to other issues).

| Table 5.2: Summary of cumulative risk impact assessment results for each plant in the study group (excluding the question of fixed fire suppression in the MCR).  |                         |                   |                        |
|---|-------------------------|-------------------|------------------------|
|   | Potentially Significant | Small Risk Impact | Very Small Risk Impact |
| Calvert Cliffs 1  |                         | X                 |                        |
| Dresden 2&3 <sup>1</sup>  | X                       |                   |                        |
| Farley 1&2 <sup>1</sup>   | X                       |                   |                        |
| Kewaunee <sup>1</sup>   |                         |                   | X                      |
| Palisades <sup>1</sup>  |                         |                   | X                      |
| Robinson <sup>1</sup>   | X                       |                   |                        |
| St. Lucie 1&2 <sup>1</sup>  |                         | X                 |                        |
| Summer  |                         |                   | X                      |
| Turkey Point 3&4 <sup>1,2</sup>   | X                       |                   |                        |
| <p>1. These plants have indeterminate exemptions that could lead to a potentially significant cumulative impact. Only at Turkey Point is the overall cumulative impact ranking based on the judgement of the authors regarding the potential contribution of the indeterminate exemptions.</p> <p>2. The Turkey Point exemptions considered here are those that were in effect at the time of the IPEEE fire analysis (circa 1991).</p> |                         |                   |                        |

The question of fixed fire suppression in the MCR is not explicitly considered in the assessment of cumulative impact. For the five plants having indeterminate exemptions relating to other matters (i.e., unrelated to lack of fixed suppression in the MCR), the discussions below provide a nominal assessment of the potential impact of these exemptions. The resolution of indeterminate

exemptions may change the cumulative CDF impact. Therefore, for those plants where the cumulative CDF impact is ranked as either very small or small, if there are indeterminate exemptions, there is a potential for the cumulative CDF impact to increase to potentially significant.

The cumulative impact findings for each plant are summarized as follows:

Calvert Cliffs 1 has a total of five exemptions.<sup>17</sup> Of the five, only two are found to have had a potential discernible impact on plant fire CDF (CAL-03, and 05). The others were found to have had no discernible impact. Overall, as a result of the exemptions, one impacted scenario has the potential for a small risk contribution and there are several impacted scenarios whose cumulative CDF contribution is very small. Hence, it is concluded that for Calvert Cliffs the Appendix R exemptions have had, at most, a small cumulative impact on fire risk.

Dresden has a total of 11 exemptions that are ranked in all four risk significance categories. It seems that most of the fire areas at Dresden identified in the IPEEE submittal as significant CDF contributors (CDF in excess of  $1E-5/ry$ ) are impacted by an exemption. The cumulative impact of the exemptions at Dresden is found to be potentially significant. This derives primarily from the three exemptions ranked individually as potentially significant. There is also a potential contribution from the three indeterminate exemptions that may also represent a potentially significant cumulative impact.

Farley has a total of 54 exemptions ranked in all four risk significance categories. It is concluded that exemptions may have had a potentially significant cumulative impact on fire risk at Farley. This cumulative impact derives from two sources. First is the risk impact of three potentially significant exemptions. Given that each of these exemptions was found to be potentially significant, their cumulative impact is also potentially significant. However, the cumulative impact of the 50 small and very small category exemptions is also found to be potentially significant. Numerous scenarios with individual contributions that are below  $1E-5/ry$  are impacted, and the cumulative CDF contribution for all such areas is potentially significant (i.e., greater than  $1E-5/ry$ ). Hence, even in the absence of the potentially significant and indeterminate exemptions, a potentially significant cumulative impact can be demonstrated.

Kewaunee has just three exemptions. None of these was ranked as potentially significant, and only one, relating to lack of fixed fire suppression in the MCR, was ranked as indeterminate. Putting aside the question of MCR fire suppression, it is found that exemptions at Kewaunee have had no cumulative impact on fire risk, i.e., at most a very small impact.

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<sup>17</sup> Recall that Calvert Cliffs 2 had no identified exemptions

Palisades has five exemptions. None of these was ranked as potentially significant, and only one, relating to lack of fixed fire suppression in the MCR, was ranked as indeterminate. Putting aside the question of MCR fire suppression, it is found that exemptions at Palisades have had, at most, a very small cumulative impact on fire risk.

Robinson has 13 exemptions, none of which taken individually were found to be potentially significant. This is largely based on the IPEEE findings in that none of the impacted areas had a CDF contribution substantially higher than  $1E-5/ry$ . There were however, several impacted areas with contributions just below  $1E-5/ry$  whose cumulative CDF contribution does add to greater than  $1E-5/ry$ . It is on this basis that a cumulative risk impact is postulated. Given in particular the potential impact of exemptions HBR-06, 08, and 12, it is concluded that the cumulative risk impact of the exemptions at Robinson is potentially significant.

Summer has only two exemptions, and both are ranked as having a very small risk impact. It is concluded that Appendix R exemptions have had, at most, a very small cumulative impact on plant fire risk at Summer.

St. Lucie has 40 exemptions. The cumulative impact of exemptions that can definitively be assessed is found to be small. There is, however, some potential for a significant cumulative impact as a result of, in particular, four indeterminate exemptions that cannot be assessed.

Turkey Point had 36 exemptions at the time of the IPEEE fire analysis. The cumulative risk impact of exemptions at Turkey Point as they existed at the time of the IPEEE fire analysis is found to be potentially significant. This finding is based primarily on the judgement of the authors regarding the four indeterminate turbine building exemptions. In this case, the exemptions remain indeterminate because the IPEEE had screened the entire turbine building and there is no alternate basis for establishing the risk contribution of the impacted areas. Based on the staff documentation reviewed in this study, it appears clear that the licensee IPEEE fire analysis did not fully address the fire hazards present in the turbine hall. Despite the lack of a defensible CDF estimates for the impacted areas, it is concluded that taken as a group the cumulative impact of these four exemptions in particular is potentially significant. The plant's cumulative impact has been ranked accordingly. It is again noted that new exemptions have superseded a number of the exemptions considered in this study, and that the licensee has implemented a number of fire protection program improvements that would impact the risk significance of the exemptions. This study has not included consideration of either the new set of exemptions nor the associated plant improvements.

### 5.3 Qualitative Risk Impact

Qualitative risk impacts relate to shifts in the nature or source of the dominant plant fire risk scenarios, and to the extent to which fire risk mitigation is dependent on various aspects of the defense in depth fire protection strategy. Relevant risk insights developed in these areas include the following:

- *Manual versus Fixed Automatic Suppression:* Numerous cases are noted involving the lack of fixed automatic fire suppression systems in fire areas containing redundant trains of safe shutdown equipment. Indeed, this represented the single most common class of exemptions encountered in the sample group. With no fixed fire suppression in place, the impacted plants become more dependent on manual fire fighting. Exemptions in this group proved to be especially important for Farley and Dresden in that all of the exemptions found to be potentially significant fall into this group. This group is also well represented in the risk indeterminate exemptions. In general, these exemptions were also often noted in conjunction with lack of fire barriers for redundant cables (e.g. Farley) and/or lack of fixed detection. The lack of fire barriers in particular was found to substantially increase the potential risk significance of these exemptions.
- *Lack of Separation and Absent Fire Barriers:* Several cases are noted in which fire barriers are nominally required but not installed. This is also a relatively common class of exemptions. In these cases, there is a shift away from passive protection of one train of safe shutdown equipment as a means of ensuring plant safety towards fire prevention, minimizing fire hazards, prompt intervention, and alternate shutdown or manual repair and recovery. These cases often are encountered in conjunction with a lack of fire suppression as well. It is these latter cases that are generally found to be potentially significant.
- *Reliance on Manual Actions to Overcome Fire Damage:* In the case of Farley, Robinson, and Dresden in particular, it is noted that many of the exemptions were granted in part on the basis that procedures would be established to take manual actions to regain control of components and systems damaged by fire. While such actions are commonly cited for fires in certain areas of the plant, such as the MCR (e.g., Dresden), cable spreading rooms, and in some cases the relay or auxiliary equipment room, for Farley these actions are cited for many areas in the plant. In some cases several actions would be required. In these cases there is a clear shift away from passive/active protection of the redundant train and towards manual repair/recovery of fire damaged systems through operator actions. It is also noted that most of the exemptions at Farley that cite such actions also involve the lack of 1-hour fire barriers to protect the redundant train and fixed fire suppression systems.



#### 5.4 General Insights

It was noted that a simple count of the number of exemptions at a given plant provides no insight into the potential significance of exemptions. This is attributed in large part to the observation that plant practices vary widely. In some cases a single exemption will impact numerous fire areas/zones (e.g., DRS-03 impacts 23 fire areas and DRS-04 impacts 22 fire areas). In other cases, a licensee sought multiple exemptions for essentially the same plant feature when it impacted multiple fire areas (e.g., Farley has approximately 14 exemptions related to removable transoms on essentially identical fire doors in various fire areas). Another factor in this observation is the fact that many exemptions were identified that had no discernible impact on plant fire risk, even when the cumulative impact was considered.

The type of exemptions and the specific areas of impact varies significantly from plant-to-plant for the nine plants addressed in this study. However, there are many common elements among the exemptions. General groups or classes of exemptions identified in the study include the following:

- **Lack of Fixed Fire Suppression in General Areas** - Approximately half of the exemptions in the sample group are related to lack of fixed fire suppression in general plant areas. There are three common bases upon which these exemptions are sought/granted.
  - The majority of cases cited that one train of equipment (usually cables) is protected by a one-hour fire barrier system (typically a local fire wrap) in areas with relatively modest fuel loads and few fixed fire sources. The assessment of these exemptions generally concluded that they have a very small risk impact.
  - A second subset of this class of exemptions cited no local fire barrier protection, but did cite that there is substantial separation of the redundant trains well in excess of the nominal twenty-foot requirement of Appendix R. Again, these cases typically cite minimal fuel loads and no significant fire sources. The assessment generally found these exemptions to have a very small risk impact.
  - A third subset of this class of exemptions proved to be more problematic. This subclass cited lack of 1-hour barriers between redundant trains, less than 20 feet of separation, and lack of automatic suppression system. For example, both of the potentially significant exemptions at Farley fall into this group. In general, if these exemptions impacted fire zones that the IPEEE identified as risk significant (i.e.,  $CDF > 1E-5/ry$ ), then they are ranked as either potentially significant or risk indeterminate.
- **Lack of Fixed Suppression in the MCR** - Another commonly encountered class of exemptions is lack of fixed suppression specifically in the MCR. Ultimately, these exemptions are found to be risk indeterminate. This assessment is based primarily on the fact that no clear consensus has developed regarding the magnitude of risk due to MCR fires, and because the IPEEE analyses are not amenable to a detailed examination of the relevant questions.

- **Inadequate Separation** - This class of exemptions deals with cases where there is separation between redundant trains, but either the intervening space did contain some combustibles or the distance did not comply with Appendix R requirements (twenty-feet of horizontal space with no intervening combustibles). This is cited as a factor in close to half of the exemptions in the sample group. In cases where there is substantial separation, the area is partly protected by automatic suppression, the area is very large, and/or the area is open (there is no ceiling) the exemptions are generally found to have a small or very small risk impact. In cases where there is also a lack of fixed fire suppression cited, the exemptions were typically found to be indeterminate because of lack of sufficient information upon which to assess the potential that a suppression system would intervene before critical damage is realized.
- **Inadequate Separation Inside Containment** - This is a specific set of separation related exemptions that impacted containment. In the majority of these cases it is concluded that the exemptions have a very small risk impact. However, indeterminate ranking is assigned if the information available indicated some potential for a pinch-point of a critical set of cables and/or if the proximity to fire sources is not clear.
- **Barriers Lacking Specific Fire Rating** - Another commonly encountered class of exemptions are related to substantial physical barriers that lacked a specific fire rating. These are typically associated with major structural members (walls, ceilings, floors) and various openings in these members that are not protected by fire rated closure devices (doorways, ventilation ducts/dampers, cable or pipe penetrations, valve-stem pass-throughs, etc.). So long as there is evidence of a substantial fire barrier, and the fire hazards present did not appear to pose a significant challenge to the barriers, these exemptions are judged to have a very small risk impact. In a few cases the exemptions are identified as indeterminate if the information available is not sufficient to make a definitive judgement (e.g., STL-05 and -20).
- **Lack of Emergency Lighting** - At least three plants in the study group had exemptions for a lack of fixed emergency lighting. In all cases, the licensees have portable lighting available. There were two sub-groups within this group; namely, exemptions impacting containment and those impacting areas outside containment. The potential risk implications of these exemptions relates to the reliability of human recovery actions. The assessment of the two sub-groups is as follows:
  - Exemptions that impact containment are found to have no discernible risk impact and are categorized as having, at most, a very small risk impact. This is because, to the authors knowledge, no fire risk analysis has ever credited a manual recovery action that requires containment entry.
  - For exemptions impacting other plant areas than containment, the exemptions were generally categorized as having, at most, a small risk impact. There is a potential for some impact on fire CDF quantification, but in the judgement of the authors

the impact will not be potentially significant. The corresponding IPEEEs did not, however, provide sufficient information to assess the actual impact with any confidence.

- Reliance on Human Actions to Recover/Repair Damaged Equipment and Systems - A number of exemptions address areas/zones where loss of safe shutdown cables and equipment would require operators to manipulate controls or equipment at several locations of the plant to achieve safe shutdown. For these exemptions, the IPEEE submittal is scrutinized carefully to ascertain that manual actions and the specific scenarios are addressed properly. In several cases it appeared that the relevant actions had not been explicitly considered in the IPEEE. In these cases an indeterminate rankings is generally assigned.

It is also noted that in the assessment of individual exemptions, various factors are identified that contributed to uncertainty in our assessments of CDF impact. The most commonly cited factors are related to the lack of sufficient detail in the IPEEE analysis to support definitive assessments, the degree of conservatism associated with licensee's assumptions (both cases of apparent optimism and pessimism are encountered), and/or the general validity of the underlying assumptions (which often are not clearly stated). We note that the application of the IPEEEs to this study goes beyond the intent of the IPEEE process.

It is also noted in several cases that the final assessment of risk impact is based primarily, or entirely, on the CDF for a given area cited in the corresponding IPEEE study. That is, if the cited CDF is less than  $1E-5$ , then this was nominally taken to indicate that the exemption was not potentially significant. In this study it is generally assumed that each IPEEE is a complete and accurate representation of the plant's fire risk. Hence, in many cases the robustness of the significance rankings depends on the robustness of the corresponding IPEEE analysis.

## 6 References

1. *Regulatory Guide 1.174*, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," USNRC, July 1998.
2. Letter, F.J. Hebdon, USNRC, to T.F. Plunkett, FPL, Subject: "Exemption from Certain Requirements of 10 CFR 50, Appendix R, for Turkey Point Units 3 and 4, Regarding Fire Barriers in the Turbine Building (TAC Nos. M99324 and M99325)," Dec. 22, 1998.
3. Letter, F.J. Hebdon, USNRC, to T.F. Plunkett, FPL, Subject: "Exemption from Certain Requirements of 10 CFR 50, Appendix R, for Turkey Point Units 3 and 4, Regarding Fire Barriers in Outside Areas Excluding the Turbine Area (TAC Nos. M97422 and M97423)," Oct. 8, 1998.

Note: References to plant IPEEE submittals and other documentation reviewed in this study (e.g., SERs) are provided in the corresponding appendices.

## **Appendix A: Individual Exemption Assessment for Calvert Cliffs 1**

**Plant:** Calvert Cliffs 1

**Exemption #:** CAL-01

**Document Accession #:** 8209230588-01

**Appendix R Section:** III.G.2.a.

### **Exemption Description:**

Use of non-rated watertight doors, bullet proof doors, and water curtains in specified plant areas where 3-hour fire boundaries are required.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

### **Analysis:**

(CAL-01) - From the "Exemption Rationale" provided by the NRC staff, it can be concluded that the licensee has a good experimental basis to assume that alternate means of protection provided for the impacted doors are equivalent to 3-hour rated barriers. Given that the barriers provide significant protection against fire propagation, the duration and thus the severity of the fire in these compartments has to be large to overcome the barrier. The likelihood of such severe fires is very small. Specific to the water curtains, failures in the fire protection water supply system might disable the curtains. However, coincident occurrence of a severe fire and failure of the water supply system is a low probability event. The licensee cites tests that demonstrate substantial fire resistance characteristics, and the NRC staff concurred with this assessment. The licensee has also demonstrated in the IPEEE submittal that the CDFs for cross-zone fire scenarios is very small. Hence, it is concluded that this exemption has very small risk impact.

### **Points of Uncertainty:**

(CAL-01) - It is assumed that none of the areas where these doors are used contain large quantities of a combustible material such as lubricating or hydraulic oil. An oil spill fire in close proximity to a door might cause premature failure of the barriers. It is also assumed that the water curtains are being used in conjunction with an un-rated door rather than as doorway "closures" alone.

### **Relevant IPEEE Citations:**

(CAL-01) - In Sections 4.3.3 and 4.6.6 of the IPEEE submittal (Ref. C-1), the licensee has summarized the results of an extensive analysis of barrier failure and propagation of fire between

adjacent compartments. Table 4.6.6a of Ref. C-1 lists the fire propagation scenarios that were analyzed. The CDFs for these scenarios range between 1E-12 and 1E-07 per year.

\*\*\*\*\*

**Plant:** Calvert Cliffs

**Exemption #:** CAL -02

**Document Accession #:** 8404090081-01

**Appendix R Section:** III.G.2.a.

**Exemption Description:**

Lack of approved fire door (i.e., use un-rated of watertight door) assemblies for protecting personnel access openings in 3-hour rated fire boundaries in the service water pump rooms.

**Location Binning Category:** Intake structure

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:**

(CAL-02) - See CAL-01

**Points of Uncertainty:**

(CAL-02) - See CAL-01

**Relevant IPEEE Citations:**

(CAL-02) - See CAL-01

\*\*\*\*\*

**Plant:** Calvert Cliffs

**Exemption #:** CAL -03

**Document Accession #:** 8404090081-02

**Appendix R Section:** III.G.2.

**Exemption Description:**

Lack of automatic suppression throughout Fire Areas 10 and 11 of the auxiliary building.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:**

(CAL-03) - Both of the fire areas impacted by this exemption were subdivided into fire compartments for analysis in the IPEEE (10 compartments for fire area 10 and approximately 81 compartments for fire area 11). Ultimately all of the compartments screen either during the preliminary screening stages based on "no PRA components or cables, a low functional impact or a low fire hazard" (in this context fire hazard appears to mean fire ignition frequency per section 4.3.1.4 of the submittal) or during quantitative screening using a  $10^{-6}$ /ry CDF contribution screening criteria. It must also be noted that the Calvert Cliffs analysis included an extensive inter-compartment fire analysis and that no significant inter-compartment scenarios related to these fire compartments were identified. Since the CDF contribution for all of these compartments is less than  $10^{-6}$  /ry even given the lack of fixed suppression, the exemption is found to have very small risk impact. The cumulative effect of the CDFs for all compartments combined is also less than  $10^{-6}$  /ry. Hence, overall, this exemption has very small risk impact. It must be added that this finding is heavily dependent on the findings of low CDF contribution for the impacted fire areas and area combinations.

**Points of Uncertainty:** It is assumed that in Table 4.6.5b of IPEEE submittal, the entry "-10'/-15' Hallways" corresponds to the balance of the compartments for Fire Area 10 that were not screened in the preliminary analysis.

**Relevant IPEEE Citations:**

(CAL-03) - The IPEEE submittal (Ref. C-1) addresses fire areas 10 and 11 (see pp. 4-10, 13, 14, 55, and 56 and 4-M-1 to 10). All of fire area 10 is ultimately screened out based on low CDF (Table 4.6.5b). However, detailed analysis is conducted for several compartments within fire area 11. Per Table 4.6.5c (p. 4-55) of Ref. C-1, the CDF for all fire area 11 compartments is below  $10^{-6}$  /ry. The total CDF for the 8 areas presented in Table 4.6.5c for area 11 is  $8.94 \times 10^{-7}$  /ry. The CDF for the entire exemption (i.e., the sum of CDF for fire areas 10 and 11 using Tables 4.6.5b and 4.6.5c) is  $9.79 \times 10^{-7}$  /ry.

\*\*\*\*\*

**Plant:** Calvert Cliffs

**Exemption #:** CAL -04

**Appendix R Section: III.O.**

**Exemption Description:**

The Reactor Coolant Pump oil collection system is not sized to contain the entire lube oil system inventory.

**Location Binning Category:** Containment

**PRA Step Binning Category:** FHA : Sources

**Potential for CDF Reduction:** Small

**Analysis:**

(CAL-04) - Since, the oil collection system can handle one RCP pump's full oil inventory, overflow would require simultaneous failure of more than one pump. The general probability of this happening is very small. The one potential source for such failures would be a significant seismic event. The RCPs and oil collection system are designed to withstand a SSE. Hence, a very substantial earthquake would be required to cause such a failure. This is a low probability event. Further, for the oil to actually represent a fire threat, it must be ignited. The likelihood of ignition at the location of the RCPs is, if anything, reduced by the fact that oil is drained away to the remote location of the collection tank. The collection tank itself is generally located remote from the RCPs and outside the biological shield wall. Hence, if the tank overfills, then a spill through the tank vent will occur at the tank location with the spilled oil collecting ultimately in the containment sump. Again, ignition must occur for a fire threat to ensue. Hence, one must postulate an ignition source present after the tank overflow occurs either near the tank or in the containment sump. This, too, is a low probability event. The potential for large RCP pump oil fires is not addressed in the IPEEE submittal. However, because a number of very low probability events is required to result in an actual fire threat, this exemption is highly unlikely to lead to fire risk scenarios of  $1E-5/ry$  or higher. On this basis the exemption is found to have a small risk impact.

**Points of Uncertainty:**

(CAL-04) - None

**Relevant IPEEE Citations:**

(CAL-04) - The IPEEE submittal (Ref. C-1) addresses the containment in Sections 4.3.1.5 and has screened out based on FIVE methodology recommendation. The RCP oil collection system is mentioned and it is concluded that it is adequate to maintain the oil in a confined space. The seismic analysis of IPEEE submittal does not address the possibility of multiple RCP failure from an earthquake.



\*\*\*\*\*

**Plant:** Calvert Cliffs

**Exemption #:** CAL -05

**Document Accession #:** 9008270043-01

**Appendix R Section:** III.J.

**Exemption Description:**

Use of portable handlights of the rechargeable type with an 8-hour rating staged outside containment as an alternative to permanently installed 8-hour emergency lighting for locations within containment.

**Location Binning Category:** Containment

**PRA Step Binning Category:** RQ : HRA

**Potential for CDF Reduction:** Very Small

**Analysis:**

(CAL-05) - None of the fire scenarios analyzed in the IPEEE require operators to enter the containment after a fire. Therefore, the absence of fixed emergency lights inside containment has no bearing on fire risk. Also, the containment is rarely entered during normal operation and there is almost no need for emergency lighting for evacuation purposes during normal plant operation. Therefore, this exemption is found to have a very small risk impact.

**Points of Uncertainty:**

(CAL-05) - It is assumed none of the human actions modeled in the internal events PRA used for estimating CDFs require entry into the containment. It is also noted that the IPEEE analysis has not considered shutdown risk.

**Relevant IPEEE Citations:**

(CAL-05) - The IPEEE submittal addresses human actions in Section 4.6.3. Whether or not an action has to take place inside the containment is not addressed in that Section.

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**References:**

- C-1 "Calvert Cliffs Nuclear Power Plant, Probabilistic Risk Assessment - Individual Plant Examination of External Events", Baltimore Gas and Electric, August 1997.

**TABLE A-1: SUMMARY CATEGORIZATION OF INDIVIDUAL EXEMPTIONS FOR CALVERT CLIFFS (CAL)**

| <b>Exemp.<br/>#</b> | <b>Exemption Description</b>   | <b>Location Binning<br/>Category</b> | <b>PRA Step<br/>Binning<br/>Category</b> | <b>Potential for<br/>CDF<br/>Reduction</b> |
|---------------------|--|--------------------------------------|--|--|
| CAL -01             | Use of non-rated watertight doors, bullet proof doors, and water curtains in specified plant areas where 3-hour fire boundaries are required.  | General process area                 | FHA : FCIA                               | Insignificant                              |
| CAL -02             | Lack of approved fire door assemblies for protecting personnel access openings in 3-hour rated fire boundaries in the service water pump rooms - substantial doors are in place but lack specific fire rating. | Intake structure                     | FHA : FCIA                               | Insignificant                              |
| CAL-03              | Lack of automatic suppression throughout Fire Areas 10 and 11 of the auxiliary building.   | General process area                 | FHA : Det/Supp                           | Insignificant                              |
| CAL-04              | The Reactor Coolant Pump oil collection system is not sized to contain the entire lube oil system inventory - the capacity of one pump can be contained.   | Containment                          | FHA : Sources                            | Insignificant                              |
| CAL-05              | Use of rechargeable portable hand-lights in lieu of fixed emergency lights within containment - lights with an 8-hour rating are staged outside containment.   | Containment                          | RQ : HFA                                 | Insignificant                              |

## **Appendix B: Individual Exemption Assessment for Dresden 2&3**

**Plant:** Dresden 2 and 3

**Exemption #:** DRS-01

**Document Accession #:** 8302080194-01

**Appendix R Section:** III.G.3

**Exemption Description:** Fire detection system and fixed fire suppression system not installed in Control Room Panels area, 4KV switchgear areas, and 480V, 250V, and 125V Motor Control Center areas.

**Location Binning Category:** MCR, Switchgear room (4KV, 480V, 250V and 125V)

**PRA Step Binning Category:** FHA: Det/Supp

**Potential for CDF Reduction:** Potentially Significant (switchgear room 1.1.1.4) / Indeterminate (MCR) / Very Small (remaining fire zones)

**Analysis:** (DRS-01) - Several fire zones are addressed in this exemption:

The MCR, similar to other plants, is not equipped with automatic fire suppression system. This aspect of the exemption is discussed in Section 4 of the report body and its risk impact remains indeterminate.

Of the other impacted zones only one is found in the IPEEE submittal to have a CDF that exceeds  $1\text{E-}6/\text{ry}$  (switchgear zone 1.1.1.4 at  $\text{CDF}=1.78\text{E-}05/\text{ry}$ ). Hence, a properly positioned fire suppression system may have a significant impact on the CDF. However, it appears that the CDF for this zone may have been conservatively assessed in the IPEEE fire analysis. Bounding CCDF values assuming loss of all equipment in the zone have been applied for all fires because the exact location of all cables could not be determined. Further, the risk contribution of transient and self-ignited cable fires has likely been overstated. This may actually have masked contributions from other risk significant fire sources. On the other hand, the licensee analysis may be appropriate given a potential for energetic switchgear faults. If the IPEEE CDF estimate is taken as correct, then the lack of fire suppression in this one switchgear zone is found to potentially have significant risk impact. However, this finding is highly sensitive to the IPEEE findings, in this case, the finding of a high CDF contribution. Because the analysis assumes loss of all systems and equipment due to fire, a suppression system would be given substantial credit for preventing critical damage. Nominally, a 0.05 factor of reduction (1/20) could be assumed for the impacted scenario. This would reduce the CDF contribution from  $1.78\text{E-}5/\text{ry}$  to about  $8.9\text{E-}7/\text{ry}$ .

For the remaining impacted zones, none are found to have a CDF greater than  $1\text{E-}5/\text{ry}$ ; hence, the

exemption is found to have very small risk impact for these zones.

**Points of Uncertainty:** (DRS-01) - The exemption description does not identify the specific fire zones where the MCCs and switchgear are located. We have assumed that Section 4.7.2.3 of Ref. D-1 addresses the same zones. Further, the exemption rationale provided by the USNRC cites that fire detection is available in the impacted zones, although the exemption summary cites a lack of fire detection. If fire detection is, indeed, not available, then the risk impact may need to be reassessed. For fire zone 1.1.1.4, the finding of risk significance is based entirely on the IPEEE fire analysis results which sites a CDF contribution in excess of  $1\text{E-}5/\text{ry}$ . This assessment may not realistically reflect the actual risk contribution of the zone and may have masked the actual fire sources likely to be dominant contributors.

**Relevant IPEEE Citations:** (DRS-01) - Section 4.7.2.3 of Ref. D-1 discusses the fire zones that contain the switchgear mentioned in this exemption. The CDFs are  $9.11 \times 10^{-6}$  and  $1.78 \times 10^{-5}$  per reactor year for Units 2 and 3 respectively. Loss of offsite power is not possible from these zones. The main line of defense for preventing core damage is the Isolation Condenser. The IPEEE submittal indicates that there is automatic detection in the zones addressed by this exemption. It is stated that this is a conservative CDF because the licensee has not conducted detailed modeling of fire growth and has not taken into consideration opportunistic positioning of the fire (per the discussions on p. 4-34 of Ref. D-1).

\*\*\*\*\*  
**Plant:** Dresden 2 and 3

**Exemption #:** DRS-02

**Document Accession #:** 8908220394-01

**Appendix R Section:** III.G.1.a.

**Exemption Description:** One train of systems to achieve hot and cold shutdown from control room or emergency control station is not free of fire damage; cannot be repaired within 72 hours.

**Location Binning Category:** MCR

**PRA Step Binning Category:** PPR: Eq&Sys; RQ: HRA, Recov.

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (DRS-02) - This exemption addresses the possibility of control circuit failure, fuse failures and potential spurious operations due to fires in the MCR. To overcome such faults manual actions must be taken that require pulling fuses, replacing fuses, manually operating

disconnect switches, tripping circuit breakers, shedding non-safety loads for buses, and transferring control circuits to emergency control stations. Reference [D-2] indicates that the control circuits for 4KV and 480V buses, the inboard isolation condenser valves, and the reactor relief valves may experience spurious operation and are the primary subject of this exemption. Spurious operation of reactor relief valves can be considered as, effectively, a LOCA. The NRC determined that the licensee has demonstrated that it has the proper procedures and equipment to conduct the manual actions addressed in this exemption. The nature, number, and complexity of the required actions, however, raises several human factors and human reliability related questions.

It would appear that the IPEEE submittal has not provided full consideration of these questions. As a minimum three important questions should be addressed: (1) is there sufficient time for the manual actions to be effective, (2) would the equipment sustain damage before the fuses are pulled, and (3) what is the probability that these actions will be successful and timely given a severe MCR fire, or fire elsewhere that might compromise the same set of circuits (e.g., the cable spreading and/or relay rooms). The IPEEE submittal does not address these issues. There are indications that this exemption may have the potential for significant risk impact, but further analysis would be required to quantitatively assess the risk impact. The information in the IPEEE submittal itself is not sufficient to support this analysis, and it does not appear that a detailed HRA analysis was performed by the licensee regarding these actions. Hence the risk impact of this exemption remains indeterminate.

**Points of Uncertainty: (DRS-02)** - The IPEEE submittal [D-1] does not address the human reliability issues relevant to this exemption for fire zones where a fire may cause the failure modes addressed in this exemption. Reference [D-2] does not specify the fire zones where the specific failure modes that have been discussed in this exemption may occur from a fire causing cable damage. Since a LOCA is possible (from spurious operation of reactor relief valves, as indicated in Reference [D-2]), a probabilistic model of the manual actions may yield risk significant results.

**Relevant IPEEE Citations: (DRS-02)** - The control room analysis is presented in Section 4.7.4.2 of Reference [D-1] but does not discuss manual recovery actions or the need to make repairs to achieve safe shutdown. The total CDF contribution of the MCR is 1.66E-6 which is approximately 0.005% of the total fire CDF for the plant. The potential for similar failures due to fires in either the cable spreading room or relay room are not discussed in the submittal.

\*\*\*\*\*  
**Plant: Dresden 2 and 3**

**Exemption #: DRS-03**

**Document Accession #: 8908220394-04**

### Appendix R Section: III.G.3.

**Exemption Description:** Lack of fire detection and/or fixed fire suppression in Reactor Building Areas RB2-1, RB2-11, and RB3-11; zones for which alternative shutdown capability is provided.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA: Det/Supp

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (DRS-03) - This exemption actually impacts, to some degree, 23 fire zones. From the exemption rationale provided by the NRC Staff it can be inferred that fire detection will eventually occur by automatic means for all the fire areas/zones addressed in this exemption, albeit somewhat delayed for some fire zones. Further, the fuel load in the impacted zones is cited as ranging from "negligible to low." The staff rationale statement adds for all of these fire zones a safe shutdown path independent of the impacted zones will remain available for all fire scenarios. In Reference [D-2] it is stated that the alternative safe shutdown path (presumably the isolation condenser) is separated from all fire zones where it is intended to be used by 3-hour fire rated barriers, etc.

We could not clearly identify the corresponding fire zones in the IPEEE submittal because the fire zone designations used in the IPEEE fire analysis are not consistent with those used in the exemption documents. Several reactor building fire zones were examined in the IPEEE fire analysis. Based on the zone descriptions, the nature of the equipment threatened in each zone, and the lack of full fire detection and suppression coverage, it appears highly probable that the risk significant reactor building zones considered in the IPEEE are, in fact, impacted by the exemption. Ultimately only three zones are identified as risk significant as defined in this study ( $CDF > 1E-5/ry$ ):

- Zone 1.1.2.3 -  $CDF = 2.34E-5/ry$  for U2: This zone contains switchgear and is protected by partial fire detection and partial fire sprinkler coverage (only in the Shutdown Cooling Heat Exchanger Room). It appears likely that this zone is impacted by the exemption given the lack of zone wide suppression and detection.
- Zone 1.1.1.3 -  $CDF = 5.06E-5$  for U3: This zone is already impacted by DRS-10 for essentially the same conditions. Its assessment will be deferred to DRS-10
- Zone 1.1.1.4 -  $CDF = 1.78E-5/ry$  for U3: This area is also cited in exemption DRS-01 for essentially the same conditions. Its assessment will be deferred to DRS-01.

Note that in all three zones, the IPEEE sites relatively long fire damage times. Hence, there appears to be a significant potential for risk reduction. From the IPEEE submittal it cannot be inferred what credit was already allowed for the partial fire protection, how important the rooms with sprinkler coverage are in comparison to the non-protected rooms, nor what additional credit for full zone coverage would be appropriate. Given these quantification uncertainties, and the uncertainty regarding whether or not the identified zones are indeed impacted, the risk impact of

this exemption remains indeterminate.

**Points of Uncertainty:** (DRS-03) - The fire zone identifiers shown in exemption description do not match the fire zone/area identifiers used in the IPEEE submittal. Given the zone descriptions and the lack of full fire detection/suppression coverage, it is inferred that the fire zones cited above are included among the 23 impact fire zones. The finding of a potential for significant risk reduction is based entirely on the findings of the IPEEE which reports relatively high CDF values.

**Relevant IPEEE Citations:** (DRS-03) - See Table 4.9, on page 4-67 and Section 4.7.2 of the IPEEE.

\*\*\*\*\*  
**Plant:** Dresden 2 and 3

**Exemption #:** DRS-04

**Document Accession #:** 8908220394-05

**Appendix R Section:** III.G.3.

**Exemption Description:** Fixed fire suppression and or fire detection systems not installed in 22 fire zones of Turbine Building.

**Location Binning Category:** Turbine Building

**PRA Step Binning Category:** FHA: Det/Supp

**Potential for CDF Reduction:** Potentially Significant (fire zone 7.0.A.1) / Indeterminate (fire zone 8.2.6.A) / Very Small (remaining zones)

**Analysis:** (DRS-04) - The IPEEE submittal concludes that the turbine building includes the most risk significant fire zones at the plant (the Dresden analysis is based on fire zone contributions not fire area contributions). Indeed, the top two contributors for each unit are turbine building zones. Further, there are a total of eight turbine building zones that contribute CDF scenarios greater than  $1E-5/ry$  for either one or both units. The exemption impacts 22 fire zones (identified below). All eight of the dominant turbine building zones are included in this list of impacted fire zones. The USNRC Staff evaluation report, Reference D-2, cites that all fire zones have detection, or partial fixed suppression, or both. The partial fire suppression systems appear to be focused on specific fire hazards and do not provide protection against all the fire sources that are present. Significant risk contributors include the following eight impacted fire zones:

- 7.0.A.1 (U1 CDF  $1.04E-5/ry$ ): Automatic detection installed, no fixed automatic fire suppression, threatened equipment includes "125vdc buses, 125vdc distribution panels, 125vdc battery chargers, 250 vdc battery chargers and numerous safe shutdown circuits in

cable trays/conduits." Critical damage from battery charger fires is postulated in 13 minutes. Hence, time is available for automatic suppression to intervene with high reliability. Given the CDF estimate just greater than  $1E-5/ry$ , and a probable reduction by approximately a factor of 0.05 (1/20) the modified CDF would be estimated as  $5E-7/ry$ . This risk reduction is at the threshold of significance as defined in this study. Hence, if this fire zone is addressed by the exemption, the risk impact can potentially be significant.

8.2.4 (U2 CDF= $1.38E-5/ry$ ): The IPEEE states that automatic detection and automatic sprinklers are installed. The exemption cites that the sprinklers are designed for protection of the cable trays in the zone. The risk is stated to be dominated by human failures.

Installation of a full zone-wide fire suppression is unlikely to impact the CDF estimate and hence, if this fire zone is addressed by the exemption, the risk impact should be very small.

8.2.5.A (U1 CDF  $1.57E-5/ry$ ): Threatened safe shutdown equipment includes "480V MCC, Condensate Transfer Pumps, HPCI valve, Main Steam Isolation Valves, Service Water Cooling to Unit 2/3 CRD Pump Valve, Unit 2/3 Condensate Storage Tank Level Indicators and numerous safe shutdown circuits in cable trays and/or conduits." Off-site power may also be lost. Fire protection features include detection, partial sprinkler coverage and 1-hour wraps on Unit 3 cables in the zone. 96% of the fire CDF results from a "bounding analysis" of transient fires and self-ignited cable fires. The zone includes substantial fire sources including the MCCs and MCC transformers. It appears that the licensee assessment of this zone is conservative, and has not given substantial credit to the installed fire suppression systems. Because the suppression system does protect against major fire sources, the risk contribution appears to have been overstated by the licensee. Despite the high zone CDF reported by the licensee, installation of zone-wide suppression is not likely to substantially impact the CDF. Hence, if this fire zone is addressed by the exemption, the risk impact should be very small.

8.2.5.C (U1 CDF  $1.32E-5/ry$ , U2 CDF  $2.15E-5/ry$ ): Fire suppression systems have been installed in large portions of this fire zone and protect many of the most significant fire sources. However, it appears that unprotected fire sources do exist at the north end of the zone. "Numerous" safe shutdown cables are threatened in this zone and a LOSP is also postulated. The zone risk is again dominated by a "bounding" analysis of transient and self-ignited cable fires. The staff concluded that "any additional detection and suppression systems would not significantly enhance the level of safety at Dresden." Given the presence of suppression for most of the zone, there appears to be little potential for significantly reducing fire risk by extending this coverage. The IPEEE may have overstated the risk contribution of this zone. Hence, if this fire zone is addressed by the exemption, the risk impact should be very small.

8.2.5.E (U2 CDF  $5.27E-5/ry$ ): Threatened equipment includes "Condensate Transfer Pumps, HPCI valve, Main Steam Isolation Valves, Service Water Cooling to Unit 2/3 CRD Pump Valve, Condensate Local Control Panel, Unit 3 Diesel Generator Cooling Water Flow Indicator, and numerous safe shutdown circuits in cable trays and/or conduits including the Unit 2/3 Diesel Generator Auxiliaries." LOSP is also assumed. Fire protection features include sprinkler coverage in part of the zone (protecting the major fire hazards), and detection in the one corridor zone that lacks any suppression capability.



Also, 1-hour barriers are installed for the Diesel Generator Auxiliary cables. MCC fires are cited as the most severe fires, but the most severe consequences are postulated only after substantial time has passed. These scenarios apparently account for about 38% of the total zone CDF. The balance of the risk appears to be based on a "bounding analysis" of transient and self-ignited cable fires where little credit is apparently given to fire suppression. It would appear that the licensee has overstated the risk contribution for this zone by not given full credit to the installed fire suppression systems. It appears that installation of zone wide suppression would not significantly impact fire risk as compared to the existing systems that are aimed at the significant fire sources. Hence, if this fire zone is addressed by the exemption, the risk impact should be very small.

- 8.2.6.A (U1 CDF  $6.16E-5/ry$ ): This zone includes "4-kV switchgear, 480 V MCC's, Analog Trip Modules, and numerous safe shutdown circuits in cable trays and/or conduits." Fire protection includes fire detection, water spray directed at the "hydrogen seal oil pump skid," and water spray directed at "cable trays on the south end of the mezzanine floor." LOSP is also postulated. The most severe fires are identified switchgear fires. Again, the risk is dominated (92%) by a "bounding" analysis of transient and self-ignited cable fires. There appears to be a significant potential for risk reductions due to installation of zone-wide fire suppression. However, given the level of detail provided in the IPEEE submittal it is not possible to quantify the potential reductions. Hence, the risk impact of the exemption for this fire zone remains indeterminate.

- 8.2.6.C (U1 CDF= $5.87E-5/ry$ , U2 CDF= $5.89E-5/ry$ ): Threatened equipment in this zone includes: "Unit 2 and Unit 3 TBCCW Heat Exchanger Isolation Valves, Unit 2 and Unit 3 Turbin Oil cooler Isolation Valves, Unit 2 and Unit 3 Concentrator Condenser Outlet Isolation valves, 480V MCC 39-2, and Unit 2/3/ Control Rod Drive Cross Tie Valves, and numerous safe shutdown circuits routed in cable trays and/or conduits." Fire protection features include sprinklers throughout the bulk of the zone and water spray directed at one specific oil fire hazard. There is apparently no automatic detection. Given the presence of near zone-wide sprinkler coverage, there appears to be little potential gain for extension of this protection to the unprotected portions of the zone. The analysis has given minimal credit for the existing systems based on a lack of detailed cable tracing information. Hence, the fire CDF has likely been overstated in the licensee analysis. If this fire zone is addressed by the exemption, the risk impact should be very small.

The licensee analysis of turbine building fire CDF is generally dominated by "bounding" analyses of transient and self-ignited cable fire scenarios. It appears likely that the licensee has, indeed, overstated the risk associated with such fires. In most of the risk significant fire zones impacted by this exemption, substantial fire suppression coverage already exists. Hence, for most zones it would not appear that substantial additional risk benefit can be gained by extending this coverage. However, there are exceptions to this conclusion: (1) zone 7.0.A.1 - the fire risk in this zone is just above the threshold of significance defined in this study ( $1E-5/ry$ ); (2) zone 8.2.6.A - given the estimated CDF of  $6.16E-5/ry$  and only partial suppression coverage there appears to be a potential for reducing fire risk given extension of the existing coverage to the full zone. However, there is insufficient information available in the IPEEE submittal to allow the quantification of the potential risk reductions.

This exemption, somewhat like DRS-01, has presented a unique situation. On one hand, this exemption raised questions about the validity of IPEEE fire analysis, and on the other hand it can be concluded that the licensee has overstated the CDF contribution of transient and self-ignited cable fires. It appears that the "conservative" treatment of these fire sources may have masked the actual dominant fire sources. Substantial effort would be required to review the IPEEE analyses in detail to determine if this is, in fact, the case. This is clearly beyond the scope of this study. Understanding the CDF contribution of the identified turbine building zones is critical to understanding fire risk at Dresden. It is not, however, clear that the most significant fire sources have been appropriately identified and quantified.

Given the IPEEE results, if the above listed fire zones are addressed by the exemption, one must conclude that for fire zone 7.0.A.1 only the exemption has potentially significant risk impact, and for fire zone 8.2.6.A the risk impact remains indeterminate. For the remaining zones the exemption is found to have very small risk impact. However, these findings are entirely based on the high CDF values cited in the IPEEE study.

**Points of Uncertainty: (DRS-04)** - It is assumed that the 22 impacted fire zones are: 8.2.1.A, 8.2.2.A, 8.2.5.A, 8.2.5.B, 8.2.6.A, 8.2.6.B, 8.2.7, 7.0.A, 9.0.A, 8.1, 8.2.1.B, 8.2.2.B, 8.2.4, 8.2.5.D, 8.2.5E, 8.2.6.D, 8.2.6.E, 6.1, 7.0.B, 9.0.B, 8.2.5.C, and 8.2.6.C. It is assumed that there are not cable pinch-points in near proximity to substantial and fast growing fire sources so that the installation of fixed fire suppression capability can be credited with mitigating critical damage with high reliability. If there are substantial fire sources with a potential to damage critical sets of equipment in less than approximately 5 minutes, then the effectiveness of the fixed suppression might be mitigated to some extent. Based on the IPEEE discussion, this does not appear to be the case. It is also assumed that fire zone 7.0.A.1 as identified in the IPEEE is a subset of fire zone 7.0.A as identified in the exemption.

**Relevant IPEEE Citations: (DRS-04)** - The 22 impacted fire zones are: 8.2.1.A, 8.2.2.A, 8.2.5.A, 8.2.5.B, 8.2.6.A, 8.2.6.B, 8.2.7, 7.0.A, 9.0.A, 8.1, 8.2.1.B, 8.2.2.B, 8.2.4, 8.2.5.D, 8.2.5E, 8.2.6.D, 8.2.6.E, 6.1, 7.0.B, 9.0.B, 8.2.5.C, and 8.2.6.C. Several turbine building fire zones are addressed in the IPEEE. The turbine building includes the most significant fire zones for each unit. In the IPEEE, see Table 4.9 on page 4-67 of Ref. D-1 and the analyses presented in Sections 4.7.2.4, 4.7.2.6, 4.7.2.7, and 4.7.2.8 on pages 4-29 through 4-54.

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**Plant: Dresden 2 and 3**

**Exemption #: DRS-05**

**Document Accession #:** 8908220394-06

**Appendix R Section:** III.G.3.

**Exemption Description:** Fire detection and/or fire suppression systems not installed in reactor building (two zones).

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA: Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (DRS-05) - The "Exemption Rationale" provided by the NRC staff indicates that these two fire zones are void of any safe shutdown cables or equipment. Hence, the primary concern would be the spread of fire from an unprotected zone to an adjacent zone in the same fire zone that might contain safe shutdown equipment. Because the impacted fire zones have "negligible fire loads", the possibility of this event is remote and the risk impact of the exemption should be very small.

**Points of Uncertainty:** (DRS-05) - The fire zones addressed by the exemption cannot be identified in the IPEEE submittal. This information is not, however, considered critical to our assessment. Given the descriptions provided in the "Exemption Rationale" these zones are deemed as screened in the earliest stages of IPEEE fire analysis.

**Relevant IPEEE Citations:** (DRS-05) - These fire zones cannot be identified in the IPEEE submittal.

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**Plant:** Dresden 2 and 3

**Exemption #:** DRS-06

**Document Accession #:** 8710070256-01

**Appendix R Section:** III.G.3.

**Exemption Description:** Lack of automatic fire detection and fixed suppression in the drywell expansion gap.

**Location Binning Category:** Containment

**PRA Step Binning Category:** FHA: Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (DRS-06) - This exemption request seems to be based on the specific interpretation of

what is considered as a compartment or zone. Based on conservative definition of this region as a distinct fire zone, the need for installing fixed detection and suppression systems was addressed. The drywell expansion gap is filled with insulating material and would normally be considered part of the containment structure. Further, since the containment is inerted and the penetration zones outside the containment are protected by fire protection systems, this exemption has very small risk impact.

**Points of Uncertainty:** None

**Relevant IPEEE Citations:** (DRS-06) - The zone is not discussed in the IPEEE.

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**Plant:** Dresden 2 and 3

**Exemption #:** DRS-07

**Document Accession #:** 8908220394-02

**Appendix R Section:** III.G.2.

**Exemption Description:** Fire hazards present between redundant trains of safe shutdown equipment in upper and lower crib houses; loss of safe shutdown capability.

**Location Binning Category:** Intake structure

**PRA Step Binning Category:** FHA: Sources

**Potential for CDF Reduction:** Small

**Analysis:** (DRS-07) - The two zones addressed by this exemption may contain safe shutdown cables associated with redundant trains of service water (the ultimate heat sink). This should make the fire zones significant risk contributors. In the exemption rationale it is stated that the fuel load in these zones is small, curbs for containing oil spills will limit fire intensity, the sprinkler system on top of the cable trays will control fires, and automatic detection is provided. Based on these arguments, and since in the IPEEE submittal these zones have been screened out, it is nominally concluded that the CDFs for these zones are less than  $1.0 \times 10^{-6}$  /ry. However, since the exact value of the CDFs cannot be established, it is not possible to ascertain that the sum of the two CDFs is less than  $1.0 \times 10^{-6}$  /ry. Hence, the level of risk impact of this exemption must be selected as small.

**Points of Uncertainty:** It is assumed that the crib house contains all service water pumps which serve as the ultimate heat sink. Also, it is assumed that the likelihood of a major oil spill and a

severe fire is very small. Verification of the basis for screening / not addressing this zone in the IPEEE submittal would be needed to resolve the underlying uncertainty, but this would likely require licensee interactions and/or access to the IPEEE second tier information.

**Relevant IPEEE Citations:** (DRS-07) - Crib houses are not addressed in the IPEEE submittal.

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**Plant:** Dresden 2 and 3

**Exemption #:** DRS-08

**Document Accession #:** 8908220394-03

**Appendix R Section:** III.G.2.b.

**Exemption Description:** Intervening combustibles or fire hazards are present and automatic fire suppression systems are not provided between the redundant trains of equipment in Reactor Building.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA: Det/Supp, Sources

**Potential for CDF Reduction:** Small

**Analysis:** (DRS-08) - The primary focus of this exemption was placed on the existence of intervening combustibles, apparently because the lack of fire suppression is addressed in exemption DRS-10. In this analysis, we will also focus on the question of intervening combustible and defer the question of fire suppression to DRS-10. It was determined by the NRC staff that propagation times between redundant trains would be quite long. This is consistent with typical BWR Reactor Building layouts where there are very large interconnected zones. The large zones would also minimize the possibility of hot gases collecting in a localized area. Based on the information provided in the staff evaluation report, separation distances of at least 75 feet of horizontal space are available between redundant trains of safe shutdown cables and equipment. The long propagation time means higher probability of success for the fire suppression activities (i.e., detection of the fire, fire brigade response and suppression of the fire before redundant trains are damaged).

Nominally, the IPEEE identifies both zones 1.1.2.2 and 1.1.1.3 as risk significant ( $CDF > 1E-5/ry$ ). The other two impacted zones are not risk significant ( $CDF < 1E-5/ry$ ). However, the analysis of zone 1.1.2.2 is cited by the licensee to be conservative, and we generally concur with that finding. Therefore, given the high probability of success for the fire brigade, the risk significance of an automatic fire suppression system should be minimal in the context of the intervening

combustibles. In this context, the exemption for intervening combustibles is not considered to have a potentially significant risk impact. On the other hand, given the CDFs reported in the IPEEE submittal, the level of risk impact of the exemption must be considered as small. See DRS-10 for a discussion of the lack of fire suppression coverage.

**Points of Uncertainty:** (DRS-08) - The CDF for two of the four fire zones addressed in this exemption is significant ( $>1E-5$ ). Licensee (as stated in the IPEEE submittal) and NRC staff statements emphasize that the CDFs are very conservative. An additional element of uncertainty lies in the presence of 4KV switchgear equipment in two of the four fire zones. Such equipment have the potential for energetic faults and can cause the initiation of a severe fire. It must be noted that fire zones 1.1.1.2 and 1.1.1.3 are also impacted by the lack of fire suppression cited in DRS-10

**Relevant IPEEE Citations:** (DRS-08) - Per Reference D-2 the following zones are addressed in this exemption:

| Fire Zone | Description                                   | Unit 2 CDF      | Unit 3 CDF      |
|-----------|---|-----------------|-----------------|
| 1.1.2.2   | Unit 2 Reactor Building, Elev. 545            | 8.76E-06 per ry |                 |
| 1.1.2.3   | Unit 2 Reactor Building, Open Area, Elev. 545 | 2.34E-05 per ry |                 |
| 1.1.1.2   | Unit 3 Reactor Building, Ground Floor         |                 | 7.39E-06 per ry |
| 1.1.1.3   | Unit 3 Reactor Building, Second Floor         |                 | 5.06E-05 per ry |

Thus at least two of the four zones can be considered as risk significant. An important element of fire zones 1.1.2.3 and 1.1.1.3 is the presence of 4KV switchgear that have the potential for causing an energetic failure damage to adjacent cables and equipment. The IPEEE submittal reports 102 minutes for fire zone 1.1.2.3 and 42 minutes for fire zone 1.1.1.3. to "most serious consequences".

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**Plant:** Dresden 2 and 3

**Exemption #:** DRS-09

**Document Accession #:** 8908220394-07

**Appendix R Section:** III.G.2.

**Exemption Description:** Automatic fire suppression not installed in four zones of Reactor Building.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA: Det/Supp

## **Potential for CDF Reduction: Small**

**Analysis:** (DRS-09) - While automatic suppression has not been installed, the redundant train cables of concern have been protected by 1-hour fire barriers. The exemption cites that the fire load in the impacted zones is low, and there are no significant fire source hazards present. Hence, the potential for a fire of sufficient severity to threaten the barriers is assumed to be small. Given that a fire detection system is available in these fire zones, there will likely be significant time available for the fire brigade to prepare and attack the fire before these 1-hour barriers will fail. Thus, the probability of fire suppression before critical damage is high. This is also consistent with the IPEEE findings that these fire zones are not risk significant. Based on these arguments, and since in the IPEEE submittal these zones have been screened out, it is nominally concluded that the CDFs for these zones are less than  $1.0 \times 10^{-6}$  /ry. However, since the exact values of the CDFs cannot be established, it is not possible to ascertain that the sum of the CDFs is less than  $1.0 \times 10^{-6}$  /ry. Hence, the level of risk impact of this exemption must be selected as small.

**Points of Uncertainty:** (DRS-09) - Based on the discussions provided in Reference D-2, it can be surmised that the four fire zones addressed by this exemption contain redundant cables that are in close proximity of one another and only those associated with one train of the Isolation Condenser are wrapped with 1-hour fire barrier. Although the IPEEE submittal and NRC staff analysis conclude that risk is not significant, the quality of the wrapped fire barrier has a strong influence on this conclusion. The finding of risk insignificance is partly, but not entirely, dependent of the findings of low CDF contribution in the IPEEE fire analysis.

**Relevant IPEEE Citations:** (DRS-09) - The specific zones (i.e., 1.1.2.1, 1.3.2, 1.1.1.1, 1.4.1) addressed in this exemption are not explicitly identified in the IPEEE submittal. Since these fire zones are not part of the list of risk significant zones in Table 4.9, p. 4-67 of Ref. D-1, it can be assumed that they were appropriately screened and are not risk significant.

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**Plant:** Dresden 2 and 3

**Exemption #:** DRS-10

**Document Accession #:** 8908220394-08

**Appendix R Section:** III.G.2.

**Exemption Description:** Automatic fire suppression not installed in two zones of reactor building.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA: Det/Supp

## **Potential for CDF Reduction: Potentially Significant**

**Analysis:** (DRS-10) - This exemption impacts fire zones 1.1.1.2 and 1.1.1.3. Note that these same zones are also impacted by exemption DRS-08 relating to the presence of intervening combustibles between redundant trains. Based on the IPEEE submittal, fire zone 1.1.1.3 is risk significant with a Unit 3 CDF contribution of  $5.06\text{E-}5/\text{ry}$ . The CDF contribution for fire zone 1.1.1.2 is less than  $1\text{E-}6$ , hence, it is not considered risk significant as defined in this study. The NRC Staff evaluation report, Reference D-2, states that the main focus of the staff review with this exemption was the potential loss of redundant cables associated with the Diesel Generator (DG) 2/3. In contrast, the IPEEE submittal states that fire zone 1.1.1.3 contains "4-kV switchgear, SDC pump discharge valves, RBCCW pumps, RBCCW heat exchangers, RWCU valves, reactor pressure and level instrumentation, and numerous safe shutdown circuits routed in cable trays and/or conduits." The IPEEE submittal also states that a LOSP cannot result from fires in these zones, hence, the loss of the DG cables should be of secondary concern. The potential for significant risk impact appears greater than one would infer from the Staff Evaluation Report. The analysis of this zone has identified the switchgear as the most severe fire source but these were assumed to be slow developing fires. These sources represented less than 17% of the total zone CDF. The majority of the CDF contribution from zone 1.1.1.3 (83%) resulted from a conservative assessment of transient fires and self-ignited cable fires. As noted in DRS-04, the licensee approach has likely overstated the CDF contribution of these fires. Nonetheless, an assessment of significance of risk impact is attempted based on the existing study. This assessment is considered to be less robust than other cases considered in this study because of the way in which the licensee has analyzed fires.

Given the low CDF contribution for zone 1.1.1.2 the exemption as applied to this room would have a very small risk impact. However, given the risk significance of zone 1.1.1.3, the exemption as applied to this room is found to have a potentially significant risk impact. In particular, if a suppression system were to be installed in zone 1.1.1.3, a substantial risk reduction may be realized. In general, a fixed fire suppression system would be credited in a fire risk analysis as having a reliability of at least 95-98%. While the details of the fire modeling analysis are not available, given the qualitative discussions which state that long damage times were predicted, the existence of a fire suppression system would likely mitigate the critical fire damage with a reliability similar to the overall system reliability. Hence, the CDF estimate for the fire zone would be reduced by at least a factor of 0.05. This would imply a total risk contribution given the suppression system of no more than  $2.5\text{E-}6/\text{ry}$  as compared to the estimate of  $5.06\text{E-}5/\text{ry}$  in IPEEE submittal.

**Points of Uncertainty:** (DRS-10) - This exemption address two of the same fire zones as those addressed in exemption DRS-08. An energetic fault of the 4KV switchgear in fire zone 1.1.1.3 may damage all the cables addressed in the two exemptions. The relationship between the two exemptions cannot be verified in References D-1 and D-2.

**Relevant IPEEE Citations:** (DRS-10) - Per Reference D-2 the following zones are addressed in



this exemption:

| Fire Zone | Description                           | Unit 2 CDF | Unit 3 CDF      |
|-----------|---------------------------------------|------------|-----------------|
| 1.1.1.2   | Unit 3 Reactor Building, Ground Floor |            | 7.39E-06 per ry |
| 1.1.1.3   | Unit 3 Reactor Building, Second Floor |            | 5.06E-05 per ry |

Thus one of the two zones can be considered as risk significant. An important element of fire zones 1.1.1.3 is the presence of a 4KV switchgear that has the potential for causing an energetic fault and damage to adjacent cables and equipment.

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**Plant:** Dresden 2 and 3

**Exemption #:** DRS-11

**Document Accession #:** 8908220394-09

**Appendix R Section:** III.G.3.

**Exemption Description:** Fixed fire suppression systems not installed in main control room, auxiliary equipment room.

**Location Binning Category:** MCR, Relay room

**PRA Step Binning Category:** FHA: Det/Supp

**Potential for CDF Reduction:** Indeterminate (MCR) / Small (Relay room)

**Analysis:** (DRS-11) - The lack of fixed suppression in the control room is common to practically all power plants. For a discussion see Section 4 of the report body. The risk impact of this exemption remains indeterminate. In the case of the auxiliary equipment room, which appears to be equivalent to the plant relay room, since the IPEEE submittal does not address the room explicitly, it is assumed that it was screened out based on a low CDF. Normally the relay room is found to be a risk significant fire area at many plants. Further, proper analysis of the relay room often requires consideration of MCR abandonment scenarios since MCR circuits may be lost. Based on these arguments, and since the auxiliary equipment room is not addressed in the IPEEE submittal, it is concluded that the CDFs for this zone is less than  $1.0 \times 10^{-6}$  /ry. However, since the exact values of the CDF cannot be established, the level of risk impact of this exemption is considered to be small.

**Points of Uncertainty:** (DRS-11) - The auxiliary equipment room is not explicitly addressed in the IPEEE submittal. It is assumed that it is screened out based on low CDF (less than  $1\text{E-}06$  per year). If the basis for screening the relay room from the analysis is found to be weak, then the risk change due to lack of suppression could be found to be significant.

**Relevant IPEEE Citations:** (DRS-11) - The MCRis addressed in explicitly in Section 4.7.4 of Ref. D-1. The auxiliary equipment room is not addressed.

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**References:**

- D-1 "Individual Plant Examination of External Events - Dresden Nuclear Power Station Units 2 and 3", ComEd, December 30, 1997.
- D-2 "Exemption", In the matter of Commonwealth Edison Company, Dresden Nuclear Power Station, Unit Nos. 2 and 3, August 15, 1989.

**TABLE B-1: SUMMARY OF CATEGORIZATION OF INDIVIDUAL EXEMPTIONS FOR DRESDEN 2 AND 3 (DRS)**

| <b>Exemp #</b>  | <b>Exemption Description</b>  | <b>Location Binning Category</b> | <b>PRA Step Ninning Category</b> | <b>Potential for CDF Reduction</b>  |
|-----------------|---|----------------------------------|----------------------------------|---|
| <b>DRS - 01</b> | Fire Detection system and fixed fire suppression system not installed in Control Room Panels area, 4KV switchgear areas , and 480V, 250V, and 125V Motor Control Center areas. - Significance of risk impact varies for the different impacted zones.   | MCR; Switchgear rooms (2)        | FHA: Det&Supp                    | Potentially Significant (switchgear room 1.1.1.4) / Indeterminate (MCR) / Very Small (the rest of the fire zones) |
| <b>DRS - 02</b> | One train of systems to achieve hot and cold shutdown from control room or emergency control station is not free of fire damage; cannot be repaired within 72 hours. - Exemption found indeterminate based on lack of treatment in IPEEE submittal.   | MCR                              | PPR: Eq&Sys; RQ: HRA/Recov.      | Indeterminate   |
| <b>DRS - 03</b> | Lack of fire detection and/or fixed fire suppression in Reactor Building Areas RB2-1, RB2-11, and RB3-11; zones for which alternative shutdown capability is provided - IPEEE zone designations don't match exemption area designations. Three risk significant RB fire zones from the IPEEE submittal are assumed to be impacted but risk significance cannot be assessed. | General process area             | FHA: Det&Supp                    | Indeterminate   |
| <b>DRS - 04</b> | Fixed fire suppression and/or fire detection systems not installed in 22 fire zones of Turbine Building. - Exemption has potentially significant risk impact for zones 7.0.A.1 only and remain indeterminate for zone 8.2.6.A only. All other zones have substantial suppression coverage and are not considered as risk significant.                                       | Turbine Building                 | FHA: Det&Supp                    | Potentially Significant (fire zone 7.0.A.1) / Indeterminate (fire zone 8.2.6.A) / Very Small (remaining zones)    |
| <b>DRS - 05</b> | Fire detection and/or fire suppression systems not installed in reactor building (two zones).   | General process area             | FHA: Det&Supp                    | Very Small  |
| <b>DRS - 06</b> | Lack of automatic fire detection and fixed-fire suppression systems in the drywell expansion gap.   | Containment                      | FHA: Det&Supp                    | Very Small  |
| <b>DRS - 07</b> | Fire hazards present between redundant trains of safe shutdown equipment in upper and lower crib houses; loss of safe shutdown capability   | Intake structure                 | FHA: Sources                     | Small   |

| <b>Exemp #</b>  | <b>Exemption Description</b>  | <b>Location Binning Category</b> | <b>PRA Step Ninning Category</b> | <b>Potential for CDF Reduction</b>       |
|-----------------|---|----------------------------------|----------------------------------|--|
| <b>DRS - 08</b> | Intervening combustibles or fire hazards are present and automatic fire suppression systems are not provided between the redundant trains of equipment in Reactor Building. - note coupling to DRS-10 for two zones | General process area             | FHA: Det&Supp,<br>FHA: Sources   | Small                                    |
| <b>DRS - 09</b> | Automatic fire suppression not installed in four zones of Reactor Building.   | General process area             | FHA: Det&Supp                    | Small                                    |
| <b>DRS - 10</b> | Automatic fire suppression not installed in two zones of reactor building. - Zones impacted are risk significant per the IPEEE submittal  | General process area             | FHA: Det&Supp                    | Potentially Significant                  |
| <b>DRS - 11</b> | Fixed fire suppression systems not installed in main control room, auxiliary equipment room. - The relay room is assumed screened and was therefore found to have small risk impact, the MCR is indeterminate.      | MCR, Relay room                  | FHA: Det&Supp                    | Indeterminate (MCR) / Small (Relay room) |

**Appendix C: Individual Exemption Assessment for J. M. Farley**

**Plant:** Farley

**Exemption #:** FAR -01

**Document Accession #:** 8402010336-01

**Appendix R Section:** III.G.2.d.

**Exemption Description:** Lack of 20 feet of separation free of intervening combustibles between redundant cables inside containment.

**Location Binning Category:** Containment

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR -01) - In typical fire PRAs containment fires are not found to be significant risk contributors. This is also consistent with guidance given to licensees in FIVE. In this specific case it can be inferred that there is some separation in cable routing for redundant instrumentation trains. Furthermore, the cables are IEEE 383 qualified and are all housed in conduits. The only fire source apparently considered credible by the NRC staff is transient fuels which are extremely unlikely during plant operation. Given that there is some separation among instrumentation trains and the fuel loading of concern is primarily of transient type, it can be concluded that the corresponding CDF should be very small and therefore, the exemption is considered to have very small risk impact.

**Points of Uncertainty:**

(FAR -01) - It is assumed that the instrumentation cables are well separated inside the control room and there are no active and risk significant safety related components inside the containment modeled in the fire risk analysis.

**Relevant IPEEE Citations:** (FAR -01) - The containments are fire Areas 1-55 and 2-55 (or 55A). Licensee has not explicitly analyzed the containment in the IPEEE fire analysis.

\_\_\_\_\_\*\*\*\*\*\_\_\_\_\_  
**Plant:** Farley

**Exemption #:** FAR -02

**Document Accession #:** 8512060387-01

**Appendix R Section: III.G.2.c.**

**Exemption Description:** Diesel generator building (DGB) redundant train not protected by 1-hour barrier nor automatic fire suppression installed fire area 56A.

**Location Binning Category:** Diesel Generator area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR -02) - This exemption is one of several exemptions that deals with doors that are not fire rated. The doors in question are certified by the manufacturer to be capable of meeting the performance criteria of the relevant NFPA standards. However, because the doorways have removable transoms to facilitate movement of equipment, the doors do not comply with one part of the standards which explicitly prohibit this configuration. In turn, because the door is not fire rated, the licensee treated the two adjacent rooms as a single fire area which introduces a nominal requirement to protect one train (it is not clear however, how the licensee has treated these fire zones in the IPEEE fire analysis). Had the doors been rated, it would appear that the exemption would not be required. Based on testing and certifications from the manufacturer, the USNRC accepted these doors as equivalent to the desired fire rating. In the context of fire risk, there would be no performance differences assumed between these doors and fully rated fire doors. Hence, the CDF reported in IPEEE submittal notwithstanding, this exemption is considered to have very small risk impact.

**Points of Uncertainty:** None

**Relevant IPEEE Citations:** (FAR -02) - In Table 4-2 of IPEEE submittal the licensee screens out the fire interaction associated with this fire compartment. The CDF associated with this fire compartment is 4.04E-06/ry (Table 4-10 of Ref. F-1).

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**Plant:** Farley

**Exemption #:** FAR -03

**Document Accession #:** 8512060387-02

**Appendix R Section: III.G.2.c.**

**Exemption Description:** Diesel Generator Building (DGB) fire area 56, zone b & c redundant train not enclosed; automatic fire suppression not installed.

**Location Binning Category:** Diesel Generator area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Summary:** (FAR -03) - See FAR-02

**Analysis:** (FAR -03) - See FAR-02

**Points of Uncertainty:** (FAR -03) - Based on the "exemption rationale" provided by the USNRC staff, it is assumed that this exemption deals with the exact same situation regarding fire door qualification as FAR-02.

**Relevant IPEEE Citations:** (FAR -03) - see FAR-02

\*\*\*\*\*

**Plant:** Farley

**Exemption #:** FAR -04

**Document Accession #:** 8512060387-03

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Fire area 51 does not have enclosed redundant safe shutdown cables, installed automatic fire suppression.

**Location Binning Category:** General Process area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR -04) - From Table 4-4 of the IPEEE submittal it can be inferred that this fire area contains minimal safety-related cables or equipment. The CDF obtained by licensee confirms this. Further, the exemption summary provided by the NRC staff indicates that the only concerns associated with this exemption relate to long-term battery room ventilation needs (in excess of 20 hours). Therefore, this exemption is considered to have very small risk impact.

**Points of Uncertainty:** None

**Relevant IPEEE Citations:** (FAR -04) - The IPEEE submittal discusses fire compartment 51A. We assume that it corresponds with the fire area addressed in this exemption. Fire initiation frequency is  $1.24 \times 10^{-4}/\text{ry}$  (p. 14 of 30 Table 4-3 of Ref. F-1). The CCDP is  $7.75 \times 10^{-6}/\text{ry}$  (p. 3 of 7 of Table 4-7 Ref. F-1) and CDF is  $9.6 \times 10^{-9}/\text{ry}$  (p. 3 of 7 of Table 4-8 Ref. F-1).

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**Plant:** Farley

**Exemption #:** FAR -05

**Document Accession #:** 8512060387-04

**Appendix R Section:** III.G.2.c.

**Exemption Description:** In Auxiliary Building, twelve (12) areas don't have one train of redundant safe shutdown cables enclosed in a 1-hour fire barrier, and automatic fire suppression not installed.

**Location Binning Category:** General Process area(s)

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR -05) - The description of this exemption is somewhat misleading. In discussions with the cognizant NRC staff it was revealed that the only deficiency being addressed by this exemption was the fact that certain fire doors between impacted fire areas could not be listed as Class A fire doors (See FAR-02 for a detailed discussion). None of the individual areas in question actually contains redundant safe shutdown equipment. It is only in the combination of areas assuming loss of equipment in adjoining fire areas that a potential for loss of redundant trains might occur. The licensee interpretation is hence conservative in that only in the absence of the doors would detection, suppression and barriers be required. As noted in FAR-02 the doors can be assumed substantially compliant with the performance aspects of the barrier standard.

Given this interpretation, the likelihood of fire propagation from room to room must be very unlikely. These situations are considered in the IPEEE submittal and none are found to be risk significant. Per the IPEEE submittal, the CDFs for all but two of the fire areas impacted by this exemption are less than  $1\text{E-}6/\text{ry}$ . The two exceptions are areas 1-41 and 2-41, each of which has a CDF contribution on the order of  $5\text{E-}5/\text{ry}$  (assuming "Train A on service" - even with "Train B on service" the CDF for each remains above  $1\text{E-}5/\text{ry}$ ). Indeed, for each unit these are the two highest CDF contributors under conditions of "Train A on-service" representing approximately 50% of the overall fire CDF. Despite these high CDF estimates, the exemption is still found to have very small risk impact. Again, with the understanding that the only point of deficiency is the non-compliant doors, the CDF of individual fire areas would not be impacted.



Hence, the exemption is considered to have very small risk impact.

Points of Uncertainty: (FAR-05)None

Relevant IPEEE Citations: (FAR -05) - The following information is provided in the IPEEE submittal for the affected compartments:

| Fire Area | Area Description | Sub Areas | Fire Initiation Frequency (per year) | CCDP                 | Screening CDF (per year) | Final CDF (per year)  |
|-----------|------------------|-----------|--------------------------------------|----------------------|--------------------------|-----------------------|
| 1-08      | Cable Chase      | 8-A       | $3.291 \times 10^{-4}$               | 0.047                | $2.7 \times 10^{-7}$     |                       |
| 1-31      | Cable Chase      | 31-A      | $3.291 \times 10^{-4}$               | 0.047                | $2.7 \times 10^{-7}$     |                       |
| 1-41      | Cable Chase      | 41-A      | $9.002 \times 10^{-3}$               | 0.047                | $4.2 \times 10^{-4}$     | $5.43 \times 10^{-5}$ |
| 1-42      | Corridors A B    |           | $3.831 \times 10^{-4}$               | 0.047                | $3.1 \times 10^{-7}$     |                       |
| 1-75      |                  |           |                                      | 0.047                | $2.7 \times 10^{-7}$     |                       |
| 2-08      |                  |           |                                      | 0.047                | $2.7 \times 10^{-7}$     |                       |
| 2-17      |                  |           |                                      | $1.9 \times 10^{-4}$ | $2.1 \times 10^{-7}$     |                       |
| 2-18      |                  |           |                                      | $1.9 \times 10^{-4}$ | $6.0 \times 10^{-7}$     |                       |
| 2-31      |                  |           |                                      | 0.047                | $2.7 \times 10^{-7}$     |                       |
| 2-41      |                  |           |                                      | 0.029                | $4.3 \times 10^{-4}$     | $5.26 \times 10^{-5}$ |
| 2-42      |                  |           |                                      | 0.047                | $9.0 \times 10^{-7}$     |                       |
| 2-75      |                  |           |                                      | 0.047                | $2.7 \times 10^{-7}$     |                       |

The discussions provided in Sections 4.6.4.7 and 4.6.4.18 of Ref. [F-1] regarding fire zone 1-41 and 2-41 indicate that 4.16kV bus F may get affected by a fire in these zones, and CCW and SW systems are affected as well.

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Plant: Farley

Exemption #: FAR -06

Document Accession #: 8512060387-05

Appendix R Section: III.G.2.c.

**Exemption Description:** In Auxiliary Building, ten (10) areas (switchgear room, cable chase and diesel generator) don't have safe shutdown cables 1-hour barrier enclosed, and automatic fire suppression not installed.

**Location Binning Category:** Switchgear room; Cable tunnels; Diesel Generator area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very small

**Analysis:** (FAR -06) - The situation in this exemption is virtually identical to that discussed for FAR-05 above. The single deficiency being cited is the lack of a Class A fire rating for certain doorways between fire areas impacted by the exemption (see FAR-02). In this case, per the IPEEE submittal, the CDFs for all but two of the areas identified in Reference [F-2] as part of this exemption are all less than  $1\text{E-}6/\text{ry}$ . The two exceptions are areas 1-21 and 2-21. These areas are the Train B equivalents to areas 1-41 and 2-41 which are addressed in FAR-05. The CDF for 1-21 is  $2.25\text{E-}5/\text{ry}$  and 2-21 has a CDF of  $2.68\text{E-}5$ , both when Train B is "on service". When Train A is "on service" each area's CDF contribution drops to about  $8\text{E-}6/\text{ry}$ .

As with FAR-05, because the only deficiency being addressed in the exemption is the fire doors, the quantification of individual fire area contributions is not impacted. Because the doors meet the performance criteria of a fully rated barrier, the room-to-room scenarios would also be unaffected. Hence, the exemption is considered to have very small risk impact

**Points of Uncertainty:** (FAR -06) - None

**IPEEE Implications:** (FAR -06) - The following information is provided in the IPEEE submittal for fire compartments that are addressed in this exemption:

| Fire Area | Area Description | Sub Areas | Fire Initiation Frequency (per year) | CCDP                   | Screening CDF (per year) | Final CDF (per year) |
|-----------|------------------|-----------|--------------------------------------|------------------------|--------------------------|----------------------|
| 1-09      | Cable Chase      | 9-A       | $3.291 \times 10^{-4}$               | 0.05                   | $5.725 \times 10^{-7}$   |                      |
|           |                  | 9-B       | $3.291 \times 10^{-4}$               | 0.05                   | $5.725 \times 10^{-7}$   |                      |
| 1-19      | Switchgear       | 19-A      | $3.215 \times 10^{-3}$               | $3.227 \times 10^{-4}$ | $1.037 \times 10^{-6}$   |                      |
| 1-21      | Switchgear       | 21-A      | $3.502 \times 10^{-3}$               | 0.023                  | $8.184 \times 10^{-5}$   | $2.3 \times 10^{-5}$ |
| 1-23      | Switchgear       | 23-A      | $3.203 \times 10^{-3}$               | $2.118 \times 10^{-4}$ | $6.784 \times 10^{-7}$   |                      |
| 1-30      | Cable Chase      | 30-A      | $3.291 \times 10^{-4}$               | $2.118 \times 10^{-4}$ | $6.970 \times 10^{-8}$   |                      |
| 1-76      |                  |           |                                      | $2.2 \times 10^{-4}$   | $7.0 \times 10^{-8}$     |                      |
| 2-19      |                  |           |                                      | $3.3 \times 10^{-4}$   | $9.8 \times 10^{-7}$     |                      |
| 2-21      |                  |           |                                      | 0.023                  | $8.6 \times 10^{-5}$     | $2.2 \times 10^{-5}$ |
| 2-23      |                  |           |                                      | $2.2 \times 10^{-4}$   | $6.8 \times 10^{-7}$     |                      |
| 2-30      |                  |           |                                      | $2.2 \times 10^{-4}$   | $7.0 \times 10^{-8}$     |                      |
| 2-76      |                  |           |                                      | $2.2 \times 10^{-4}$   | $7.0 \times 10^{-8}$     |                      |

\*\*\*\*\*

**Plant:** Farley

**Exemption #:** FAR -07

**Document Accession #:** 8512060387-06

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Service water valve box does not have a 3-hour barrier between redundant cabling and equipment.

**Location Binning Category:** Intake structure

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-07) - Per "Exemption Rationale" provided by the NRC staff, the redundant valves are separated by a 3 foot thick reinforced concrete wall. The reason that the wall is not rated as a 3 hour barrier is a single penetration 10 feet above the floor that is sealed but the seal is not fire rated. Thus, the possibility of fire damage on both sides of the wall is very remote and the penetration seal can provide adequate protection against propagation of smoke and hot gases. Also, it is stated that an analysis done by the licensee has concluded that the valves would not change position in case of cable damage in this area. Hence, in the unlikely event that damage occurs on both sides of the wall, the valves will remain in their original position and service water will remain available. Thus, this exemption is considered to have very small risk impact.

**Points of Uncertainty:** The specific valve box is not identified in the exemption description. It is assumed that it is one of several valve boxes listed in the IPEEE submittal and that the valve boxes are located in the intake structure.

**Relevant IPEEE Citations:** (FAR-07) - The fire areas that are possibly addressed in this exemption are 1-SVB-1, 1-SVB-2, 1-SVB-3, and 1-SVB-3 for Unit 1 and 2-SVB-1, 2-SVB-2, 2-SVB-3, and 2-SVB-3 for Unit 2. The fire initiation frequency for the fire areas is  $2 \times 3.291 \times 10^{-4} = 6.6 \times 10^{-4}/\text{ry}$ . The CCDP for these areas is  $7.74 \times 10^{-6}$  and final CDF is  $2.549 \times 10^{-9}/\text{ry}$ . In the IPEEE submittal the CDF associated with the failure of the valves in two adjacent compartments has not been addressed.

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -08

**Document Accession #:** 8512060387-07

**Appendix R Section:** III.G.2.c.

**Exemption Description:** In Auxiliary Building, areas 2-043 redundant cable not enclosed by 1-hour barrier, and automatic fire suppression not installed.

**Location Binning Category:** General Process area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-08) - In the IPEEE submittal, the licensee has concluded that the individual fire scenarios for this compartment screen out. From the "Exemption Rationale" provided by the NRC staff it can be concluded that in the case of loss of redundant trains present in this area many other safe shutdown related features and paths remain available and the batteries would not be adversely affected. Therefore, the exemption is considered to have very small risk impact.

**Points of Uncertainty:** (FAR-08) - None

**Relevant IPEEE Citations:** (FAR-08) - This fire area (2-43) is auxiliary building elevation 155'-0" and 175'-0" NW and SW quad. Fire initiation frequency is  $1.52 \times 10^{-3}/\text{ry}$ . The CCDP is  $4.382 \times 10^{-2}$ . The CDF is shown as less than  $1 \times 10^{-6}/\text{ry}$  based on low combustible loading of the area. This is based on the observation that individual fire scenarios for this compartment screen out.

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -09

**Document Accession #:** 8512060387-08

**Appendix R Section:** III.G.2.

**Exemption Description:** Auxiliary Building communication room safe shutdown cables not enclosed by 1-hour rated barrier, multiple hot shorts.

**Location Binning Category:** General Process area

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction: Very Small**

**Analysis:** (FAR -09) - The concern in this exemption relates to the potential for multiple hot shorts in fire area 2-15 to result in spurious PORV valve operation and a potential for LOCA. The NRC staff concluded that in the event of multiple hot shorts, the adverse effects can be mitigated by removing power from the transfer relays. PORV and head vent related equipment are affected.

This fire area has the potential for causing a small LOCA and the timing of the events in terms of manual mitigative actions may be critical. The risk impact of this exemption is therefore sensitive to the specific assumptions made regarding fire growth, suppression and human error probabilities. It should be noted that the licensee has concluded that the CCDP for this area is 0.073, which is an indication of the potential risk significance of the fire compartment. The IPEEE submittal concludes that this area is not risk significant and it screens on low CDF contribution. On this basis, given that the IPEEE submittal reports a CDF less than  $1 \times 10^{-6}$ , it is concluded that the exemption has very small risk impact. However, it may be noted that this conclusion is sensitive to the robustness of the analysis conducted by the licensee regarding the small likelihood associated with fire initiation, growth and damage to critical cables and equipment in the fire zone.

**Points of Uncertainty:**

(FAR -09) - It is assumed that the licensee has properly quantified the frequency of fire damage in this compartment and has properly considered the possibility of hot shorts. Since the CCDP for this fire compartment is greater than 0.01, there is a potential for this exemption to have small or significant risk impact as well. Our conclusion is based entirely on licensee's reported CDF value.

**Relevant IPEEE Citations:** (FAR -09) - The fire area is 2-15. Fire initiation frequency is  $3.291 \times 10^{-4}$ /ry. CCDP is  $7.288 \times 10^{-2}$  and the CDF is  $4.155 \times 10^{-7}$ /ry.

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -10

**Document Accession #:** 8512060387-09

**Appendix R Section:** III.G.2.

**Exemption Description:** Auxiliary Building stairwell has no automatic fire suppression.

**Location Binning Category:** General Process area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-10) - According to the IPEEE submittal, the CCDP for this area is small which implies that other shutdown paths are available independent of this area. In the "Exemption Rationale" provided by the NRC staff it is stated that the redundant safe shutdown cabling have been enclosed in a fire barrier. The fire load in a stairwell is typically very low. Given the low CDF contribution of the impacted area, this exemption is considered to have very small risk impact.

**Points of Uncertainty:** None

**Relevant IPEEE Citations:** (FAR-10) - The fire area is 2-SO2. Fire initiation frequency is  $3.291 \times 10^{-4}$ /ry. CCDP is  $2.142 \times 10^{-4}$  and the CDF is  $7.049 \times 10^{-8}$ /ry.

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -11

**Document Accession #:** 8512060387-10

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Service water valve box # 1 redundant cabling not enclosed in 1-hour rated barrier, automatic fire detection suppression not installed.

**Location Binning Category:** Intake structure

**PRA Step Binning Category:** FHA : FCIA; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-11) - See FAR -07

**Points of Uncertainty:** (FAR-11) - See FAR-07

**Relevant IPEEE Citations:** (FAR-11) - The fire area is 2SVB1. Fire initiation frequency is  $3.291 \times 10^{-4}$ /ry. The CCDP is  $7.745 \times 10^{-6}$  and CDF is  $2.549 \times 10^{-9}$ /ry.

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -12

**Document Accession #:** 8512060387-11

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Service water valve box #2 redundant cabling not enclosed in 1-hour rated barrier; automatic fire detection, suppression not installed.

**Location Binning Category:** Intake structure

**PRA Step Binning Category:** FHA : FCIA; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-12) – See FAR -07, -11

**Points of Uncertainty:** (FAR-12) – See FAR-07, -11

**Relevant IEEE Citations:** (FAR-12) – The fire area is 2SVB2. Fire initiation frequency is  $3.291 \times 10^{-4}/\text{ry}$ . The CCDP is  $7.745 \times 10^{-6}$  and CDF is  $2.549 \times 10^{-9}/\text{ry}$ .

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -13

**Document Accession #:** 8512060387-12

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Auxiliary Building battery room redundant cables not enclosed with 1-hour barrier; automatic fire suppression not installed.

**Location Binning Category:** General Process Area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR -13) - In the "Exemption Rationale" provided by the NRC staff, it is stated that manual actions have to be taken to overcome failure of instrument air and regain control of at least one PORV to achieve RCS depressurization. Also, the licensee had agreed to develop special procedures to deal with a fire in this area. Given that manual actions are needed to overcome the effects of a fire in this compartment, there is a potential for significant risk impact

due to the probability of human errors.

The IPEEE reports that the CDF for the impacted area is less than  $1\text{E-}06/\text{ry}$ . This conclusion is based on an analysis of individual fire growth scenarios within the compartment. It must be noted that the CCDP reported in the IPEEE submittal is 0.052, which indicates that this fire compartment can be risk significant. Thus, the sensitivity of the conclusion that the fire compartment is not risk significant to the underlying assumptions and fire ignition and growth analysis must be very high. Based primarily on the results of the IPEEE that the area CDF is less than  $1\text{E-}06/\text{ry}$ , it is concluded that this exemption should be considered to have very small risk impact.

**Points of Uncertainty:** (FAR -13) - It is assumed that the licensee has properly quantified the frequency of fire damage in this compartment. Since the CCDP for this fire compartment is significant, there is a potential for this exemption to have either small or significant risk impact. Our conclusion is based entirely on the licensee's reported CDF value and analysis in the IPEEE submittal.

**Relevant IPEEE Citations:** (FAR-13) -The fire area is 2-20. Fire initiation frequency is  $5.135 \times 10^{-4}/\text{ry}$ . The CCDP is  $5.167 \times 10^{-2}$  and CDF is less than  $1.0 \times 10^{-6}/\text{ry}$ . The CDF is concluded based on individual fire source analysis

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -14

**Document Accession #:** 8512060387-13

**Appendix R Section:** III.G.2.

**Exemption Description:** Non-rad side corridor, auxiliary building, redundant train of cables not 1-hour barrier enclosed.

**Location Binning Category:** General Process area

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR -14) - See FAR-13

**Points of Uncertainty:** (FAR -14) - See FAR-13

**Relevant IPEEE Citations:** (FAR-14) - The fire area is 2-020. Fire initiation frequency is



5.135x10<sup>-4</sup>/ry. The CCDP is 5.167x10<sup>-2</sup> and CDF is less than 1.0x10<sup>-6</sup>/ry.

\*\*\*\*\*  
Plant: Farley

Exemption #: FAR -15

Document Accession #: 8609180289-01

Appendix R Section: III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-008 of auxiliary building.

**Location Binning Category:** Cable tunnel

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-15) - From the information provided in the IPEEE submittal and the "Exemption Rationale" provided by the NRC staff, it can be concluded that this cable chase includes an important set of cables serving redundant trains. Hence, the risk level associated with this compartment is very sensitive to the underlying analysis assumptions. The CCDP for the area is given as 0.047 indicating the nominal importance of the area to fire risk. Assuming that the licensee has properly conducted the fire risk analysis for this fire compartment and given that the final estimated CDF is less than 1E-06, it can be concluded that this exemption has very small risk impact. However, as it is discussed for such exemptions as FAR-09, it may be noted that this conclusion is sensitive to the robustness of the analysis conducted by the licensee regarding the small likelihood associated with fire initiation, growth and damage to critical cables and equipment in the fire zone.

**Points of Uncertainty:** (FAR -15) - It is assumed that the licensee has properly quantified the frequency of fire damage in this compartment. Since the CCDP for this fire compartment is greater than 0.01, there is a potential for this exemption to have either small or significant risk impact. Our conclusion is based entirely on licensee's reported CDF value.

**Relevant IPEEE Citations:** (FAR-15) -The fire area is 1-08 (a cable chase). Fire initiation frequency is 3.291x10<sup>-4</sup>/ry. The CCDP is 4.736x10<sup>-2</sup> and CDF is 2.702x10<sup>-7</sup>/ry.

\*\*\*\*\*  
Plant: Farley

**Exemption #: FAR -16**

**Document Accession #: 8609180289-02**

**Appendix R Section: III.G.2.c.**

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1- 075 of auxiliary building.

**Location Binning Category:** Cable Tunnel

**PRA Step Binning Category:** FHA : FCIA; Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-16) - See FAR-15

**Points of Uncertainty:** (FAR-16) - See FAR-15

**Relevant IPEEE Citations:** (FAR-16) -The fire area is 1-075 (cable tunnel). Fire initiation frequency is  $3.291 \times 10^{-4}/\text{ry}$ . The CCDF is  $4.736 \times 10^{-2}$  and CDF is  $2.702 \times 10^{-7}/\text{ry}$ .

\*\*\*\*\*

**Plant:** Farley

**Exemption #: FAR -17**

**Document Accession #: 8609180289-03**

**Appendix R Section: III.G.2.c.**

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-017 of auxiliary building.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-17) - According to the IPEEE submittal, the CCDF for this compartment is small. This implies that several shutdown paths remain available in case of damage to the redundant safe shutdown cables in this compartment. Since the associated CDF is smaller than

$1 \times 10^{-6}$ , this exemption is considered to have very small risk impact.

**Points of Uncertainty:** (FAR-17) - The finding of risk insignificance is based on the IPEEE results.

**Relevant IPEEE Citations:** (FAR-17) - The fire area is 1-017 (battery room 1A). Fire initiation frequency is  $1.129 \times 10^{-3}/\text{ry}$ . The CCDP is  $1.870 \times 10^{-4}$  and CDF is  $2.111 \times 10^{-7}/\text{ry}$ .

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -18

**Document Accession #:** 8609180289-04

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 1-hour between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-018 of auxiliary.

**Location Binning Category:** Switchgear room

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-18) - See FAR-17

**Points of Uncertainty:** (FAR-18) - See FAR-17

**Relevant IPEEE Citations:** (FAR-18) - The fire area is 1-018 (switchgear room 1A). Fire initiation frequency is  $3.125 \times 10^{-3}/\text{ry}$ . The CCDP is  $1.870 \times 10^{-4}$  and CDF is  $6.012 \times 10^{-7}/\text{ry}$ .

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**Plant:** Farley

**Exemption #:** FAR -19

**Document Accession #:** 8609180289-05

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown

cables, and automatic fire suppression not installed in fire area 1-041 of auxiliary building.

**Location Binning Category:** Switchgear

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-19) - This exemption appears redundant to FAR-05 except that it is exclusive to fire area 1-41 rather than generally applied to multiple fire areas. There appears to be nothing unique about this exemption in comparison to FAR-05. For further discussion of this fire area see FAR-05.

**Points of Uncertainty:** (FAR-19) -See FAR-05

**Relevant IPEEE Citations:** (FAR-19) - See FAR-05

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**Plant:** Farley

**Exemption #:** FAR -20

**Document Accession #:** 8609180289-06

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 2-041 of auxiliary building.

**Location Binning Category:** Switchgear

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** (FAR-18) -

**Analysis:** (FAR-20) - See FAR-19 and FAR-05: This is identical to FAR-19 but impacts the corresponding Unit 2 fire area. The exemption appears redundant to FAR-05.

**Points of Uncertainty:** (FAR-20) - See FAR-05

**Relevant IPEEE Citations:** (FAR-20) - See FAR-05

**Plant:** Farley

**Exemption #:** FAR -21

**Document Accession #:** 8609180289-07

**Appendix R Section:** III.G.2.

**Exemption Description:** Lack of 3-hour barrier between redundant trains of cabling, equipment and non-safety associated circuits; or not enclosed by 1-hour barrier, fire area 1-042 of auxiliary building.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-21) - From the CCDP (0.047) reported in the IPEEE submittal it can be concluded that this compartment has important equipment and cables. However, since the final CDF for this compartment is less than  $10^{-6}$ /ry, the exemption is concluded to have very small risk impact. This conclusion is highly sensitive to the underlying assumptions used in the fire ignition, growth, and damage analysis conducted by the licensee in the IPEEE analysis of the impacted fire area. Assuming that the licensee has properly conducted the fire risk analysis for this fire compartment, it is concluded that this exemption has very small risk impact. Similar to exemption FAR-15 and FAR-09, the final conclusion is sensitive to the robustness of licensee's analysis of the likelihood of fire initiation, growth and damage.

**Points of Uncertainty:** (FAR -21) - It is assumed that the licensee has properly quantified the frequency of fire damage in this compartment. Since the CCDP for this fire compartment is greater than 0.01, there is a potential for this exemption to be have either small or significant risk impact. Our conclusion is based entirely on the licensee's reported CDF value.

**Relevant IPEEE Citations:** (FAR-21) -The fire area is 1-42 (Corridors A and B at Elevation 139'0" of Auxiliary Building). Fire initiation frequency is  $3.831 \times 10^{-4}$ /ry. The CCDP is  $4.666 \times 10^{-2}$  and CDF is  $3.098 \times 10^{-7}$ /ry.

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -22

**Document Accession #:** 8609180289-08

**Appendix R Section: III.G.2.c.**

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-031 of auxiliary building.

**Location Binning Category:** Cable tunnel

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-22) - This exemption appears to be quite similar to FAR-15 but impacts a different set of Auxiliary Building areas. See FAR-15.

**Points of Uncertainty:** (FAR-22) - See FAR-15

**Relevant IPEEE Citations:** (FAR-22) -The fire area is 1-31 (Cable Chases). Fire initiation frequency is  $3.291 \times 10^{-4}/\text{ry}$ . The CCDP is  $4.736 \times 10^{-2}$  and CDF is  $2.702 \times 10^{-7}/\text{ry}$ .

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**Plant:** Farley

**Exemption #:** FAR -23

**Document Accession #:** 8609180289-09

**Appendix R Section: III.G.2.c.**

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-021 of auxiliary building.

**Location Binning Category:** Switchgear room

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-23) - This exemption appears redundant to FAR-06 but is exclusive to fire area 1-21. See discussion of FAR-19 and FAR-06.

**Points of Uncertainty:** (FAR-23) - See FAR-06

**Relevant IPEEE Citations:** (FAR-23) -See FAR-06

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**Plant:** Farley

**Exemption #:** FAR -24

**Document Accession #:** 8609180289-10

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-023 of auxiliary building.

**Location Binning Category:** Switchgear room

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-24) - From the CCDP provided in the IPEEE submittal we can infer that other paths independent of the impacted fire area are available to shutdown the plant. Given that the final estimated CDF is less than  $10^{-6}$ /ry, this exemption is considered to have very small risk impact.

**Points of Uncertainty:** (FAR-24) - None

**Relevant IPEEE Citations:** (FAR-24) -The fire area is 1-23 (switchgear room). Fire initiation frequency is  $3.203 \times 10^{-3}$ /ry. The CCDP is  $2.118 \times 10^{-4}$  and CDF is  $6.784 \times 10^{-7}$ /ry.

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -25

**Document Accession #:** 8609180289-11

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-019 of auxiliary building.

**Location Binning Category:** Switchgear room

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Small

**Analysis:** (FAR-25) - From the CCDP provided in the IPEEE submittal (3E-4) we can conclude that other paths are available to shutdown the plant. Given that the final CDF is slightly greater than  $1.0 \times 10^{-6}/\text{ry}$ , this exemption is considered to have small risk impact.

**Points of Uncertainty:** (FAR-25) - None

**Relevant IPEEE Citations:** (FAR-25) - The fire area is 1-019. Fire initiation frequency is  $3.215 \times 10^{-3}/\text{ry}$ . The CCDP is  $3.227 \times 10^{-4}$  and CDF is  $1.037 \times 10^{-6}/\text{ry}$ .

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**Plant:** Farley

**Exemption #:** FAR -26

**Document Accession #:** 8609180289-12

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-012 of auxiliary building.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-26) - From the CCDP reported in the IPEEE submittal (4.6E-2) it can be concluded that this compartment has important equipment and cables. The IPEEE submittal reports a final CDF less than  $1\text{E-}06/\text{ry}$ . This implies that the CDF reported in the IPEEE is highly sensitive to the underlying assumptions of the fire ignition, growth, and damage analysis conducted by the licensee. However, since the final CDF for this compartment is less than  $10^{-6}/\text{ry}$ , the exemption is considered to have very small risk impact. However, as it is discussed for exemptions FAR-09 and -15, the final conclusion is sensitive to the robustness of licensee's analysis.

**Points of Uncertainty:** (FAR -26) - It is assumed that the licensee has properly quantified the frequency of fire damage in this compartment. Since the CCDP for this fire compartment is greater than 0.01, there is a potential for the exemption to have either small or significant risk



impact. Our conclusion is based entirely on the licensee's reported CDF value.

**Relevant IPEEE Citations:** (FAR-26) -The fire area is 1-12. Fire initiation frequency is  $3.726 \times 10^{-4}/\text{ry}$ . The CCDP is  $4.589 \times 10^{-2}$  and CDF is  $2.963 \times 10^{-7}/\text{ry}$ .

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**Plant:** Farley

**Exemption #:** FAR -27

**Document Accession #:** 8609180289-13

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-013 of auxiliary building.

**Location Binning Category:** Cable tunnel

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-27) - From the CCDP reported in the IPEEE submittal (0.021) it can be concluded that this compartment has important equipment and cables. However, since the final CDF for this compartment is less than  $10^{-6}/\text{ry}$ , the risk significance of this exemption is considered to have very small risk impact. However, as it is discussed for exemptions FAR-09 and -15, the final conclusion is sensitive to the robustness of licensee's analysis.

**Points of Uncertainty:** (FAR -27) - It is assumed that the licensee has properly quantified the frequency of fire damage in this compartment. Since the CCDP for this fire compartment is greater than 0.01, there is a potential for this exemption to have either small or significant risk impact. Our conclusion is based entirely on the licensee's reported CDF value.

**Relevant IPEEE Citations:** (FAR-27) -The fire area is 1-013. Fire initiation frequency is  $4.265 \times 10^{-4}/\text{ry}$ . The CCDP is  $2.150 \times 10^{-2}$  and CDF is  $1.589 \times 10^{-7}/\text{ry}$ .

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**Plant:** Farley

**Exemption #:** FAR -28

**Document Accession #:** 8609180289-14

**Appendix R Section: III.G.2.c.**

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-076 of auxiliary building.

**Location Binning Category:** Cable tunnel

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-28) - From the CCDP provided in the IPEEE submittal (2E-4) we can conclude that other paths are available to shutdown the plant. Given that the CDF is less than  $10^{-6}$ /ry, this exemption is considered to have very small risk impact.

**Points of Uncertainty:** None

**Relevant IPEEE Citations:** (FAR-28) -The fire area is 1-76 (cable tunnel train B). Fire initiation frequency is  $3.291 \times 10^{-4}$ /ry. The CCDP is  $2.118 \times 10^{-4}$  and CDF is  $6.970 \times 10^{-8}$ /ry.

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**Plant:** Farley

**Exemption #:** FAR -29

**Document Accession #:** 8609180289-15

**Appendix R Section: III.G.2.c.**

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-030 of auxiliary building

**Location Binning Category:** Cable tunnel

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-29) - From the CCDP provided in the IPEEE submittal (2E-4) we can conclude that other paths are available to shutdown the plant. Given that the CDF is less than  $10^{-6}$ /ry, it is concluded that this exemption has very small risk impact.

**Points of Uncertainty:** None

**IPEEE Implications:** (FAR-29) -The fire area is 1-30 (Cable Chase). Fire initiation frequency is  $3.291 \times 10^{-4}$ /ry. The CCDP is  $2.118 \times 10^{-4}$  and CDF is  $6.970 \times 10^{-3}$ /ry.

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**Plant:** Farley

**Exemption #:** FAR -30

**Document Accession #:** 8609180289-16

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-016 of auxiliary building.

**Location Binning Category:** Cable tunnel

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-30) - From the CCDP provided in the IPEEE submittal ( $3E-4$ ) we can conclude that other paths are available to shutdown the plant. Given that the CDF is less than  $10^{-6}$ /ry, it is concluded that this exemption has very small risk impact.

**Points of Uncertainty:** None

**Relevant IPEEE Citations:** (FAR-30) -The fire area is 1-16 (battery room 1B). Fire initiation frequency is  $1.129 \times 10^{-3}$ /ry. The CCDP is  $3.227 \times 10^{-4}$  and CDF is  $6.970 \times 10^{-3}$ /ry.

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**Plant:** Farley

**Exemption #:** FAR -31

**Document Accession #:** 8609180289-17

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 3-hour barrier between trains of redundant safe shutdown cables in fire area 1-005 of auxiliary building; lack of 1-hour barrier between redundant safe shutdown cables in rooms 172 and 181 and an automatic suppression system in fire area 1-005 of auxiliary building.

**Location Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR -31) - This exemption addresses fire area 1-05 which is comprised of four fire compartments (1-05A through 1-05D). The IPEEE submittal analyzes CDF and other issues for individual fire compartments. Per the "Exemption Rationale" provided by the NRC staff, the compartments within this fire area are well separated from one another with fire rated walls and doors. Therefore, the results based on separate analysis of the individual compartments provided in the IPEEE submittal appear to be valid. The CCDPs for fire compartments 1-05A through 1-05C are small, indicating that several paths are available to achieve safe shutdown. For these compartments, the exemption is deemed to be of minimal risk significance. Compartment 1-05D has a relatively large CDDP (0.084) indicating that there is important safe shutdown equipment and cables within the compartment. Given the small final estimated CDF reported for this fire compartment, the analysis must be very sensitive to the underlying assumptions used in the fire ignition, growth, and damage analysis conducted by the licensee. Given that the CDF is less than  $10^{-6}$ /ry, it is concluded that the exemption has very small risk impact. However, as it is mentioned above and similar to exemptions FAR-09 and 15, the final conclusion is sensitive to the robustness of licensee's analysis.

**Points of Uncertainty:** (FAR-31) - It is assumed that the discussion provided in "Exemption Rationale" is valid and fire propagation among the fire compartments that comprise this fire area is difficult and has a low probability of occurrence. It is also assumed that the licensee has properly quantified the frequency of fire damage in fire compartment 1-05D. Since the CDDP for this fire compartment is greater than 0.01, there is a potential for this exemption to have either small or significant risk impact. Our conclusion is completely based on licensee's reported CDF value.

**Relevant IPEEE Citations:** (FAR-31) - The IPEEE submittal reports the following information regarding the fire compartments in the referenced fire area.

| Fire Area | Fire Initiation Frequency (per year) | CCDP (per year)        | Screening CDF (per year) |
|-----------|--------------------------------------|------------------------|--------------------------|
| 1-005A    | $3.291 \times 10^{-4}$               | $1.163 \times 10^{-3}$ | $2.628 \times 10^{-9}$   |
| 1-005B    | $7.526 \times 10^{-4}$               | $2.279 \times 10^{-5}$ | $5.943 \times 10^{-3}$   |
| 1-005C    | $7.736 \times 10^{-4}$               | $8.236 \times 10^{-6}$ | $2.148 \times 10^{-3}$   |
| 1-005D    | $7.526 \times 10^{-4}$               | $8.368 \times 10^{-2}$ | $< 1.000 \times 10^{-6}$ |

Based on the information provided in Table 4-2 in Ref. F-1, it can be concluded that there are openings among the fire compartments that comprise this fire area and fire can propagate from

one to others.

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**Plant:** Farley

**Exemption #:** FAR -32

**Document Accession #:** 8609180289-18

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-035 of auxiliary building.

**Location Binning Category:** Cable vault

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Potential Significant Risk Impact

**Analysis:** (FAR-32) - The IPEEE submittal reports CCDPs for several fire scenarios within the fire compartments impacted by this exemption. These values appear to be heavily dependent on human actions to overcome fire-induced faults on both trains of CCW and SW. The CDF after detailed analysis is  $2.9\text{E-}05/\text{ry}$  (with train A "on service"). Table 4-6 also confirms that the area is not protected by fixed suppression. Therefore, if modifications are implemented to make these compartments compliant with Appendix R requirements (i.e., separation/protection of redundant trains and addition of fixed automatic fire suppression) this would reduce the dependency on human recovery actions, and on manual suppression. The CDF associated with these compartments may decrease significantly. Hence, this exemption is found to have significant risk impact. However, given the information in the IPEEE submittal it is not possible to estimate the risk benefit that might be realized.

**Points of Uncertainty:** (FAR-32) - The systems and components cited in the IPEEE submittal and in Reference [F-3] do not coincide. It is not clear what the results of the licensee fire modeling showed with regard to fire sources, damage times, and suppression credit. Hence, risk change quantification is not possible.

**Relevant IPEEE Citations:** (FAR-32) - Fire area 1-035 (electrical penetration room A) and consists of compartments 333 and 347. Fire initiation frequency is  $1.580 \times 10^{-3}/\text{ry}$ . The screening CCDP is  $3.218 \times 10^{-1}$  and screening CDF is  $7.025 \times 10^{-6}/\text{ry}$ . This area is addressed in Sections 4.6.4.6, 4.6.5.2, and 4.6.7.2.4 which provides the following:

- The CCDP for a fire in compartment 333 is  $7.745 \times 10^{-6}$ .
- Four scenarios are considered in compartment 347 with the following CCDPs:

- $2.833 \times 10^{-2}$ ,  $7.906 \times 10^{-3}$ ,  $2.171 \times 10^{-5}$ , and  $2.120 \times 10^{-2}$ .
- The large CCDPs are heavily dependent on operator recovery actions.
  - The final core damage frequencies are  $2.90 \times 10^{-5}/\text{ry}$  and  $1.79 \times 10^{-6}/\text{ry}$  (from Table 4-10) for Train A or B being in service respectively.

The discussions provided in Section 4.6.4.2 of Reference [F-1] indicate that both trains of CCW and SW, and Train B of ac power are affected by the postulated fire scenario but this is not consistent with the IPEEE assumptions. It may be that a plant modification has been made that impacted this vulnerability.

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**Plant:** Farley

**Exemption #:** FAR -33

**Document Accession #:** 8609180289-19

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-004 of auxiliary building; lack of 3-hour barriers between trains of redundant safe shutdown cables for some fire area.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-33) - Based on the IPEEE submittal, the CCDPs for the fire compartments that are impacted by this exemption are very small. This implies that several shutdown paths remain available despite the damage to redundant safe shutdown cables in these compartments. Since the associated CDFs for all compartments are less than  $1.0 \times 10^{-6}/\text{ry}$ , it is concluded that this exemption has very small risk impact.

**Points of Uncertainty:** None

**Relevant IPEEE Citations:** (FAR - 33) - The Fire Area 1-04 consists of 25 fire compartments, which in turn consist of a large number of rooms. The IPEEE submittal reports CCDPs for the fire compartments that generally range between  $7.7 \times 10^{-6}$  and  $5.7 \times 10^{-3}$  with an outlier being  $4.019 \times 10^{-2}$  for fire compartment 1-4A10. The CDFs reported for these compartments generally range between  $4.2 \times 10^{-9}$  and  $1.0 \times 10^{-6}/\text{ry}$ , with the exception of fire zones 1-4A10 and 1-4A17. The CDFs of the latter two fire zones are  $4.7 \times 10^{-6}/\text{ry}$  and  $8.153 \times 10^{-4}/\text{ry}$  respectively. These are screening CDFs. The licensee has analyzed 1-4A10 further, in Sections 4.6.4.1 and 4.6.5. In

Section 4.6.4.1, the licensee has concluded that CCDP for this fire compartment is  $2.852 \times 10^{-4}$ . The associated CDF is  $3.42 \times 10^{-7}/\text{ry}$  (Table 4-10). For 1-4A17, there are no further discussion in Section 4.6 of the submittal and there are no entries for revised CCDP in Table 4-9. However, in Table 4-10, the licensee provides  $2.51 \times 10^{-7}/\text{ry}$  as the revised CDF.

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**Plant:** Farley

**Exemption #:** FAR -34

**Document Accession #:** 8609180289-20

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of an installed automatic fire suppression system in the auxiliary building stairwell, fire area 1-S02.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-34) - Per the IPEEE submittal, the CCDP for this area is small ( $2\text{E}-4$ ), which implies that other shutdown paths are available independent of this area. In the "Exemption Rationale" provided by the NRC staff it is stated that the redundant safe shutdown cabling have been enclosed in a fire barrier. The fire load of stairwells is typically very low. Given that the CDF is less than  $10^{-6}/\text{ry}$ , it is concluded that this exemption has very small risk impact.

**Points of Uncertainty:** None.

**Relevant IPEEE Citations:** (FAR-34) -The fire area is 1-S02. Fire initiation frequency is  $3.291 \times 10^{-4}/\text{ry}$ . The CCDP is  $2.142 \times 10^{-4}$  and CDF is  $7.049 \times 10^{-8}/\text{ry}$ .

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**Plant:** Farley

**Exemption #:** FAR -35

**Document Accession #:** 8609180289-21

## Appendix R Section: III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-034 of auxiliary building.

**Location Binning Category:** Cable vault

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Potential Significant Risk Impact

**Analysis:** (FAR-35) - Based on the IPEEE submittal, fire compartment 1-34B is a significant fire risk contributor, in particular, when Train B is "on service". Although from the discussions provided in Section 4.6.4.5 it may be inferred that both trains of CCW and SW are affected, the CCDP for each of the compartments that comprise this fire area are small. This means that several shutdown paths remain available in case of damage to the redundant safe shutdown cables in any one compartment. Hence, the fire growth and damage analysis must have postulated a relatively high conditional probability of critical damage given a fire. This would imply that installation of a fixed fire suppression system and protection of the redundant cables might substantially reduce the damage potential, and thereby substantially reduce the fire risk.

The overall CDF for 1-34B is  $1.61\text{E-}05/\text{ry}$  with Train B "on service". Therefore this exemption is concluded to have a potential for significant risk impact. As with other exemptions that have a potential for significant risk impact, the potential risk reductions cannot be quantified.

**Points of Uncertainty:** (FAR-35) - There is an inconsistency between Table 4-8 of Ref. F-1 (which gives the screening CDFs) and Tables 4-9 and 4-10 (where the results of detailed analysis are presented). Using the fire initiation frequencies reported in Table 4-3 and the CCDPs of Table 4-9, the CDF in Table 4-10 cannot be verified. It is assumed that Tables 4-9 and 4-10 provide the correct CCDPs and CDFs. Also, there are inconsistencies between References [F-1] and [F-3] in terms of communication paths between the two rooms and equipment and cables that may fail from a fire in this fire area.

**Relevant IPEEE Citations:** (FAR-35) - The fire area (electrical penetration room) is comprised of fire compartments 1-34A and 1-34B. Per Table 4-2 of the submittal, the two compartments do not communicate. The IPEEE submittal reports the following information in Tables 4-7 and 4-8.

| Fire Areas | Fire Initiation Frequency | Screening CCDP (per year) | Screening CDF (per year) |
|------------|---------------------------|---------------------------|--------------------------|
| 1-034A     | $6.334 \times 10^{-4}$    | $3.797 \times 10^{-5}$    | $2.405 \times 10^{-8}$   |
| 1-034B     | $2.183 \times 10^{-3}$    | $5.077 \times 10^{-3}$    | $1.920 \times 10^{-7}$   |

Fire compartment 1-34B, per Table 4-3, includes electrical cabinets, transformers and hydrogen piping. Fire compartment 1-34B was analyzed in detail (Section 4.6.4.5 gives a summary of that



analysis). Four scenarios have been identified for that compartment. The CCDPs for the four scenarios are 2.8E-03, 2.8E-03, 6.7E-05, and 1.3E-04 (from Table 4-9). In Table 4-10, the combined CDF for all four scenarios is reported as  $1.61 \times 10^{-5}/\text{ry}$  which contradicts with the screening CDF shown above. From the discussions in Section 4.6.4.5 of Reference [F-1], it may be inferred that both trains of CCW and SW will be affected by a fire in this area.

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**Plant:** Farley

**Exemption #:** FAR -36

**Document Accession #:** 8609180289-22

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Non-fire rated reach-rod penetrations are located in walls between trains of redundant safe shutdown cables in fire areas 1-004 and 1-005 of the auxiliary building, Unit 1, and fire areas 2-004 and 2-005 of the auxiliary building, Unit 2.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR -36) - The exemption deals with unsealed reach-rod penetrations in the walls between adjacent fire areas. The openings are of relatively small size. The NRC staff analysis concluded that the assembly provided for securing and sealing the reach rods can provide sufficient protection against the propagation of the effects of a fire in one compartment to another. Further, automatic fire sprinklers are provided in all of the impacted areas. Therefore, the conclusions reached for exemptions FAR-31 and FAR-33 apply here as well and the exemption is considered to have very small risk impact.

**Points of Uncertainty:** (FAR -36) - See FAR-31

**Relevant IPEEE Citations:** (FAR -36) - See FAR-31 and FAR-33.

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**Plant:** Farley

**Exemption #:** FAR -37

**Document Accession #:** 8609180289-23

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-020 of the auxiliary building.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR -37) - The fire area is comprised of three fire compartments. The CCDP for two compartments is small and therefore, it can be concluded that sufficient number of shutdown paths are available to mitigate the effects of fire damage in these compartments. The CCDP for Fire Compartment 1-20A is 0.052 which appears (per the discussions provided in the "Exemption Rationale" provided by the NRC staff) to depend on several manual recovery actions needed to achieve safe shutdown. Given that the licensee has concluded that for all three fire compartments the CDFs are less than  $1.0 \times 10^{-6}$  /ry, this exemption is considered to have very small risk impact. However, similar to exemptions FAR-09 and -15, this conclusion is sensitive to the underlying assumptions regarding fire ignition, growth, damage, detection and suppression used in the IPEEE.

**Points of Uncertainty:** (FAR -37) - It is assumed that the licensee has properly quantified the frequency of fire damage in this compartment. Since the CCDP for fire compartment 1-20A is greater than 0.01, there is a potential for this exemption to have either small or significant risk impact. Our conclusion is based entirely on the licensee's reported CDF value.

**Relevant IPEEE Citations:** (FAR-37) -The fire area 1-20 is comprised of three fire compartments 1-20A through 1-20C. Fire initiation frequencies are  $4.113 \times 10^{-3}$ ,  $3.396 \times 10^{-4}$  and  $9.425 \times 10^{-4}$  /ry respectively. The CCDPs are  $5.193 \times 10^{-2}$ ,  $3.360 \times 10^{-3}$  and  $1.081 \times 10^{-4}$ . The CDFs are  $5.524 \times 10^{-7}$ ,  $2.592 \times 10^{-7}$  and  $1.019 \times 10^{-7}$  /ry.

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -38

**Document Accession #:** 8609180289-24

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 2-042 of auxiliary building.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR -38) - An important part of this exemption is virtually identical to that discussed for FAR-02 above, regarding the fire rating of the transom section of the doors in this fire compartment. Based on testing and certifications from the manufacturer, the USNRC accepted these doors as equivalent to the desired fire rating. In the context of fire risk, it is concluded that there would be no performance differences assumed between these doors and fully rated fire doors. Hence, this part of the exemption is considered to have very small risk impact. In the IPEEE submittal, the CCDP for the area is about 0.05 which appears (per the discussions provided in the "Exemption Rationale" provided by the NRC staff) to depend on several manual recovery actions needed to achieve safe shutdown. Given that the licensee has reported that the CDF is less than  $1.0 \times 10^{-6}$  /yr, this exemption is concluded to have very small risk impact. This part of the conclusion is sensitive to the underlying assumptions regarding fire ignition, growth, damage, detection and suppression used in the IPEEE.

**Points of Uncertainty:** (FAR -38) - It is assumed that the licensee has properly quantified the frequency of fire damage in this compartment. Since the CCDP for this fire compartment is greater than 0.01, there is a potential for this exemption to have either small or significant risk impact. Our conclusion is based entirely on the licensee's reported CDF value.

**Relevant IPEEE Citations:** (FAR-38) -The fire area is 2-042. Fire initiation frequency is  $3.726 \times 10^{-4}$  /ry. The CCDP is  $4.666 \times 10^{-2}$  and CDF is  $8.695 \times 10^{-7}$  /ry.

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -39

**Document Accession #:** 8609180289-25

**Appendix R Section:** III.G.2.d.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-009 of auxiliary building.

**Location Binning Category:** Cable tunnel

**PRA Step Binning Category: FHA : Grw&Dmg**

**Potential for CDF Reduction: Very Small**

**Analysis:** (FAR -39) - The impacted fire area is comprised of two fire compartments. The CCDP for both compartments is about 0.05 which appears (per the discussions provided in the "Exemption Rationale" provided by the NRC staff) to depend on several manual recovery actions needed to achieve safe shutdown. Also in the Exemption Rationale it is stated that the licensee would protect one train of the auxiliary feedwater system with a one-hour fire barrier. Given the installation of the fire barrier and that the licensee has concluded that for both fire compartments the CDFs are less than  $1.0 \times 10^{-6}$  /ry, this exemption is therefore considered to have very small risk impact. This conclusion is sensitive to the underlying assumptions regarding fire ignition, growth, damage, detection and suppression used in the IPEEE submittal.

**Points of Uncertainty:** (FAR -39) - It is assumed that the licensee has properly quantified the frequency of fire damage in these compartments. Since the CCDP for the two fire compartments is greater than 0.01, there is a potential for this exemption to have either small or significant risk impact. Our conclusion is based entirely on the licensee's reported CDF value.

**Relevant IPEEE Citations:**

(FAR-39) – The IPEEE submittal provides the following information:

| Fire Area | Fire Initiation Frequency | Screening CCDP         | Screening CDF (per year) |
|-----------|---------------------------|------------------------|--------------------------|
| 1-009A    | $6.582 \times 10^{-4}$    | $5.019 \times 10^{-2}$ | $5.725 \times 10^{-7}$   |
| 1-009B    | $6.582 \times 10^{-4}$    | $5.019 \times 10^{-2}$ | $5.725 \times 10^{-7}$   |

Both fire compartments are cable chases.

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**Plant: Farley**

**Exemption #: FAR -40**

**Document Accession #: 8609180289-26**

**Appendix R Section: III.G.2.c.**

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-001 of auxiliary building.

**Location Binning Category: General process area**

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR -40) - The fire area is comprised of several fire compartments. The CCDP for all but one of these compartments is small. In the case of fire compartment 1-1G, the CCDP is 0.04 which appears (per the discussions provided in the "Exemption Rationale" provided by the NRC staff) to depend on several manual recovery actions required to achieve safe shutdown, and failure of redundant trains that are separated by 10 feet of horizontal space. Given the modest separation between redundant trains, and that the licensee has concluded that for all fire compartments the CDFs are less than  $1 \times 10^{-6}$  /ry, this exemption is concluded to have very small risk impact. This conclusion, in the case of 1-1G, is sensitive to the underlying assumptions regarding fire ignition, growth, damage, detection and suppression used in the IPEEE submittal.

**Points of Uncertainty:** (FAR -40) - It is assumed that the licensee has properly quantified the frequency of fire damage in fire compartment 1-1G. Since the CCDP for that fire compartment is greater than 0.01, there is a potential for this exemption to have either small or significant risk impact. Our conclusion is based entirely on the licensee's reported CDF value.

**Relevant IPEEE Citations:** (FAR -40) - The fire area consists of several fire compartments. The CCDP for the collection of fire compartments, except for 1-1G, range between  $7.7 \times 10^{-6}$  and  $1.1 \times 10^{-4}$ . The CCDP for 1-1G is  $3.993 \times 10^{-2}$ . The CDFs for all the compartments, including 1-1G, range between  $2.55 \times 10^{-9}$  and  $7.1 \times 10^{-7}$  /ry.

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**Plant:** Farley

**Exemption #:** FAR -40X

**Document Accession #:** 8609180289-27

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in 9 rooms, fire area 1-006 of auxiliary building

**SPECIAL NOTE:** (FAR -40X) - This appears to be a spurious entry in the FIREDAT data base. Supporting documentation verified that this is, in fact, a combination of the exemption description for FAR-40 and the exemption rationale provided for FAR-41. Therefore, this exemption is not used in the statistical analysis and other parts of the report and is not included in the count of Farley exemptions.

Plant: Farley

Exemption #: FAR -41

Document Accession #: 8609180289-28

Appendix R Section: III.G.2.c.

**Exemption Description:** Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in 12 rooms, fire area 1-006 of auxiliary building

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Small

**Analysis:** (FAR-41) - From the information provided in the IPEEE submittal it can be concluded that a single fire cannot fail the redundant set of equipment in this fire area. This is further confirmed in the evaluation provided in Reference [F-4]. Although the overall CDF for this fire area is greater than  $1E-05$ , this exemption is concluded to have small impact on risk. From the IPEEE submittal we can conclude that added barriers protecting redundant trains would enhance fire safety and reduce the CCDP associated with the area. However, from a review of the information provided in Reference [F-4] and IPEEE submittal, it is concluded that any modification to fire 6-C cannot reduce the CCDP significantly. Therefore, given that the CCDPs are either already small or not strongly dependent on the redundant trains present in the fire area, it is deemed that the reduction in the total CDF will be less than  $1.0 \times 10^{-5}/\text{ry}$ . Since the extent of reduction cannot be estimated within a reasonable level of confidence, it is concluded that this exemption has small risk impact.

**Points of Uncertainty:** (FAR-41) - It is assumed that the fire propagation and fire initiation frequencies that lead to the conclusion that CCW and AFW pumps and associated cables are not affected by a single fire are properly modeled in the IPEEE fire analysis.

**Relevant IPEEE Citations:** (FAR -41) - The fire area 1-06 (corridors in the Auxiliary Building) includes 5 fire compartments that consist of several compartments. The CCDP and CDF for the five fire compartments are as follows:

| Fire Area | Fire Initiation Frequency (per year) | CCDP (per year) | CDF (per year) |
|-----------|--------------------------------------|-----------------|----------------|
|           |                                      |                 |                |

|     |                        |                        |                          |
|-----|------------------------|------------------------|--------------------------|
| 6-A | $3.554 \times 10^{-3}$ | $4.644 \times 10^{-2}$ | $2.900 \times 10^{-4}$   |
| 6-B | $3.409 \times 10^{-4}$ | $2.116 \times 10^{-2}$ | $9.866 \times 10^{-7}$   |
| 6-C | $1.598 \times 10^{-3}$ | 0.2408                 | $1.504 \times 10^{-3}$   |
| 6-D | $7.526 \times 10^{-4}$ | $2.116 \times 10^{-5}$ | $1.481 \times 10^{-7}$   |
| 6-E | $7.526 \times 10^{-4}$ | $8.685 \times 10^{-4}$ | $< 1.000 \times 10^{-6}$ |

In Section 4.6.4.2 of Ref. F-1, fire Compartment 6-A is further analyzed. The new CCDP is  $7.8 \times 10^{-5}$ . The corresponding CDF is  $3.66 \times 10^{-7}/\text{ry}$  (from Table 4-10 of Ref. F-1). Fire compartment 6-C is also further analyzed in Section 4.6.4.3. Two scenarios are considered. In one scenario turbine driven auxiliary feedwater pump and instrument air will be lost. In the other scenario, one CCW pump, the turbine drive AFW pump, the instrument air, one PORV and all MSIVs and ARVs are failed. The new CCDPs for the new scenarios are 0.062 and  $2.294 \times 10^{-3}$ . The overall CDF for the 1-6C (Table 4-10) is  $1.27 \times 10^{-5}/\text{ry}$ .

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**Plant:** Farley

**Exemption #:** FAR -42

**Document Accession #:** 8701080634-01

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Service water intake structure does not have one train of redundant cables enclosed in 1-hour barrier, installed automatic fire suppression. Fire Area 72.

**Location Binning Category:** Intake structure (Service water)

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (FAR-42) - The IPEEE fire analysis has concluded that the CDF in this fire area is slightly over  $1 \times 10^{-5}/\text{ry}$ . The main scenario analyzed, per IPEEE submittal, is loss of on-service train of the service water system and operator actions to restore service water and CCW. Per Reference [F-5] all ten service water pumps are located in fire zone 72A. Reference [F-5] provides an extensive discussion of the fire protection systems that are available at the pump deck. The pumps are separated horizontally by 5 feet on center. Assuming that these are vertical pumps, it can be inferred that the outside covers of the pumps are separated from one another between 1 to 3 feet. A motor fire has the potential of radiating heat to its adjacent motors. It seems that the IPEEE fire analysis has not addressed this scenario. Also, Reference [F-5] provides a discussion of loss of 125 VDC panels can lead to simultaneous loss of several service water pumps. This scenario is also not addressed in the IPEEE submittal. Given that there are potentially important fire scenarios that have not been addressed in the IPEEE submittal and that

the fire is found to be risk significant, the risk significance of the exemption remains indeterminate.

**Points of Uncertainty:** (FAR-42) - The IPEEE submittal discusses possibility of failure of one train of service water. It is not clear if the IPEEE fire analysis has taken into consideration other scenarios where multiple trains are affected.

**Relevant IPEEE Citations:** (FAR-42) - The fire area is 72 (Service water intake structure). Fire initiation frequency is  $9.182 \times 10^{-3}/\text{ry}$ . The CCDP is  $3.767 \times 10^{-2}$  and screening CDF is  $1.730 \times 10^{-5}/\text{ry}$ . The detailed analysis is summarized in Section 4.6.4.10 of Ref. F-1. Two scenarios are considered for this compartment. The CCDPs for these two scenarios are  $6.5\text{E-}03$  and  $1.4\text{E-}04$ . The CDF for this fire compartment is  $1.40 \times 10^{-5}/\text{ry}$ .

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -43

**Document Accession #:** 8701080634-02

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Unit 2 Auxiliary building cable chase, switchgear room and cable tunnel don't have one train of redundant cable 1-hour enclosed, nor automatic fire detection or suppression installed throughout area.

**Location Binning Category:** Cable tunnel; Switchgear room

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-43) - The same discussion as that provided for FAR-19 applies to this exemption as well. The exemption appears redundant to FAR-06.

**Points of Uncertainty:** (FAR-43) - See FAR-06

**Relevant IPEEE Citations:** (FAR-43) - See FAR-06

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -44



**Document Accession #:** 8701080634-03

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Fire area 2-005 of the Unit 2 auxiliary building does not have 1-hour barrier for one train of redundant cable, nor installed automatic fire suppression.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR -44) - See FAR -31. This exemption appears to be a direct Unit 2 analog to the Unit 1 exemption addressed in FAR-31.

**Points of Uncertainty:** (FAR -44) - See FAR -31

**Relevant IPEEE Citations:** (FAR -44) - See FAR -31

\_\_\_\_\_\*\*\*\*\*\_\_\_\_\_  
**Plant:** Farley

**Exemption #:** FAR -45

**Document Accession #:** 8701080634-04

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Unit 2 Auxiliary building, electrical penetration rooms, do not have one redundant train enclosed by 1-hour barrier; automatic fire suppression not installed.

**Location Binning Category:** Cable vault

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-45) – In the “Exemption Rationale” provided by the NRC staff it is stated that manual actions have to be undertaken to overcome the failures caused by the fire. This is clearly reflected in the relatively large CCDP (0.04). However, the licensee reports that the final CDF is less than 1E-06/ry. Assuming that the licensee has properly conducted the fire risk analysis for this fire compartment, based on CDF less than  $1.0 \times 10^{-6}$  /ry, it is concluded that this exemption has

very small risk impact. However, it must be added that this conclusion is sensitive to the underlying assumptions regarding fire ignition, growth, damage, detection and suppression.

**Points of Uncertainty:** (FAR-45) – It is assumed that only fire area 2-35 is addressed by this exemption. Also, it is assumed that the licensee has properly quantified the frequency of fire damage in this compartment. Since the CCDP for this fire compartment is greater than 0.01, there is a potential for this exemption to have either small or significant risk impact. Our conclusion is completely based on licensee's reported CDF value.

**Relevant IPEEE Citations:** (FAR-45) – The fire area is 2-035 (electrical penetration). Fire initiation frequency is  $8.994 \times 10^{-4}/\text{ry}$ . The CCDP is  $3.959 \times 10^{-2}$  and CDF is  $6.171 \times 10^{-7}/\text{ry}$ .

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**Plant:** Farley

**Exemption #:** FAR -46

**Document Accession #:** 8701080634-05

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Unit 2 Auxiliary building vertical cable chase requires one redundant train be enclosed by 1-hour barrier.

**Location Binning Category:** Cable Tunnel

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR -46) - Since, per Reference [F-1], the CDF for this fire area is less than  $1\text{E}-06/\text{ry}$ , the impact of any modification to the plant to comply with Appendix R requirements in this fire area would have minimal impact on risk. Therefore, the risk impact of this exemption is deemed to be very small. However, it must be noted that the fire area is a cable chase and contains, per Table 4-5 of Reference [F-1], cables associated with equipment that lead to a large CCDP (namely 0.05). From this we can conclude that our conclusion is sensitive to the assumptions made by the licensee regarding the potential for fire occurrence, propagation and damage to cable.

**Points of Uncertainty:** (FAR - 46) - Since the CCDP is large (which is commensurate with the system trains that could be lost in a fire in this fire area), the conclusions of this evaluation is completely dependent on the frequency of fire initiation, propagation, detection and suppression, and cable damage conducted by the licensee.

**Relevant IPEEE Citations:** (FAR - 46) - Fire Area 2-013 is a cable chase . The fire initiation frequency for this area is  $6.9\text{E-}04/\text{ry}$ , the screening CCDP is 0.052, and the screening CDF is less than  $1\text{E-}06$ . Per Table 4-5 of IPEEE submittal, Fire Area 2-013 contains B train of AC power, both trains of instrument air and pressurizer pressure control (i.e., PORVs) and turbine driven AFW.

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**Plant:** Farley

**Exemption #:** FAR-47

**Document Accession #:** 8701080634-06

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Unit 2 Auxiliary building, electrical penetration (fire area 2-034), requires one train enclosed by 1-hour barrier, installation of automatic fire suppression.

**Location Binning Category:** Cable vault

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Vary Small

**Analysis:** (FAR-47) - In the IPEEE submittal the licensee cites the CCDP for fire compartment 2-34B as 0.04. The high CCDP value appears to be the result of manual recovery actions required to achieve safe shutdown. However, after a detailed analysis, the licensee has concluded that the CDF for both fire compartments is less than  $1 \times 10^{-6}/\text{ry}$ . From this it can be concluded that the risk impact of this exemption is very small. However, it must be added that this conclusion is sensitive to the underlying assumptions regarding fire ignition, growth, damage, detection and suppression.

**Points of Uncertainty:** (FAR-47) - It is assumed that the licensee has properly quantified the frequency of fire damage in fire compartment 2-34B. Since the CCDP for this fire compartment is greater than 0.01, there is a potential for this exemption to have either small or significant risk impac. Our conclusion is based entirely on the licensee's reported CDF value.

**Relevant IPEEE Citations:** (FAR-47) - The Fire Area is comprised of fire compartments 2-034A and 2-034B. IPEEE submittal provides the following information:

| Fire Areas | Fire Initiation Frequency | CCDP (per year)        | CDF (per year)         |
|------------|---------------------------|------------------------|------------------------|
| 2-034A     | $6.334 \times 10^{-4}$    | $5.078 \times 10^{-3}$ | $6.461 \times 10^{-8}$ |

|        |                        |                        |                        |
|--------|------------------------|------------------------|------------------------|
| 2-034B | $2.185 \times 10^{-3}$ | $3.959 \times 10^{-2}$ | $1.923 \times 10^{-7}$ |
|--------|------------------------|------------------------|------------------------|

Plant: Farley

Exemption #: FAR -48

Document Accession #: 8701080634-C7

Appendix R Section: III.G.2

**Exemption Description:** Unit 2 Auxiliary building, fire areas 2-009 and 2-076, require 1 train be enclosed in 1-hour rated barrier; installation of automatic fire detection in and 2-076.

**Location Binning Category:** Cable tunnel

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR - 48) - Fire Area 2-76 is addressed in FAR - 44. Fire Area 2-009 is similar to Fire Area 1-009 in Unit 1. The discussions provided for FAR - 39 applies to Unit 2 as well. Based on those discussions it can be concluded that the exemption has very small risk impact.

**Points of Uncertainty:** See FAR-43 and FAR-39

**Relevant IPEEE Citations:** (FAR - 48) - Issues related to Fire Area 2-76 that are addressed in the IPEEE submittal are mentioned in FAR - 44. Fire Area 2-009 has been analyzed as fire compartments 2-09A and 2-09B with CDFs  $5.7 \times 10^{-7}$  and  $4.1 \times 10^{-7}/\text{ry}$ .

Plant: Farley

Exemption #: FAR -49

Document Accession #: 8701080634-08

Appendix R Section: III.G.2.c.

**Exemption Description:** Unit 2 Auxiliary Building, fire area 2-031 requires one train be enclosed in 1-hour rated fire barrier.

**Location Binning Category:** Cable tunnel

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-49) – See FAR-32. This area is similar to 1-31, its counterpart in Unit 1.

**Points of Uncertainty:** (FAR-49) – See FAR-22.

**Relevant IPEEE Citations:** (FAR-49) – The fire area is 2-031. The Fire initiation frequency is  $3.291 \times 10^{-4}$ . The screening CCDF is  $4.736 \times 10^{-2}$  and the screening CDF is  $2.702 \times 10^{-7}/\text{ry}$ .

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**Plant:** Farley

**Exemption #:** FAR -50

**Document Accession #:** 8701080634-09

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Unit 2 Auxiliary Building, fire area 2-006 requires one train be enclosed by 1-hour rated related barrier and automatic fire suppression installed.

**Location Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Small

**Analysis:** (FAR -50) - The fire area is comprised of 5 fire compartments. For four of the five compartments, the licensee concludes that the CCDFs are smaller than 0.01 and the CDFs are smaller than  $1.0 \times 10^{-6}/\text{ry}$ . In the case of fire compartment 2-6C, the CCDF is 0.062, which means that the exemption can potentially have significant risk impact. However, the licensee reports that the CDF is less than  $1\text{E-}05/\text{ry}$  ( $7.7\text{E-}06/\text{ry}$ ). From this CDF we conclude that the exemption has small risk impact.

**Points of Uncertainty:** The conclusion that this exemption has small risk impact is based entirely on the licensee analysis. If the CDF contribution of this room is only marginally higher than cited in the licensee study, then implementation of more complete Appendix R compliance (installation of fire barriers and/or installation of fixed suppression) the risk reduction might be substantial.

**Relevant IPEEE Citations:** (FAR -50) - The fire area 2-06 includes 5 fire compartments that consist of several compartments. The CCDP and CDF for the five fire compartments are as follows:

| Fire Area | Fire Initiation Frequency (per year) | CCDP (per year)        | CDF (per year)         |
|-----------|--------------------------------------|------------------------|------------------------|
| 6-A       | $3.508 \times 10^{-3}$               | 0.924                  | $5.413 \times 10^{-4}$ |
| 6-B       | $3.409 \times 10^{-4}$               | $2.837 \times 10^{-3}$ | $1.323 \times 10^{-7}$ |
| 6-C       | $1.598 \times 10^{-3}$               | 0.157                  | $2.509 \times 10^{-4}$ |
| 6-D       | $9.348 \times 10^{-4}$               | $2.116 \times 10^{-5}$ | $3.571 \times 10^{-8}$ |
| 6-E       | $7.526 \times 10^{-4}$               | $8.370 \times 10^{-4}$ | $6.299 \times 10^{-7}$ |

In Section 4.6.4.15 of Ref. F-1, fire Compartment 6-A is further analyzed. Two scenarios are identified. The CCDPs for the two scenarios are  $7.8 \times 10^{-5}$  and  $2.793 \times 10^{-4}$ . The corresponding overall CDF is  $4.65 \times 10^{-7}/\text{ry}$  (from Table 4-11 of Ref. F-1). Fire compartment 6-C is also further analyzed in (Section 4.6.4.3 gives the details for Unit 1 that applies to this case as well) and the new CDF for the compartment (Table 4-11) is  $7.70 \times 10^{-6}/\text{ry}$ . Per Table 4-9 one of the CCDPs for detailed fire compartment 2-6C analysis is 0.062.

\*\*\*\*\*  
**Plant:** Farley

**Exemption #:** FAR -51

**Document Accession #:** 8701080634-10

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Unit 2 auxiliary building, fire area 2-001 requires 1-hour rated barrier for 1 train and installation of automatic fire suppression.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR- 51) – See FAR -40

**Points of Uncertainty:** (FAR- 51) – See FAR -40

**Relevant IPEEE Citations:** (FAR- 51) – See FAR -40

**Plant:** Farley

**Exemption #:** FAR -52

**Document Accession #:** 8701080634-11

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Unit 2 Auxiliary building, fire area 2-004 requires 1-hour rated barrier for 1 train and installation of automatic fire detection and suppression systems.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-52) - Based on the IPEEE submittal, the CCDPs for all but one compartment in Area 2-04 are small (2-4A10 with a CCDP of 0.03), and ultimately the licensee concludes that the CDFs for all of the fire compartments that comprise this fire area are less than  $1.0 \times 10^{-6}$  /ry . Therefore, the risk impact of this exemption is very small.

**Points of Uncertainty:** (FAR - 52) - The assessment assumes that the licensee has appropriately quantified fire risk, in particular, in compartment 2-4A10.

**Relevant IPEEE Citations:** (FAR - 52) - The Fire Area 2-04 consists of 22 fire compartments, which in turn consist of a large number of rooms. The IPEEE submittal reports CCDPs for the fire compartments that, with the exception of two compartments, range between  $7.7 \times 10^{-6}$  and  $1.2 \times 10^{-3}$ . The CCDP for fire compartments 2-4A10 and 2-4A14 are 0.032 and 0.04 respectively. The CDFs for the majority of the compartments range between  $3.8 \times 10^{-8}$  and  $2.6 \times 10^{-7}$  /ry. The CDF for 2-4A10 is reported to be less than  $1 \times 10^{-6}$  /ry. The CDF for the following fire compartments is significant:

| Fire Compartment | Screening CDF (per year) | CCDP after detailed analysis | CDF after detailed analysis |
|------------------|--------------------------|------------------------------|-----------------------------|
| 2-4A16           | $2.474 \times 10^{-5}$   | $1.265 \times 10^{-4}$       | $6.31 \times 10^{-7}$       |
| 2-4C             | $1.242 \times 10^{-5}$   | $2.915 \times 10^{-5}$       | $3.26 \times 10^{-8}$       |
| 2-4F             | $1.242 \times 10^{-5}$   | $9.894 \times 10^{-5}$       | $1.43 \times 10^{-8}$       |

These fire compartments were further analyzed and the new CDFs are also presented above.

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**Plant:** Farley

**Exemption #:** FAR -53

**Document Accession #:** 8701080634-12

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Twenty-three fire areas require 1-hour rated protection of structural steel supporting raceway assemblies; load-carrying characteristics suspect.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg; FCIA

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (FAR -53) – The “Exemption Rationale” provided by the NRC staff focuses on the structural integrity of the unprotected supports. However, there is also potential concern that the unprotected supports may act as a conduit for heat to enter into the protected envelope. Discussions with the cognizant NRC staff reveal that thermal path issues were not considered at the time of the exemption review. Further, the Farley fire barriers are all of the material Kaowool, a mineral fiber blanket material. It does not appear that the manufacturer installation procedures of the time addressed the issue of protecting potential thermal paths. The failure to protect the supports to an adequate distance would lead to a substantial reduction in the performance of the barrier system. Hence, this exemption has a potential to be risk significant, although not for the reasons considered important at the time. It is not, however, known how these local fire barriers were treated in the IPEEE. Further, information on the nature and severity of postulated fire sources is not given in the IPEEE. A proper analysis of barrier performance must consider the nature of the fire sources. Hence, the risk significance of this exemption is found to be indeterminate.

**Points of Uncertainty:** (FAR -53) - The IPEEE does not address the issues raised in this exemption, nor does it indicate how fire barriers were treated in the analysis.

**Relevant IPEEE Citations:** None

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**Plant:** Farley

**Exemption #:** FAR -54



**Document Accession #:** 8701080634-13

**Appendix R Section:** III.G.

**Exemption Description:** Ninety-four doors within auxiliary and diesel generator buildings, and service water intake structure deviate from NFPA Standard No.80 installation requirements.

**Location Binning Category:** General process area; Intake structure (Service water area); Diesel Generator area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (FAR-54) – See FAR-02

**Points of Uncertainty:** None

**Relevant IPEEE Citations:** None

\*\*\*\*\*

**References:**

- F-1 "Joseph M. Farley Nuclear Plant, Unit 1 and Unit 2, Individual Plant Examination of External Events", Southern Nuclear Operating Company, June 28, 1995.
- F-2 Attachment 2 to the letter from Hugh L. Thompson, Division of Licensing, USNuclear Regulatory Commission, to R. P. McDonald, Alabama Power Company, November 19, 1985.
- F-3 Enclosure 2 - Safety Evaluation by the Office of Nuclear Reactor Regulation, Related to Exemption from 10 CFR 50, Appendix R, Alabama Power Company, November 19, 1985, Joseph M. Farley Nuclear Plant, Unit 1.
- F-4 Attachment - Safety Evaluation by the Office of Nuclear Reactor Regulation, Related to Exemption from 10 CFR 50, Appendix R, Alabama Power Company, November 19, 1985, Joseph M. Farley Nuclear Plant, Unit 1.
- F-5 Enclosure 2 to the letter from Thomas M. Novak, Division of PWR Licensing-A, USNuclear Regulatory Commission, to R. P. McDonald, Alabama Power Company, December 39, 1986.

**TABLE C-1: SUMMARY CATEGORIZATION OF INDIVIDUAL EXEMPTIONS FOR FARLEY 1 AND 2**

| Exemp. # | Exemption Description   | Location Binning Category                             | PRA Step Binning Category | Potential for CDF Reduction |
|----------|---|---|---------------------------|-----------------------------|
| FAR-01   | Lack of 20 feet of separation free of intervening combustibles between redundant cables inside containment.   | Containment   | FHA : Grw&Dmg             | Very Small                  |
| FAR-02   | Diesel generator building (DGB) redundant train not protected by 1-hour barrier nor automatic fire suppression installed fire area 56A.   | Diesel generator area                                 | FHA : Grw&Dmg; Det/Supp   | Very Small                  |
| FAR-03   | Diesel Generator Building (DGB) fire area 56, zone b & c redundant train not enclosed; automatic fire suppression not installed.  | Diesel generator area                                 | FHA : Grw&Dmg; Det/Supp   | Very Small                  |
| FAR-04   | Fire area 51 does not have enclosed redundant safe shutdown cables, installed automatic fire suppression.   | General process area                                  | FHA : Grw&Dmg; Det/Supp   | Very Small                  |
| FAR-05   | In Auxiliary Building, twelve (12) areas don't have one train of redundant safe shutdown cables enclosed in a 1-hour fire barrier, and automatic fire suppression not installed. - Actually similar to FAR-02 dealing with fire door discrepancy  | General process area                                  | FHA : Grw&Dmg; Det/Supp   | Very Small                  |
| FAR-06   | In Auxiliary Building, ten (10) areas (switchgear room, cable chase and diesel generator) don't have safe shutdown cables 1-hour barrier enclosed, and automatic fire suppression not installed. - Similar to FAR-05 with the Train B counterparts. The CDFs for areas 1-21 and 2-21 are significant. | Switchgear room; Cable tunnels; Diesel generator area | FHA : Grw&Dmg; Det/Sepp   | Very Small                  |
| FAR-07   | Service water valve box does not have a 3-hour barrier between redundant cabling and equipment.   | Intake structure                                      | FHA : FCIA                | Very Small                  |
| FAR-08   | In Auxiliary Building, areas 2-043 redundant cable not enclosed by 1-hour barrier, and automatic fire suppression not installed.  | General process area                                  | FHA : Grw&Dmg; Det/Supp   | Very Small                  |
| FAR-09   | Auxiliary Building communication room safe shutdown cables not enclosed by 1-hour rated barrier, multiple hot shorts.   | General process area                                  | FHA : Grw&Dmg             | Very Small                  |
| FAR-10   | Auxiliary Building stairwell has no automatic fire suppression installed.   | General process area                                  | FHA : Det/Supp            | Very Small                  |
| FAR-11   | Service water valve box # 1 redundant cabling not enclosed in 1-hour rated barrier, automatic fire detection suppression not installed.   | Intake Structure                                      | FHA : FCIA; Det/Supp      | Very Small                  |
| FAR-12   | Service water valve box #2 redundant cabling not enclosed in 1-hour rated barrier; automatic fire detection, suppression not installed.   | Intake structure                                      | FHA : FCIA; Det/Supp      | Very Small                  |

| <b>Exemp. #</b> | <b>Exemption Description</b>  | <b>Location Binning Category</b> | <b>PRA Step Binning Category</b> | <b>Potential for CDF Reduction</b> |
|-----------------|---|----------------------------------|----------------------------------|------------------------------------|
| <b>FAR-13</b>   | Auxiliary Building battery room redundant cables not enclosed with 1-hour barrier; automatic fire suppression not installed.  | General process area             | FHA : Grw&Dmg; Det/Supp          | Very Small                         |
| <b>FAR-14</b>   | Non-rad side corridor, auxiliary building, redundant train of cables not 1-hour barrier enclosed.   | General process area             | FHA : Grw&Dmg                    | Very Small                         |
| <b>FAR-15</b>   | Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-008 of auxiliary building.   | Cable Tunnel                     | FHA : Grw&Dmg                    | Very Small                         |
| <b>FAR-16</b>   | Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1- 075 of auxiliary building.  | Cable Tunnel                     | FHA : FCIA; Grw&Dmg              | Very Small                         |
| <b>FAR-17</b>   | Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-017 of auxiliary building.   | General process area             | FHA : Grw&Dmg; Det/Supp          | Very Small                         |
| <b>FAR-18</b>   | Lack of 1-hour between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-018 of auxiliary.  | Switchgear room                  | FHA : Grw&Dmg; Det/Supp          | Very Small                         |
| <b>FAR-19</b>   | Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-041 of auxiliary building. - Exemption appears redundant to FAR-05       | Switchgear                       | FHA : Grw&Dmg; Det/Supp          | Very Small                         |
| <b>FAR-20</b>   | Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 2-041 of auxiliary building. - Exemption appears redundant to FAR-05   | Switchgear                       | FHA : Grw&Dmg                    | Very Small                         |
| <b>FAR-21</b>   | Lack of 3-hour barrier between redundant trains of cabling, equipment and non-safety associated circuits; or not enclosed by 1 hour barrier, fire area 1-042 of auxiliary building.                           | General process area             | FHA : Grw&Dmg                    | Very Small                         |
| <b>FAR-22</b>   | Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-031 of auxiliary building.   | Cable tunnel                     | FHA : Grw&Dmg                    | Very Small                         |
| <b>FAR-23</b>   | Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-021 of auxiliary building. - This exemption appears redundant to FAR-06. | Switchgear room                  | FHA : Grw&Dmg; Det/Supp          | Very Small                         |
| <b>FAR-24</b>   | Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-023 of auxiliary building.   | Switchgear room                  | FHA : Grw&Dmg; Det/Supp          | Very Small                         |

| Exemp. # | Exemption Description  | Location Binning Category | PRA Step Binning Category | Potential for CDF Reduction |
|----------|--|---------------------------|---------------------------|-----------------------------|
| FAR-25   | Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-019 of auxiliary building.  | Switchgear room           | FHA : Grw&Dmg; Det/Supp   | Small                       |
| FAR-26   | Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-012 of auxiliary building.  | General process area      | FHA : Grw&Dmg; Det/Supp   | Very Small                  |
| FAR-27   | Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-013 of auxiliary building.  | Cable tunnel              | FHA : Grw&Dmg             | Very Small                  |
| FAR-28   | Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-076 of auxiliary building.  | Cable tunnel              | FHA : Grw&Dmg; Det/Supp   | Very Small                  |
| FAR-29   | Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-030 of auxiliary building   | Cable tunnel              | FHA : Grw&Dmg             | Very Small                  |
| FAR-30   | Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-030 of auxiliary building.  | Cable tunnel              | FHA : Grw&Dmg; Det/Supp   | Very Small                  |
| FAR-31   | Lack of 3-hour barrier between trains of redundant safe shutdown cables in fire area 1-005 of auxiliary building; lack of 1-hour barrier between redundant safe shutdown cables in rooms 172 and 181 and an automatic suppression system in fire area 1-005 of auxiliary building. | ump room                  | FHA : Grw&Dmg             | Very Small                  |
| FAR-32   | Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-035 of auxiliary building. - The impacted fire area is risk significant and lack suppression of redundant train protection.                   | Cable vault               | FHA : Grw&Dmg; Det/Supp   | Significant                 |
| FAR-33   | Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-004 of auxiliary building; lack of 3-hour barriers between trains of redundant safe shutdown cables for some fire areas.                      | General process area      | FHA : Grw&Dmg; Det/Supp   | Very Small                  |
| FAR-34   | Lack of an installed automatic fire suppression system in the auxiliary building stairwell, fire area 1-S02.   | General process area      | FHA : Det/Supp            | Very Small                  |

| Exemp. # | Exemption Description  | Location Binning Category        | PRA Step Binning Category  | Potential for CDF Reduction |
|----------|--|----------------------------------|----------------------------|-----------------------------|
| FAR-35   | Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-034 of auxiliary building. - impacted area is risk significant and lacks suppression and redundant train protection.    | Cable vault                      | FHA : Grw&Dmg;<br>Det/Supp | Significant                 |
| FAR-36   | Non-fire rated reach-rod penetrations are located in walls between trains of redundant safe shutdown cables in fire areas 1-004 and 1-005 of the auxiliary building, Unit 1, and fire areas 2-004 and 2-005 of the auxiliary building, Unit 2.               | General process area             | FHA : FCIA                 | Very Small                  |
| FAR-37   | Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-020 of the auxiliary building.  | General process area             | FHA : Grw&Dmg              | Very Small                  |
| FAR-38   | Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 2-042 of auxiliary building.  | General process area             | FHA : Grw&Dmg              | Very Small                  |
| FAR-39   | Lack of 1-hour barrier between trains of redundant safe shutdown cables in fire area 1-009 of auxiliary building.  | Cable tunnel                     | FHA : Grw&Dmg              | Very Small                  |
| FAR-40   | Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in fire area 1-001 of auxiliary building.  | General process area             | FHA : Grw&Dmg;<br>Det/Supp | Very Small                  |
| FAR-41   | Lack of 1-hour barrier between trains of redundant safe shutdown cables, and automatic fire suppression not installed in 12 rooms, fire area 1-006 of auxiliary building   | General process area             | FHA : Grw&Dmg;<br>Det/Supp | Small                       |
| FAR-42   | Service water intake structure does not have one train of redundant cables enclosed in 1-hour barrier, installed automatic fire suppression. Fire Area 72.   | Intake structure (Service water) | FHA : Grw&Dmg              | Indeterminate               |
| FAR-43   | Unit 2 Auxiliary building cable chase, switchgear room and cable tunnel don't have one train of redundant cable 1-hour enclosed, nor automatic fire detection or suppression installed throughout area. - redundant to FAR-06 but is exclusive to area 2-21. | Cable tunnel;<br>Switchgear room | FHA : Grw&Dmg;<br>Det/Supp | Very Small                  |
| FAR-44   | Fire area 2-005 of the Unit 2 auxiliary building does not have 1-hour barrier for one train of redundant cable, nor installed automatic fire suppression.  | General process area             | FHA : Grw&Dmg;<br>Det/Supp | Very Small                  |
| FAR-45   | Unit 2 Auxiliary building, electrical penetration rooms, do not have one redundant train enclosed by 1-hour barrier; automatic fire suppression not installed.   | Cable vault                      | FHA : Grw&Dmg;<br>Det/Supp | Very Small                  |

| Exemp. # | Exemption Description  | Location Binning Category  | PRA Step Binning Category | Potential for CDF Reduction |
|----------|--|--|---------------------------|-----------------------------|
| FAR-46   | Unit 2 Auxiliary building vertical cable chase requires one redundant train be enclosed by 1-hour barrier.   | Cable tunnel   | FHA : Grw&Dmg             | Very Small                  |
| FAR-47   | Unit 2 Auxiliary building, electrical penetration (fire area 2-034), requires one train enclosed by 1-hour barrier, installation of automatic fire suppression.    | Cable vault  | FHA : Grw&Dmg; Det/Supp   | Very Small                  |
| FAR-48   | Unit 2 Auxiliary building, fire areas 2-009 and 2-076, require 1 train be enclosed in 1-hour rated barrier; installation of automatic fire detection in and 2-076. | Cable vault  | FHA : Grw&Dmg; Det/Supp   | Very Small                  |
| FAR-49   | Unit 2 Auxiliary building, fire area 2-031 requires one train be enclosed in 1-hour rated fire barrier.  | Cable tunnel   | FHA : Grw&Dmg             | Very Small                  |
| FAR-50   | Unit 2 Auxiliary building, fire area 2-006 requires one train be enclosed by 1-hour rated related barrier and automatic fire suppression installed.                | Pump room  | FHA : Grw&Dmg; Det/Supp   | Small                       |
| FAR-51   | Unit 2 auxiliary building, fire area 2-001 requires 1-hour rated barrier for 1 train and installation of automatic fire suppression.                               | General process area   | FHA : Grw&Dmg; Det/Supp   | Very Small                  |
| FAR-52   | Unit 2 Auxiliary building, fire area 2-004 requires 1-hour rated barrier for 1 train and installation of automatic fire detection and suppression systems.         | General process area   | FHA : Grw&Dmg; Det/Supp   | Very Small                  |
| FAR-53   | Twenty-three fire areas require 1-hour rated protection of structural steel supporting raceway assemblies; load carrying characteristics suspect.                  | General process area   | FHA : Grw&Dmg; FCIA       | Indeterminate               |
| FAR-54   | Ninety four doors within auxiliary and diesel generator buildings, and service water intake structure deviate from NFPA Standard No.80 installation requirements.  | General process area; Intake structure (Service water area); Diesel Generator area | FHA : FCIA                | Very Small                  |

## **Appendix D: Individual Exemption Assessment for Kewaunee**

**Plant:** Kewaunee

**Exemption #:** KEW-01

**Document Accession #:** 8607010258-01

**Appendix R Section:** III.G.2.d

**Exemption Description:** Lack of 20 feet of separation between redundant trains with no intervening combustibles or fire hazards in the containment.

**Location Binning Category:** Containment

**PRA Step Binning Category:** FHA: Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (KEW-01) - This exemption impacts fires inside the containment. The primary concern is potential loss of instrumentation. If the redundant shutdown trains of instrumentation are lost, the operators in the control room will lose the ability to monitor the primary loop and reactor instrumentation. Such an event is considered to eventually lead to core damage. However, in a typical containment, the combustible loading is not significant in most areas. The reactor coolant pump oil system, which is the largest fire hazard inside a containment, includes provisions to collect the oil and prevent a very large oil fire. The exemption rationale provided by the NRC staff also cites a wood storage container, but it was concluded that this did not represent a fire threat to the critical cables. Also, it can be assumed that there is some separation between redundant instrumentation trains such that only severe fires can affect them simultaneously. These observations are consistent with the IPEEE submittal that concludes that the containment is not a significant fire risk contributor (per Table 1 of the IPEEE submittal as presented in Ref. K-3). Therefore, this exemption is found to have a very small risk impact.

**Points of Uncertainty:** The IPEEE does not discuss the possibility of major loss of instrumentation in case of a fire inside the containment. It is assumed in this analysis that the instrumentation cables inside the containment are provided with sufficient separation such that a single minor fire cannot fail a critical set of instrumentation circuits.

**Relevant IPEEE Citations:** (KEW-01) - The IPEEE includes a qualitative discussion of containment fires (Section 4.1.2 of Ref. K-1). It is argued that no major fire can occur because the combustible loading is low and because of the reactor coolant pump oil collection system. Also see Table 1 of the IPEEE submittal.

\*\*\*\*\*  
**Plant:** Kewaunee

**Exemption #:** KEW-02

**Document Accession #:** 8805310005-01

**Appendix R Section:** III.G.2.b

**Exemption Description:** Lack of automatic fire suppression system in the shield building.

**Location Binning Category:** Cable tunnel

**PRA Step Binning Category:** FHA: Det&Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (KEW-02) - Based on the "Exemption Rationale" provided by NRC staff, the area includes smoke detectors, has low combustible loading, and the fire brigade can enter during plant operation to fight a fire. It is also stated that there is separation between the electrical penetrations that are apparently the only risk significant targets of interest. It can be concluded that the likelihood of a fire in this fire zone is small and that it will require a relatively severe fire to cause damage to redundant trains. This means that the fire brigade (alerted by the smoke detectors) will have sufficient time to suppress the fire before critical damage with a high success probability. This is consistent with the IPEEE findings where the area was screened based on qualitative arguments. Therefore, the likelihood of damage to redundant trains is small and this exemption is found to have very small risk impact.

**Points of Uncertainty:** (KEW-02) - It is assumed that the area is readily accessible for the fire brigade to enter during normal operation without a major delay. It is assumed that the area includes the electrical penetrations into the containment and does not include motors, pumps, or electrical cabinets so that a low fire occurrence frequency can be assigned to this fire zone.

**Relevant IPEEE Citations:** (KEW-02) - The IPEEE submittal (Ref. K-1) addresses the shield building (fire zone SB-65) on pp. 4-15 and 4-16. The area contain alternate trains "that are not readily segregated" The following statement is made regarding this fire zone: "Fires in designated zone SB-65 are not discussed because it is a narrow area in which personnel rarely enter during operation, and no transient combustibles, the only credible source of a fire". There is no other discussion regarding this fire zone.



**Plant:** Kewaunee

**Exemption #:** KEW-03

**Document Accession #:** 8805310005-02

**Appendix R Section:** III.G.3

**Exemption Description:** Lack of fixed fire suppression system in the control room.

**Location Binning Category:** Control room

**PRA Step Binning Category:** FHA: Det&Supp

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (KEW-03) - This exemption is discussed in Section 4 of the reports main body. As an additional note, at Kewaunee, cabinets in the control room have smoke detectors [Ref. K-1, Page 4-26]. This means that the fire may be detected in two ways: by the smoke detectors and by the operators from smelling the odors or visually.

**Points of Uncertainty:** None

**Relevant IPEEE Citations:** (KEW-03) - The control room is addressed in References K-1 and K-3 (fire zone designation is AX-35). See pp. 4-20, 4-23, 4-24, and 4-26 of Re. K-1. It is assumed that a fire is detected and extinguished manually in a short time with high reliability. The failure probability of manual fire fighting is taken to be  $1.0 \times 10^{-4}$  which appears somewhat optimistic in comparison typical assumptions. Two risk significant fire scenarios are attributed to the control room. Their CDFs are  $1.45 \times 10^{-5}$  and  $1.84 \times 10^{-5}$  per year (Table 1 in Ref. K-3).

\*\*\*\*\*

#### **References:**

K-1 "Individual Plant Examination of External Events - Summary Report", Wisconsin Public Service Corporation, June 28, 1994.

K-2 "Response to Request for Additional Information (RAI) on the IPEEE", Wisconsin Public Service Corporation, 1995

K-3 "Response to RAIs F.1 and F.3", Wisconsin Public Service Corporation, October 13, 1995.

**Table D-1: SUMMARY CATEGORIZATION OF INDIVIDUAL EXEMPTIONS FOR KEWAUNEE (KEW)**

| <b>Exemp. #</b> | <b>Exemption Description</b>  | <b>Location Binning Category</b> | <b>PRA Step Binning Category</b> | <b>Risk Impact</b>   |
|-----------------|---|----------------------------------|----------------------------------|----------------------|
| <b>KEW - 01</b> | <b>Lack of 20 feet of separation between redundant trains with no intervening combustibles or fire hazards in the containment</b> | <b>Containment</b>               | <b>FHA : Grw&amp;Dmg</b>         | <b>Very Small</b>    |
| <b>KEW - 02</b> | <b>Lack of automatic fire suppression system in the shield building.</b>  | <b>Cable Tunnel</b>              | <b>FHA : Det/Supp</b>            | <b>Very Small</b>    |
| <b>KEW - 03</b> | <b>Lack of fixed fire suppression system in the control room.</b>   | <b>Control Room</b>              | <b>FHA : Det/Supp</b>            | <b>Indeterminate</b> |

## **Appendix E: Individual Exemption Assessment for Palisades**

**Plant:** Palisades

**Exemption #:** PAL -01

**Document Accession #:** 8302230419-01

**Appendix R Section:** III.G.3.b.

**Exemption Description:** A fixed fire suppression system is not installed in the control room.

**Location Binning Category:** Main control room

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (PAL-01) - See Section 4 in the report's main body. Note that the IPEEE cites the existence of fire detectors in the MCR panels which would likely lead to more rapid fire detection and manual intervention than in a similar case that lacks fixed fire detection within the panels. Hence, the potential significance of the lack of suppression may be modestly mitigated at Palisades.

**Points of Uncertainty:** None

**Relevant IPEEE Citations:** (PAL-01) - Main Control Room is Fire Area 1 (p. 4-18 and 4-20, Ref. P-1). See also pages 4-5, 4-31, 4-39, 4-42, 4-59, 4-77 and 4-84. On p. 4-39 it is indicated that smoke detectors exist in the control room. Two CDF values are reported depending on the conditions assumed in the analysis, 1.30E-06 and 6.79E-06 per year.

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**Plant:** Palisades

**Exemption #:** PAL -02

**Document Accession #:** 8507170448-01

**Appendix R Section:** III.G.3.

**Exemption Description:** Fixed fire suppression system is not installed in Engineered Safeguards Panel Room.

**Location Binning Category:** Relay room

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (PAL-02) - The fire area impacted by this exemption contains the Safeguards Panel and two MCCs. The IPEEE submittal has concluded that the CDF for this area is  $3.35E-8$ /ry. Since the area contains control circuits that are normally on stand-by, the CDF, as indicated by the results presented in the IPEEE submittal, is likely small. Therefore, this exemption is found to have a very small risk impact.

**Points of Uncertainty:** (PAL-02) - It is assumed that the Engineered Safeguards Panel Room is Fire Area 15 as identified in the IPEEE.

**Relevant IPEEE Citations:** (PAL-02) - The Engineered Safeguards Panel Room is Fire Area 15 (p. 4-18 and 4-21, Ref. P-1). It is addressed on pages 4-36, 4-43, 4-52, 4-60 and 4-85 of Ref. P-1. The Safeguards Panel provides the remote shutdown capability under emergency conditions where control room evacuation becomes necessary. 480 VAC MCC 7 and 8 are also in this area. This area was retained for further analysis (p. 4-43, Ref. P-1). Fire ignition frequency is  $1.50E-4$ /ry. On p. 4-85, it is indicated that the CDF for this room is  $3.35E-8$ /ry.

\*\*\*\*\*

**Plant:** Palisades

**Exemption #:** PAL -03

**Document Accession #:** 8507170448-02

**Appendix R Section:** III.G.3.

**Exemption Description:** Fixed fire suppression system not installed in corridor between Charging Pump Room and IC Switchgear Room in the Reactor Building.

**Location Binning Category:** General process area, switchgear room

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (PAL-03) - From the information provided in the IPEEE submittal it can be inferred that the impacted fire areas may contain a number of safety systems. The IPEEE submittal concludes that the CDFs for these areas are between  $2.26E-8$  and  $6.73E-7$  per year. Since the

CDFs for the areas are small, the reduction in the CDF that may be gained from a fixed suppression system would not have a significant impact on fire risk. Therefore, given the cited CDF contributions for the impacted areas, this exemption is found to have a very small risk impact. This conclusion is based entirely on the IPEEE finding of low risk significance for the impacted area.

**Points of Uncertainty:** (PAL-03) - It is assumed that one of or both of the fire areas 13A1 and 13A2 are the corridor addressed in this exemption. These two areas were selected because the charging pumps are located at elevation 590' of the auxiliary building. It is also assumed that the licensee analysis of the impacted fire areas is complete and accurate.

**Relevant IPEEE Citations:** (PAL-03) - The IPEEE Submittal identifies two areas 13A1 and 13A2 (p. 4-20, Ref. P-1) as corridors associated with the elevation 590' of the auxiliary building where the charging pumps are located.. It is also addressed on pages 4-34, 4-35, 4-42, 4-52, 4-59 and 4-84 of Ref. P-1. These two areas were retained for further analysis (p. 4-42, Ref. P-1). Fire ignition frequency is  $5.37\text{E-}3$  and  $2.06\text{E-}3$  per year (p. 4-52 of Ref. P-1) for 13A1 and 13A2 respectively. On pg. 4-85, it is indicated that the CDFs for these rooms are  $6.73\text{E-}7$  and  $2.26\text{E-}8$  per year respectively.

\*\*\*\*\*  
**Plant:** Palisades

**Exemption #:** PAL -04

**Document Accession #:** 8507260178-01

**Appendix R Section:** III.G.2.d.

**Exemption Description:** Lack of separation of cable trays by a horizontal distance of more than 20 feet with no intervening combustibles.

**Location Binning Category:** Containment

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (PAL-04) - The IPEEE indicates that there is substantial distance (75 feet) between redundant cable penetrations impacted by this exemption. From this we can assume that there are no "pinch-points" where the instrumentation cables converge such that a small fire could cause the failure of a critical set of instrumentation circuits. Assuming that the containment at Palisades has features similar to those of other PWRs, the risk associated with fires inside the containment should be quite small. In the IPEEE the containment is screened on a qualitative basis and by

reference to FIVE. Therefore, this exemption is found to have a very small risk impact.

**Points of Uncertainty:** (PAL-04) - It is assumed that the containment at Palisades is similar to other PWR containments and there are no "pinch-points" where a critical set of instrumentation cables might be damaged by a small fire.

**Relevant IPEEE Citations:** (PAL-04) - The containment is Fire Area 14 (p. 4-18 and 4-21, Ref. P-1) and is addressed on pages 4-37 (Section 4.5.2), 4-43, 4-44, 4-52, 4-60 and 4-84 of Ref. P-1. Using qualitative arguments, referencing FIVE and that other PRAs have not found containment fire scenarios as risk significant, the licensee has screened out the containment (page 4-44 of Ref. P-1). On page 4-38, it is stated that there is 75 feet separation between redundant cable penetrations and 25 feet separation among the reactor coolant pumps.

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**Plant:** Palisades

**Exemption #:** PAL -05

**Document Accession #:** 9107120255-01

**Appendix R Section:** III.G.2.d.

**Exemption Description:** Lack of 20 feet separation between redundant instrumentation in the Containment Air Room.

**Location Binning Category:** General Process Area

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (PAL-05) - From the discussions in the "Exemption Rationale" provided by NRC staff, it is inferred that only a limited number of instrumentation cables are present in this room and the plant can be safely shutdown even given loss of these cables. This would be consistent with the fact that the room appears to be within containment (based on the exemption rationale). Therefore, the lack of separation between cable trays is of little risk significance and this exemption is found to have a very small risk impact.

**Points of Uncertainty:** (PAL-05) - The IPEEE does not appear to identify a fire zone as "Containment Air Room". It is assumed based on the exemption rationale that Containment Air Room is inside containment. Also, it is assumed that the only safety related components in this room are instrumentation cables as implied in the exemption rationale statement.

**Relevant IPEEE Citations:** (PAL-05) - None

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**References:** E-1: "Response to Generic Letter 88-20, Supplement 4, Individual Plant Examination of External Events for Severe Accident Vulnerabilities, Final Report," Consumers Power Co., Palisades Plant, Docket 50-255, June 1995.

**Table E-1: SUMMARY CATEGORIZATION OF INDIVIDUAL EXEMPTIONS FOR PALISADES ( PAL)**

| <b>Exemp. #</b> | <b>Exemption Description</b>  | <b>Location Binning Category</b> | <b>PRA Step Binning Category</b> | <b>Risk Impact</b>   |
|-----------------|---|----------------------------------|----------------------------------|----------------------|
| <b>PAL -01</b>  | <b>A fixed fire suppression system is not installed in the control room.</b>  | <b>MCR</b>                       | <b>FHA : Det/Supp</b>            | <b>Indeterminate</b> |
| <b>PAL-02</b>   | <b>Fixed fire suppression system not installed in Engineered Safeguards Panel Room.</b>   | <b>Relay room</b>                | <b>FHA : Det/Supp</b>            | <b>Very Small</b>    |
| <b>PAL-03</b>   | <b>Fixed fire suppression system not installed in corridor between Charging Pump Room and IC Switchgear Room in the Reactor building.</b> | <b>General process area</b>      | <b>FHA : Det/Supp</b>            | <b>Very Small</b>    |
| <b>PAL-04</b>   | <b>Lack of separation of cable trays by a horizontal distance of more than 20 feet with no intervening combustibles.</b>                  | <b>Containment</b>               | <b>FHA : Grw&amp;Dmg</b>         | <b>Very Small</b>    |
| <b>PAL-05</b>   | <b>Lack of 20 feet separation between redundant instrumentation in the Containment Air room.</b>  | <b>Containment</b>               | <b>FHA : Grw&amp;Dmg</b>         | <b>Very Small</b>    |



## **Appendix F: Individual Exemption Assessment for H. B. Robinson**

**Plant:** H. B. Robinson

**Exemption #:** HBR-01

**Document Accession #:** 8112070107-01

**Appendix R Section:** III.G.3

**Exemption Description:** Lack of a fixed fire suppression system in the control room.

**Binning Categories:** Control room fire

**PRA Step Binning Category:** FHA: Det. Supp

**Impact on Fire Risk:** Indeterminate

**Analysis:** (HBR-01) - See discussion in Section 4 of the report body. Note that the IPEEE cites that the Robinson MCR does include smoke detectors inside the control panels that contain safe shutdown controls and circuits.

**Points of Uncertainty:** None

**Relevant IPEEE Citations:** (HBR-01) -The control room is addressed in Section 4.6.3 (p. 4-56) of Ref. H-1. The main control room is designated as fire compartment A/22. As indicated on p. 4-58 of Ref. H-1, there are smoke detectors inside the control panels that contain safe shutdown controls and circuits. Table 4.6-4 (p. 4-123) gives the fire scenarios postulated inside the control room. The CDFs for the scenarios are presented in Table 4.6.5 (p. 4-129). They range between  $9.18\text{E-}11$  and  $1.98\text{E-}05$  per year. The total CDF is  $4.47\text{E-}05$  per year.

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**Plant:** H. B. Robinson

**Exemption #:** HBR-02

**Document Accession #:** 8312140199-01

**Appendix R Section:** III.G.

**Exemption Description:** Lack of 3 hour fire barriers separating redundant residual heat removal trains; lack of automatic suppression system; and lack of independent alternate cold shutdown capability

**Location Binning Category:** Pump room

**PRA Step Binning Category:** FHA: Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (HBR-02) - Since only cold shutdown equipment and cables are affected by this exemption, the contribution to CDF will be very small. This is consistent with the findings of the IPEEE submittal in that this area was screened using qualitative arguments. Therefore, this exemption if found to have at most a very small risk impact.

**Points of Uncertainty:** (HBR-02) - It is assumed that Fire Area H which consists of Fire Zone 27 is the area cited in the IPEEE analysis that is impacted by this exemptions.

**Relevant IPEEE Citations:** (HBR-02) - Fire Area H which consists of Fire Zone 27 (p. 4-89 of Ref. H-1) contains the RHR pumps. It was screened out using qualitative methods (p. 4-93 of Ref. H-1) because it only affects cold shutdown equipment and cables. In general the IPEEE analyses are limited to consideration of a 24 hour "mission window" and the focus is placed on achieving hot shutdown.

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**Plant:** H. B. Robinson

**Exemption #:** HBR-03

**Document Accession #:** 8312141099-02

**Appendix R Section:** III.G.2

**Exemption Description:** Lack of fire detection system, lack of automatic fire suppression system, lack of 20 feet separation and lack of alternate shutdown capability in the service water pump area.

**Location Binning Category:** Intake structure

**PRA Step Binning Category:** FHA: Det/Supp and Grw&Dmg

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (HBR-03) - This exemption appears to imply a potential for loss of both trains of service water. Service water is an important plant system and loss of both trains may be a significant contributor. Plant personnel rely on manual detection and suppression of fires for this fire zone and, according to Reference [H-2], the area does not have a roof, there are no combustible materials except for short sections of the power cables that come out of the concrete and feed into the pump motors, and the area is monitored through a television camera by the security personnel. Also, it can be inferred that the four pumps are staggered in such a way that the separation among them is about 2 to 4 feet and the distance between two end pumps is 13 feet. Despite these limitations, the IPEEE has concluded that the risk associated with this area is small. The service water pumps generally contain large quantities of oil, and power is supplied to them at 4 kV. The screening CDF assuming loss of all equipment in the area (i.e., all four service water pumps) is cited at  $2.75\text{E-}2$  which is relatively high. The screening CDF was  $3.16\text{E-}4$  assuming a nominal fire frequency and loss of all pumps. Hence, the area is nominally very important. However, the area is ultimately screened from the analysis and no detailed quantification is provided. The final CDF is reported to be on the order of  $10^{-6}$  per year. From the submittal it is not clear how the licensee has reached such a small CDF value given the screening CDF of  $3.16\text{E-}4$  per reactor year. The fire initiation frequency (per Table 4.6-5, p. 4-130 of Reference H-2) used in the final CDF computation is  $8.0\text{E-}5$ . This is presumably based on crediting various fire protection features (such as manual suppression prior to damage), low combustible loading and use of fire modeling results. Although the in-situ combustible load is low, the possibility of a fire (e.g., a motor or oil fire) that can affect other pumps cannot be dismissed without a thorough analysis of the effects of such an event. In particular, there is no mention of any means of containing an oil spill, and the possibility of a high pressure oil leak and fire is not addressed. Given these factors, there appears to be a strong basis to question the IPEEE conclusions regarding the CDF contribution of fires in this area. Verification would require through a review of documentation supporting the fire initiation frequencies assigned to the specific fire scenarios, a review of the fire modeling assumptions and results, and perhaps an independent analysis of potential fire effects. This is beyond the scope of this study. Given the uncertainties in the fire initiation frequency, risk impact of this exemption is found to be risk indeterminate.

**Points of Uncertainty:** (HBR-03) - There appears to be a substantial basis for questioning the licensee's IPEEE analysis of the impacted fire area. It is not clear how the small fire scenario/critical damage frequencies (i.e.,  $8.00\text{E-}05$  in Table 4.6-5, p. 4-130 of Reference H-1) have been obtained given the physical conditions cited in the exemption. If the licensee has employed optimistic assumptions in the fire growth and damage assessment, then the risk contribution of this area could be significant.

**Relevant IPEEE Citations:** (HBR-03) - The service water pump area has Fire Zone 29 and Fire Area G designations in the IPEEE (see pp. 4-88, 4-93, 4-101, 4-121 and 4-130 of Reference H-1). The area survives initial screening with a rather high screening CDF. However, the final CDF is reported as on the order of  $1\text{E-}6/\text{ry}$ . From the submittal it is not clear how the licensee has reached such a small CDF value from the preliminary CDF of  $3.16\text{E-}4/\text{ry}$ .

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**Plant:** H. B. Robinson

**Exemption #:** HBR-04

**Document Accession #:** 8312140199-03

**Appendix R Section:** III.M.2

**Exemption Description:** Lack of qualification of fire barrier cable penetration seal in north cable vault area

**Location Binning Category:** Cable vault

**PRA Step Binning Category:** FHA: FCIA, PPR: Eq&Sys

**Potential for CDF Reduction:** Very Small

**Analysis:** (HBR-04) - From the "Exemption Rationale" provided by NRC staff it can be inferred that the penetration seals are rated as 2-hour fire barriers. From fire growth analysis it has been demonstrated that rated fire seals and barriers can withstand severe fires and therefore, the likelihood of a fire that could overcome these seals would be very small. The area is protected by fire detectors and an automatic CO2 suppression system. This further reduces the likelihood of a fire severe enough to challenge the two hour rating of the seals. Given these considerations, in terms of fire risk, in this case the difference between a 2-hour and 3-hour rated barrier would not be considered as a significant factor in a typical fire risk analysis. Therefore this exemption is found to have, at most, a very small risk impact.

**Points of Uncertainty:** (HBR-04) - None.

**Relevant IPEEE Citations:** (HBR-04) - The North Cable Vault is designated as Fire Area D and Fire Zone 9 (see pages 4-84, 4-92, and 4-100 of Ref. H-1). The licensee has concluded that the CDF for this fire zone is  $2.56 \times 10^{-7}$  per reactor year and has screened it.

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**Plant:** H. B. Robinson

**Exemption #:** HBR-05

**Document Accession #:** 8504040295-01

**Appendix R Section: III.O.**

**Exemption Description:** Lack of oil collection system for reactor coolant pumps in the containment.

**Location Binning Category:** Containment

**PRA Step Binning Category:** FHA : Sources

**Potential for CDF Reduction:** Very Small

**Analysis:** (HBR-05) - See Section 4 of the main body for discussion.

**Points of Uncertainty:** (HBR-05) - None

**Relevant IPEEE Citations:** (HBR-05) - This issue is not discussed in the IPEEE

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**Plant:** H. B. Robinson

**Exemption #:** HBR-06

**Document Accession #:** 8609290355-01

**Appendix R Section: III.G.3**

**Exemption Description:** Lack of fire detection in fire zones 12 and 13 and lack of fixed fire suppression system and alternate shutdown capability in some of the fire zones of the Auxiliary Building.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA: Det/Supp

**Potential for CDF Reduction:** Small

**Analysis:** (HBR-06) - This exemption impacts several fire zones within the auxiliary building including several that are identified as risk important. From a review of the IPEEE analysis of the fire zones in Fire Area A (the aux. bld.) it can be concluded that only a handful of the fire zones in this fire area do not contain fire detection or fixed fire suppression equipment. From a review of the equipment list (mostly associated cables) present in these fire zones it is inferred that those zones that do have a large collection of such equipment are equipped with detection and

suppression systems. For these zones, the IPEEE submittal concludes that the CDF is on order of  $1E-5/ry$ . Hence, the extension of suppression and detection coverage may result in small risk reductions for these areas. All but two of the remaining zones (those with only a few important pieces of equipment and cables) are equipped with detectors. The CDFs for these zones were found to be very small and all were ultimately screened. Two fire zones (A/12 and A/13) do not have fire detectors. These are identified in the IPEEE submittal as the "Waste Holdup Tk/RHR HX" and "Chem. Stor./Boric Acid Batch Tk" rooms. Both fire zones have been screened in the initial stages of the fire analysis based on an assessment that the CDF contribution is very small (much smaller than  $1E-6/ry$ ). Fire zone A/13 was qualitatively screened based on no Appendix R SSD equipment and no fire-induced initiating events. Zone A/12 was screened quantitatively - assuming loss of all equipment in the room, the CCDP is  $7.05E-5$  and the CDF is  $8.88E-8$ . Using the information provided in the IPEEE submittal, it can be concluded that the impact of fixed fire suppression system or fire detectors in Fire Zones 12 and 13 would not have a significant risk impact. However, given that a handful of scenarios with CDF contributions on the order of  $1E-5/ry$  may be impacted, this exemption is found to have a potential for a small risk impact.

**Points of Uncertainty:** (HBR-06) - The assessment of risk impact is based entirely on the CDF values reported in the IPEEE. The actual risk impact for individual scenarios cannot be assessed because the IPEEE submittal lacks sufficient detail regarding how fire detection and suppression have been credited.

**Relevant IPEEE Citations:** (HBR-06) - The fire zones in Fire Area A are listed on p. 4-84 of Ref. H-1 along with the systems/trains present in each fire zone. The first screening CDFs are shown on pp. 4-92 and 93. At this stage, Fire Zone A/12, which contains both trains of CCW and SW systems, is screened based on a CCDP of  $7.05E-5$  given fire damage. Fire Zone A/13, which contain both trains of SW is screened based on qualitative arguments. Fire Zone A/21, which contains a large collection of safe shutdown trains, has also been screened out (p. 4-100 of Ref. H-1) based on fire growth and propagation modeling. The modeling apparently showed that the most significant fire sources cannot lead to equipment damage. Several fire scenarios have been postulated for the remaining three fire zones. The scenarios are defined in the following pages: Fire Zone 7 (pp. 4-40 and 4-104 to 4-107), screening CCDP=0.33 with potential for station blackout, total CDF =  $1.11 \times 10^{-5} /ry$  (p. 4-125), includes detectors and pre-action sprinklers; Fire Zone 19 (pp. 4-109 to 4-114), total CDF =  $1.50 \times 10^{-5} /ry$ ; Fire Zone 20 (pp. 4-115 to 4-117), total CDF =  $2.38 \times 10^{-5} /ry$ , includes detectors and 2 trains of Halon system. Sections 4.6.2.2 and 4.6.2.4 of Ref. H-1 provide a detailed discussion of fire scenarios in Fire Zones 7 and 20.

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**Plant:** H. B. Robinson

**Exemption #:** HBR-07

**Document Accession #:** 8609290355-02

### **Appendix R Section: III.G.3**

**Exemption Description:** Lack of fire detection and fixed fire suppression system installation in fire zone 4 and fire area B, for which alternate shutdown capability is provided in the Charging Pump, VCT and Non-regenerative HX rooms.

**Location Binning Category:** Pump room

**PRA Step Binning Category:** FHA: Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (HBR-07) - The primary risk significant target for these areas appears to be the service water system. From the information provided in the IPEEE submittal it can be inferred that the service water system will not be completely disabled due to a fire in these zones. Therefore, prompt intervention in fires in not critical, and the lack of fire detection and suppression systems would not lead to a severe condition. This is consistent with the findings of the IPEEE submittal that the CDF is small. Therefore, the added benefit provided by installing detection and suppression systems will not have a significant impact on fire risk. On this basis the exemption is found to have a very small risk impact. This finding is based on the IPEEE cited CDF and is sensitive to the robustness of the of the IPEEE submittal findings.

**Points of Uncertainty:** (HBR-07) - Based on the CCDP provided in the IPEEE submittal it is inferred that the service water system will not be completely disabled from a fire in this zone.

**Relevant IPEEE Citations:** (HBR-07) - Fire Area B is comprised of Fire Zone 4 and other compartments. The content of this fire zone is given on p. 4-85 of Ref. H-1. The area contains both trains of SW, and CVCS systems. The fire zone has been screened out (p. 4-92 of Ref. H-1) based on a CCDP of  $2.3E-05$  and CDF smaller than  $1E-6$  /ry.

\*\*\*\*\*

**Plant:** H. B. Robinson

**Exemption #:** HBR-08

**Document Accession #:** 8609290355-03

### **Appendix R Section: III.G.3**

**Exemption Description:** Lack of automatic fire detection and fixed fire suppression systems in fire area G.

**Location Binning Category:** Intake structure, General process areas, Turbine building, Diesel generator

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Small

**Analysis:** (HBR-08) - Fire Area G is comprised of several fire zones and compartments including compartments identified in the IPEEE as fire risk important. It includes, among other zones, the Service Water Pump Area (Fire Zone G/29) that was also the subject of HBR-03. Of the rest of the fire zones, only zones G/25 and G/26 include a significant collection of safe shutdown cables and equipment. Fire Zone G/25 is equipped with a fire detection system and a partial deluge system. Therefore, it would appear that this exemption has a minimal impact on this fire zone. Assuming that the deluge system has been designed to address the most significant fire hazards, then the only question is the potential risk benefit of extending coverage to the full zone. There does not appear to be any clear or significant benefit to such an action. Fire Zone G/26 is the yard and transformer areas. The transformers are protected by fire protection systems; hence, the installation of additional fire protection features (detection and fixed suppression for other specific hazards) would not appear to provide added risk benefit. The rest of the fire zones impacted by this exemption are generally open areas and are generally protected by fire hydrants (manual suppression). Aside from the Service Water Pump area, which has already been covered under HBR-03, added fire protection or fixed fire suppression system will not have a significant impact on the probability of damage to safe shutdown equipment and cables. Therefore, given that the risk important areas already are provided with partial fixed suppression coverage, this exemption (relating to lack of area wide coverage) is found have, at most, a potential for a small risk impact.

**Points of Uncertainty:** (HBR-08) - It is assumed that the partial suppression coverage has been designed to address the most serious and risk significant fire sources so that extension of the coverage to area-wide protection would not significantly impact fire risk.

**Relevant IPEEE Citations:** (HBR-08) - The fire zone contents are provided on p. 4-88 of Ref. H-1. Most fire zones of this fire area screen out as indicated on p. 4-93. The following fire zones did not screen out and for each several fire scenarios have been postulated:

| <u>Fire Zone</u> | <u>pp.</u>            | <u>Total CDF</u>          |
|------------------|-----------------------|---------------------------|
| G/25             | 4-118 to 119, 4-129   | $3.85 \times 10^{-6}$ /ry |
| G/26             | 4-120, 4-129 to 4-130 | $3.70 \times 10^{-5}$ /ry |
| G/29             | 4-121, 4-130          | $4.37 \times 10^{-6}$ /ry |

Fire scenarios related to G/26 are discussed in Section 4.6.2.5 of Ref. H-1.

\*\*\*\*\*



**Plant:** H. B. Robinson

**Exemption #:** HBR-09

**Document Accession #:** 8609290355-04

**Appendix R Section:** III.G.2.f

**Exemption Description:** Lack of separation of cables by a non-combustible radiant energy shield in the containment.

**Location Binning Category:** Containment

**PRA Step Binning Category:** FHA: Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (HBR-09) - This exemption implies a nominal potential for the loss of redundant instrumentation cables within containment. In particular, the lack of separation of cables raises a question about the vulnerability of the instrumentation cables to a large RCP oil fire. In Reference [H-3], NRC staff argue that small combustible fuel loading, localized fixed suppression systems and structural features of the cable trays and conduits reduce the likelihood of fire damage to these cables significantly. In the IPEEE analysis, fires inside containment were screened by direct reference to general statements made in FIVE. According to Reference [H-3] the instrumentation circuits that are the focus of this exemption are associated with steam generator level and temperature indications at the alternate shutdown panels in the charging pump room and turbine deck. Given that in a typical PWR other instrumentation circuits are available to provide roughly equivalent readings, the operators will have some indications to enable to conduct safe shutdown procedures. Therefore, this exemption is found to have, at most, a very small risk impact.

**Points of Uncertainty:** (HBR-09) - The licensee provided no assessment of containment fires in its IPEEE submittal.

**Relevant IPEEE Citations:** (HBR-09) - The designations of the containment are Fire Zone 24 and Fire Area F (p.4-87 of Ref. H-1). The containment has been screened out by referring to a very broad and generalized statement in FIVE regarding risk significance of containment (p. 4-93 of Ref. H-1).

\*\*\*\*\*

**Plant:** H. B. Robinson

**Exemption #:** HBR-10

**Document Accession #:** 8708060038-01

**Appendix R Section:** III.J.

**Exemption Description:** Lack of 8-hour battery powered lighting in access routes to charging pump room, CCW HX room, battery room, SI pump room, SW intake structure, containment, RHR pit.

**Location Binning Category:** Pump rooms

**PRA Step Binning Category:** RQ : HRA

**Potential for CDF Reduction:** Small

**Analysis:** (HBR-10) - Lack of fixed, battery powered emergency lighting affects safe personnel egress during an emergency and supports local operator actions. The lack of such lighting may impact the HRA for recovery actions in the event of a loss of power to the station lighting system. As stated in the "Exemption Rationale" portable lighting is available for the affected fire compartments. So long as there is some form of lighting available, the type of lighting used for gaining access to the affected areas and for conducting the proper actions is a secondary contributor to the probability of human error. Some degradation in reliability of human recovery might result, but overall this will likely have, at most, a small impact on the quantification of fire CDF. It must be added that in practice, hand held lighting is often used during local actions regardless of the availability of local fixed lighting system. Thus, this exemption is found to have, at most, a small risk impact.

**Points of Uncertainty:** (HBR-10) - It is assumed that the procedures that call for operator actions in those areas addressed in this exemption clearly state that proper hand-held lighting has to be carried into those areas.

**Relevant IPEEE Citations:** (HBR-10) - The specific issue is not mentioned in the IPEEE submittal.

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**Plant:** H. B. Robinson

**Exemption #:** HBR-11

**Document Accession #:** 8807120348-01

**Appendix R Section:** III.J.

**Exemption Description:** Lack of 8 hour battery power lighting for access routes to service water structure and SI Pump room , containment and RHR areas.

**Location Binning Category:** Intake structure, pump rooms

**PRA Step Binning Category:** RQ : HRA

**Potential for CDF Reduction:** Small

**Analysis:** (HBR-11) - See HBR-10.

**Points of Uncertainty:** (HBR-11) - See HBR-10

**Relevant IPEEE Citations:** (HBR-11) - See HBR-10

\*\*\*\*\*

**Plant:** H. B. Robinson

**Exemption #:** HBR-12

**Document Accession #:** 9010250185-01

**Appendix R Section:** III.G.2.b

**Exemption Description:** Intervening combustibles between redundant trains of cables in the CCW pump room.

**Location Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Small

**Analysis:** (HBR-12) - The screening CCDP assuming loss of all equipment associated with this fire zone is 0.086. This indicates the potential for this fire zone to be risk significant. From the information provided in the IPEEE submittal, it can be inferred that the only significant fire sources would be transients and the CCW pumps themselves. Given that these are relatively modest fire source hazards, it appears reasonable to conclude that the CDF is relatively small. Assuming that the IPEEE analysis has employed appropriate analysis methods, the fire CDF for this compartment is on the order of  $1\text{E-}6/\text{ry}$ . The zone does have a fire detection system, a low fuel loading, the CCW pump cables are protected by 1-hour barriers, fire extinguishers are available, and hose stations are available in adjoining areas. Hence, the conclusion of a small risk

contribution may be warranted. If so, then it can be concluded that the presence of intervening combustibles between the redundant CCW pumps and associated cables has, at most, a small impact on fire risk. However, this conclusion is very sensitive to the underlying assumptions regarding fire ignition, growth, damage, detection and suppression.

**Points of Uncertainty:** (HBR-12) - It is assumed that the CCW pump room mentioned in the exemption description is the same as Fire Zone 5 and Fire Area C. It is assumed that the licensee has properly quantified the frequency of fire damage in this compartment. Since the CCDP for this fire compartment is significant, there is the potential for this exemption to be risk significant as well. Our conclusion is based entirely on the licensee's reported CDF value.

**Relevant IPEEE Citations:** (HBR-12) - The designations of the CCW pump room are Fire Zone 5 and Fire Area C (C/5, p.4-85 of Ref. H-1). This room is cited in the screening analysis as having a CCDP assuming loss of all equipment in the room of  $8.58E-2$  and a screening CDF of  $7.38E-4/ry$  (p.4-92 of Ref. H-1). This fire zone is later screened out based on a revised CDF of  $1.14E-6/ry$  (p.4-92 of Ref. H-1). The reduction is based on the fact that "fire modeling showed many sources did not damage safe shutdown equipment."

\*\*\*\*\*

**Plant:** H. B. Robinson

**Exemption #:** HBR-13

**Document Accession #:** 9210160190-01

**Appendix R Section:** III.J.

**Exemption Description:** Lack of 8-hour battery power emergency lighting for 10 access routes to areas in which cold shutdown operation and repair activities take place.

**Location Binning Category:** General process area

**PRA Step Binning Category:** RQ : HRA, Recov.

**Potential for CDF Reduction:** Very Small

**Analysis:** (HBR-13) - See HBR 10. In this case since access to the impacted areas is only needed to achieve cold shutdown, the risk impact is found to be very small (rather than small).

**Points of Uncertainty:** (HBR-13) - See HBR 10. Also note that the IPEEE considers achieving hot shutdown as success and does not explicitly address cold shutdown.

Relevant IPEEE Citations: (HBR-13) - None.

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**References:**

- H-1 "H. B. Robinson Steam Electric Plant Unit 2, Individual Plant Examination for External Events", Final Report June 1995.
- H-2 Enclosure 2 to Serial: RNP-RA/95-0209, letter from R. M. Krich of CP&L to USNRC, November 30<sup>th</sup>, 1995.
- H-3 Enclosure 1 to Letter from Steven A. Varga, Operating Reactors Branch #1, Division of Licensing, US Nuclear Regulatory Commission to Mr. E. E. Utley, Executive Vice President, Carolina Power and Light Company, November 25, 1983.

**TABLE F-1: SUMMARY CATEGORIZATION OF INDIVIDUAL EXEMPTIONS FOR H.B. ROBINSON (HBR)**

| <b>Exemp. #</b> | <b>Exemption Description</b>  | <b>Location Binning Category</b>   | <b>PRA Step Binning Category</b> | <b>Risk Impact</b> |
|-----------------|---|--|----------------------------------|--------------------|
| HBR - 01        | Lack of a fixed fire suppression system in the control room.  | Control room fire  | FHA: Det&Supp                    | Indeterminate      |
| HBR - 02        | Lack of 3 hour fire barriers separating redundant RHR trains; lack of automatic suppression system; and lack of independent alternate cold shutdown capability  | Pump room  | FHA: Grw&Dmg                     | Very Small         |
| HBR - 03        | Lack of fire detection system, lack of automatic fire suppression system, lack of 20 feet separation and lack of alternate shutdown capability in the SW pump area.   | Intake structure   | FHA: Det&Supp and Grw&DMG.       | Indeterminate      |
| HBR - 04        | Lack of qualification of fire barrier cable penetration seal in north cable vault and area  | Cable vault  | FHA:FCIA, PPR: Eq&Sys            | Very Small         |
| HBR - 05        | Lack of oil collection system for reactor coolant pumps in the containment.   | Containment  | FHA: Sources<br>FHA: Grw&Dmg     | Very Small         |
| HBR - 06        | Lack of fire detection in fire zones 12 and 13 and fixed fire suppression system and lack of alternate shutdown capability in some of the fire zones of the Auxiliary Building                                      | General Process area   | FHA: Det&Supp                    | Small              |
| HBR - 07        | Lack of fire detection and fixed fire suppression system installation in fire zones 4 and fire area B, for which alternate shutdown capability is provided in the Charging Pump, VCT and Non-regenerative HX rooms. | Pump room  | FHA: Det&Supp                    | Very Small         |
| HBR - 08        | Lack of automatic fire detection and fixed fire suppression systems in fire area G.   | Intake structure, General process area, Turbine Building, Diesel generator | FHA: Det&supp                    | Small              |
| HBR - 09        | Lack of separation of cables by a non-combustible radiant energy shield in the containment.   | Containment  | FHA: Grw&Dmg                     | Very Small         |
| HBR - 10        | Lack of 8-hour battery powered lighting in access routes to charging pump room, CCW HX room, battery room, SI pump room, SW intake structure, containment, RHR pit.   | Process area   | RQ: HFA<br>RQ: Recov.            | Small              |

| <b>Exemp. #</b> | <b>Exemption Description</b>  | <b>Location Binning Category</b> | <b>PRA Step Binning Category</b> | <b>Risk Impact</b> |
|-----------------|---|----------------------------------|----------------------------------|--------------------|
| <b>HBR - 11</b> | <b>Lack of 8 hour battery power lighting for access routes to service water structure and SI Pump room , containment and RHR areas.</b>                 | <b>Process area</b>              | <b>RQ: HFA<br/>RQ: Recov.</b>    | <b>Small</b>       |
| <b>HBR - 12</b> | <b>Intervening combustibles between redundant trains of cables in the CCW pump room.</b>  | <b>Pump room</b>                 | <b>FHA: Grw&amp;Dmg</b>          | <b>Small</b>       |
| <b>HBR - 13</b> | <b>Lack of 8-hour battery power emergency lighting for 10 access routes to areas in which cold shutdown operation and repair activities take place.</b> | <b>Process area</b>              | <b>RQ: HFA<br/>RQ: Recov.</b>    | <b>Very Small</b>  |

**Appendix G: Individual Exemption Assessment for St. Lucie**

**Plant:** St. Lucie 2

**Exemption #:** STL-01

**Document Accession #:** 8304200442-01

**Appendix R Section:** III.G.2.a.

**Exemption Description:** A 3-hour fire rated damper is not installed in the duct penetrating the wall between the Pipe Tunnel and Division A Cable Penetration Area.

**Location of Binning Category:** General process area, Cable vault

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-01) In the IPEEE fire analysis, Compartments A22 and J have been screened out separately and the analysis has not taken into account the possibility of fire propagation from one to the other. The Pipe Tunnel is deemed to contain a minimal number of cables and the combustible loading is small. Therefore, the possibility of a fire that could create sufficiently hot gases to propagate through the open duct into the Cable Penetration Area and damage cables there is deemed to be very unlikely. The possibility of a large fire in the Cable Penetration Area does exist. However, since the Pipe Tunnel contains a minimal number of cables, the propagation of hot gases into the Pipe Tunnel would lead to minimal additional plant impact. It must be added that since both areas contain automatic fire detection systems and the Penetration Area contains automatic sprinklers, the probability of a large fire is considered to be small. Therefore, lack of a 3 hour rated fire barrier is deemed to have very small impact on fire risk.

**Points of Uncertainty:** (STL-01) It is assumed that FIVE Compartment A22 is the same as "Division A Cable Penetration Area" and FIVE Compartment J, Appendix R zone 24 is the same as "Pipe Tunnel". These are the two areas mentioned in the exemption description.

**Relevant IPEEE Citations:** (STL-01) The lack of 3 hour rated fire damper between FIVE Compartment A22 (p.40 of 129 of Ref. S-1) and FIVE Compartment J (p. 42 of 129) is not discussed in the IPEEE fire analysis. It seems that in IPEEE fire analysis, the licensee has assumed that the two compartments are perfectly separated.

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**Plant:** St. Lucie 2

**Exemption #:** STL-02

**Document Accession #:** 8304200442-02

**Appendix R Section:** III.G.2.a.

**Exemption Description:** A 3-hour fire rated damper is not installed in the duct penetrating the wall between the Electrical Equipment and Supply Fan Room and the Control Room.

**Location of Binning Category:** MCR, Relay room, General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-02) The exemption summary does note that a 1-hour barrier is available. Typically, fire growth analyses have shown that a 1-hour fire barrier provides sufficient protection against a large spectrum of possible fire severities. Therefore, the likelihood of a fire in the Fan Room failing the ducts is deemed to be very unlikely. This exemption is considered to have very small risk impact.

**Points of Uncertainty:** None

**Relevant IPEEE Citations:** (STL-02) The licensee has combined these areas with the Control Room (FIVE Compartment F, page 33 of 129 in Ref. S1). On page 21 of 129 Ref. S1, the licensee provides a discussion of Control Room Fires but does not discuss the possibility of fire propagation from adjacent areas into the Control Room. However, the fire analysis presented in the submittal can be considered as conservative and fire scenarios that include propagation into the Control Room can be considered as a subset of those considered in the Control Room fire scenarios.

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**Plant:** St. Lucie 2

**Exemption #:** STL-03

**Document Accession #:** 8304200442-03

**Appendix R Section:** III.G.2.a.

**Exemption Description:** A 3-hour fire rated damper is not installed in the duct penetrating the wall between the Component Cooling Water Surge Tank Room and the Control Room.

**Location of Binning Category:** MCR, General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-03) As it is stated in the exemption summary, the combustible loading in the CCW Surge Tank Room is extremely small. Therefore, a fire in this room that could jeopardize the habitability of the control room is deemed to be very unlikely. Given, the defense in depth provided by the alternate shutdown capability, this exemption is considered to have very small risk impact.

**Points of Uncertainty:** None

**Relevant IPEEE Citations:** (STL-03) Licensee has combined the CCW Surge Tank Room as part of the areas with the Control Room (FIVE Compartment F, page 33 of 129 in Ref. S1). On page 21 of 129 Ref. S1, licensee provides a discussion of Control Room Fires but does not discuss the possibility of fire propagation from outside into the Control Room.

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**Plant:** St. Lucie 2

**Exemption #:** STL-04

**Document Accession #:** 8304200442-04

**Appendix R Section:** III.G.2.a.

**Exemption Description:** A 3-hour fire rated damper is not installed in the duct penetrating the wall between the Shutdown Heat Exchanger Room and the Corridor on the 0.50 feet elevation of the Reactor Auxiliary Building.

**Location of Binning Category:** General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Small

**Analysis:** (STL-04) In a typical auxiliary building the heat exchangers for shutdown cooling are

located at the lowest elevations and often no other safe shutdown or PRA equipment or cables are located or routed through the same areas. Therefore, the argument that the fuel loading in the areas is negligible as presented in the staff exemption rationale appears reasonable. Also, the small P2 (CCDP assuming loss of all equipment) cited in the IPEEE submittal for these areas verifies that only a handful of safe shutdown components are present in these zones. However, the CDF for Area O, where the Corridor (hallway) is located is greater than  $1 \times 10^{-6}$  /ry. Since the IPEEE submittal does not provide sufficient information regarding the areas within Area O that lead to this CDF, it had to be assumed that the CDF corresponds to a fire close to the heat exchanger rooms. Given this assumption, the risk impact of this exemption must be concluded to be small. ts

**Points of Uncertainty:** (STL-04) - Although Area O is a very large area, since no detailed information is provided, the CDF associated with this area has to be assumed to correspond to every part of the area.

**Relevant IPEEE Citations:** (STL-04) - In IPEEE submittal, the licensee has treated zones 15A, 15B and 20 (the two heat exchanger areas and the hallway) (see pp. 42 and 43 of 129 in Ref. S1) as completely separate fire zones and does not acknowledge the lack of proper fire dampers. The two heat exchanger rooms (zones 15A and 15B) have been screened out based on small CDF (less than  $1 \times 10^{-7}$ ). However, zone 20 is part of a larger area (App. R Area O) that has an estimated CDF of  $1.34 \times 10^{-6}$  /ry.

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**Plant:** St. Lucie 2

**Exemption #:** STL-05

**Document Accession #:** 8304200442-05

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Three hatch openings exist in 3-hour fire-rated barriers separating redundant trains in the Reactor Auxiliary Building.

**Location of Binning Category:** General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (STL-05) - Since fires propagate vertically and create a hot gas layer under the ceiling, the possibility of hatch cover failure should be examined carefully. However, since the combustible loading of the areas below the hatch is small, the likelihood of a fire that can

overcome the cover and damage cables and equipment above should be small. This is augmented by the fact that the areas above the hatch are protected by automatic fire detection and suppression systems. This will further reduce the frequency of a damaging fire and will serve to protect the hatches in the event that fire products do start to penetrate the hatches in significant quantity. From the information provided on page 9-8 of Reference [S-2] it can be inferred that fire zones 32, 34 and 51W share a set of hatches at column coordinates RAJ and RA5 and fire zone 51E has a hatch at column coordinates RAC and RA4. The cited fire zones include a switchgear room and a cable vault. Therefore, since the importance of the cables and equipment that could be located directly above the hatches is not known, the risk impact of this exemption remains indeterminate.

**Points of Uncertainty:** (STL-05) - The exemption description does not provide specific fire zone or area numbers. The fire zones had to be inferred from the information provided in Reference [S-2].

**Relevant IPEEE Citations:** (STL-05) - The specific hatchways are not mentioned in the IPEEE submittal. The fire zones that can be inferred from the information provided in Reference [S-2] addressed in the IPEEE submittal, are as follows:

| <u>Appendix R zone:</u> | <u>CDF</u>             |
|-------------------------|------------------------|
| 32                      | $2.67 \times 10^{-6}$  |
| 34                      | $4.48 \times 10^{-6}$  |
| 51W                     | (Part of fire zone 32) |

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**Plant:** St. Lucie 2

**Exemption #:** STL-06

**Document Accession #:** 8304200442-06

**Appendix R Section:** III.G.2.a.

**Exemption Description:** A Full height 3-hour barrier is not provided between the redundant shutdown heat exchangers.

**Location of Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-06) - Exemption STL-04 addresses the same fire zones as this exemption. The critical equipment in the impacted area is separated by an eight foot high fire rated wall, but this wall does not extend to the ceiling. The only way that a fire can damage both heat exchangers is if the hot gas layer in the room drops below the 8 foot level to engulf the redundant heat exchangers or becomes hot enough to radiate heat directly down onto the heat exchangers. Even under such conditions, at least one heat exchanger may remain unaffected because pipes, valves and heat exchangers are not readily susceptible to fire. Given the fuel loading of a typical shutdown heat exchanger room, it is very unlikely for a fire to be severe enough to cause damage across an 8 feet tall wall. Therefore, it is deemed that this exemption has very small risk impact.

**Points of Uncertainty:** (STL-06) - The exemption description does not provide specific fire zone or area numbers and therefore cannot be matched against specific areas discussed in the IPEEE submittal (Ref. S-1). It is assumed that fire zones 15A and 15B are intended in this exemption. These fire zones are assumed to contain no other equipment or cables and there are no active components associated with the operation of the heat exchangers. If there are active components in the fire zones that must operate after the occurrence of fire, may get damaged only from the effects of hot gas layer.

**Relevant IPEEE Citations:** (STL-06) - The specific heat exchangers and dividing wall could not be identified in the IPEEE submittal. It is assumed that fire zones 15A and 15B are the subject of this exemption. The CDF for these fire zones (p. 42 of 139 Ref. S-1) is  $1.40 \times 10^{-8}$  /ry.

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**Plant:** St. Lucie 2

**Exemption #:** STL-07

**Document Accession #:** 8304200442-07

**Appendix R Section:** III.G.2.a.

**Exemption Description:** A Full height 3-hour barrier is not provided between the redundant shutdown cooling pumps.

**Location of Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-07) - The "Exemption Rationale" states that the pumps are separated by 20 feet and the fuel loading of the room is negligible. Assuming that a major oil spill in this room is very

unlikely, and that there are very little, if any, cables from safe shutdown circuits, it can be concluded that the frequency of occurrence of a fire that may damage redundant pumps should be very small. Also, since only low pressure pumps are present in this room, the corresponding CCDP should be small as well. Thus, the CDF and consequently the impact of this exemption on risk must be very small.

**Points of Uncertainty:** (STL-07) - There is no discussion of LPSI pump fires provided in the IPEEE submittal. It is assumed that the room only contains low pressure injection pumps, which are not needed for cold shutdown. It is also assumed that the pumps are exposed to one another, contain small amount of lubricating oil and there are few if any safe shutdown cables in this room. Also, it is assumed that large quantities of oil are not introduced into this room. The conclusions are highly dependent on the assumption that the low combustible loading of the room and low probability of transient fuels being present.

**Relevant IPEEE Citations:** (STL-07) - The LPSI pumps and corresponding room could not be identified in the IPEEE submittal.

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**Plant:** St. Lucie 2

**Exemption #:** STL-08

**Document Accession #:** 8304200442-08

**Appendix R Section:** III.G.2.a.

**Exemption Description:** A Full height 3-hour barrier is not provided between each of the three charging pumps.

**Location of Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-08) - The arguments made for STL-06 apply in part here as well. Although, oil may be present, the fire zones include added protection provided by an automatic fire detection system. Also, the CCDP associated with the loss of all three charging pumps tend to be small. Therefore, this exemption is deemed to have very small risk impact.

**Points of Uncertainty:** (STL-08) - Given that in the IPEEE fire analysis, the licensee has treated these rooms as separate compartments, it is assumed that the fire barriers among the three pumps will provide some protection against direct exposure from a fire in one room to the other.

**Relevant IPEEE Citations:** (STL-08) - In Table 4-2 (p. 43 of 129) of Ref. S-1, three separate compartments are defined for the three charging pumps. The FIVE Compartment designators for these pumps are N18I, N18II, and N18III. All three compartments are screened out based on low CDF. The P2 (CCDP) for each room is on the order of 1E-06 and the CDFs are on the order of 1E-09 per year.

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**Plant:** St. Lucie 2

**Exemption #:** STL-09

**Document Accession #:** 8304200442-09

**Appendix R Section:** III.G.2.

**Exemption Description:** The following areas lack automatic fire suppression systems: Division A switchgear Room, Division B Switchgear Room, Hallway to the Division B Fan Room, Elevation 43 Feet Reactor Auxiliary Building, Component Cooling Area, Steam Tunnel, Intake Structure, Aerated Waste Storage Tank Room, Gas Decay Tank Cubicle 2C.

**Location of Binning Category:** Switchgear room, General process areas, Intake structure

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Indeterminate (for 1 of the 8 impacted fire zones), Small (for nother 1 of the 8 impacted fire zones), and Ver Small (for the rest of the 8 impacted fire zones)

**Analysis:** (STL-09) The lack of automatic suppression systems and presence of fire detection system means that the fire brigade is relied upon to suppress fires in the impacted areas. The implication of relying solely on the fire brigade is that the amount of damage may be greater than the situation where the area has an automatic fire suppression system as well. The damage is expected to be greater because the fire brigade requires significantly more time than does an automatic suppression system. Depending on the location and severity of the fire, the system may activate in a short time. In Ref. S-2 it is noted that each of the areas is covered by "early warning fire detection." Further, redundant cables are either enclosed in 1-hour fire barriers or are separated by 20 feet. For all but one area, the fuel load is "low" with two exception (A/B switchgear rooms) and in these two rooms the redundant cables have 2-hour protection. The areas identified in this exemption are discussed separately below:

1. Division A Switchgear - In IPEEE submittal, this room is combined with several other rooms of the same division. The P2 (assuming that it is the same as CCDP) is small, which can be interpreted as meaning that several paths remain available in case of a fire damage in this set of compartments. Also the CDF is less than 1E-6/ry. Hence, this exemption is found to have very small risk impact in this area.

2. Division B Switchgear - Although the CCDP for this fire zone is small, the CDF is between  $1E-06$  and  $1E-05$  /ry. Hence, this exemption is found to have small risk impact.

3. Hallway to the Division B Fan Room El. 43' - This area is on the same floor as the Division A Switchgear. The analysis used as the basis for granting the exemption (p.9-11 of Reference [S-2]) is focused on low fire load associated with in-situ combustibles. A large fire caused by transient combustibles in a hallway is deemed to be more likely (because of higher likelihood of the presence of transient fuels) than it would be in an enclosed, limited access area. Therefore, the possibility of the fire affecting other areas, compromising access to the fire area, or jeopardizing safe shutdown cables or equipment may exist. It was not, however, possible to identify any area in the IPEEE submittal that corresponds clearly to this hallway. Hence, the risk contribution remains unknown. Hence, the risk significance for this particular zone cannot be assessed and the risk impact of this exemption for this zone remains indeterminate.

4. Component Cooling Area - The IPEEE submittal (on page 44 of 129) indicates that there is a separate CCW building. A separate building may imply that fire cannot propagate to areas outside the building and affect other shutdown systems and equipment. The licensee has concluded that this building can be screened; hence, this exemption is found to have very small risk impact in this area.

5. Steam Tunnel - The steam tunnel is not addressed in the IPEEE submittal. Generally no other equipment and cables are located in steam pipe tunnels and it appears likely that this area screened. Hence, this exemption is found to have very small risk impact in this area.

6. Intake Structure - In the IPEEE submittal, the licensee has concluded that this building can be screened. The CDF is well below  $1E-6$ /ry. Hence, this exemption is found to have very small risk impact in this area.

7. Aerated Waste Storage Tank Room - This room is not discussed in the IPEEE submittal. This type of area generally does not contain shutdown related equipment or cables. Presumably the area was screened. Hence, this exemption is found to have very small risk impact in this area.

8. Gas Decay Tank Cubicle 2C - Similar to the preceding case, the area is not identified in the IPEEE submittal, but this type of area generally does not contain shutdown related equipment or cables and therefore. Hence, this exemption is found to have very small risk impact in this area.

**Points of Uncertainty: (STL-09)** - Several areas addressed in the exemption could not be found in the IPEEE submittal. The steam tunnel is assumed to be void of safe shutdown equipment or cables. It is assumed that the core damage analysis done for IPEEE submittal is a complete and accurate "picture" of plant fire risk and that safe shutdown can be achieved with failed service water (intake structure) or component cooling water systems. It is assumed that the Aerated Waste Storage Tank Room is associated with Unit 2 and, unlike that of Unit 1, does not contain safety related cables or equipment. Similarly, it is assumed that the Gas Decay Tank Cubicle 2C does not contain any safe shutdown related cables or equipment.

The conclusions regarding this exemption are highly sensitive to the assumptions made regarding presence of safe shutdown cables and equipment. If safe shutdown cables or equipment are present in some of the impacted areas, the CCDP associated with an area may then become



significant and the presence of automatic suppression system may have a significant risk impact.

**Relevant IPEEE Citations:** (STL-09) - The IPEEE submittal addresses some of the listed compartments and buildings explicitly. From the discussions and information provided in the submittal it can be concluded for a few cases the impact of the exemption is negligible.

1. Division A switchgear Room - FIVE compartment A, App. R zone 37, CDF =  $8.6E-07$
2. Division B Switchgear Room - FIVE compartment C, App. R zone 34, CDF =  $4.5E-06$
3. Hallway to the Division B Fan Room Elevation 43 Feet Reactor Auxiliary Building - this area designator could not be found.
4. Component Cooling Area - FIVE compartment C-C, App. R zone 3, CDF =  $8.6E-07$  (p. 44 of 129)
5. Steam Tunnel - this area designator could not be found
6. Intake Structure - FIVE compartment R-R, App. R zone 49, CDF =  $7.1E-08$  (p. 46 of 129)
7. Aerated Waste Storage Tank Room - this area designator could not be found
8. Gas Decay Tank Cubicle 2C - this area designator could not be found.

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**Plant:** St. Lucie 2

**Exemption #:** STL-10

**Document Accession #:** 8304200442-10

**Appendix R Section:** III.G.3.

**Exemption Description:** A fixed suppression system is not installed in the control room.

**Location of Binning Category:** Control room

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (STL-10) - See Section 4 of the report's main body.

**Points of Uncertainty:** See Section 4 of the report's main body.

**Relevant IPEEE Citations:** (STL-10) - The licensee has assigned a probability of 0.05 to failure of operators and the fire brigade to suppress the fire prior to MCR abandonment. This is conservative in comparison to other IPEEE submittals.

Plant: St. Lucie 2

Exemption #: STL-11

Document Accession #: 8304200442-11

Appendix R Section: III.G.2.

**Exemption Description:** Separation between redundant trains (cable trays) of either 20 ft horizontal distance free of intervening combustibles or a noncombustible radiant heat shield or of providing an automatic fire suppression system is not provided inside containment.

**Location of Binning Category:** Containment

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-11) The containment is generally not an important fire risk contributor. The main concern is loss of a critical set of instrumentation in a containment fire. Given that the licensee has implemented added features to protect various cables (radiant shields for the cable trays and 1-hour barriers for the conduits per the "Exemption Rationale" provided by the NRC staff), this exemption is deemed to have very small risk impact.

**Points of Uncertainty:** (STL-11) - The containments at St. Lucie are similar to other PWR containments and there appears to be sufficient separation between redundant cable penetrations.

**Relevant IPEEE Citations:** (STL-11) - On P. 47 of 129, Ref. S-1, licensee cites the statement made in FIVE regarding insignificant risk contribution of containments. No specific analysis of containment fire risk is provided.

Plant: St. Lucie 1

Exemption #: STL-12

Document Accession #: 8503080142-01

Appendix R Section: III.G.3.

**Exemption Description:** Lack of a fixed suppression system in the Control Room.

**Location of Binning Category:** MCR

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (STL-12) See STL-10

**Points of Uncertainty:** (STL-12) See STL-10

**Relevant IPEEE Citations:** (STL-12) See STL-10

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**Plant:** St. Lucie 1

**Exemption #:** STL-13

**Document Accession #:** 8503080142-02

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Lack of a 3-hour rated fire barriers in the charging pump area.

**Location of Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-13) See STL-08

**Points of Uncertainty:** (STL-13) See STL-08

**Relevant IPEEE Citations:** (STL-13) See STL-08

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**Plant:** St. Lucie 1

**Exemption #:** STL-14

**Document Accession #:** 8503080142-03

**Appendix R Section:** III.G.2.b.

**Exemption Description:** Lack of automatic fire suppression system in the intake cooling water area.

**Location of Binning Category:** Intake structure

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-14) The intake cooling water area is an open air area. Therefore, a fire would be free burning and would not form a hot gas layer. The impact on adjacent equipment and cables would be through radiant heating only. A large fire that would engulf multiple equipment is deemed to be very unlikely. It requires the occurrence of specific scenarios (e.g. large quantity of oil spill in a large area and ignition of the oil before operators become aware of the spill and formation of a tall and severe fire that radiates on other equipment). The IPEEE fire analysis estimated a CDF for this area of  $8.9E-7$ . Hence, installation of a fire suppression system would not significantly impact the fire risk. Given that the likelihood of such an event is small and the licensee has used a small CCDP for a fire in this area, it is concluded that the exemption has very small risk impact. It is deemed that this conclusion is sensitive to the assumption that the service water pumps are well separated and therefore only a large exposing fire can damage all trains of service water.

**Points of Uncertainty:** (STL-14) - It is assumed that the service water pumps are well separated, such that only a large exposing fire can affect two pumps at the same time. Also, it is assumed that the oil cannot collect at or near where pump motors or associated cables are located. The conclusions regarding this exemption is highly sensitive to the assumptions made regarding possibility of oil collecting where the pumps are and the distance between redundant pumps.

**Relevant IPEEE Citations:** (STL-14) - The FIVE compartment is R-R and App. R Zone is 3. The P2 is  $1.97E-04$  and the CDF is  $8.9E-07$  per year. Hence, this area was screened.

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**Plant:** St. Lucie 1

**Exemption #:** STL-15

**Document Accession #:** 8503080142-04

**Appendix R Section:** III.G.2.b.

**Exemption Description:** Lack of an automatic fire suppression system in the steam trestle area.

**Location of Binning Category:** General process area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-15) - The Steam Threstle is an open air area and redundant trains are separated by 28 feet and with a missile shield. A missile shield is generally a thick reinforced concrete wall. Therefore, a fire would be free burning and would not form a hot gas layer. The impact on adjacent equipment and cables would be via radiation heating, and radiant heat would be blocked by the missile shield. Given the distance and available shield, the likelihood of damage to redundant trains is very small. Therefore, this exemption is deemed to have very small risk impact.

**Points of Uncertainty:** (STL-15) - It is assumed that the area does not include unusually high quantity of combustibles. Also it is assumed that at each side of the missile shield loss of safety related cables and equipment does not lead to a large CCDP. However, this area could not be tied to any of the fire areas examined in the IPEEE submittal.

**Relevant IPEEE Citations:** (STL-15) - The IPEEE submittal does not identify any areas with this name.

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**Plant:** St. Lucie 1

**Exemption #:** STL-16

**Document Accession #:** 8503080142-05

**Appendix R Section:** III.G.2.b.

**Exemption Description:** Lack of an automatic fire suppression system and lack of a full coverage fire detection system in the component cooling water area.

**Location of Binning Category:** Pump area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-16) - This area is similar to the intake structure. It is open to the atmosphere,

and is without walls or a ceiling. However, since it is about component cooling pumps, it is inferred that the equipment is smaller, the separation distances are shorter, and the quantity of combustibles is less than that found in the intake structure. Since fire propagation and damage can only occur through radiative heat transfer, the time to damage will be greater than that for an enclosed area. Similar to the discussions for STL-14, the likelihood of a fire that can damage redundant trains is small. Since the CCDP cited in the IPEEE submittal for this area is also found to be small, this exemption is concluded to have very small risk impact. It is deemed that this conclusion is sensitive to the assumption that the component cooling pumps are well separated and therefore only a large exposing fire can damage all redundant trains.

**Points of Uncertainty:** (STL-16) - It is assumed that this area is similar to the intake structure, is open to the atmosphere, and is without walls or a ceiling. It is assumed that it contains the CCW pumps. It is assumed that the equipment are smaller, the distances are shorter and the quantity of combustibles is less than that found in the intake structure.

It is assumed that the component cooling water pumps are well separated, such that only a large exposing fire can affect two pumps at the same time. Also, it is assumed that the oil cannot collect at or near where pump motors or associated cables are located. The conclusions regarding this exemption is highly sensitive to the assumptions made regarding possibility of oil collecting where the pumps are and the distance between redundant pumps.

**Relevant IPEEE Citations:** (STL-16) - This fire area is addressed as FIVE Compartment UU (p. 38 of 129 in Ref. S-1). The core damage frequency is  $7.39E-07$  (p. 38 of 129 of Ref. S-1).

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**Plant:** St. Lucie 1

**Exemption #:** STL-17

**Document Accession #:** 8503080142-06

**Appendix R Section:** III.G.2.b.

**Exemption Description:** Lack of an automatic fire suppression system and fire detection system in the diesel oil storage tank area.

**Location of Binning Category:** Diesel Generator area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-17) - Diesel oil storage tanks are generally not an important risk contributor in typical fire PRAs. This is confirmed with small CDF reported in the IPEEE submittal. The tanks are needed if loss of offsite power occurs. This cannot, typically, happen from a fire in the oil storage tank area. Therefore, the impact of added fire protection in this area would have minimal effect on associated CDF and this exemption is deemed to have very small risk impact.

**Points of Uncertainty:** (STL-17) - It is assumed that the licensee has appropriately considered the possibility of multi-compartment fire interactions associated with this fire area.

**Relevant IPEEE Citations:** (STL-17) - The IPEEE submittal addresses this area on p. 38 of 129 (Ref. S-1). The estimated core damage frequency is 1.60E-07 per year.

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**Plant:** St. Lucie 1

**Exemption #:** STL-18

**Document Accession #:** 8503080142-07

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Lack of 3-hour fire rated barriers in the duct penetration between the pipe tunnel and Division A cable penetration area and in the duct penetration between the pipe tunnel and emergency core cooling system heat exchanger room.

**Location of Binning Category:** General process area, cable vault

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-18) - This exemption is similar to STL-01. The Penetration area contains large quantities of cables, but only from one train. The other areas that are connected to this area by ventilation ducts have very low combustible loading and the equipment in them is not susceptible to fire damage (pipes and heat exchangers). Therefore, even a large fire (a very unlikely event given the characteristics of these compartments) that affects several compartments will have minimal risk impact. This appears to be confirmed by the CDF results for these areas cited in the IPEEE submittal (less than 1E-6/ry). This exemption is therefore found to have very small risk impact.

**Points of Uncertainty:** (STL-18) - It is assumed that the Pipe Tunnel does not contain any

safety related cables and there are no significant ignition sources or in-situ combustibles.

**Relevant IPEEE Citations:** (STL-18) - The Division A penetration area is part of FIVE Compartment A. It has App. R zone designation 77. The CDF for compartment A is  $6.56E-07$  per year. The Pipe Tunnel is part of FIVE Compartment J, it has App. R zone designation 33. The CDF for compartment J is  $5.77E-07$  per year. The IPEEE submittal does not give any indications that there is a communication path between these two zones.

\*\*\*\*\*

**Plant:** St. Lucie 1

**Exemption #:** STL-19

**Document Accession #:** 8503080142-08

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Lack of 3-hour fire rated barriers in the reactor auxiliary building separating the personnel area and the hold up tank area.

**Location of Binning Category:** General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (STL-19) - This exemption relates to an open doorway between two adjacent fire areas. One of the two areas (the Personnel Room) is found in the IPEEE fire analysis to be risk significant. However, it cannot be determined whether or not the IPEEE fire analysis included consideration of damage in the adjoining hold-up tank room. From the discussions provided on pages 17 and 18 of Reference [S-3] it can be inferred there is no substantial impediment to the flow of hot gases and smoke from one zone to the other. The fire scenario that may damage safe shutdown cables in both rooms requires a large fire in one room that injects enough hot gasses into the second room so as to cause damage. However, since there is no door at all in the opening, the fire need not challenge a physical fire barrier. The probability of damage in both rooms depends on the amount and type of combustibles present, and on the available detection and suppression systems. The hold up tank area is generally free of other materials. However, the personnel area may contain large quantities of transient combustibles. No detailed information regarding the personnel area and how it was analyzed could be found in the IPEEE submittal, and the hold up tank room is not mentioned at all. Given that there is an open passage between the room and there are redundant trains within the two zones, the IPEEE fire analysis should have addressed fire scenarios involving both rooms. This does not appear to be the case; hence, there appears to be a substantial basis for questioning the robustness of the results presented in IPEEE



submittal in this regard. Also, it may be noted that if the IPEEE fire analysis has assumed damage will occur in both rooms, the exemption might still be found to have significant risk impact because the personnel room itself was found in the IPEEE fire analysis to be risk significant. Given (1) there is little specific information regarding the two areas provided in the IPEEE submittal, (2) the presence of redundant trains in the two zones, (3) an open unprotected path for the spread of fire products and heat from one room to the other, and (4) the cited risk significance of the Personnel Room, it is concluded that the risk impact of the exemption remains indeterminate.

**Points of Uncertainty:** (STL-19) - Insufficient information is provided in the IPEEE submittal to determine the significance of propagation of hot gases from one zone to the other. It is not clear if the IPEEE fire analysis had considered the potential for damage in both rooms.

**Relevant IPEEE Citations:** (STL-19) - The Personnel Room is Appendix R Zone 43, part of Appendix R Area C (p. 31 of 129, Table 4-1 of Reference [S-1]). The CDF associated with Area C is  $4.30 \times 10^{-5}$  per reactor year. The submittal identifies a "Hold-up tank enclosure" (FIVE Compartment E and App. R Zone 41). The associated CDF for this area is  $9.73 \times 10^{-7}$  per reactor year. The IPEEE submittal does not discuss the possibility of propagation of fire, smoke and hot gases between the two fire zones.

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**Plant:** St. Lucie 1

**Exemption #:** STL-20

**Document Accession #:** 8503080142-09

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Lack of 3-hour fire rated barriers in the reactor auxiliary building in hatch openings between elevations -0.50 feet and 19.50 feet.

**Location of Binning Category:** General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (STL-20) - Similar to STL-05, it is important to know what cables and equipment are located near the hatches that may be affected if hot gases do propagate through a hatch. Since this information is not readily available, the risk impact of the exemption remains indeterminate.

**Points of Uncertainty:** (STL-20) - Similar to STL-05, the exemption description does not provide specific fire zone or area numbers. The fire zones had to be inferred from the information provided in Reference [S-3]. The hatch located at RAC and RA4 coordinates could not be found on the fire protection layout drawings (Figure 9.5A-3, Amendment No.12, 12/93).

**Relevant IPEEE Citations:** (STL-20) - Similar to STL-05, the specific hatchways are not mentioned in the IPEEE submittal. The fire zones that can be inferred from the information provided in Reference [S-3] addressed in the IPEEE submittal, are as follows:

| <u>Appendix R zone</u> | <u>CDF</u>             |
|------------------------|------------------------|
| 56                     | $4.30 \times 10^{-5}$  |
| 55W                    | (Part of fire zone 56) |

\*\*\*\*\*

**Plant:** St. Lucie 1

**Exemption #:** STL-21

**Document Accession #:** 8503080142-10

**Appendix R Section:** III.O.

**Exemption Description:** Lack of ability of the reactor coolant pump oil collection system to hold the entire reactor coolant pump lube oil system inventory.

**Location of Binning Category:** Containment

**PRA Step Binning Category:** FHA : Sources

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-21) - See Section 4 of the main body. St. Lucie is at a low seismicity site and therefore, the likelihood of an earthquake of sufficient magnitude to cause simultaneous failure of more than one RCP is considered to be small; hence, the exemption is considered to have very small risk impact.

**Points of Uncertainty:** (STL-21) - None

**Relevant IPEEE Citations:** (STL-21) - This issue is not discussed in the IPEEE submittal.

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**Plant:** St. Lucie 1

**Exemption #:** STL-22

**Document Accession #:** 8503080142-11

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Lack of 3-hour rated fire barriers associated with watertight doors.

**Location of Binning Category:** General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-22) - The test conducted by the licensee verifies the effectiveness of the doors. Typically, fire propagation analysis shows that even unrated barriers provide some degree of protection that makes the fire required for causing damage severe and therefore unlikely. Therefore, watertight doors can be considered as effective fire barriers for leading to low likelihoods of fire damage to safe shutdown cables and equipment on the two sides of the door. Based on this, it can be concluded that this exemption has very small risk impact.

**Points of Uncertainty:** (STL-22) - It is assumed that the doors are not used for areas with excessively high combustible loading..

**Relevant IPEEE Citations:** (STL-22) - This issue is not discussed in the IPEEE submittal.

\*\*\*\*\*

**Plant:** St. Lucie 2

**Exemption #:** STL-23

**Document Accession #:** 8612100269-01

**Appendix R Section:** III.F.

**Exemption Description:** Lack of fire detection systems in the Aerated Waste Storage Room and Gas Decay Tank Cubicle 2c.

**Location of Binning Category:** General process area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-23) - Based on the exemption summary, because of low combustible loading, the likelihood of a fire that can sustain itself for a long time is very small in these compartments. Fire growth analyses have shown that to overcome a fire barrier, although only one-hour rated, requires a very severe fire. Since one train of cables are wrapped in 1-hour fire barrier, the possibility of failure of both trains is deemed to be very unlikely. Therefore, this exemption is deemed to have very small risk impact.

**Points of Uncertainty:** (STL-23) - It is assumed that the two areas are void of any ignition sources and combustible materials that can start a fire that can jeopardize the cables and were appropriately screened in the IPEEE analysis.

**Relevant IPEEE Citations:** (STL-23) - The areas are not identified in the IPEEE submittal.

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**Plant:** St. Lucie 2

**Exemption #:** STL-24

**Document Accession #:** 8612100269-02

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Lack of 3-hour fire rated doors, HVAC duct dampers, and penetration seals in exterior walls of the diesel oil storage tank area (Fire Areas AA and BB).

**Location of Binning Category:** Diesel Generator area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-24) - As it is discussed in the discussion for STL-17, the risk significance of diesel oil storage tanks is minimal. Since the concern is about exterior walls, the risk impact of this exemption is even less than that of STL-17.

**Points of Uncertainty:** (STL-24) - None

**Relevant IPEEE Citations:** (STL-24) - These areas are not addresses explicitly in the IPEEE submittal (Ref. S1)

\*\*\*\*\*  
**Plant:** St. Lucie 2

**Exemption #:** STL-25

**Document Accession #:** 8612100269-03

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Lack of 3-hour fire rated barrier between AFW pumps A and B and their redundant counterpart, AFW pump C.

**Location of Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Grw&Dmg, FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-25) - Per the information provided on page 3 of Reference S-4, it can be concluded that the AFW pumps are separated from one another by at least a 1 inch thick missile shield. Further, the pump area is open to the atmosphere so that a substantial hot gas layer cannot form. Given that (1) the missile shield will delay the propagation of a fire, (2) will mitigate radiant energy exchange, and that (3) a substantial hot gas layer cannot be formed, it is concluded that this exemption has very small risk impact.

**Points of Uncertainty:** (STL-25) - It is assumed that the IPEEE fire analysis had treated the two zones as completely separate areas.

**Relevant IPEEE Citations:** (STL-25) - AFW pumps A and B are located in FIVE Compartment F-F/6 I (p.44 of 129 in Ref. [S-1]), and AFW pump C is located in FIVE Compartment F-F/6 II. The corresponding CCDP is 2.0E-04 leading to a CDF contribution of 4.0E-07/ry.

\*\*\*\*\*  
**Plant:** St. Lucie 2

**Exemption #:** STL-26

**Document Accession #:** 8612100269-04

**Appendix R Section:** III.G.2.

**Exemption Description:** Lack of protection for structural supports for conduits which are protected by a fire-rated "wrap" in Fire Areas A, B, C, H, I and O.

**Location of Binning Category:** General process area, cable vault, switchgear room, battery room, relay room,

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-26) - This exemption is similar in nature to exemption FAR-54 of J. M. Farley. However, there are substantial differences that ultimately impact the final assessment of risk significance. In the case of STL-26, there are unprotected steel supports for fire barrier clad conduits in six fire areas of Unit 2. As in the case of Farley, the USNRC staff evaluation only discusses the potential for structural collapse. There is no discussion of the potential that heat conducted along the supports during a fire would by-pass (or "thermally short-circuit") the protective barrier. Nominally, the support structures for a raceway must also be clad to some distance out from the raceway to mitigate this problem. However, the staff evaluation did not provide any discussion of this issue. Discussions with the cognizant USNRC/NRR staff indicate that this was not a specific concern at the time that the St. Lucie exemptions were being evaluated. It was only in more recent years that particular attention has been focused on this concern. However, these discussions also revealed that the barriers at St. Lucie are made of Thermo-Lag, a trademark product of Thermal Science Inc of St. Louis MO. Further, the barriers were installed in accordance with then current manufacturer guidelines. Those guidelines did establish a requirement to clad the structural supports for at least nine inches out from the raceway specifically to address the "thermal short-circuit" issue. St. Lucie did comply with this requirement. More recent studies do indicate that additional cladding may be needed to ensure a fully rated fire barrier system, but at the time the "9-inch rule" was considered adequate to mitigate thermal paths into the barrier. In this case the exemption truly did deal with the potential for structural collapse. This concern was found by the staff to be of little real concern, and structural collapse of a cable raceway has, to the knowledge of the authors, never been considered as a mechanism of cable failure in a fire risk analysis. Given this perspective, the exemption is found to have very small risk impact.

**Points of Uncertainty:** (STL-26) - None.

**Relevant IPEEE Citations:** (STL-26) - The treatment of raceway fire barriers is not discussed in the IPEEE submittal. Fire Areas B, I, and O do include fire zones that have a CDF greater than 1E-06 per year.

**Plant:** St. Lucie 2

**Exemption #:** STL-27

**Document Accession #:** 8612100269-05

**Appendix R Section:** III.G.2.

**Exemption Description:** Six water-tight doors installed in 3-hour fire-rated barriers: One in the 3-hour barrier separating the pipe tunnel from the shutdown heat exchanger room; one in the 3-hour barrier separating the shutdown heat exchanger room from the ECCS pump room, three in the 3-hour barrier separating the ECCS pump room from the Auxiliary Building at Elevation -0.5' ; and one in the 3-hour barrier separating the charging pump area from the pipe tunnel.

**Location of Binning Category:** Pump room, General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-27) - See STL-22

**Points of Uncertainty:** (STL-27) - See STL-22

**Relevant IPEEE Citations:** (STL-27) - See STL-22

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**Plant:** St. Lucie 2

**Exemption #:** STL-28

**Document Accession #:** 8612100269-06

**Appendix R Section:** III.G.

**Exemption Description:** Unrated electrical penetration seals are used in the containment structure that interfaces with Fire Zones 22 and 23.

**Location of Binning Category:** Containment, Cable vault

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-28) - The primary purpose of these penetration seals is to allow for pressure buildup inside the containment. Therefore, as determined by the NRC staff, the seals should be able to prevent any smoke egress from one side to the other. It is deemed that the likelihood of hot gas egress and direct fire propagation is also very small. If a fire occurs in the penetration room, the local fire detector and automatic suppression system reduces the likelihood of development of a large fire which can overcome the seal and cause hot gas egress or fire propagation through the seals. The likelihood of a large containment fire that can overcome the seals, because of large containment volume and low combustible loading, is also deemed to be very small. Furthermore, fire propagation modeling has demonstrated that non-combustible materials delay propagation of fire significantly. Therefore, this exemption is considered to have very small risk impact.

**Points of Uncertainty:** (STL-28) - It is assumed that the faces of the seals are non-combustibles and cover the penetration completely.

**Relevant IPEEE Citations:** (STL-28) - The IPEEE submittal does not address the issue.

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**Plant:** St. Lucie 2

**Exemption #:** STL-29

**Document Accession #:** 8612100269-07

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Unrated mechanical penetration seals are used in Fire Zones 24, 25, and 39 and in the containment structure that interfaces with Fire Zones 22 and 23.

**Location of Binning Category:** Containment, General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-29) - In addition to the discussions provided for STL-28, the mechanical seals are typically of non-combustible construction and therefore, not immediately susceptible to fire. Therefore, this exemption is found to have very small risk impact.

**Points of Uncertainty:** (STL-29) - It is assumed that the faces of the seals are non-combustibles



and cover the penetration completely.

**Relevant IPEEE Citations:** (STL-29) - In the IPEEE submittal, licensee has combined Fire Zones 24 and 39 as one fire area and has concluded that the CDF is less than  $1.0E-6/ry$ .

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**Plant:** St. Lucie 2

**Exemption #:** STL-30

**Document Accession #:** 8612100269-08

**Appendix R Section:** III.O.

**Exemption Description:** The oil collection system is not capable of collecting oil from all four of the RCP lube oil systems.

**Location of Binning Category:** Containment

**PRA Step Binning Category:** FHA : Sources

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-30) - See STL-21

**Points of Uncertainty:** (STL-30) - See STL-21

**Relevant IPEEE Citations:** (STL-30) - See STL-21

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**Plant:** St. Lucie 2

**Exemption #:** STL-31

**Document Accession #:** 8612100269-09

**Appendix R Section:** III.G.2.

**Exemption Description:** The containment and hydrogen purge makeup and exhaust systems consist of non-fire-rated piping and valves instead of the usual fire-rated HVAC ducts and dampers.

**Location of Binning Category:** Containment, General process area

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-31) - Similar to the penetration seals addressed in STL-28, a non-fire rated device that is mainly constructed of non-combustible materials has been proven to provide some fire resistance and lead to a long fire growth period. Thus, given the availability of local fire protection equipment and the fire brigade, the likelihood of fire propagation via the non-fire rated piping and valves is very small. Therefore, this exemption is considered to have very small risk impact.

**Points of Uncertainty:** (STL-31) - None

**Relevant IPEEE Citations:** (STL-31) - The IPEEE submittal does not discuss the issue.

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**Plant:** St. Lucie 2

**Exemption #:** STL-32

**Document Accession #:** 8612100269-10

**Appendix R Section:** III.G.2.

**Exemption Description:** Lack of a complete automatic suppression system throughout Fire Areas H, I, and O.

**Location of Binning Category:** General process area, cable tunnel, cable vault

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Small

**Analysis:** (STL-32) - The CDF for the fire areas addressed in this exemption range from  $7.2 \times 10^{-7}$  to  $2.7 \times 10^{-6}$  /ry. Some of the areas addressed in this exemption are marginally risk significant. Added automatic suppression system will reduce the CDF to below  $1 \text{E-}06$  per year. However, the extent of reduction is not clear. Thus, the impact of the exemption on risk can only be judged to be small category.

**Points of Uncertainty:** (STL-32) - The final conclusion is based on an assumption that an

automatic fire suppression system in FIVE Compartments O and I21/51W will have some impact on the CDF.

**Relevant IPEEE Citations:** (STL-32) - The fire zones that comprise Fire Area H do not typically contain safe shutdown cables or equipment. This is evidenced in the IPEEE submittal. The CCDP for this fire area is very small and the CDF is  $7.2 \times 10^{-7}$  /ry. The other two Fire Areas (i.e., I and O) include compartments that may contain a large number of safe shutdown equipment and cables. The probability of core damage given a fire ("FIVE P2") shown in Table 4-2 on pages 42 of 129 and 43 of 129 in Ref. S-1 range between  $2.9 \times 10^{-5}$  and  $4.4 \times 10^{-3}$ . Two CDFs are reported for I -  $2.7 \times 10^{-6}$  and  $4.2 \times 10^{-8}$  per year. The CDF for O is  $1.3 \times 10^{-6}$  per year.

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**Plant:** St. Lucie 2

**Exemption #:** STL-33

**Document Accession #:** 8612100269-11

**Appendix R Section:** III.G.

**Exemption Description:** Early warning fire detectors have not been installed in the following locations:

- Letdown heat exchanger room
- Ion exchanger room
- Waste and boric acid concentrator room
- Holdup tank cubicles
- Boric acid batching room
- Hallway to the division B fan room

**Location of Binning Category:** General process area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-33) Since, per the "Exemption Rationale", the areas addressed in this exemption do not contain safe shutdown cables, a fire localized to these areas may burn unnoticed until operators become alerted by either other means (e.g., equipment malfunction), direct personnel observation or egress of the gases from the fire to other covered areas. The impact of these fires will be limited and little or no safe shutdown equipment will be lost. Therefore, this exemption is considered to have very small risk impact.

**Points of Uncertainty:** (STL-33) - The areas addressed in this exemption contain only a few safe shutdown related cables.

**Relevant IPEEE Citations:** (STL-33) - FIVE Compartment H includes the majority of the fire compartments addressed in this exemption. The overall CCDF and CDF for this FIVE compartment is  $5.3E-05$  and  $7.2E-07$  per year, respectively.

\*\*\*\*\*

**Plant:** St. Lucie 2

**Exemption #:** STL-34

**Document Accession #:** 8612100269-12

**Appendix R Section:** III.G.2.

**Exemption Description:** Lack of 3-hour fire rating for fire barrier penetrations and a doorway opening in the common wall between the corridor and charging pump room.

**Location of Binning Category:** General process area, pump room

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-34) - The fire zones separated by the common wall addressed in this exemption, house the charging pumps. From the IPEEE submittal it can be inferred that, the very small probability values indicate that besides charging pump related equipment and cables, there are no other equipment and cables in these fire zones. Furthermore, since there are other core cooling paths besides using the charging pumps, it can be concluded that the CDF associated with a fire scenario that includes propagation from one zone to the other is very small. Therefore, this exemption is considered to have very small risk impact.

**Points of Uncertainty:** (STL-34) - It is assumed that, other than charging pump related equipment and cables, there are no safe shutdown related cables or equipment in the four fire compartments.

**Relevant IPEEE Citations:** (STL-34) - Licensee has treated entire charging pump room and corridor complex as one fire area (Area 18), which comprises of four fire zones. In Table 4-2 p. 43 of 129, Ref. S1, licensee has concluded that FIVE P2 is in the order of  $10^{-6}$  and therefore the CDF for all four fire zones is in the order of  $10^{-4}$  per reactor year. The very small probability values indicate that besides charging pump related equipment and cables, there are no other

equipment and cables in these fire zones. Furthermore, since there are other core cooling paths besides using the charging pumps, it can be concluded that the CDF associated with a fire scenario that includes propagation from one zone to the other is very small.

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**Plant:** St. Lucie 2

**Exemption #:** STL-35

**Document Accession #:** 8612100269-13

**Appendix R Section:** III.J.

**Exemption Description:** Lack of 8-hour battery powered lighting units inside containment to facilitate operator access to the shutdown cooling valves.

**Location of Binning Category:** Containment

**PRA Step Binning Category:** RQ : HRA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-35) - See Appendix A, CAL-05

**Points of Uncertainty:** (STL-35) - It is assumed that the procedures that call for operator actions in those areas addressed in this exemption clearly state that proper hand-held lighting has to be carried into those areas as part of the procedural step.

**Relevant IPEEE Citations:** (STL-35) - The specific issue is not mentioned in the IPEEE submittal.

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**Plant:** St. Lucie 1

**Exemption #:** STL-36

**Document Accession #:** 8703130080-01

**Appendix R Section:** III.G.2.d.

**Exemption Description:** Lack of separation of safe shutdown cables and associated non-safety

circuits of redundant trains by 20 feet of horizontal distance with no intervening combustibles or fire hazards in fire area "A" of the reactor containment building.

**Location of Binning Category:** Containment

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-36) - See STL-11

**Points of Uncertainty:** (STL-36) - See STL-11

**Relevant IPEEE Citations:** (STL-36) - See STL-11

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**Plant:** St. Lucie 1

**Exemption #:** STL-37

**Document Accession #:** 8703130080-02

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Lack of 3-hour rated electrical penetration seals in the containment structure.

**Location of Binning Category:** Containment, cable vault

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-37) - See STL-28

**Points of Uncertainty:** (STL-37) - See STL-28

**Relevant IPEEE Citations:** (STL-37) - See STL-28

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**Plant:** St. Lucie 1

**Exemption #:** STL-38

**Document Accession #:** 8703130080-03

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Lack of 3-hour rated mechanical penetration seals in the containment structure.

**Location of Binning Category:** Containment, General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-38) - See STL-29

**Points of Uncertainty:** (STL-38) - See STL-29

**Relevant IPEEE Citations:** (STL-38) - See STL-29

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**Plant:** St. Lucie 1

**Exemption #:** STL-39

**Document Accession #:** 8703130080-04

**Appendix R Section:** III.G.2.a

**Exemption Description:** Lack of separation by a 3-hour rated fire barrier (dampers).

**Location of Binning Category:** Unknown

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-39) - This exemption relates to the lack of three-hour rated dampers in ventilation ducts penetrating the walls between three fire areas. Per the information provided in

Reference [S-5], it can be inferred that only one of the three fire areas impacted by this exemption contains hot shutdown equipment. The other two areas contain valves required to achieve cold shutdown. Even if the cables leading to these valves are damaged, the valves can be manipulated manually once a fire has been suppressed. Given that a long time (on the order of days) is available to complete this action, the likelihood of failure is very low. In terms of the CDF contribution, fire scenarios involving damage to equipment in the Division A Electrical Penetration Room are bounding, and these were considered in the IPEEE fire analysis. The CDF for Division A Electrical Penetration Room is well below  $1E-5/ry$ ; hence, this exemption is found to have very small risk impact.

**Points of Uncertainty:** (STL-39) - None

**Relevant IPEEE Citations:** (STL-39) - From Reference [S-5], it can be inferred that the following Appendix R fire zones are the subject of this exemption:

| <u>Appendix R zone:</u> | <u>CDF:</u>           |
|-------------------------|-----------------------|
| 33                      | $5.77 \times 10^{-7}$ |
| 31                      | $6.32 \times 10^{-8}$ |
| 77                      | $6.56 \times 10^{-7}$ |

The IPEEE submittal does not address the lack of proper 3-hour dampers in ducts between zones 33 and 31 and between zones 33 and 77.

Plant: St. Lucie 1

Exemption #: STL-40

Document Accession #: 8703130080-05

Appendix R Section: III.J.

**Exemption Description:** Lack of 8-hour battery powered emergency lighting in the containment building.

**Location of Binning Category:** Containment

**PRA Step Binning Category:** RQ : HRA

**Potential for CDF Reduction:** Very Small

**Analysis:** (STL-40) - See STL-35, and Appendix A, CAL-05

**Points of Uncertainty:** (STL-40) - See STL-35



**Relevant IPEEE Citations: (STL-40) - See STL-35**

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**References:**

- S-1 "St. Lucie Units 1 & 2, Individual Plant Examination for External Events Submittal", Florida Power and Light, December 1994.
- S-2 Safety Evaluation Report related to the operation of St. Lucie Plant Unit 2, Docket No. 50-389" US Nuclear Regulatory Commission, Office of Nuclear Reactor Regulations, NUREG-0843, Supplement No. 3, April, 1983.
- S-3 Attachment to the letter from James R. Miller, Operating Reactors Branch #3, Division of Licensing, USNuclear Regulatory Commission, to J. W. Williams, Jr. Florida Power & Light Company, February 21, 1985.
- S-4 Safety Evaluation by the Office of Nuclear Reactor Regulations, Fire Protection Deviation Requests from Appendix A to BTP APCSB 9.5-1 and from Appendix R to 10 CFR Part 50, Florida Power & Light Company, St. Lucie Plant, Unit 2, ADOCK # 05000389.
- S-5 Safety Evaluation by the Office of Nuclear Reactor Regulations, Fire Protection Deviation Requests from Appendix A to BTP APCSB 9.5-1 and from Appendix R to 10 CFR Part 50, Florida Power & Light Company, St. Lucie Plant, Unit 1, ADOCK # 05000335.

**TABLE G-1: SUMMARY CATEGORIZATION OF INDIVIDUAL EXEMPTIONS FOR ST. LUCIE 1 AND 2 (STL)**

| Exemp. # | Exemption Description   | Location Binning Category                                      | PRA Step Binning Category | Potential for CDF Reduction |
|----------|---|--|---------------------------|-----------------------------|
| STL-01   | A 3-hour fire rated damper is not installed in the duct penetrating the wall between the Pipe Tunnel and Division A Cable Penetration Area.   | General process area   | FHA : FCIA                | Very Small                  |
| STL-02   | A 3-hour fire rated damper is not installed in the duct penetrating the wall between the Electrical Equipment and Supply Fan Room and the Control Room.   | MCR; Relay room;<br>General process area                       | FHA : FCIA                | Very Small                  |
| STL-03   | A 3-hour fire rated damper is not installed in the duct penetrating the wall between the Component Cooling Water Surge Tank Room and the Control Room.  | MCR; General process area                                      | FHA : FCIA                | Very Small                  |
| STL-04   | A 3-hour fire rated damper is not installed in the duct penetrating the wall between the Shutdown Heat Exchanger Room and the Corridor on the 0.50 feet elevation of the Reactor Auxiliary Building.  | General process area   | FHA : FCIA                | Small                       |
| STL-05   | Three hatch openings exist in 3-hour fire-rated barriers separating redundant trains in the Reactor Auxiliary Building.   | General process area   | FHA : FCIA                | Indeterminate               |
| STL-06   | A full height 3-hour barrier is not provided between redundant shutdown heat exchangers   | General process area   | FHA : Grw&Dmg             | Very Small                  |
| STL-07   | A Full height 3-hour barrier is not provided between the redundant shutdown heat exchangers.  | Pump room  | FHA : Grw&Dmg             | Very Small                  |
| STL-08   | A Full height 3-hour barrier is not provided between each of the three charging pumps   | Pump room  | FHA : Grw&Dmg             | Very Small                  |
| STL-09   | The following areas lack automatic fire suppression systems: 1. Division A switchgear Room, 2. Division B Switchgear Room, 3. Hallway to the Division B Fan Room Elevation 43 Feet Reactor Auxiliary Building, 4. Component Cooling Area, 5 Steam Tunnel, 6. Intake Structure, 7. Aerated Waste Storage Tank Room, 8. Gas Decay Tank Cubicle 2C | Switchgear room,<br>General process areas,<br>Intake structure | FHA: Det/Supp             | Indeterminate               |
| STL-10   | A fixed suppression system is not installed in the control room   | Control Room   | FHA : Det/Supp            | Indeterminate               |
| STL-11   | Separation between redundant trains (cable trays) of either 20 ft horizontal distance free of intervening combustibles or a noncombustible radiant heat shield or of providing an automatic fire suppression system is not provided inside containment.   | Containment  | FHA: Grw&Dmg              | Very Small                  |
| STL-12   | Lack of a fixed suppression system in the Control Room  | MCR  | FHA : Det/Supp            | Indeterminate               |

| Exemp. # | Exemption Description   | Location Binning Category  | PRA Step Binning Category | Potential for CDF Reduction |
|----------|---|--|---------------------------|-----------------------------|
| STL-13   | Lack of a 3-hour rated fire barriers in the charging pump area  | Pump room  | FHA : Grw&Dmg             | Very Small                  |
| STL-14   | Lack of automatic fire suppression system in the intake cooling water area.   | Intake structure   | FHA : Det/Supp            | Very Small                  |
| STL-15   | Lack of an automatic fire suppression system in the steam trestle area.   | General process area   | FHA : Det/Supp            | Very Small                  |
| STL-16   | Lack of an automatic fire suppression system and lack of a full coverage fire detection system in the component cooling water area.   | Pump area  | FHA : Det/Supp            | Very Small                  |
| STL-17   | Lack of an automatic fire suppression system and fire detection system in the diesel oil storage tank area  | Diesel Generator area  | FHA : Det/Supp            | Very Small                  |
| STL-18   | Lack of 3-hour fire rated barriers in the duct penetration between the pipe tunnel and division a cable penetration area and in the duct penetration between the pipe tunnel and emergency core cooling system heat exchanger room. | General process area, cable vault  | FHA : FCIA                | Very Small                  |
| STL-19   | Lack of 3-hour fire rated barriers in the reactor auxiliary building separating the personnel area and the hold up tank area.   | General process area-  | FHA : FCIA                | Indeterminate               |
| STL-20   | Lack of 3-hour fire rated barriers in the reactor auxiliary building in hatch openings between elevations -0.50 feet and 19.50 feet.  | General process area   | FHA : FCIA                | Indeterminate               |
| STL-21   | Lack of ability of the reactor coolant pump oil collection system to hold the entire reactor coolant pump lube oil system inventory.  | Containment  | FHA : Sources             | Very Small                  |
| STL-22   | Lack of 3-hour rated fire barriers associated with watertight doors.  | General process area   | FHA : FCIA                | Very Small                  |
| STL-23   | Lack of fire detection systems in the Aerated Waste Storage Room and Gas Decay Tank Cubicle 2c.   | General process area   | FHA : Det/Supp            | Very Small                  |
| STL-24   | Lack of 3-hour fire rated doors, HVAC duct dampers, and penetration seals in exterior walls of the diesel oil storage tank area (Fire Areas AA and BB).   | Diesel Generator area  | FHA : FCIA                | Very Small                  |
| STL-25   | Lack of 3-hour fire rated barrier between AFW pumps A and B and their redundant counterpart, AFW pump C.  | Pump room  | FHA : Grw&Dmg             | Very Small                  |
| STL-26   | Lack of protection for structural supports for conduits which are protected by a fire-rated "wrap" in Fire Areas A, B, C, H, I and O.   | General process area, cable vault, switchgear room, battery room, relay room | FHA : Grw&Dmg             | Very Small                  |

| Exemp. # | Exemption Description  | Location Binning Category                       | PRA Step Binning Category | Potential for CDF Reduction |
|----------|--|---|---------------------------|-----------------------------|
| STL-27   | Six water-tight doors installed in 3-hour fire-rated barriers: One in the 3-hour barrier separating the pipe tunnel from the shutdown heat exchanger room; one in the 3-hour barrier separating the shutdown heat exchanger room from the ECCS pump room, three in the 3-hour barrier separating the ECCS pump room from the Auxiliary Building at Elevation -0.5' ; and one in the 3-hour barrier separating the charging pump area from the pipe tunnel. | Pump room; General process area                 | FHA : FCIA                | Very Small                  |
| STL-28   | Unrated electrical penetration seals are used in the containment structure that interfaces with Fire Zones 22 and 23.  | Containment; General process area               | FHA : FCIA                | Very Small                  |
| STL-29   | Unrated mechanical penetration seals are used in Fire Zones 24, 25, and 39 and in the containment structure that interfaces with Fire Zones 22 and 23.   | Containment; General process area               | FHA : FCIA                | Very Small                  |
| STL-30   | The oil collection system is not capable of collecting oil from all four of the RCP lube oil systems.  | Containment                                     | FHA : Sources             | Very Small                  |
| STL-31   | The containment and hydrogen purge makeup and exhaust systems consist of non-fire-rated piping and valves instead of the usual fire- rated HVAC ducts and dampers  | Containment                                     | FHA : Grw&Dmg             | Very Small                  |
| STL-32   | Lack of a complete automatic suppression system throughout Fire Areas H, I, and O.   | General process area, cable tunnel, cable vault | FHA : Det/Supp            | Small                       |
| STL-33   | Early warning fire detectors have not been installed in the following locations: Letdown heat exchanger room, Ion exchanger room, Waste and boric acid concentrator room, Holdup tank cubicles, Boric acid batching room, Hallway to the division B fan room   | General process area                            | FHA : Det/Supp            | Very Small                  |
| STL-34   | Lack of 3-hour fire rating for fire barrier penetrations and a doorway opening in the common wall between the corridor and charging pump room.   | General process area, pump room                 | FHA : FCIA                | Very Small                  |
| STL-35   | Lack of 8-hour battery powered lighting units inside containment to facilitate operator access to the shutdown cooling valves  | Containment                                     | RQ : HFA                  | Very Small                  |

| <b>Exemp. #</b> | <b>Exemption Description</b>  | <b>Location Binning Category</b>         | <b>PRA Step Binning Category</b> | <b>Potential for CDF Reduction</b> |
|-----------------|---|--|----------------------------------|------------------------------------|
| <b>STL-36</b>   | <b>Lack of separation of safe shutdown cables and associated non-safety circuits of redundant trains by 20 feet of horizontal distance with no intervening combustibles or fire hazards in fire area "A" of the reactor containment building.</b> | <b>Containment</b>                       | <b>FHA : Grw&amp;Dmg</b>         | <b>Very Small</b>                  |
| <b>STL-37</b>   | <b>Lack of 3-hour rated electrical penetration seals in the containment structure.</b>  | <b>Containment, cable vault</b>          | <b>FHA : FCIA</b>                | <b>Very Small</b>                  |
| <b>STL-38</b>   | <b>Lack of 3-hour rated mechanical penetration seals in the containment structure.</b>  | <b>Containment, General process area</b> | <b>FHA : FCIA</b>                | <b>Very Small</b>                  |
| <b>STL-39</b>   | <b>Lack of separation of dampers by a 3-hour rated fire barrier.</b>  | <b>Not known</b>                         | <b>FHA : FCIA</b>                | <b>Very Small</b>                  |
| <b>STL-40</b>   | <b>Lack of 8-hour battery powered emergency lighting in the containment building.</b>   | <b>Containment</b>                       | <b>RQ : HFA</b>                  | <b>Very Small</b>                  |

## **Appendix H: Individual Exemption Assessment for V. C. Summer**

**Plant:** V. C. Summer 1

**Exemption #:** SUM-01

**Document Accession #:** 8208230411-01

**Regulatory Section:** BPT 9.5-1 C.1

**Exemption Description:** Lack of automatic fire detection in the areas in Table 9-1 under "Deviations Granted by the Staff".

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for Risk Reduction:** Very Small

**Analysis:** (SUM-01) - It is not clear exactly which fire areas or zones are impacted by this exemption because the cited Table 9-1 was not included in the exemption summary. However, this information is not needed to complete the assessment of the risk significance. It is stated that the impacted zones do not contain safety related equipment susceptible to fire. Rather, the only safety related equipment consists of piping and metal tanks containing noncombustible fluids. Further, fire detection is possible by a variety of automatic means. Hence, the risk significance of a lack of fire detection in these areas can be assumed to have, at most, a very small risk impact.

**Points of Uncertainty:** It is not known what specific fire areas are impacted by this exemption. A combination of three factors might lead to a finding of risk significance: (1) should the cited tanks contain a high hazard fuel such as diesel fuel or oil (the exemption summary implies that the contents are noncombustible), and (2) if these areas might represent a fire threat to adjacent areas, and (3) if those adjacent areas contain risk important and fire vulnerable equipment, then the risk impact might be found to be significant.

**Relevant IPEEE Citations:** None

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**Plant:** V. C. Summer 1

**Exemption #:** SUM-02

**Document Accession #:** 8612050103-01

**Appendix R Section: III.L.2.d.**

**Exemption Description:** Lack of T-cold monitoring function capability for four (4) fire area/zones.

**Location Binning Category:** General process area

**PRA Step Binning Category:** RQ : Recov/HFA

**Potential for Risk Reduction:** Very Small

**Analysis:** (SUM-02) - From the information provided in the exemption summary, it cannot be determined which four plant areas are impacted by this exemption. However, this information is not required to assess the risk significance of this exemption. As indicated in the analysis described as part of "Exemption Rationale" by NRC staff, loss of T-Cold monitoring function can be compensated for by other plant parameters that will remain available. Loss of all channels of T-cold would have some effect on control room operators (the associated HEPs). That is, the probability of core damage due to control room operator error would nominally be affected by the loss of T-cold monitoring capability. However, because there are other parameters available to achieve the same function, operators are capable of monitoring the conditions of the core, the steam generators, and primary cooling loop. Further, the control room itself would not be affected by a fire in the fire zones where loss of T-cold may occur. Hence, it is reasonable to assume that the change in HEP is small. Hence, this exemption is found to have, at most, a very small risk impact.

**Points of Uncertainty:** The four specific area impacted by the exemption are not known. However, this information is not needed to complete the assessment.

**Relevant IPEEE Citations:** None.

**TABLE H-1: SUMMARY CATEGORIZATION OF INDIVIDUAL EXEMPTIONS FOR V.C. SUMMER (SUM)**

| <b>Exemp #</b>  | <b>Exemption Description</b>  | <b>Location Binning Category</b> | <b>PRA Step Binning Category</b> | <b>Risk Impact</b> |
|-----------------|---|----------------------------------|----------------------------------|--------------------|
| <b>SUM - 01</b> | <b>Lack of automatic fire detection in the areas in the Table 9-1 under "Deviations Granted by the Staff"</b> | <b>General process area</b>      | <b>FHA : Det/Supp</b>            | <b>Very Small</b>  |
| <b>SUM - 02</b> | <b>Lack of T-cold process monitoring function capability for four (4) fire areas/zones.</b>                   | <b>General Process area</b>      | <b>RQ : Recov / HFA</b>          | <b>Very Small</b>  |



## **Appendix I: Individual Exemption Assessment for Turkey Point**

**Plant:** Turkey Point

**Exemption #:** TUR -01

**Document Accession #:** 8404230366-01

**Appendix R Section:** III.G.2.b.

**Exemption Description:** Automatic suppression and detection not provided for component cooling water area, redundant cables and equipment not separated by 20 feet.

**Location Binning Category:** General Process Area

**PRA Step Binning Category:** FHA : Det/Supp ; Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR - 01) - The areas described in the exemption appear to correspond to fire zones 47 and 54 in the IPEEE analysis. These two zones were both screened during the initial stages of analysis and no detailed quantification is provided. This early screening would imply that the exemption has little or no risk significance. Further, based on the "Exemption Rationale" statement provided by the NRC staff, the licensee agreed to install automatic fire suppression systems and early warning fire detection systems in the two fire zones addressed in this exemption. Licensee implementation of these commitments cannot be confirmed (but is assumed) because the IPEEE does not discuss the fire protection features of the impacted area. The CCW pumps of concern are separated horizontally by 12 feet; hence it appears reasonable to assume that only severe unsuppressed fires might lead to critical damage. Based primarily on the early screening of the impacted compartments in the IPEEE study, this exemption is found to have a very small risk impact.

**Points of Uncertainty:** (TUR - 01) - Our conclusion is based primarily on the licensee IPEEE screening results and assumes that the impacted areas correspond to fire zones 47 and 54 as cited in the IPEEE.

**Relevant IPEEE Citations:** (TUR - 01) - Fire zones 47 and 54 (see Table 3.7-2 of Ref. T-1) contain the CCW pumps. Both zones have been screened out in IPEEE submittal (Ref. T-1) and in Ref. T-2 it is claimed that many of the cables associated with these two zones are embedded in concrete and are not susceptible to fire effects.

**Plant:** Turkey Point

**Exemption #:** TUR -02

**Document Accession #:** 8404230366-02

**Appendix R Section:** III.G.2.

**Exemption Description:** Automatic fire detection and suppression systems not installed in containment area, auxiliary feedwater pump area, condensate storage area and main steam platform.

**Location Binning Category:** Containment; Pump room; General process area, Turbine Building

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Indeterminate (Fire Zones 84 and 89), Very Small (all other Fire Zones)

**Analysis:** (TUR - 02) - The exemption impacts four separate and distinct fire zones. The analysis of each of these zones is as follows:

- 1) Containment - From the discussions provided by the NRC staff as part of exemption TUR-08, it can be inferred that some separation exists among redundant cables inside the containment. Further, the licensee apparently committed to re-locating certain cables to enhance this separation as a condition of approval. Hence, large fires would be required to impact the redundant cables, and large fires inside containment are generally considered unlikely. (Also see TUR-08 as it also addresses some containment separation issues.) The containment was not addressed in the IPEEE submittal, but in response to a USNRC RAI, the licensee did site that the containment was screened in Phase 1 of the FIVE analysis. It is concluded that this part of the exemption has a very small impact on fire risk due to fires in containment.
- 2) Auxiliary Feedwater pump area (Fire Zone 84)- The impacted area appears to be fire zone 84 as identified in the IPEEE analysis. Per Reference [T-3], the fire barriers present in this fire zone is rated at 25 minutes fire resistance. Further, the licensee fire analysis appears to have not adequately addressed the fire hazards present in this zone. Hence, the CDF results presented in the IPEEE submittal are considered unreliable. Lacking an alternate basis for the assessment of the zone's CDF contribution, the risk impact of this exemption remains indeterminate for this fire area.
- 3) Condensate Storage Areas (Fire Zone 89) - The situation regarding the condensate storage area is identical to that of the AFW pump area (#2 above). Therefore, the IPEEE results are not valid for this fire zone and the risk impact of this exemption remains indeterminate. .
- 4) Main Steam Header Platform - The IPEEE cites that there is no safe shutdown related equipment or cables in this area. Hence, the exemption has no potential risk significance for this fire area.

**Points of Uncertainty:** (TUR - 02) - The licensee IPEEE fire analysis of the turbine building is considered unreliable based on the USNRC documents cited above. However, there is no alternate basis for the assessment of risk impact.

**Relevant IPEEE Citations:** (TUR - 02) - 1) Containment - Fire zone, 59-60, IPEEE submittal states that containment is not important fire risk and therefore, no impact.  
2) Aux Feed Pump - FZ-84- Ref. T-2 gives the  $1.68\text{E-}3$  for fire initiations and  $3.95\text{E-}7$  for CDR.  
3) Condensate Storage- FZ-89 - Ref T-2 gives fire initiations frequency of  $4.33\text{E-}4$  and CDF of  $3.25\text{E-}9$ .

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**Plant:** Turkey Point

**Exemption #:** TUR -03

**Document Accession #:** 8404230366-03

**Appendix R Section:** III.G.2.C.

**Exemption Description:** Redundant auxiliary feedwater (AFW) components not separated; automatic fire suppression systems not installed; feedwater platform fire zones.

**Location Binning Category:** General Process Area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR - 03) - The impacted fire zones are cited in the exemption summary as being outdoors and appears to correspond to fire zone 113 in the IPEEE submittal. This area was quantitatively screened in the IPEEE analysis with a CDF estimated at  $3.2\text{E-}9/\text{ry}$ . The exemption summary states that the redundant cables are all separated by 20 feet of horizontal space that is free of intervening combustibles. The redundant AFW valves that are also of significance are vertically separated by eight feet with a solid steel platform in between. Given the very low reported CDF this exemption is concluded to have a very small impact on plant fire risk.

**Points of Uncertainty:** (TUR - 03) - It is assumed that this exemption applies to fire zone 113 in the IPEEE analysis and that the licensee has applied appropriate screening methods.

**Relevant IPEEE Citations:** (TUR - 03) - The zone is identified in Table 3.7-2 on page 3.0-271 of the original submittal (Reference T-1). The estimated CDF was reported on page 18 of the licensee RAI response (Reference T-2) as  $3.2 \times 10^{-9} / \text{ry}$ .

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**Plant:** Turkey Point

**Exemption #:** TUR-04

**Document Accession #:** 8404230366-04

**Appendix R Section:** III.G.2.c.

**Exemption Description:** For intake area, automatic suppression are not installed.

**Location Binning Category:** Service water area

**PRA Step Binning Category:** FHA: Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR - 04) - This exemption appears to impact fire zones 119 and 120 as identified in the IPEEE. The estimated CDF cited in the licensee RAI response [Reference T-2] was  $7.8E-7/ry$ . The intake structure is open to the atmosphere. From the fire analysis described in IPEEE submittal, it can be inferred that fire detection and suppression were not critical factors in the CDF evaluation. Therefore, the estimated CDF would not increase significantly if an automatic fire suppression system was assumed. On this basis the exemption is found to have a very small impact on plant fire risk.

**Points of Uncertainty:** (TUR - 04) - The finding of risk insignificance is based on the IPEEE conclusion of low CDF contribution. Hence, this finding is dependent on the robustness of the IPEEE analysis.

**Relevant IPEEE Citations:** (TUR - 04) - Fire zones 119 and 120, the fire initiation frequency is  $6.2 \times 10^{-3}/ry$  per fire zone. CDF is  $7.8 \times 10^{-7}$  provides a detailed discussion of fire modeling and CDF evaluation.

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**Plant:** Turkey Point

**Exemption #:** TUR -05

**Document Accession #:** 8404230366-05

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Redundant diesel radiator rooms; not enclosed by complete fire rated barriers.

**Location Binning Category:** Diesel Generator area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR - 05) - This exemption appears to impact to fire zone 131 as identified in the IPEEE analysis. The fire frequency for this area was estimated at less than  $1E-6/ry$ , and the area screened on this basis alone. The "Exemption Rationale" of TUR-23 states that there is a wall between the redundant cooling fans and that one side of the area is completely open. Hence, there is a substantial barrier to redundant train damage, and little potential for hot layer formation. There are no in-situ combustibles in this area and a fire causing redundant diesel damage and simultaneous loss of offsite power must be postulated for any the fires to be risk significant (i.e., a station blackout). Given these observations, the exemption is concluded to have a very small risk impact.

**Points of Uncertainty:** (TUR - 05) - The cited fire frequency appears somewhat low for a diesel generator area, but it is assumed that this area contains little or no fire hazards other than the cooling fans themselves.

**Relevant IPEEE Citations:** (TUR - 05) - The submittal calls this area fire zone #131, "Diesel Generator Cooling Area". It is screened out (per the licensee RAI responses in Reference T-2). The frequency of fire initiation is estimated to be less than  $10^{-6}/year$ .

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**Plant:** Turkey Point

**Exemption #:** TUR-06

**Document Accession #:** 8404230366-06

**Appendix R Section:** III.G.2.a.

**Exemption Description:** Residual heat removal areas do not have 3 hour barrier for redundant equipment.

**Location Binning Category:** Pump room

**PRA Step Binning Category: FHA : Grw&Dmg**

**Potential for CDF Reduction: Very Small**

**Analysis:** (TUR - 06) - This exemption appears to impact fire zones 12, 13, 15 and 16. All four of these fire zones were screened from the analysis. Based on the "Exemption Rationale" provided by the NRC staff, the licensee has agreed to install early warning detection and a partial wall between redundant RHR pumps. Given these protective and mitigative devices and that RHR pumps are not needed to maintain hot shutdown, the risk significance of these areas, as it is also concluded by the licensee in the IPEEE submittal, is minimal. Thus, it is concluded that the lack of proper separation among redundant RHR pumps has very small risk impact.

**Points of Uncertainty:** (TUR - 06) - None.

**Relevant IPEEE Citations:** (TUR - 06) - Fire zones are 12, 13, 15 and 16. All four fire zones have been screened out. The zones 12, 13 and 16 have screened based on lack of either a safety system in the zone or lack of occurrence of an initiating event. The CDF for fire zone 15 is estimated as  $4.36 \times 10^{-7}$  per year.

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**Plant:** Turkey Point

**Exemption #:** TUR-07

**Document Accession #:** 8404230366-07

**Appendix R Section:** III.G.2.

**Exemption Description:** Charging pump rooms are not protected by proposed automatic suppression system.

**Location Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR - 07) - The exemption summary provided by NRC staff states that the impacted rooms are protected by partial fire suppression systems. The IPEEE appears to cite these rooms as fire zones 45 and 55. The CDFs estimated by the licensee in both areas are less than  $10^{-6}$  per year. Since, safe shutdown can be achieved even given failure of the charging pumps, the added

protection provided by full area suppression system would lead to minimal risk reduction. It is thus concluded that this exemption has very small risk impact.

**Points of Uncertainty:** (TUR - 07) - None

**Relevant IPEEE Citations:** (TUR - 07) - The impacted fire zones are 45 (unit 3) and 55 (unit 4). Fire initiation frequency is  $1.52E-3$ / year for both zones. CDF is  $9.2E-7$ / year for fire zone 45 and  $6.87E-7$ / year for fire zone 55.

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-08

**Document Accession #:** 8404230366-08

**Appendix R Section:** III.G.

**Exemption Description:** Containment building does not have a non-combustible radiant energy shield between redundant safe shutdown equipment and cables with less than 20 feet of separation.

**Location Binning Category:** Containment

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR - 08) - The licensee IPEEE analysis did not address fires inside containment. The exemption summary does state that the redundant cable trains will be rerouted and/or protected in most areas within containment so loss of all instrumentation from a single fire is very unlikely. PORVs and related pressurizer instrumentation cables, if damaged, will prevent the use of the pressurizer during a forced shutdown. However, the plant can be shutdown by other means. Therefore, this exemption is considered to have a very small risk impact.

**Points of Uncertainty:** (TUR - 08) - None

**Relevant IPEEE Citations:** (TUR - 08) - The Licensee IPEEE submittal states, without any analysis, that containment is not risk significant.

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-09

**Document Accession #:** 8404230366-09

**Appendix R Section:** III.G.3.

**Exemption Description:** Control room not provided with fixed fire suppression.

**Location Binning Category:** MCR

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (TUR - 09) - See discussion in Section 4 of the report's main body

**Points of Uncertainty:** (TUR - 09) - See Section 4 in the report's main body

**Relevant IPEEE Citations:** (TUR - 09) - The MCR fire zone designation is 106. Fire initiation frequency is  $1.86E-2$  per year. The control room is protected by smoke detectors (p.248 of 340, Ref I-1) in the general area and heat detectors in the kitchen area.

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-10

**Document Accession #:** 8404230366-10

**Appendix R Section:** III.J.

**Exemption Description:** Containment units do not have 8-hour battery powered lighting units inside.

**Location Binning Category:** Containment

**PRA Step Binning Category:** RQ : HFA

**Potential for CDF Reduction:** Very Small



**Analysis:** (TUR - 10) - See Appendix A, CAL-05

**Points of Uncertainty:** (TUR - 10) - None

**Relevant IPEEE Citations:** (TUR - 10) - None

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-11

**Document Accession #:** 8404230366-11

**Appendix R Section:** III.O.

**Exemption Description:** Reactor coolant pump oil collection system not sized to hold entire lube oil inventory.

**Location Binning Category:** Containment

**PRA Step Binning Category:** FHA : Sources

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR - 11) - See discussions in Section 4 of the main body. In the specific case of Turkey Point, additional impetus for a very small risk impact ranking results from the low seismicity of the site in Florida.

**Points of Uncertainty:** (TUR - 11) - None

**Relevant IPEEE Citations:** (TUR - 11) - The licensee has screened out the containment without any analysis.

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-12

**Document Accession #:** 8404230367-01

**Appendix R Section:** III.G.2.b.

**Exemption Description:** Redundant cable and equipment in the CCW (Fire Zone 47) lack of 20 feet of separation between intervening combustibles, and installation of automatic fire suppression.

**Location Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR - 12) - This exemption impacts fire zone 47, and this zone was screened from the IPEEE analysis in the Phase 1 screening based on a lack of initiating events. Given the fast acting fire detection and deluge water fire suppression systems, the likelihood of damage to all CCW pumps must be small. Hence, this exemption is concluded to have a very small risk impact.

**Points of Uncertainty:** (TUR - 12) - On P.6 and 7 of 22 of Ref. T-2, the licensee lists the cables present in this fire zone. It does not include CCW cables. This appears inconsistent with the area designation as the "CCW pump and heat exchanger" area.

**Relevant IPEEE Citations:** (TUR - 12) - Fire initiation frequency is  $1.41E-3$ . The area was screened out based on lack of an initiating event.

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-13

**Document Accession #:** 8404230367-02

**Appendix R Section:** III.G.2.b.

**Exemption Description:** Redundant cable and equipment in the CCW (fire zone 54) lack of 20 feet of separation between intervening combustibles, and installation of automatic fire suppression.

**Location Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR - 13) - See TUR-12

**Points of Uncertainty:** (TUR - 13) - None

**Relevant IPEEE Citations:** (TUR - 13) - Fire initiation frequency is  $4.56E-3$  per year (Reference T-2). The area contains CCW and CVCS cables (P.5 of 22, Reference T-2). Licensee states that loss of those cables would not disable the entire system and therefore, would not cause an initiating event. The fire zone is screened out based on this premise.

\*\*\*\*\*  
**Plant:** Turkey Point

**Exemption #:** TUR-14

**Document Accession #:** 8404230367-03

**Appendix R Section:** III.G.2.

**Exemption Description:** Fire zone 79 lacks installation of automatic fire detection and suppression systems.

**Location Binning Category:** Turbine Building

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (TUR-14) - Based on the information provided in the IPEEE submittal, this area contains cables from a large set of safety related systems. The zone was ultimately screened with an estimated CDF of  $7.5E-7$ /ry. However, based on more recent USNRC staff reviews, as discussed in TUR-02, the results of IPEEE fire analysis for the turbine building are considered unreliable because the analysis did not take into consideration the effectiveness of fire barriers in this zone nor did it fully address the fire hazards present in the impacted areas. Therefore, the risk impact of this exemption remains indeterminate.

**Points of Uncertainty:** (TUR-14) - The licensee IPEEE analysis for the impacted zone is considered unreliable, but there is no alternate basis for the assessment of risk impact.

**Relevant IPEEE Citations:** (TUR-14) - The fire zone is designated as "Outdoor area west of unit 4 Containment" and includes cables from AFW, CCW, CVCS, MVAC, ICW, instrumentation electric power, RCS and RPS. The fire initiation frequency is given as  $1.52E-3$  per year.

\*\*\*\*\*  
**Plant:** Turkey Point

**Exemption #:** TUR-15

**Document Accession #:** 8404230367-04

**Appendix R Section:** III.G.2.

**Exemption Description:** Fire zone 84 lacks installation of automatic fire detection and suppression systems.

**Location Binning Category:** Turbine Building

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (TUR-15) - See TUR-02, Analysis Item 2.

**Points of Uncertainty:** (TUR-15) - See TUR-02, Analysis Item 2

**Relevant IPEEE Citations:** (TUR-15) - See TUR-02, Analysis Item 2  
\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-16

**Document Accession #:** 8404230367-05

**Appendix R Section:** III.G.2

**Exemption Description:** Fire zone 89 lacks installation of automatic fire detection and suppression systems.

**Location Binning Category:** Turbine Building

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (TUR-16) - See TUR-02, Analysis Item 3

**Points of Uncertainty:** (TUR-16) - See TUR-02, Analysis Item 3

**Relevant IPEEE Citations:** (TUR-16) - See TUR-02, Analysis Item 3

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-17

**Document Accession #:** 8404230367-06

**Appendix R Section:** III.G.2

**Exemption Description:** Fire zone 114 lacks installation of automatic fire detection and suppression systems.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-17) - See TUR-02, Analysis Item 4

**Points of Uncertainty:** (TUR-17) - See TUR-02, Analysis Item 4

**Relevant IPEEE Citations:** (TUR-17) - See TUR-02, Analysis Item 4

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-18

**Document Accession #:** 8404230367-07

**Appendix R Section:** III.G.2

**Exemption Description:** Fire zone 115 lacks installation of automatic fire detection and suppression systems.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-18) - See TUR-02, Analysis Item 4

**Points of Uncertainty:** (TUR-18) - See TUR-02, Analysis Item 4

**Relevant IPEEE Citations:** (TUR-18) - See TUR-02, Analysis Item 4

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-19

**Document Accession #:** 8404230367-08

**Appendix R Section:** III.G.2

**Exemption Description:** Redundant safe shutdown equipment in fire zone 113 lacks a 1-hour rated fire barrier and installation of automatic fire suppression.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-19) - Fire zone 113 is identified in the IPEEE as the "feedwater platform" and the area ultimately screens on low CDF. The "Exemption Rationale" by the NRC staff indicates that there is 20 feet separation between redundant trains and the redundant AFW valves are separated vertically by 12 feet with a 1/4" steel shield between them. Since the area is open to the atmosphere a hot gas layer would not accumulate. From fire propagation modeling it has been shown that 1/4" steel plate can provide sufficient shielding effect to delay the heat up of shielded equipment considerably. Thus, it will take an extremely severe fire to fail the redundant trains in this fire zone. Also, in the case of loss of AFW, other paths remain available for safe shutdown. Therefore, this exemption has very small risk impact.

**Points of Uncertainty:** (TUR-19) - The finding of risk insignificance is based on the IPEEE conclusion of low CDF contribution. Hence, this finding is dependent on the robustness of the IPEEE analysis.

**Relevant IPEEE Citations:** (TUR-19) - The fire zone (113) is designated as "Feedwater Platform". The fire initiation frequency is  $5.6E-4$  per year. The CDF is  $3.21E-9$  per year (p.18 of 22, Reference T-2).

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-20

**Document Accession #:** 8404230367-09

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Redundant safe shutdown equipment in fire zone 116 lacks a 1-hour rated fire barrier and installation of automatic fire suppression.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-20) - See TUR-19

**Points of Uncertainty:** (TUR-20) - See TUR-19

**Relevant IPEEE Citations:** (TUR-20) - See TUR-19

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-21

**Document Accession #:** 8404230367-10

**Appendix R Section:** III.G.2

**Exemption Description:** Fire zone 119 lacks installation of an automatic fire suppression system.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-21) - Fire zone 119 is the Unit 4 intake structure. See TUR-04

**Points of Uncertainty:** (TUR-21) - See TUR-04

**Relevant IPEEE Citations:** (TUR-21) - See TUR-04

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**Plant:** Turkey Point

**Exemption #:** TUR-22

**Document Accession #:** 8404230367-11

**Appendix R Section:** III.G.2.

**Exemption Description:** Fire zone 120 lacks installation of an automatic fire suppression system.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-22) - Fire Zone 120 is the Unit 3 Intake Structure. See TUR-04

**Points of Uncertainty:** (TUR-22) - See TUR-04

**Relevant IPEEE Citations:** (TUR-22) - See TUR-04

\*\*\*\*\*

**Plant:** Turkey Point



**Exemption #:** TUR-23

**Document Accession #:** 8404230367-12

**Appendix R Section:** III.G.2.

**Exemption Description:** Redundant diesel radiator rooms lack complete enclosure by 3-hour rated barriers.

**Location Binning Category:** Diesel Generator Area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-23) - See TUR-05

**Points of Uncertainty:** (TUR-23) - See TUR-05

**Relevant IPEEE Citations:** (TUR-23) - See TUR-05

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-24

**Document Accession #:** 8404230367-13

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Redundant safe shutdown equipment in fire area B lacks a 1-hour rated fire barrier and installation of automatic fire suppression.

**Location Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-24) - Fire area B includes fire zones 11, 12, and 13 and is primarily associated with RHR. All three zones screened in Phase 1 of the FIVE analysis. See TUR-06

**Points of Uncertainty:** (TUR-24) - See TUR-06

**Relevant IPEEE Citations:** (TUR-24) - See TUR-06

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-25

**Document Accession #:** 8404230367-14

**Appendix R Section:** III.G.2.c.

**Exemption Description:** Redundant safe shutdown equipment in Fire Area C lacks a 1-hour rated fire barrier and installation of automatic fire suppression.

**Location Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Grw&Dmg; Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-25) - Fire area C includes fire zones 14, 15, and 16 and are primarily related to RHR. All three zones ultimately screened on low CDF. See TUR-06

**Points of Uncertainty:** (TUR-25) - See TUR-06

**Relevant IPEEE Citations:** (TUR-25) - Fire Area C includes fire zones 14, 15 and 16, which are designated "RHR Heat Exchanger", "RHP Pump 4A Room" and "RHP Pump 4B Room". All three areas have been screened out. See TUR-06

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-26

**Document Accession #:** 8404230367-15

**Appendix R Section:** III.G.2.

**Exemption Description:** Fire Area N charging pump room lacks area-wide automatic fire suppression.

**Location Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-26) - Fire area N corresponds to fire zone 45 in the IPEEE analysis. See TUR-07

**Points of Uncertainty:** (TUR-26) - See TUR-07

**Relevant IPEEE Citations:** (TUR-26) - See TUR-07

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-27

**Document Accession #:** 8404230367-16

**Appendix R Section:** III.G.2.

**Exemption Description:** Fire Area O charging pump room lacks area-wide automatic fire suppression.

**Location Binning Category:** Pump room

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-27) - Fire Area O corresponds to fire zone 55 in the IPEEE analysisSee TUR-07

**Points of Uncertainty:** (TUR-27) - See TUR-07

**Relevant IPEEE Citations:** (TUR-27) - See TUR-07

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-28

**Document Accession #:** 8404230367-17

**Appendix R Section:** III.G.2.

**Exemption Description:** Fire Area P of containment building lacks 1-hour rated barrier for redundant equipment and cables with a separation of less than 20 feet.

**Location Binning Category:** Containment

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-28) - Fire Zone P is the containment structure. See TUR-08

**Points of Uncertainty:** (TUR-28) - See TUR-08

**Relevant IPEEE Citations:** (TUR-28) - See TUR-08

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-29

**Document Accession #:** 8404230367-18

**Appendix R Section:** III.G.2.

**Exemption Description:** Fire Area Q of containment building lacks 1-hour rated barrier for redundant equipment and cables with a separation of less than 20 feet.

**Location Binning Category:** Containment

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-29) - Fire Area Q is the sister unit containment structure. See TUR-08

**Points of Uncertainty:** (TUR-29) - See TUR-08

**Relevant IPEEE Citations:** (TUR-29) - See TUR-08

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**Plant:** Turkey Point

**Exemption #:** TUR-30

**Document Accession #:** 8404230367-19

**Appendix R Section:** III.G.3.

**Exemption Description:** Control room lacks installation of fixed fire suppression.

**Location Binning Category:** MCR

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Indeterminate

**Analysis:** (TUR-30) - See TUR-09.

**Points of Uncertainty:** (TUR-30) - See TUR-09

**Relevant IPEEE Citations:** (TUR-30) - See TUR-09

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**Plant:** Turkey Point

**Exemption #:** TUR-31

**Document Accession #:** 8404230367-20

**Appendix R Section:** III.J.

**Exemption Description:** Inside containment lacks 8-hour battery powered emergency lighting.

**Location Binning Category:** Containment

**PRA Step Binning Category:** RQ : HFA

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-31) - See TUR-10, and Appendix A, CAL-05

**Points of Uncertainty:** (TUR-31) - See TUR-10

**Relevant IPEEE Citations:** (TUR-31) - See TUR-10

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**Plant:** Turkey Point

**Exemption #:** TUR-32

**Document Accession #:** 8404230367-21

**Appendix R Section:** III.O

**Exemption Description:** RCP oil collection system lacks equivalent size to hold entire lube oil inventory.

**Location Binning Category:** Containment

**PRA Step Binning Category:** FHA : Sources

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-32) - See TUR-11.

**Points of Uncertainty:** (TUR-32) - See TUR-11

**Relevant IPEEE Citations:** (TUR-32) - See TUR-11

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-33

**Document Accession #:** 8708240214-01

**Appendix R Section:** III.G.2.

**Exemption Description:** Five unsealed penetrations in the fire rated barrier floor separating Fire Area AAA from Fire Area A in the auxiliary building.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-33) - Fire Area A has safety related cables in fire zones 4, 5, 9, 10 and 18. Fire zone 18 screened on low ignition frequency, and fire zones 4, 5, 9, and 10 all screened on low CDF (ranging from  $1\text{E-}8$  to  $3\text{E-}7$  per ry). Because the exemption deals with lack of penetration seals, multi-room effects should also be considered. The exemption summary focuses on concerns for fire zones 4 and 5, and the adjacent (apparently directly above) zone 24. However, zone 24 contains no safe shutdown equipment so fire spread to this zone is not risk significant. Given that the CDFs for these fire zones are all less than  $1 \times 10^{-6}$  /ry, the lack of seals in the penetrations is not expected to have a significant impact on the risk and the exemption is concluded to have small risk impact.

**Points of Uncertainty:** (TUR-33) - None

**Relevant IPEEE Citations:** (TUR-33) - The following fire zones comprise the two fire areas.

|    | Fire Area AAA      | Safety |    | Fire Area A                | Safety | CDF              |
|----|--------------------|--------|----|----------------------------|--------|------------------|
| 1  | Hold up Tank A     | —      | 4  | Aux Bldg Corridor          | X      | $1.45\text{E-}8$ |
| 2  | Hold up Tank B     | —      | 5  | Chem. Drain Tank           | X      | $4.50\text{E-}8$ |
| 3  | Hold up Tank C     | —      | 6  | Gas Compressor Room        | —      |                  |
| 21 | Counting Room      | —      | 7  | Gas Compressor Room        | —      |                  |
| 22 | Hot Lab            | —      | 8  | Waste Hold up Tank         | —      |                  |
| 23 | Gas Decay Tank     | —      | 9  | Waste Evaporator-feed pump | X      | $3.52\text{E-}7$ |
| 24 | Gas Decay Tank     | —      | 10 | Pipeway                    | X      | $1.58\text{E-}8$ |
| 29 | Spent fuel pit     | —      | 17 | Spent Resin Storage Tank   | —      |                  |
| 42 | Spent fuel pit     | —      | 18 | Area under evaporators     | X      |                  |
| 43 | SFP-Pump/HX/Filter | —      |    |                            |        |                  |
| 44 | New Fuel Storage   | —      |    |                            |        |                  |
| 46 | Laundry Room       | —      |    |                            |        |                  |
| 56 | New Fuel Storage   | —      |    |                            |        |                  |
| 57 | SFP-Pump/HX/Filter | —      |    |                            |        |                  |

|      |                                     |     |  |  |  |  |
|------|-------------------------------------|-----|--|--|--|--|
| 65   | Qualified Safety Parameters Display | --- |  |  |  |  |
| 111  | VCT                                 | --- |  |  |  |  |
| 112  | VCT                                 | --- |  |  |  |  |
| 121A | Radwaste Bldg                       | --- |  |  |  |  |
| 126B | Radwaste Bldg                       | --- |  |  |  |  |
| 126C | Radwaste Bldg                       | --- |  |  |  |  |
| 126D | Radwaste Bldg                       | --- |  |  |  |  |
| 129  | Main Sec. Bldg                      | --- |  |  |  |  |
| 130  | Alt Sec. Bldg                       | --- |  |  |  |  |

All fire zones have been screened out. The CDF for 4, 5, 9 and 10 range from 1.45E-8 to 3.52E-7 per year.

\*\*\*\*\*

**Plant:** Turkey Point

**Exemption #:** TUR-34

**Document Accession #:** 8708240214-02

**Appendix R Section:** III.G.2.

**Exemption Description:** Two 8-inch and 6-inch unsealed penetrations exist in the 3-hour fire rated barrier floor separating Fire Area F from Fire Area A.

**Location Binning Category:** General process area

**PRA Step Binning Category:** FHA : FCIA

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-34) - Fire areas A and F are each made up of several individual fire zones. Based on the exemption summary, it would appear that the penetrations in question connect fire zone 10 in Area A to Fire zones 48, 49, and 50 in fire zone F. Fire zones 48, 49, and 50 were all screened on low ignition frequency. Hence fire spread from these zones into fire zone 10 is not risk significant. Further, there is no safe shutdown equipment cited in fire zones 48, 49, or 50 (page 3.0-259 of Ref. T-1). Hence, fire spread from fire zone 10 to the other zones is also not risk significant. Finally, fire zone 10 was screened on low CDF. On this basis this exemption is concluded to have insignificant very small risk impact.



**Points of Uncertainty:** (TUR-34) - It is assumed that the fire zones associated with the unsealed penetrations are 10, 47, 48, and 49.

**Relevant IPEEE Citations:** (TUR-34) - The safe shutdown equipment is listed in table 3.7-1 of the original submittal. The fire zones making up the two fire areas are identified in Table 3.7-2. The RAI response provides the screening results.

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**Plant:** Turkey Point

**Exemption #:** TUR-35

**Document Accession #:** 8708240214-03

**Appendix R Section:** III.G.2.d.

**Exemption Description:** Intervening combustibles between redundant safe shutdown components, circuitry in containment exist.

**Location Binning Category:** Containment

**PRA Step Binning Category:** FHA : Grw&Dmg

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-35) - See TUR-08

**Points of Uncertainty:** (TUR-35) - See TUR-08

**Relevant IPEEE Citations:** (TUR-35) - See TUR-08

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**Plant:** Turkey Point

**Exemption #:** TUR-36

**Document Accession #:** 8708240214-04

**Appendix R Section:** III.G.2.

**Exemption Description:** Fire zones outside turbine building do not have fire detection or automatic suppression systems.

**Location Binning Category:** Yard/General Process Area

**PRA Step Binning Category:** FHA : Det/Supp

**Potential for CDF Reduction:** Very Small

**Analysis:** (TUR-36) - The "Exemption Rationale" provided by the NRC staff states that all of the impacted areas are open to the outside and therefore hot gases cannot accumulate. Also, 20 feet of separation exists between redundant equipment or they are wrapped in 1-hour fire barriers. Given the separation and fire wraps, it can be concluded that a fire that can damage redundant equipment must be very severe and thus very unlikely. Other than the intake cooling water structure, no areas outside the main plant buildings were identified as significant risk contributors in the IPEEE analysis. Hence, this exemption is concluded to have very small risk impact.

**Points of Uncertainty:** (TUR-36) - It is not clear from the exemption exactly which fire zones are impacted. However, none of the outdoor areas at the plant were found to be risk significant (except the intake cooling water structure).

**Relevant IPEEE Citations:** (TUR-36) - Since the specific fire zones impacted by the analysis cannot be identified, it is unclear how they were treated in the IPEEE.

#### **References:**

- T-1 "Turkey Point Nuclear Plant, Units 3 and 4, Individual Plant Examination of External Events", Florida Power and Light Company, June, 1994.
- T-2 Turkey Point Nuclear Plant, Units 3 and 4, Response to Request for Additional Information, Individual Plant Examination of External Events", Attachment to the letter from Robert J. Hovey, Events", Florida Power and Light Company, December 18, 1995.
- T-3 Attachment to the letter from Fredrick J. Hebdob, Director, Office of Nuclear Reactor Regulation, USNRC, to Mr. T. F. Plunkett, President-Nuclear Division, Florida Power and Light Company, December 22, 1998.

**TABLE I-1: SUMMARY CATEGORIZATION OF INDIVIDUAL EXEMPTIONS FOR TURKEY POINT (TUR)**

| <b>Exemp. #</b> | <b>Exemption Description</b>  | <b>Location Binning Category</b>                   | <b>PRA Step Binning Category</b> | <b>Risk Impact</b> |
|-----------------|---|--|----------------------------------|--------------------|
| TUR-01          | Automatic suppression and detection not provided for component cooling water area, redundant cables and equipment not separated by 20 feet.                             | General process area                               | FHA : Det/Supp;<br>Grw&Dmg       | Very Small         |
| TUR-02          | Automatic fire detection and suppression systems not installed in containment area, auxiliary feedwater pump area, condensate storage area and main stream platform.    | Containment;<br>Pump room;<br>General process area | FHA : Det/Supp                   | Very Small         |
| TUR-03          | Redundant auxiliary feedwater (AFW) components not separated; automatic fire suppression systems not installed; feedwater platform fire zones.                          | General process area                               | FHA :<br>Grw&Dmg;<br>Det/Supp    | Very Small         |
| TUR-04          | For intake area, automatic suppression are not installed  | Service water area                                 | FHA : Det/Supp                   | Very Small         |
| TUR-05          | Redundant diesel radiator rooms; not enclosed by complete fire rated barriers.  | Diesel generator area                              | FHA : FCIA                       | Very Small         |
| TUR-06          | Residual heat removal areas do not have 3 hour barrier for redundant equipment.   | Pump room  | FHA : Grw&Dmg                    | Very Small         |
| TUR-07          | Charging pump rooms are not protected by proposed automatic suppression system.   | Pump room  | FHA : Det/Supp                   | Very Small         |
| TUR-08          | Containment building does not have a non-combustible radiant energy shield between redundant safe shutdown equipment and cables with less than 20 feet of separation.   | Containment  | FHA : Grw&Dmg                    | Very Small         |
| TUR-09          | Control room not provided with fixed fire suppression.  | MCR  | FHA : Det/Supp                   | Indeterminate      |
| TUR -10         | Containment units do not have 8-hour battery powered lighting units inside.   | Containment  | RQ : HFA                         | Very Small         |
| TUR-11          | Reactor coolant pump oil collection system not sized to hold entire lube oil inventory.   | Containment  | FHA : Sources                    | Very Small         |
| TUR-12          | Redundant cable and equipment in the CCW (Fire Zone 47) lack of 20 feet of separation between intervening combustibles, and installation of automatic fire suppression. | Pump room  | FHA : Grw&Dmg                    | Very Small         |

| <b>Exemp. #</b> | <b>Exemption Description</b>  | <b>Location Binning Category</b> | <b>PRA Step Binning Category</b> | <b>Risk Impact</b> |
|-----------------|---|----------------------------------|----------------------------------|--------------------|
| TUR-13          | Redundant cable and equipment in the CCW (Fire Zone 54) lack of 20 feet of separation between intervening combustibles, and installation of automatic fire suppression. | Pump room                        | FHA : Grw&Dmg                    | Very Small         |
| TUR-14          | Fire zone 79 lacks installation of automatic fire detection and suppression systems.  | General process area             | FHA : Det/Supp                   | Very Small         |
| TUR-15          | Fire zone 84 lacks installation of automatic fire detection and suppression systems.  | General process area             | FHA : Det/Supp                   | Very Small         |
| TUR-16          | Fire zone 89 lacks installation of automatic fire detection and suppression systems.  | General process area             | FHA : Det/Supp                   | Very Small         |
| TUR-17          | Fire zone 114 lacks installation of automatic fire detection and suppression systems  | General process area             | FHA : Det/Supp                   | Very Small         |
| TUR-18          | Fire zone 115 lacks installation of automatic fire detection and suppression systems.   | General process area             | FHA : Det/Supp                   | Very Small         |
| TUR-19          | Redundant safe shutdown equipment in fire zone 113 lacks a 1-hour rated fire barrier and installation of automatic fire suppression.                                    | General process area             | FHA : Grw&Dmg; Det/Supp          | Very Small         |
| TUR -20         | Redundant safe shutdown equipment in fire zone 116 lacks a 1-hour rated fire barrier and installation of automatic fire suppression.                                    | General process area             | FHA : Grw&Dmg; Det/Supp          | Very Small         |
| TUR-21          | Fire zone 119 lacks installation of an automatic fire suppression system.   | General process area             | FHA : Det/Supp                   | Very Small         |
| TUR-22          | Fire zone 120 lacks installation of an automatic fire suppression system.   | General process area             | FHA : Det/Supp                   | Very Small         |
| TUR-23          | Redundant diesel radiator rooms lack complete enclosure by 3-hour rated barriers.   | Diesel generator area            | FHA : FCIA                       | Very Small         |
| TUR -24         | Redundant safe shutdown equipment in fire area B lacks a 1-hour rated fire barrier and installation of automatic fire suppression.                                      | Pump room                        | FHA : Grw&Dmg; Det/Supp          | Very Small         |
| TUR-25          | Redundant safe shutdown equipment in Fire Area C lacks a 1-hour rated fire barrier and installation of automatic fire suppression.                                      | Pump room                        | FHA : Grw&Dmg; Det/Supp          | Very Small         |
| TUR-26          | Fire Area N charging pump room lacks area-wide automatic fire suppression.  | Pump room                        | FHA : Det/Supp                   | Very Small         |
| TUR-27          | Fire Area O charging pump room lacks area-wide automatic fire suppression.  | Pump room                        | FHA : Det/Supp                   | Very Small         |

| Exemp. # | Exemption Description   | Location Binning Category | PRA Step Binning Category | Risk Impact   |
|----------|---|---------------------------|---------------------------|---------------|
| TUR-28   | Fire Area P of containment building lacks 1-hour rated barrier for redundant equipment and cables with a separation of less than 20 feet. | Containment               | FHA : Grw&Dmg             | Very Small    |
| TUR-29   | Fire Area Q of containment building lacks 1-hour rated barrier for redundant equipment and cables with a separation of less than 20 feet. | Containment               | FHA : Grw&Dmg             | Very Small    |
| TUR-30   | Control room lacks installation of fixed fire suppression   | MCR                       | FHA : Det/Supp            | Indeterminate |
| TUR-31   | Inside containment lacks 8-hour battery powered emergency lighting.   | Containment               | RQ : HFA                  | Very Small    |
| TUR-32   | RCP oil collection system lacks equivalent size to hold entire lube oil inventory.  | Containment               | FHA : Sources             | Very Small    |
| TUR-33   | Five unsealed penetrations in the fire rated barrier floor separating Fire Area AAA from Fire Area A in the auxiliary building.           | General process area      | FHA : FCIA                | Very Small    |
| TUR-34   | Two 8-inch and 6-inch unsealed penetrations exist in the 3-hour fire rated barrier floor separating Fire Area F from Fire Area A.         | General process area      | FHA : FCIA                | Very Small    |
| TUR-35   | Intervening combustibles between redundant safe shutdown components, circuitry in containment exist.                                      | Containment               | FHA : Grw&Dmg             | Very Small    |
| TUR-36   | Fire zones outside turbine building do not have fire detection or automatic suppression systems.  | Yard/General Process Area | FHA : Det/Supp            | Very Small    |