August 31, 2004

MEMORANDUM TO: Sunil Weerakkody, Section Chief
Fire Protection Engineering and Special Projects Section
Plant Systems Branch
Division of Systems, Safety, and Analysis
Office of Nuclear Reactor Regulation

FROM: Mark Henry Salley, Fire Protection Engineer ***/RA/***
Naeem Iqbal, Fire Protection Engineer
Fire Protection Engineering and Special Projects Section
Plant Systems Branch
Division of Systems, Safety, and Analysis
Office of Nuclear Reactor Regulation

SUBJECT: NUREG-1805 - DISPOSITION OF PUBLIC COMMENTS AND PERMISSION TO USE COPYRIGHTED MATERIALS

The comments on NUREG-1805 have been reviewed. James Downs composed our responses and the complete disposition can be found in Attachment 1. Additionally we have compiled the permission letters to use copyrighted material, and have assembled them in Attachment 2.

NUREG-1805 has been transmitted to the tech editor for final review and publishing. Please note the public comments are overwhelmingly positive from both nuclear and non-nuclear stakeholders, as well as numerous foreign countries.

Since the text and associated spreadsheets form the foundation for NRC performance based fire dynamics analysis, and are utilized by the risk informed Significance Determination Process, we would like to publish NUREG-1805 in a hardbound text. We have met with Gary Lauffer (OCIO/IRSD/PDSB) and Paula Garrity (OCIO/IRSD/PSS) on August 30, 2003 to discuss this option. Gary was impressed with the NUREG and suggested that the NUREG could go even further and meet the agency goals for "communication quotient." We believe NUREG-1805 will be used as both a training tool and working document for well over five years. We would also like to create a section on the NRC Fire Protection web page for possible errata and future updates.

In conclusion, we believe NUREG-1805 will meet intended NRC objectives and reflect positively on the NRC top outside stakeholders both in the United States and in other countries.

Attachments: As stated

CONTACTS: Mark Salley, NRR/DSSA/SPLB
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(301) 415-3194

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DATE	08/30/04	08/30/04	08/31/04	08/31/04

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Disposition of Comments on NUREG-1805

Vytenis (Vyto) Babrauskas, Ph.D. (Fire Science and Technology Inc.)

1. Comment: I am totally impressed. These are the sort of models that should have come as a CD with the SFPE Handbook or the Drysdale book. It's a darn impressive piece of work.

NRC Response: The compliment is noted.

2. Comment: There are some simple misspellings that should be corrected: Hesemi -> Hasemi, Navel -> Naval, Delischatsios -> Delichatsios

NRC Response: These have been corrected.

3. Comment: You may note that my HRR chapter has been greatly expanded in the 3rd edition. of the SFPE Hdbk, as contrasted to the 2nd edition.

NRC Response: The draft NUREG was issued prior to the 3rd editions on the SFPE Handbook being available. This has now been identified and we are incorporating some of the new material into the NUREG.

4. Comment: Add Bob Zalosh's Industrial Fire Protection book to the references on sprinklers; it is very good.

NRC Response: This has been added to the Additional Readings Section.

5. Comment: Maybe there should be some discussion of failure modes/possibilities for detectors and sprinklers.

NRC Response: This was included in the Assumptions + Limitations Section, as well as in the Cautions Section. Although it was not an in-depth analysis, it was extensive enough for the purpose for which this NUREG is intended for.

6. Comment: Ch. 14 should mention that overpressure is rather rare, because a majority of compartments leak enough so that this cannot happen.

NRC Response: Additional guidance has been provided.

7. Comment: Ch. 17 should mention that all results for single-element fire resistance, whether furnace-tested or calculated, should be viewed as only a crude estimate, due to 3-d frame effects in real bldgs. This was first studied by Bresler: Bresler, B., Response of Reinforced Concrete Frames to Fire, pp. 273-280 in Tenth Congress, Intl. Assn. for Bridge and Structural Engineering, Zurich (1976).

NRC Response: This was mentioned in limited detail in the Assumptions and Limitations Section and was enhanced. Further elaboration is unnecessary given the intended use of this NUREG.

8. Comment: For fire tests, basically only the ASTM, and not the NFPA versions are actually used by the test labs. So better to refer to ASTM E 108 than NFPA 256, etc etc

NRC Response: We have attempted to reference multiple names for the same test to assist users of this NUREG in equating variations of terminology within the industry. The ASTM test is our preferred citation as well.

9. Comment: The table on p. C-17 is not correct in that most of these tests are NOT tests for fire resistance. Fire resistance tests are only E 119 and related tests. Furthermore, it is not possible to have a fire resistance test for a material, only for an assembly, since it is a system property.

NRC Response: The term “fire resistance test standard” has been removed from the tables and replaced with “fire test standard”.

Fred Mowrer, Ph.D. (Department of Fire Protection Engineering, University of Maryland)

1. Comment: I want to commend both of you for what appears to be a job well done. I was somewhat critical of this project because it virtually repeated what others, including me, had done in the past. But I think the look and feel of your implementation as well as the level of documentation you have given your report and spreadsheet templates more than justifies your efforts. I would like to obtain a copy of the templates as soon as possible; I may adopt them for use in my fire modeling class.

NRC Response: The compliment is noted.

2. Comment: I was the developer of the ATF "Spreadsheet Templates for Fire Dynamics Calculations" that Gerry referred to you and feel that I should be acknowledged as the author of these templates. I noticed that your refer to EPRI TR100370 in a number of chapters. More accurately, these references should be to the EPRI report that I prepared in support of the FIVE Methodology. This reference is: F.W. Mowrer, "Methods of Quantitative Fire Hazard Analysis," EPRI TR-100443, Electric Power Research Institute, Palo Alto, CA, May 1992, 72 p.

NRC Response: We regret the oversight and include credit in the acknowledgments section.

3. Comment: I noticed that you have taken some drawings from this document and modified them for inclusion in your report without referring to the source of the documents. For example, your diagram of different mechanical ventilation systems is virtually the same as the one in TR1004433.

NRC Response: To our knowledge and best efforts, any borrowed information, graphics, or equations have been properly cited and/or granted duplication permission for this NUREG by the originator.

Peter Jackman (International Fire Consultants, Ltd.)

1. Comment: I would commend you on what on first reading appears to be an excellent body of work and a superb document.

NRC Response: The compliment is noted.

Morgan J. Hurley, P.E. (Society of Fire Protection Engineers)

1. Comment: General comment - you need more references. Any time that you provide an equation or statement of fact, you must provide a reference for where people can go for further information.

NRC Response: To our knowledge and best efforts, any borrowed information, graphics, or equations have been properly cited and/or granted duplication permission for this NUREG by the originator.

2. Comment: Page 2-10 - I believe that At is defined to include ventilation area (this would also affect equation 2-5)

NRC Response: Multiple sources have verified At excludes ventilation area. The example on page 3-177 of the SFPE Handbook (2002 ed.) is a good source.

3. Comment: Page 2-29 - I would imagine that tpeak would coincide with tburnout time in figure 2-5(b)

NRC Response: The values of tpeak does roughly coincide with Qpeak. The emphasis of figures 2-5(a) and 2-5(b) is the comparison of value of Qtotal (the area under either curve) for different fuel packages.

4. Comment: Page 2-31 - you need to calculate to determine whether the gypsum board is thermally thick or thermally thin. You cannot assume it, particularly for short exposure times. I would suggest that the line in the spreadsheets stating that thermally thin materials should be less than or equal to one inch should be deleted. Whether or not a material is thermally thin or thick is time dependent, and people should calculate whether materials are thermally thin or thick.

Page 2-41 - again, must not imply whether or not a material is thermally thick is solely a function of thickness

Page 2-47 - again, must not imply whether or not a material is thermally thick is solely a function of thickness

Page 2-54 - again, must not imply whether or not a material is thermally thick is solely a function of thickness

Page 2-65 - again, must not imply whether or not a material is thermally thick is solely a function of thickness

Page 2-73 - again, must not imply whether or not a material is thermally thick is solely a function of thickness

NRC Response: The calculation was excluded to simplify the process. The majority of situations in nuclear power plants can be simplified into the assumptions presented on the spreadsheets.

5. Comment: Page 3-1 - it is not entirely correct to say that HRR is not a fundamental property of a fuel. For example, one could calculate the HRR of a pool fire from material properties. Similarly, it is possible to calculate the HRR of a wood crib. See Babrauskas' chapter on "Heat Release Rates" in the SFPE Handbook.

NRC Response: Page 3-5 of the SFPE Handbook (2002 ed.) discusses HRR. By "fundamental properties" we intended those which are solely defined by the physical nature of the substance (like density, volume, etc.). Full scale HRR is dependent on many things which are not related to the material (view factors, geometry of the enclosure, etc.).

6. Comment: Page 3-4 - there is a correction factor for equation 3-2. See Babrauskas' chapter in the SFPE Handbook.

NRC Response: The correction factors were not present in the 1995 ed. of the SFPE Handbook and will be added.

7. Comment: Page 3-7 - I suggest deleting figure 3-2, since as stated on page 3-6, the enclosure can accentuate or attenuate the burning rate

NRC Response: Figure 3-2 does show a specific case and should not have been included in this generalized discussion. It has been removed.

8. Comment: Page 3-10 - m" is the mass burning rate of fuel per unit area

NRC Response: This error has been corrected.

9. Comment: Page 3-11 The discussion of burning wax is not quite correct. Wax breaks down to form many simpler compounds, not just H2 and CO.

NRC Response: The phrase has been changed to read: "*two of many products* produced by decomposition of wax".

10. Comment: Page 3-11 - The discussion of laminar and turbulent flames does not go anywhere, and only provides unnecessary complication. I would suggest deleting it.

NRC Response: This discussion has been deleted.

11. Comment: Page 3-13 - Figure 3-5 is more confusing than it needs to be. It looks like fuel and air are mixed prior to combustion.

NRC Response: The graphic has been modified. A diffusion flame is difficult to accurately represent graphically, hopefully the concept is more clearly presented now.

12. Comment: Page 3-27 - I would suggest adding the SFPE guide to the list of recommended additional readings

NRC Response: The guide will be reviewed and evaluated for relevance.

13. Comment: Page 3-29 - flame impingement is a poor performance criterion. I would suggest using some critical temperature instead.

NRC Response: The example is intended to familiarize the user with the calculations involved within a specific spreadsheet. Critical temperature is likely more useful, however it is not part of the spreadsheet being focused on.

14. Comment: Page 3-31 - need to add the correction factor from Babrauskas for pool fire HRR

NRC Response: See response to Comment #6.

15. Comment: Pages 3-33 and 3-37 - flame impingement is a poor performance criterion. I would suggest using some critical temperature instead.

NRC Response: See response to Comment #13.

Thomas F. Barry, P.E. (Fireriskforum)
1. Comment: I have just started to go through the draft of the Fire Dynamics Tools and from what I have seen so far you and Mark have done an outstanding job.

NRC Response: The compliment is noted.

2. Comment: The one suggestion I have is that you may want to consider including some Threshold Damage Limit (TDL) data for users to apply in interpreting potential damage impacts to people, equipment, and structures based on the modeling outputs such as radiant heat, convective temperatures, etc.

I would be glad to donate section 5.2, Target Threshold Damage Limits, from my book Risk-Informed, Performance-Based Industrial Fire Protection, which you may use, add, edit as you wish. This is a composite of published TDL data which I think would be a beneficial addition to your excellent publication.

NRC Response: The TDL data presented in Chapter 6 is focused on the applications within nuclear power plants. We will add your text to the Additional Readings Section.

3. Comment: Page 1-10, section 1.10: Should be Barry (not Berry)

NRC Response: This error has been corrected.

4. Comment: Page 1-14, section 1.12. Reference should read; Barry, T.F., Risk-Informed, Performance-Based Industrial Fire Protection, An Alternative to Prescriptive Codes, TFBarry Publications and Tennessee Valley Publications, 2002. Only available at www.fireriskforum.com <http://www.fireriskforum.com/> .

NRC Response: The reference has been correct and adheres to NRC publishing guidelines.

5. Comment: Your templates for calculating the fire resistance of structural steel members use a standard time-temperature curve. For evaluating potential oil, solvent fire exposures to steel would suggest that you also include the UL high-rise time-temperature curve as this would be very helpful and extend the usability.

NRC Response: UL 1709/ASTM E1529 is designed to test for outdoor (very well ventilated) hydrocarbon pool fires. Although there are isolated instances in nuclear power plants where this would be effective, the standard time/temperature curve will more accurately represent the vast majority of the situations this NUREG is intended to address.

Ulf Wickström, SP (Sweden)

1. Comment: This is a massive and impressive work.

NRC Response: The compliment is noted.

2. Comment: I would suggest that a look at the Eurocodes developed in Europe over the last decade or so would be worthwhile. They are by no means perfect but they could at least give some useful ideas.

NRC Response: The Eurocodes are a good reference and are mentioned within many of our cited references.

3. Comment: Page 17-14 "Shadow effects". The heat transfer to a fire exposed structure is controlled by radiation. For an open bare steel section, e.g. I or C-sections, parts will be more or less in "shadow". Therefore when calculating the heated perimeter it is more correct to just take the outer or boxed perimeter when calculating D. In Eurocode 3 this is accounted for although not fully correct. See enclosed paper from Interflam 2001: Calculation of heat transfer to structures exposed to fire – shadow effects, by Ulf Wickström.

NRC Response: We used the entire perimeter to be slightly more conservative in assessing the heating of a structural member.

4. Comment: Page 17-21 Temperature increase in steel elements
I think the heat transfer to a fire exposed structure is purely described. I suggest a look at Eurocode 1. In particular I think the use of flame emissivity is doubtful and can give rise to many misunderstandings and errors. A low assumed emissivity may lead to considerably lower bare steel temperature, but may have very little effect on other type of structures. Particular when simulating exposures in furnaces it is very misleading. The standard fire temperature is arbitrary anyhow, so why reduce it? Instead the emissivity should just be the emissivity of the exposed surface, about 0.8 for most materials. If that is assumed at least furnace tests could be simulated correctly, given the furnaces are controlled with Plate Thermometers, see ISO 832 or EN 1363-1.

NRC Response: Table 17-4 provides the resultant emissivities is various configurations, the reduction from the typical .8 is due to heat losses to the slab or facade.

5. Comment: Page 17-25 Error in formula. The formula 17-24 is wrong. Only a third of the heat capacity of the insulation can be added to the heat capacity of the steel, see Eurocode 3 or the original work: Wickström, U., TEMPERATURE ANALYSIS OF HEAVILY-INSULATED STEEL STRUCTURES EXPOSED TO FIRE, 1985:33, SP-RAPP, BORÅS SWEDEN, FIRE TECHNOLOGY REPRINTED FROM FIRE SAFETY JOURNAL. Melenek and Philip Thomas came to the same conclusion reported in FIRE SAFETY JOURNAL VOL 12, NO 1, PP. 1-8, FEBRUARY 1987.

NRC Response: There are many different methods, programs, and equations that evaluate temperatures of protected steel structures. The formula we are utilizing projects a slightly higher (and therefore more conservative) temperature curve over the first 40 minutes of the exposure. The results are similar, but the works you mentioned did not go unnoticed.

Rashid Abbas (Tennessee Valley Authority)

1. Comment: The term 't', time after ignition (sec) is incorrectly modeled as a constant (60 seconds) in the gas layer height (z) correlation. It needs to be a variable.

NRC Response: The 60 seconds is actually the time step increase we used to formulate the results. You are correct though, the term 't' is a variable.

2. Comment: It is suggested to have spreadsheets where the fire is specified as a T squared fire (slow, medium, etc.)in a tabulated format and corresponding calculation of compartment temp. and gas layer height. Please see the attached marked up spreadsheet as an example.

NRC Response: We attempted to be conservative by utilizing the peak HRR for a given material rather than formulate a projected fire growth. This also simplifies our calculation process.

Alexander Velazquez-Lozada (US NRC)

1. Comment: Page 2-9 Last paragraph. This paragraph indicates that two non-linear equations has to be solved for a complete solution of the mass flow rate. It doesn't mention that MQH is used instead. I imagine that the mass flow rate is used in another set of non-linear equations to calculate the upper layer gas temperature. I think it should be mention that we are not solving non-linear equations, instead we are using correlation from experimental data.
NRC Response: It is implied in the mentioned paragraph that solving the two equated, non-linear equations would be difficult, therefore MQH can model it.

2. Comment: Page 2-10 Equation 2-2 is repeated in page 2-11

NRC Response: It is a repeated equation and has been deleted.

3. Comment: Page 2-15 2nd paragraph. In the sentence "the plume entrains ambient air, which both cools the gas and increase the flow rate." Which both?

NRC Response: "Both" indicates the entrained ambient air does two things, it both cools the gas and increases flow rate.

4. Comment: Page 2-18"Calculation procedure," In my opinion is better to use calculate instead of derive.

NRC Response: The terminology has been modified.

5. Comment: Page 2-27 1st paragraph (continuation from page2-26), downward motion instead of descent.

NRC Response: These two terms generally mean the same thing and are used interchangeably in discussing the hot gas layer.

6. Comment: Page 2-31 1st paragraph. In the sentence "The fire is constant with an HRR of 500 kW." Do you mean that "The fire is in steady state" or "The fire has a constant HRR."

NRC Response: A constant HRR of 500 kW is implied.

7. Comment: In the examples of 2.15, include the phrase "above the floor" in the sentence "Assume that the top of the vent is 6 ft."

NRC Response: The description of measurements has been changed to substitute “tall” for “high”.

8. Comment: Page 2-47 Are the room dimensions in example problem 2-3 typical for a nuclear power plant room? What kind of room is this?

NRC Response: The dimensions are only meant to be an example of a smaller room and are not necessarily representative of any specific room at a nuclear power plant.

Deggary N. Priest (Omega Point Laboratories)

1. Comment: There is a small typo on page 17-1: The temperature at 5 minutes is 1000°F, not 100.

NRC Response: This typo has been corrected.

2. Comment: Page 17-3: "average temperature increase on the unexposed surfaces cannot exceed 121 °C (250 °F)" should be "average temperature increase on the unexposed surfaces cannot exceed 139°C (250 °F)"

NRC Response: This error has been corrected.

Gerry Wiseman (Senior Fire Protection Inspector, US NRC Region II)

1. Comment: Section 1.8.1.2 Insitu Combustibles: The writeup implies that cable insulation and jacket materials used in cable trays are they only "largest single potential fuel source".....Please consider that there are also large amounts of cables and other plastic compounds installed within large electrical cabinets, switchgear and MCC s, installed in NPPs that are somewhat unique to the NPP occupancy [IN 2002-27] (in size and potential combustibles with both measured and unmeasured HHR noted in table 2-5 of section 2.9 of

NUREG). These combustible loads , not usually IDed in the FHA should also be considered in potential fire scenarios and FDTs.

NRC Response: Text has been added on page 1-8 to read "However, any other plastic compounds installed within the NPP must be included in the FHA.".

2. Comment: Update to include combustible products known to be in NPP's, which include: 1- Pipe insulation materials, with known HRR. 2- Dielectric insulating fluids for in door transformers with technical manual. 3- Equivalent exposure HRR.

NRC Response: We have provided the best data available for known combustibles in a nuclear power plant. We acknowledge there are combustible materials for which we do not have data. Our office has discussed this with the NRC Office of Research.

Wayne D. Holmes, P.E., FSFPE (HSB Professional Loss Control)

1. Comment: You did a SUPERB job in putting that together. I can appreciate what a tremendous level of effort that went into creating it. While it is focused on the nuclear power industry, it has the elements of a great text book or reference manual for general fire protection. The NUREG is a great move by the NRC to show leadership in fire protection.

NRC Response: The compliment is noted.

2. Comment: It would be good to see an edited version published independent of the NRC for general use in fire protection
curriculum or as an general FPE reference.

NRC Response: The intended use of the document is for nuclear power plants so a generic version is not anticipated. However, this document is publicly available and non-nuclear end users are welcome to use it as is applicable in their field.

Leong Poon (Warrington Fire Research (Aust Pty Ltd in Australia)

1. Comment: I am sure that the FDT you developed will be very helpful for us to develop the 'risk-informed and performance-based' fire hazard analysis methodology.

NRC Response: The compliment is noted.

Moonhak Jee (KEPRI in Korea)

1. Comment: The equation, 10-2, on the page 10-10 of Chapter 10. Estimating Sprinkler Response Time, should be reviewed.
- u(jet) at the denominator of the equation should be square-root of u(jet)
- reference : page 11-104 at the Simplified fire growth calculation of Fire protection Handbook, NFPA

NRC Response: This typo has been corrected.

2. Comment: At the page, 10-19 of the spreadsheet calculation, Chapter 10- Method of estimationg sprinkler response time,

- the Convective heat release rate(= xc * Q' = 0.7 * 1000 = 700 Kw) was used for the calculation of ceiling jet temperature. When referring to the equation, 10-5, I guess that heat release rate (= Q' = 1000 kw) should be used in stead of O'(convective).

If there is any obvious rationale(reason), the nomenclature of Q' at the equation, 10-5, should be replaced with Q'(convective).

- reference : on the page of 2-33 of the Section 2/Chapter4 of the SFPE handbook, fire protection engineering (2nd edition), it says that " Data from these tests were correlated using the total energy release rate of the fire. Even though it is the convective fraction of the total energy release rate that is directly related to the buoyancy of the fire, most available data is correlated using the total energy release rate. For common materials, such as those used by Alpert, the convective energy release rate, Q'c, is considered to be proportional to the total energy release rate, Q' ".

NRC Response: For pool fires, Qc and Q are roughly equal. For general commodities, Qc is roughly equal to .7Q. This clarification has been added in the text.

3. Comment: On the spreadsheet Calculation, the convective heat release fraction (xc) was input with the value of 0.70.

- When referring to the page 11-12 of the calculation sheet of Chapter 11, Estimating smoke detector response time, it was used with the value of 0.50. Is there any basis or criteria for these variance? (In fact, I do not know the empirical basis)

NRC Response: Page 9-6 explains the relationship. Xc = .5 on page 11-12 was an oversight and it has been corrected.

4. Comment: On the page of 10-19 of the spreadsheet calculation, the symbol of "for r/H=0.18" at the last line for the calculation of ceiling jet temperature(for the region of plume jet) should be "for r/H < 0.18".

NRC Response: This typo has been corrected.

5. Comment: There is no answering part of the example problem 10.10-3, for the problem statement,....."

- this example is quite peculiar, and I want to review the answering part. Is this part Missing or will be included in future?

NRC Response: The solution has been added.

Francisco Joglar (SAIC)

1. Comment: The introduction to this chapter suggest that the model should be used in a closed compartment or compartments with small leakages. Based on the model development, it is fully applicable to closed rooms. However, without a specific definition of what a small leakage is, the model will predict high pressure build-ups if used in rooms with closed doors.

In my opinion, this model is applicable to closed rooms, or rooms with very small leakage paths where a fire is growing very fast (a jet fuel fire starting in the fuel tank of an airplane). Fast

growing fires will generate pressure peaks in rooms with small leakages, but these peaks are generally of short durations. Results from the model may not reflect this short duration because the time input is the time after ignition, which can be interpreted as the burning duration.

A relatively short time value of 10 s is used in the example. It is not clear if this is a burning duration input, in which case, users may peak any time value, or is intended to represent a typical pressure peak observed in compartment fires.

I also recognize that one of the most challenging tasks in modeling compartment fires is determining leakage paths. In my experience, this is a parameter is usually not available and assumed. The SFPE handbook for example in the Smoke Control chapter (Klote) mentions a 0.02 m2 leakage for doors (but the wording does not suggest that this is a recommended value).
This pressure model avoids this difficulty, but in doing so, may restricts its application to very few scenarios.

For specific nuclear plant applications, I would recommend the following discussion in the chapter:
1. A definition of what is a small leakage
2. Characteristics of nuclear plant rooms where the equation is applicable. These can be done through an example.
3. Include in the assumptions that the model was developed assuming a completely closed room (that assumption is essential and is not currently listed)
4. List some fire issues where inspectors may need such a model, and how they will use it. In other words, what is the criteria (when a pressure calculation is considered to be high?)

NRC Response: Chapter 14 had some explanation of this in the Summary Section, but more detail has been added.

Alex Marion (NEI)

1. Comment: In general, the methods provided in this NUREG should be useful to both licensees and NRC staff in developing reasonable approximations of fire scenarios in nuclear plants, in lieu of detailed fire modeling. These methods should be helpful in applying the fire protection SDP and other risk-informed, performance-based methods to plant fire protection issues.

NRC Response: The compliment is noted.

2. Comment: The methods in this NUREG are best applied by, or in consultation with, trained fire protection engineers that can provide a “sanity check” on the results. The methods in this NUREG are likely to be applied to inspections in determining the risk significance of potential inspection findings. While it is not the purpose of this NUREG to address the resolution of inspection issues, the application of these methods should be transparent to licensees so that differences in assumptions or data can be addressed.

NRC Response: There is a level of assumption that any licensee who utilizes this NUREG will have a trained fire protection engineer evaluating the inputs and outputs in relation to the scenario being modeled. The authors considered the “transparency” of the methods when the

spreadsheets were constructed. You will notice no spreadsheet employs a "black box" design but rather all steps of the calculation are clearly shown. For any assumption used in the calculation it is readily apparent where the assumption fits into the calculation and how it effects the final answer. Further the NUREG contains a section on cautions and limitations that should help to insure the input data is reasonable. Should a dispute arise over the application of a spreadsheet, the staff has trained fire protection engineers who would be available to provide a "sanity check" on the results. Our expectation is that trained fire protection engineers would be able to resolve any differences in assumptions or data such that the application is transparent for all practical purposes.

3. Comment: Chapter 2.10, Assumptions and Limitations: The terms "conventional" and "large" in assumption 1 are subjective. NRC should provide examples for room height or volume.

NRC Response: The terms "conventional" and "large" are used in Quintiere and Karlsson's Enclosure Fire Dynamics in a similar context without specifics. The general intent of the caution was to say that care should be taken when using the correlations within the chapter because they were derived partially from experimental data. The actual correlations were derived from empirical data from tests in compartments that ranged from 0.14 m2 to 24 m2 with ceiling heights up to 4.5 m. Therefore, the correlations would best apply to compartments within those limits. However, the non-dimensional nature of the correlations suggests they would apply in cases outside of those limits.

4. Comment: Assumption 6 states "Caution should be exercised when the compartment overhead are highly congested with obstructions such as cable trays, conduits, etc." This condition is the norm in a nuclear power plant. NRC should add more detailed guidance for the inspectors in such these areas, either in modifying or rejecting the approach or in interpreting the results.

NRC Response: The intent of the NUREG is to offer simple, easy-to-use fire dynamics correlations to inspectors for help in dispositioning inspection findings. More guidance in this case would result in more complexity.
The potential specific effects of obstructions in the overhead would be as follows:

For average hot gas layer temperature calculations, the actual temperatures could be lower than calculated due to the absorption of heat by the obstructions, especially if the overhead contains a large volume of obstructions that have high heat capacities.

For hot gas layer height calculations, the actual heights might be lower due to the extra volume taken up by significant obstructions.

5. Comment: Chapter 3.3.1, Burning Duration of Pool Fire: The burning duration is dependent on the volume and diameter of the pool. While this is easily calculated when the fuel is in a dike, it is not so when the spill is unconfined. The inspectors will need a method to determine the diameter of a given quantity of spilled liquid. A National Institute of Justice (NIJ) paper, "Flammable and Combustible Liquid Spill/Burn Patterns, NIJ Report 604-00, March 2001" provides some analytical and empirical values for gasoline and kerosene.

NRC Response: A more detailed analysis of unconfined spills has been added to Chapter 3.

6. Comment: Chapter 3.5, Assumptions and Limitations: The NIJ report referenced above provided the following results:
"Peak heat release rates for the spills examined on nonporous surfaces are approximately 1/4 to 1/8 of the heat release rates of equivalent diameter pool fires....Fire modeling and fire scenario evaluation for spill fires on nonporous floors should not be conducted using the heat release rates derived from pool fires." The assumptions and calculations in NUREG-1805 should be made consistent with the NIJ report.

NRC Response: Due to the limited applicability of the result of the NIJ report, no limitation will be added to the NUREG at this time. The calculation methods described in the NUREG are based on large scale tests using large pool diameters and many gallons of liquid, which would more closely resemble the situation in a NPP. The NIJ tests used less than one half of one gallon of gasoline or kerosene and would therefore not be applicable to situations in a NPP.

7. Comment: Chapter 9.5, Assumptions and Limitations: Assumption 4 states that specialized calculation approaches should be used for items such as jet fires. It would be beneficial for NRC to provide references for the inspectors.

NRC Response: A reference was added to the SFPE Handbook, Section 3, Chapter 11.

8. Comment: Chapter 10.4, Assumptions and Limitations: It would be beneficial for NRC to provide more guidance to the inspectors for considering assumptions 1, 3 and 4.

NRC Response: There is no further guidance in the literature that would be applicable to the situations in NPPs relating to the limitations of the ceiling jet calculations.

9. Comment: Chapter 16.5: The draft NUREG references Regulatory Guide 1.189 as a “requirement” for battery rooms, and lists the recommendations of several NFPA codes. Regulatory Guide 1.189 is not a requirement, and licensees may not have committed to the NFPA codes. Chapter 16.5 should acknowledge that approved plant licensing bases may differ from these provisions.

NRC Response: The text has been changed to reflect this suggestion.

10. Comment: Chapter 16.9: IEEE 484 specifies a maximum hydrogen evolution rate of 0.000269 cubic feet per minute per charging ampere per cell, so the writers are not necessarily limited to a single source of information (vendor) on this
point.

NRC Response: This reference has been added in the text in Chapter 16.6.

M. Dey (U.S. NRC PRAB/RES)

1. Comment: This document is an excellent and comprehensive compilation of tools/correlations available in the literature for Fire Hazard Analysis. The data included in the document for NPP Fire Hazard Analysis (FHA) is exceptional and will be of great value. The document will be useful for the NRC beyond the Fire Protection Inspection Program, especially for the implementation of NFPA 805.

NRC Response: The compliment is noted.

2. Comment: FDTs contains tools that are mostly based on empirical correlations. These are simple tools (which have definite advantages) for FHA. A discussion should be included in the introduction to explain the nature of these tools in context of other more sophisticated tools available for fire safety analysis, e.g., zone and CFD methods. In this respect, the term "state of the art" should not be used for these tools. State-of-the-art methods for fire safety analysis would be CFD methods being developed by NIST and other organizations. Also, the term "first order" should be explained. Does "first order" mean the tools provide conservative and bounding answers, and therefore are appropriate for screening analysis? A more appropriate description of the tools, e.g., "Simple, or Hand-Calculational" may make the nature of the tools clearer to the reader.

NRC Response: Clarifications have been added in the text of the NUREG.

3. Comment: The introduction to the document should state that the NRC will continue to conduct tests to examine and verify the accuracy of these tools for a wide range of NPP conditions. These studies will be published as they are conducted and completed by the NRC.

NRC Response: The introduction has been modified to include the recommendation.

4. Comment: We know that the accuracy of some of these tools over a range of conditions is questionable, e.g., for estimating pressure rise for compartment fires. It is important to inform the reader that some of the tools may not produce accurate answers for certain NPP conditions. The tools should not be used as "gospel" as always giving an accurate answer. The statement provided that the user needs to be informed is valuable in this respect.

NRC Response: For scenarios which the accuracy is questionable, it has been mentioned in either the associated Assumptions + Limitations Section, Cautions Section, or Summary Section. A paragraph was also added to the section titled, “How to use this NUREG”.

5. Comment: This document provides important technical information for the NRC. Therefore, it will be beneficial to contract a peer review of this document by experts that have been involved in developing the tools included in NUREG-1805. This may already have been accomplished if comments have been received from experts involved with some of these tools.

NRC Response: This NUREG was published as a draft for public comment. Many peer reviewers have also provided comments, as evident within this review.

6. Comment: The term "credible fires" is used in the document, but no further data is provided for determining credible fires. This may be a major weakness of applying these tools since most of them are highly dependent on the fire source. Page 1-4 states that one should postulate a worst-case realistic fire. How does one determine such a fire?

NRC Response: Credible fires has been elaborated on in each usage to clarify the intention.

7. Comment: The document provides valuable data for HRRs. It would be useful to supplement this data where there are gaps, e.g., for cable tray fires, as noted in the document.

NRC Response: The best data available at the time of publication was used. As more data is collected, the values will be supplemented.

8. Comment: The section on "Assumptions and Limitations" for each tool is useful. The V&V effort will provide some additional insights for inclusion in this section.

NRC Response: We look forward to including any additional insights that the V&V effort provides.

9. Comment: It will be useful to include references for all the data (in Tables) and equations included in the document so that the reader has an idea of the source of information. This would supplement the general statements on the sources of information and occasional references which have already been provided.

NRC Response: To our knowledge and best efforts, any borrowed information, graphics, or equations have been properly cited and/or granted duplication permission for this NUREG by the originator.

10. Comment: Are inspectors qualified to be informed users of these tools, especially for some of the more sophisticated methods? An option is to make a more limited set available to inspectors, with others being exercised by headquarters staff.

NRC Response: There is a level of assumption that any licensee who utilizes this NUREG will have a trained fire protection engineer evaluating the inputs and outputs in relation to the scenario being modeled. The NRC Inspectors will be well trained to understand the applications of this NUREG.

Brad Dolan (Robinson NPP PSA Engineer)

1. Comment: I first visited Browns Ferry Nuclear Plant as a student generating plant operator in 1981 and I reported for work there in 1982. Around that time a "swamp" (operator break room) story circulated about a (then) recent incident. It was sufficiently rich in detail that I'm sure it was true. Not all swamp stories were. The story was that one day indication was received that a CO2 dump had occurred in one of the cable spreading rooms. Ray Hunkapillar, who either was at the time or soon after became the operations supervisor at BFNP, didn't believe the indication so he zipped down the stairs to the spreader room to see for himself. An AUO (auxiliary unit operator), "Scooter" Jordan, mildly observed that if there had been a CO2 dump, it might be smarter to enter the spreader room in SCBA. Hunkapillar did not stop but Jordan stopped to don an air pack and then went into the spreader room, where there had in fact been a CO2 dump. Scooter then dragged his unconscious supervisor! out to fresh air, where he seemed to recover without much visible damage. Shortly after that, a wintergreen odorizer was added to the CO2 so it would be easier to tell if CO2 had dumped or not.

NRC Response: Only officially documented cases were included in the summary, but your story is a clear example of some of the hazards that CO2 presents.

Woody Walker (Arkansas Nuclear One)

1. Comment: When calculating flame height (Chapter 3), what do you do if you have a known quantity of combustible liquid (e.g. lube oil), but there is no diked area? For example, let's assume a pump is located in a 20' x 20' room, contains about a gallon of lube oil, but has no diked area. Theoretically, the pool could cover the entire room (and hence have a tremendous HRR) but the thickness of the pool would be so small that the duration of the fire would be seconds. Is there a "minimum depth" to assume for a pool, such that an unconfined area could be treated as confined when you have a known quantity? In other words, if it's unconfined assume 1 gallon will cover x amount of feet, based on a certain depth. What's the x?

NRC Response: A more detailed analysis of unconfined spills has been added to Chapter 3.

2. Comment: In the Chapter 6 examples, there is an assumed value for the heat flux. Chapter 5 describes how to calculate radiative heat flux. Is the intent to use the methods of Chapter 5 to provide the input for Chapter 6 methods (i.e. in a real world evaluation, you don't expect the inspector to assume a particular heat flux value, do you)?

NRC Response: Yes, Chapter 5 could provide the input for Chapter 6 evaluations in real world scenarios.

3. Comment: Do the materials specified in Table 7-1 represent jacket/insulation or insulation/jacket or something else. I don't know for sure but I imagine some cable manufacturers may mix a thermoplastic jacket with thermoset insulation (or vice versa). How does that relate to the data?

NRC Response: The values are given are generalizations for all cable types. A section has been added in Appendix A on time to cable damage.

4. Comment: Example Problems 7.12-1, 2 & 3 states that the cable tray contains unqualified cable (PE/PVC). Because real world cable trays generally contain a mix of different cable types (i.e. various jacket/insulation materials), how do you select the proper material? For example, a cable tray may contain 40 cables, but only one or two that are PVC, a few Neoprenes and the rest Hypalons. Should we assume the worst case (unless results are bad)? I could see this one being a tough call for the inspectors/licensees. Note : This would also apply to Example Problem 8.9-1 & 2.

NRC Response: This is a good question, however it is beyond the scope of this introductory text. Engineering judgement would be required in this situation and a paragraph elaborating on this has been added to the section titled, "How to Use this NUREG".

5. Comment: There was no solution presented for Example 10.10-3. I assume this is because the formulas will not work for the described arrangement. Correct?

NRC Response: The solution has been added.

6. Comment: Page 11-8 states that the convective HRR range is 0.6 to 0.8. However, the example problem indicates that the selected value (see page 11-12) is 0.5 of the total HRR. Since it is not a "yellow" input box on the spreadsheet, I assume the user does not select this value. Should the spreadsheets utilize 0.6? 0.7?

NRC Response: Page 9-6 explains the relationship. Xc = .5 on page 11-12 was an oversight and it has been corrected.

7. Comment: Average temperature criteria listed on page 17-3 (for a beam) is 1100F, while on page 17-6 it is listed as 1000F. Also, the maximum single point (for a column) is listed as 1200F on page 17-4 and in Table 17-2, while on page 17-6 it is listed as 1300F. Which of these are the correct criteria?

NRC Response: The differences account for whether or not the structural element is part of an assembly and if the protection of the element is carrying any of the load.

8. Comment: Example 6.11-2 utilizes Douglass Fir. The yellow box inputs (p. 6-22) show a CHF value of 21 and a TRP value of 368.5. From the spreadsheet listing, these values appear to be from "EPR, FR", not Douglass Fir.

NRC Response: This typo has been corrected.

9. Comment: The results of Example 12.12 -1 (page 12-14) indicate "10 minutes" while the spreadsheet on page 12-17 states 19.18 seconds.

NRC Response: This typo has been corrected.

10. Comment: The inputs for Example 13.9-1 (page 13-11) (e.g. vent height, interior lining thickness, material) do not match the spreadsheet inputs on page 13-12, which impacts the results on the following pages.

NRC Response: This typo has been corrected.

Tom Fernandez (DE Design, A&E)

1. Comment: There are some misspelled names such as Tanaka mispelled as Tanaks.

NRC Response: This typo has been corrected.

James R. Hutton, P.E., CSP (National Nuclear Security Administration)

1. Comment: Suggest you include algorithm for pool size in an unconfined fuel spill. In our training we told the inspectors to postulate differing size spills to do the calculation (manually loading the size of the spill) ~ as a user ~ what would you envision as an algorithm for this?

NRC Response: An algorithm and more detailed analysis of unconfined spills has been added to Chapter 3.

David J. Icove, PhD, (Tennessee Valley Authority Police)

1. Comment: The application of NRC's FDT methodology is probably the most significant contribution this decade to the fire hazard analysis field. Draft read well, was comprehensive, and consistent in each application.

NRC Response: The compliment is noted.

2. Comment: Consider a "tabbed" version for quick referencing.

NRC Response: NUREGs have a standard format which they follow. We encourage tabs to be added for more efficient use.

3. Comment: Color-coded output is important in the spreadsheet. Consider a sub-comment at the end of each spreadsheet to explain the role of each color.

NRC Response: The spreadsheets are intended to be used in conjunction with the NUREG manual. Explanations of each color coded output have been added where appropriate.

4. Comment: Consider a signature line or input variable capturing the preparer's name. The output from the spreadsheet could be a valuable appendix to a working report.

NRC Response: An area has been added to each spreadsheet for this function.

5. Comment: Consider some "graphic" showing the measurements, etc., for each calculation.

NRC Response: The spreadsheets were formulated using Microsoft Excel. This program does not support variable graphics of this nature. We encourage users to attach detailed drawings of the scenario if the output will be an appendix to a working report.

6. Comment: Make sure that SFPE Handbook (3rd Edition) is cited, where appropriate

NRC Response: The NUREG was originated using the 2nd Edition of the SFPE Handbook. We have made modifications to now adhere to the 3rd Edition and the citations have been changed where appropriate.

7. Comment: Consider additional reference, where appropriate, to Vito's "Ignition Handbook"

NRC Response: Every effort has been made to include as many references and suggested additional reading as we are aware of. We are open to reviewing any suggest work for applicability.

8. Comment: Consider a comprehensive index, glossary

NRC Response: A limited index has been added but, due to time restraints, will be elaborated on the next revision to the document.

9. Comment: We will need a "user's guide" that gives an overall foldout graphic showing the use of all of the applications. A generic problem at the center with examples surrounding might be an approach.

NRC Response: We will consider providing this at any training sessions we conduct.

10. Comment: Consider use of FDTs by fire investigators. Should I suggest it be introduced? Are you available to give a presentation at a regional fire investigation school?

NRC Response: This must be further discussed upon completion of the document after consulting with various sources at NRC.

11. Comment: Consider a "web site" for errata, updates, etc.

NRC Response: Any revisions and/or updates will be posted on the NRC website.

Nick Barilo (Bechtel Hanford, Inc.)

1. Comment: I recently downloaded a copy of your draft document NUREG-1805. I believe that you have done an excellent job of pulling together relevant information and packaging it into a usable document.

NRC Response: The compliment is noted.

Robert Toth (International Association of Arson Investigators)

1. Comment: As a fire investigator, the information that the FDT's could supply during a fire reconstruction are phenomenal.

NRC Response: The compliment is noted.

John Bryan, Ed.D (Fire Protection Engineering Professor Emeritus, University of Maryland)

1. Comment: What an encyclopedia. This is a monumental contribution to the fire protection engineering profession, and one of the most significant publications in the last decade. I hope Maryland uses portions of it for the applicable undergraduate and graduate courses.

NRC Response: The compliment is noted.

2. Comment: B-1 B.I.2, Par.. 2, line 6. delete "and combustible materials" replace with "and available combustible or flammable materials."

NRC Response: The recommended changes have been made.

3. Comment: B-4 Par. 4, fine 3. "over 90's" = "over the 1990's"

NRC Response: The recommended changes have been made.

4. Comment: B-10 Par. 1, line 4. "slop" = "slope" ; Par. 2, line 4. "incubation period of about 120 seconds" Don't understand when I look at Figure B-17, page B-12, the incubation period appears to be 400 to 800 seconds. I need a definition of "incubation period" or glasses or both.

NRC Response: The recommended changes have been made.

5. Comment: B-15 Par.2, line 3. delete "is used"

NRC Response: The recommended changes have been made.

6. Comment: B-17 Par. 1, line 1. "category to" = "category is to"

NRC Response: The recommended changes have been made.

7. Comment: B-19 New Par. after B.4.3 and before B.4.4. "NFPA 13 uses similar definitions with different meanings to refer to occupancies for the design of automatic sprinkler systems as "light hazard occupancies", ordinary hazard occupancies" and "extra hazard occupancies". Also NFPA 101 uses similar terminology to classify the hazard of the contents typically found in various occupancies as "low hazard", "ordinary hazard" and "high hazard". Hazard definitions are specific in the fire protection standards and codes relative to the scope and purpose of the documents." ; B.4.4 add the references for the new par. "NFPA 13, "Standard for Installation of Sprinkler Systems," 2002 edition, National Fire Protection Association, Quincy, Massachusetts, p.20.
"NFPA 101, "Life Safety Code," 2003 edition, National Fire Protection Association, Quincy, Massachusetts, p. 41.

NRC Response: The recommended changes have been made by adding an introduction to B.4.

8. Comment: B-22 Table B.5-1. Fire Class K, under "Extinguishing Agents" Add "Co2, Water, Wet chemical agents."
Reference: "NFPA 96. "Ventilation Control and Fire Protection of Commercial Cooking Operations", 2001 edition, National Fire Protection Association, Quincy, Massachusetts, p. 17. Underwriters Laboratories, "Fire Protection Equipment Directory," pp. 22, 118, 120.

NRC Response: The recommended changes have been made.

9. Comment: B-23 B.6.1, Par. 1, Line 1. delete "the most fire safety codes" "according to NFPA 30, Flammable Combustible Liquids Code, Par. 1, line 3. delete "are" replace with "may be" ; Par. 1, line 4. delete "Standard Method of Test for Flash Point by the Tag Closed Tester." Add after D56, "D92, D93, D1310, or D3278."

NRC Response: The recommended changes have been made.

10. Comment: B-29 Add references: "NFPA 96. "Ventilation Control and Fire Protection of Commercial Cooking Operations", 2001 edition, National Fire Protection Association, Quincy, Massachusetts.. Underwriters Laboratories, "Fire Protection Equipment Directory," 2003 edition, Northbrook, IL. Also references for ASTM D56, D92, D93, D1310, D3278 and the DOT regulation mentioned on page B-27, B.6.6, Par. 1, line 3.

NRC Response: The recommended changes have been made.

11. Comment: B-33 B.8 "Hazards" = "Hazards" ; B.8.1. Par. 2, line 3. "observed" = "observe ; Par. 3, line 2. Should "Explosive limits" be "Flammable limits" ? ; Par. 4, line I "The LEL" Add "When" = "When the LEL" delete "This" replace with "The mixture"

NRC Response: The recommended changes have been made. Explosive limits and flammable limits have very similar word meanings in this instance.

12. Comment: B-41 B. I 1. 1, Par. 1, line 1. delete "and NFPA I 0 1 (Life Safety Code)" Under Assembly, Par. 1, lines 3 & 4 delete "The Uniform Building Codes (UBC) and Standard Building Codes (SBC)" replace with "The International Building Code (IBC)"
Footnote: delete the three lines under "'Model Building Codes" replace with "International Code Conference' International Building Code (IBC) - National Fire Protection Association, NFPA 5000, Building Construction and Safety Code (BCSC)".

NRC Response: The recommended changes have been made.

13. Comment: B-42 Par. 1, line I & 3. Par 2, line 2. "(100 under the (SBC)" Don't have the IBC. If in IBC retain and change to IBC. if not delete. ; Par. 9, lines 4,5, 6. delete "the National Building Code(BOCA) and Standard Building Codes (SBCCI) and Hazardous by the Uniform Building Codes (ICBO)."' if valid in the IBC change to "International Building Code (IBC)" if not delete.

NRC Response: The recommended changes have been made.

14. Comment: B-43 11.3, Par. 1, line 9. "not" = "no"., "manufacturer" = "manufactured" no longer manufactured"

NRC Response: The recommended changes have been made.

15. Comment: B-44 Add references: "International Building Code," 2003 edition, International Code Conference, Falls Church, Virginia. NFPA 5000, "Building Construction and Safety Code," 2003 edition, National Fire Protection Association, Quincy, Massachusetts.

NRC Response: The recommended changes have been made.

16. Comment: B-45 12.1, Par.3, line 4. "systems" = "system" ; 12.2, Par. 1, line 2. delete "Standard" replace with "International"

NRC Response: The recommended changes have been made.

17. Comment: B-47 Table B. 12-1. delete and replace with attached Table.

NRC Response: The recommended changes have been made.

18. Comment: B-48 Add References: "International Building Code," 2003 edition, International Code Conference, Falls Church, Virginia. NFPA 5000, "Building Construction and Safety Code," 2003 edition, National Fire Protection Association, Quincy, Massachusetts.

NRC Response: The recommended changes have been made.

19. Comment: B-53 B.14.1, Par.3. line5. delete"is extremely toxic;"replace with "replaces the oxygen in the atmosphere:"

NRC Response: The recommended changes have been made.

20. Comment: B-59 Add new section 14.2.3 "Halon Replacement Agents" ; Par. 1, line 1. "The production of Halon 1301, 121 1, and 2402 ceased in 140 countries on January 1, 1994 as a result of The, Montreal Protocol on Substances that Deplete Stratospheric Ozone. There are approximately 13 gaseous replacement agents that have been developed and are commercially available. Table B. 14 -2 presents the commercial name, the trade name, the designation and the formula of these agents.
DiNenno has developed a compilation of the 9 common attributes of the replacement halocarbon clean agents as presented in Figure B. 14-3 (Add in the attached tables).

NRC Response: The recommended changes have been made.

21. Comment: B-59 References: NFPA 2001, "Standard on Clean Agent Fire Extinguishing Systems." 2000 edition, National Fire Protection Association, Quincy, Massachusetts. ; DiNenno, Philip J., "Direct Halon Replacement Agents and Systems," Section I 1, Chapter 2, NFPA Fire Protection Handbook, 19th. edition, A. E. Cote, Editor in Chief, National Fire Protection Association, Quincy, Massachusetts, 2003, pp. 11-21, 22.

NRC Response: The recommended changes have been made.

22. Comment: B-63 14.3.3 Par. 1, Line 2 & 3. "In fact, since 1975, accidents involving the discharge Of C02 fire suppression systems have resulted in a total of 64 deaths and 89 injuries". This data conflicts with the EPA data presented in Par. 3, Lines 3-5. delete or provide the reference for the data.

NRC Response: The recommended changes have been made.

23. Comment: B-70 Par. 5, line 2 "phosphate to do" = phosphate has to do"

NRC Response: The recommended changes have been made.

24. Comment: B-73 B. 16, Par. 1, line 2 "involving of" "involving" Par 2, line 2. "and while" = and" ; Par. 2, line 5. Add after "oil" "(boilover)" ; Par 2, line 7. Add after "the" "fire" = "the fire involves" ; Par. 3, line 1. Add after "fire fighting" "foam" = "fire fighting foam"

NRC Response: The recommended changes have been made.

25. Comment: B-74 16.2, Par. 1, line 6. "stopover" = "Boilover" ; line 8. After "asphyxiation" Add "of personnel or visibility and spacial limitations resulting in injury.".

NRC Response: The recommended changes have been made.

26. Comment: B-75 16.3, Par. 1, line 5. After "spills." Add "Subsurface application of low expansion foam to hydrocarbon storage tanks was developed in the 1960's and is now an NFPA recognized design procedure." ; line 8. Add after "devices," "except in the wildland fire situations involving class A fuels. The class A foams are generally used in concentration ratios with water of 0.1% to 1.0 %. The class A foam are used with hose line or monitor application from compressed air foam systems, air aspirating foam nozzles and conventional fog nozzles.

NRC Response: The recommended changes were not needed given the intended application of this NUREG.

27. Comment: B-76 Par. 3, line 6. "floating tanks" = "Floating roof tanks"

NRC Response: The recommended changes have been made.

28. Comment: B-77 Chemical Foam. Par. 1, lines 4 & 5. Reword after "confined to" "chemical foam portable extinguishers which are no longer listed by Underwriters Laboratories."

NRC Response: The recommended changes have been made.

29. Comment: B-77 Protein-Based Mechanical Foam, Par. 1, lines 4 & 5. delete "blood hydrolyzed by caustic soda." replace with "protein rich slaughter house byproducts for the foam stabilizing agent."

NRC Response: The recommended changes have been made.

30. Comment: B-80 Add reference: NFPA 1150, "Fire Fighting Chemicals for Class A Fuels in Rural, Suburban and Vegetated Areas," 1999 Edition, National Fire Protection Association, Quincy, Massachusetts."

NRC Response: The recommended changes have been made.

31. Comment: B-81 B. 17. 1, Par. 1, line 2. "at distance" = "at a distance" ; line 4 & 5. after "disoriented" delete "and panic thereby making it difficult to find escape routes." Replace with "suffer respiratory distress, often losing consciousness and physical mobility." ; line 7, After "than" delete "actual burning by the flames." Replace with "by the thermal exposure or flame impact."

NRC Response: The recommended changes have been made.

32. Comment: B-82 Par. 1, line 5. After "material." Add "One test protocol utilizes 4 mice rather than 6 rats and has a 10 minute post exposure period. This test protocol also cools the combustion gases and has a dynamic flow of the gases through the exposure chamber, rather than a static condition in the chamber."

NRC Response: The recommended changes were not needed given the intended application of this NUREG.

33. Comment: B-86 Add reference: "Clarke, Frederick B. "Toxicity of Combustion Products: Current Knowledge," Fire Journal, 77, 5, (September 1983), 84-97, 101, 108."

NRC Response: The recommended changes have been made.

34. Comment: B-88 Par. 2. line 3. "rate of thermal detectors" Don't know of this type of detector. Could be "rate of rise thermal detectors" or "rate compensated thermal detectors"'?

NRC Response: The recommended changes have been made.

35. Comment: B-89 Par. 4, line 13 & 14. "systems of oven or furnace chamber" = "systems for oven or furnace chambers"

NRC Response: The recommended changes have been made.

36. Comment: B-93, line 1. "Fire model" = Fire models .... .. fire model = fire models"

NRC Response: The recommended changes have been made.

37. Comment: B-96 Par. 2, line 3. "fine" = "finds"

NRC Response: The recommended changes have been made.

38. Comment: B-97 19.2.9 Par. 1, line 6. After "fires," add "except when under fire service operation and control."

NRC Response: The recommended changes were not needed given the intended application of this NUREG.

39. Comment: B-101 Table B. 19- 1, Par. 7, line 1. under Model Use, "JET" instead of "LET"

NRC Response: The recommended changes have been made.

40. Comment: B-102 Table B. 19- 1, Par. 5, line 3. under Model Use "The model includes" incomplete sentence.

NRC Response: The recommended changes have been made.

41. Comment: C-9 Par. 2, line 3. "During in this stage" = "During this stage"

NRC Response: The recommended changes have been made.

42. Comment: C-10 Table C.5-1, Par.. 5, under Term Symbol "T" = “t”

NRC Response: The recommended changes have been made.

43. Comment: C-13 Par. 2, Line 1. Delete "(NFPA 255, "Standard Method of Test of Surface Burning Characteristics of Building Materials".) Replace with "(NFPA 251., "Fire Tests of Building Construction and Materials")

NRC Response: The recommended changes have been made.

44. Comment: C-13 Add new Par. 2, under Fire Barriers. NFPA 251 provides for the evaluation of the fire resistance of building construction assemblies in a furnace exposure with the thermal exposure in accordance with the Standard Time-Temperature curve internationally adopted in 1917. Figure C.6-1 illustrates the Standard Time-Temperature test exposure curve. Figure C.6-2 presents
the ASTM El 19 (NFPA 25 1) test criteria for the fire resistance of walls, floors, ceilings/floors, ceilings/roofs and columns.

NRC Response: The recommended changes have been made.

45. Comment: C-15 & 16 Under NFPA 252, NFPA 257, NFPA 251, & UL 555 Do not understand use of term "Cellulosic fire" can not find the reference in the standards. All these test ratings are determined using the standard time- temperature curve in a furnace fueled by natural or propane gas.

NRC Response: The recommended changes have been made.

46. Comment: C-16 Par. 1, line 2. Delete "(NFPA 255, "Standard Method of Test of Surface Burning characteristics of Building Materials")" Replace with "(NFPA 251, "Fire Tests of Building Construction and Materials")"

NRC Response: The recommended changes have been made.

47. Comment: Add two Tables C.6-1 and C.6-2 (see attached)

NRC Response: The recommended changes have been made.

48. Comment: C-17 Table C.6-1 Title, delete "Resistance" from title or delete the non fire resistance tests in the Table: E84, E69, E136, E162, E648, E662" Table C.6-1 Most important fire resistant tests not included in Table: ASTM E119, ASTM E2010, and ASTM E2074. Add these tests to the table as follows: For E119 Under Org: "ASTM E119, NFPA 251 " under name: "Fire Tests of Building Construction & Materials" under sample: "Floor & ceiling, ceiling & roof, walls & partitions, columns" under property measured: "Fire resistance by thermal transmission, flame & hot gas passage, structural stability". For E2010 Under Org: "ASTM E2010, NFPA 257" under name: "Positive Pressure Fire Tests of Windows" under sample: "windows & glass block assemblies" under property measured: "retention in place" For E2074 Under Org: "ASTM E2074, NFPA 252" under name: "Fire Tests of Doors" under sample: "side hinged & pivoted swinging doors, sliding & overhead doors" property measured: “retention in place" ; Table C.6-1. Last test in table if retained in table delete "CPSC & related identification" and replace with "ASTM E970"

NRC Response: The recommended changes have been made.

49. Comment: C-18 Table C.6-2 Title, delete "Resistance" from title, none of the tests are "fire resistance tests"

NRC Response: The recommended changes have been made.

50. Comment: C-19 Table C.6-3. Title, delete "Resistance" from title, none of the tests are "fire resistance tests"

NRC Response: The recommended changes have been made.

51. Comment: C-21 Under "Test Standard" line 7. delete "ASTM E163A" replace with "ASTM E2010" ; Lines 16-20. delete "UBC numbers and UBC" replace with valid "IBC identification and numbers or delete." Line 22. Add "IOC" to "IOA/IOB" ; Line 27. After "UL555" add "UL 555C" Under title: add "Ceiling Dampers" Delete "and Ceiling Dampers" from line 26 "UL 555" ; Line

28. After "UL 555C" add "UL 555S" under title add "Leakage-Rated Dampers for use in Smoke Control Systems" ; Line 32. Add "UL 2079" under title add: "Tests for Fire Resistance of Building Joint Systems"

NRC Response: The recommended changes have been made.

52. Comment: C-22 Under "Test Standard" Lines 11-13 All "UBC" numbers obsolete, change to "IBC" numbers or delete

NRC Response: The recommended changes have been made.

53. Comment: C-23 Under "Test Standard" Line 23. "Boston Fire Dept. IX- I" under title "Classification Fire Tests of Fabrics" Not familiar with test. check validity of the listing here. If not valid replace with this listing, if valid add this listing: "Boston Fire Dept. IX- II" under title: "Mattresses, Portable Mattresses and Mattress Pads"

NRC Response: The recommended changes have been made. Boston Fire Dept. IX-I is a valid test standard which is similar to ASTM E119.

54. Comment: C-24 Under "Test Standard" lines 8-1 1. All "UBC" numbers obsolete, change to "IBC" numbers or delete.

NRC Response: The recommended changes have been made.

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ATTACHMENT 2

NFPA
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1 Batterymarch Park, Quincy, MA 02269-9101 USA
Phone: +1 (617) 770-3000 *Fax:* +1 (617) 770-0700 www.nfpa.org

March 26, 2002

Mr. Naeem Iqbal
United States Nuclear
Regulatory Commission
Washington, DC 20555-0001

VIA Facsimile
301-415-2300

Dear Mr. Iqbal:

This will confirm our telephone conversation of this afternoon regarding your request for permission to reprint material from the 18th Edition of the Fire Protection Handbook.

I have reviewed the several figures that you would like to copy. By themselves they do not constitute a great quantity of material and in most circumstances I would have no problem giving you permission to copy all of them. However, as we discussed, with the exception of Figures 5-2A and 6-9C, the remaining figures were provided to the NFPA through the courtesy of outside organizations. Each organization is named in the caption under the figure. I do not feel that NFPA has the authority to grant you the permission that you seek to use these. It would be my suggestion that you go to the various manufacturers and request permission. If a particular manufacturer gives consent to use, then you do not have to come back to seek my permission.

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I am sorry that I could not give you the full permission that you requested.

Should you have any questions with regard this permission please do not hesitate to contact me at this office.

Very truly yours,

Dennis J. Berry
Associate General Counsel

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 28, 2003

Mr. Matthew Wolff
CRC Press LLC
2000 NW Corporate Boulevard
Boca Raton, Florida 33431

SUBJECT: PERMISSION FOR REPRODUCTION OF TABLES FROM THE ENCLOSURE FIRE DYNAMICS

Dear Mr. Wolff:

The purpose of this letter is to request your permission for reproduction of certain tables from the Enclosure Fire Dynamics by Karlsson and Quintiere, 1999, as reference in the U.S. Nuclear Regulatory Commission's NUREG-1805 report. The intent of this NUREG report is to assist NRC regional inspectors in understanding fire dynamics principles while performing fire protection inspections in the U.S. nuclear power plants.

We would request your permission to reprint the following tables from Enclosure Fire Dynamics:

Chgapter 3 - Table 3.1
Chapter 3 - Wooden Pallets Data from Table 3.6

If you have any questions, please feel free to contact me (301) 415-2870 or Naeem Iqbal (301) 415-3346 or Mark Salley (301) 415-2840 of my staff.

Sincerely,

Sunil Weerakkody, Chief
Fire Protection Engineering Section
Plant Systems Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation
Fax: 301.415.2300

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08/20/2004

Naeem - Iqbal
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Mail Stop O11 A11
11555 Rockville Pike
Rockville, Maryland 20852-2738

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November 3, 2003

Sunil Weerakkody, Chief
Fire Protection Engineering Section
U.S. Nuclear Regulatory Commission
Washington, DC, 20555-0001

Mr. Weerakkody:

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Sincerely,

Morgan J. Hurley, P.E.
Technical Director

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Mildred Geshwiler
Editor, Special Publications

E-mail mgeshwiler@ashrae.org

November 4, 2003

Chief Sunil Weerakkody
Nuclear Regulatory Commission
Fire Protection Engineering Section
Mailstop O-11, A-11
Washington, D.C. 20555-0001

Dear Chief Weerakkody,

Subject: Copyright Reprint Permission Request

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Sincerely,

M. Geshwiler

Mildred Geshwiler

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 28, 2003

Mildred Geshwiler
American Society of Heating, Refrigerating and
Air-Conditioning Engineers, Inc.
1791 Tullie Circle, N.E.,
Atlanta, Georgia 30329-2305

SUBJECT: PERMISSION FOR REPRODUCTION OF TABLES FROM THE PRINCIPLES OF SMOKE MANAGEMENT

Dear Mr. Geshwiler:

The purpose of this letter is to request your permission for reproduction of certain tables from the Principles of Smoke Management by Klote and Milke, 2002, as reference in the U.S. Nuclear Regulatory Commission's NUREG-1805 report. The intent of this NUREG report is to assist NRC regional inspectors in understanding fire dynamics principles while performing fire protection inspections in the U.S. nuclear power plants.

We would request your permission to reprint the following tables from the Principles of Smoke Management:

Chapter 3 - Table 3.5
Appendix A - Table A-10

If you have any questions, please feel free to contact me (301) 415-2870 or Naeem Iqbal (301) 415-3346 or Mark Salley (301) 415-2840 of my staff.

Sincerely,

Sunil Weerakkody, Chief
Fire Protection Engineering Section
Plant Systems Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

West Yard House, Guildford Grove,
Greenwich, London SE10 8JT, UK

Tel: +44 20 8692 5050
Fax: +44 20 8692 5155
e-mail intercomm@dial.pipex.com

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Fax

To: Sunil Weerakkody **From:** Carole Franks, Conference Director

Org: US NRC **Pages:**

Fax: **Date:** 22 December 2003

Ref: Permission to use figures from 8th International Interflam conference

☑ **Urgent** ☐ **For Review** ☐ **Please Comment** ☐ **Please Reply** ☐ **Please Recycle**

Dear

Mr Weerakkody

Thank you for your letter dated 28th October which has just arrived here – I suspect it was not stamped Airmail and came by the scenic route!

There is of course not problem about using the figures by Garrad and Smith. All we ask is if appropriate there is a reference cited to the authors, Interscience and Interflam.

Thank you and kind regards,

Carole Franks

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1 Batterymarch Park, Quincy, MA 02169-7471 USA
Phone: +1 (617) 770-3000 *Fax:* +1 (617) 770-0700 www.nfpa.org

November 6, 2003

Sunil Weerakkody, Chief
Fire Protection Engineering Section
United States Nuclear Regulatory Commission
Washington, D.C. 20555-0001

RE: Fire Protection Handbook
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Dear Chief Weerakkody:

This is in response to your letter dated October 28th to Arthur Cote, in which you have requested permission to reproduce NFPA material.

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Very truly yours,

Dennis J. Berry
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12 January 2004

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Mr Sunil Weerakkody
Fire Protection Engineering Section
Plant Systems Branch
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My apologies for the delay in responding to your request.

Yours sincerely,

K J Butcher
Editorial Manager

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