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

July 12, 2001

MEMORANDUM TO: Mark Satorius, Chief
Performance Assessment Section
Inspection Program Branch
Division of inspection Program Management
Office of Nuclear Reactor Regulation

FROM: August K. Spector, Communication Task Lead
Inspection Program Branch
Division of Inspection Program Management
Office of Nuclear Reactor Regulation

SUBJECT: REACTOR OVERSIGHT PROCESS SUMMARY OF PUBLIC MEETING HELD ON July 12, 2001

On July 12, 2001a public meeting was held at the NRC Headquarters, Two White Flint North, Rockville, MD to discuss and review the initial implementation of the revised reactor oversight process. An agenda, attendance list, and information exchanged at the meeting are attached. The following dates were established for future meetings: August 15, 2001.

Attachments:

1. List of Participants
2. Agenda
3.ROP Working Group, Status of Physical Protection Cornerstone Initiatives
4.Occupational Radiation Safety SDP Information
5. Fire Protection SDP Advancements, Fire Dynamic Scenario Development Calculation Tool
6. Strawman for Discussion, Licensee self-assessment process
7. Reactor Power Reductions per 7000 Critical Hours, Draft
8. IE 03 Power Change Indicator Comparison Venn Diagram
9. Frequently Asked Question Log # 15, 16, 18, 19, 20, 21, 23

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OFC:	DIPM/IIPB					
NAME:	ASpector A. Spector					
DATE:	7/ 23 /01					

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NRC Public Meeting
Reactor Oversight Process
List of Participants
July 12, 2001

D. Hickman, NRC.
A. Madison, NRC
M. Johnson, NRC
M. Satorius, NRC
S. Ferrel, TVA
P. Loftus, COMED
R. Frahm, NRC
L. Whitney, NRC
T. Reis, NRC
T. Houghton, NEI
R. Ritzman, PSEG
M. Taylor, Exelon
A. Spector, NRR
L. Sueper, NMC
R. Huston, LSS
D. Raleigh, Scienteck
A. Halliday, Entergy
L. Nicholson, Duke
S. Ketelsen, PGE
C. Nolan, NRC
B. Palla, NRC
R. Boyce, NRR
F. Gillespie, NRR
D. Skeen, NRC
M. Cox CCNPPI
S. McCord, CCNPPI
T. Grover, CCNPPI
V. Ordaz, NRC
P. Koltay, NRR
S. Sanders, NRR

N. Iqbal, NRC
E. Weiss, NRC
J. Hannon, NRC
M. Singer, NEI
R. Rasmussen, NRC
G. Gibson, SCE
G. Cavahaugh, OPPD
G. Gibson, SCE
D. Hembree, IWPO
B. Passarelli, NRC
M. Salley, NRC
L. Hendricks, NEI
D. Waters, NEI
R. Rose, NEI

Attachment 1

AGENDA
ROUTINE ROP PUBLIC MEETING
7/12/2001

8:00AM	Welcome & Confirm Agenda	Alan Madison
8:10AM	WebPage Changes	Conchita See Ron Frahm
8:20AM	Initiating Event PI Replacement	Mike Johnson
8:45AM	Unplanned Power Changes PI Replacement	Don Hickman
9:00AM	Consolidated SDP Changes ALARA Fire Protection	Peter Koltay Roger Pedersen Mark Salley
10:30AM	Impact of Old Design Issues	Mike Johnson Bob Pascarelli
11:00AM	Credit for Licensee Self-Assessment	Steve Floyd
11:30AM	Monthly Operating Report	Frank Gillespie
12:00PM	Lunch	
1:00PM	Discussion & Resolution of FAQs	
3:00PM	Safeguards Issues (SDP/PI, etc.)	Terry Reis
4:00PM	Adjourn	

Attachment 2

ROP WORKING GROUP

Status of Physical Protection Cornerstone Initiatives

July 12, 2001

Attachment 3

Attachment 3

Physical Protection Cornerstone Action Plan

- Physical Protection Cornerstone Initiatives
  - Complete Inspection Procedure revisions-8/01
  - Complete SPA Inspection Procedure-9/01
  - Finalize PPSDP-01/02
  - Address PI issues-3/02
  - Revise inspection procedures to be in alignment with revised 73.55-06/03

All dates are tentative

SPA

- Commission SRM on SPA – July 5, 2001
- Public meeting on SPA – July 11, 2001
- Complete draft SPA inspection procedure (IP) – July 2001
- Issue draft SPA IP for regional comment (publicly available) – July 2001
- Incorporate comments on draft SPA IP – August 2001
- Public meeting on SPA Pilot Program Implementation Details – August 2001
- Issue SPA IP to support SPA pilot program – September 2001
- SPA Pilot Program – September 2001 to September 2002
- SPA Pilot Lessons Learned Evaluation Commission Paper – December 2002

PPSDP

- Establish lessons learned from interim PPSDP-7/01-08/01
- Public Meeting to Discuss Options for final PPSDP-08/01
- Develop Draft PPSDP-10/01
- Public Meeting(s) to Discuss Draft PPSDP –11/01
- Publish Final PPSDP – 01/02

- All dates are tentative

Inspection Procedures & New Rule

- Draft IPs to align with proposed rule
- Solicit internal stakeholder comments
- Revise procedures based on proposed final rule
- Solicit comments from external stakeholders
- Publication of revised procedures – 06/03

- All dates are tentative

Performance Indicators

- PIs Satisfactory for Interim
  - Have improved equipment performance
  - Are capable of identifying some program flaws
- PIs should be improved for long-term
- PI changes should be commensurate with revised rules

Performance Indicators

- PI #1 – Equipment Availability
- Shortcomings
  - The indicator does not meet its stated purpose of monitoring equipment unavailability
  - PI favors facilities with few zones of either IDS or CCTV due to normalization factor
  - Averaging of IDS/CCTV can mask problems in one of the areas

Performance Indicators

- PI # 2- Personnel Screening Program
- PI is simply the number of reportable events
- Shortcomings
  - Can only indicate broad, programmatic concerns
  - Reportability is not consistent
  - May provide indication of significant events, but provides no indication of program implementation pursuant to regulations

Performance Indicators

- PI #3 – Fitness for Duty
- PI is simply number of reported failures
- Shortcomings
  - Reporting requirements only provide information the system is working
  - Reporting requirements flawed – programmatic breakdown not reportable

Performance Indicators

- Going Forward
  - Reestablish working group to analyze and revise PIs as necessary
  - Timetable to be established – aligned with rule changes as appropriate

FAQ 20.4 PPO1

- **Question:**

Scheduled Equipment Upgrade

During a recent NRC Security Inspection (IP 71130.03) NRC Contractors were able to defeat the Intrusion Detection System (IDS) in several areas by using assisted jumps. An engineering evaluation was issued and formal modification/upgrade action was initiated that directed the installation of additional razor wire to prohibit attempts to circumvent the IDS system without being detected. Is a physical modification to a protected area boundary, that is designed to prohibit the defeat of the IDS component considered to be a system /component modification upgrade as stated in the Clarifying Notes under Scheduled Equipment Upgrade (as augmented by FAQ 259)

Response:

A modification such as that described above would be considered a system/component modification or upgrade because the razor wire barrier is acting as an ancillary system. The hours would stop being counted when the modification/upgrade was formally initiated as defined in the Scheduled Equipment Upgrade paragraph of NEI 99-02, Rev. 1

Lessons Learned Public Workshop, March 26-28, 2001

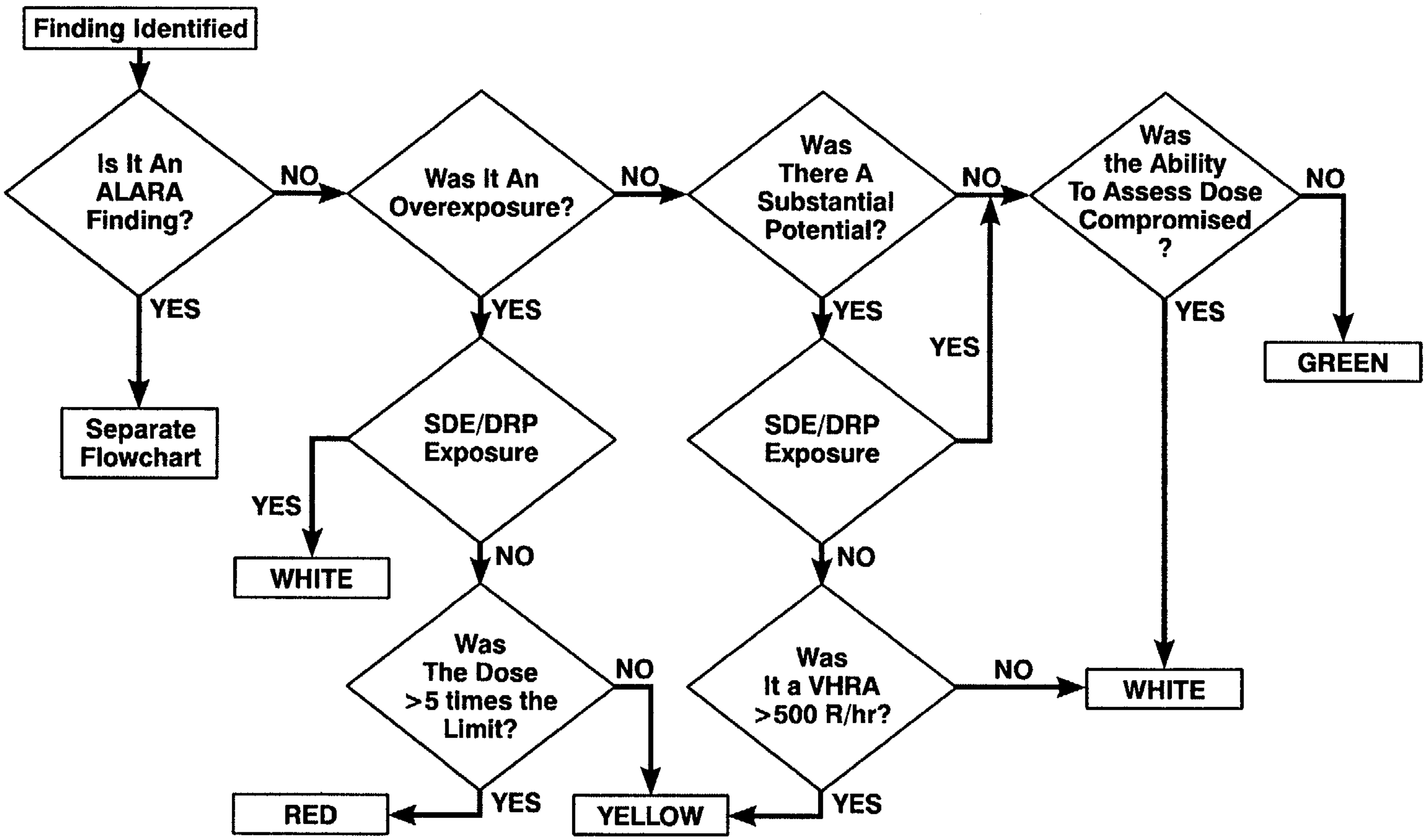
Follow-up Public Stakeholder Meetings, April - June, 2001

- April 24 th - Occupational and Public Rad Safety Issues
- May 9 th* & 29 th* - ALARA Assessment Issues
- June 8 th* - NEI Task-force/Stakeholder Meeting

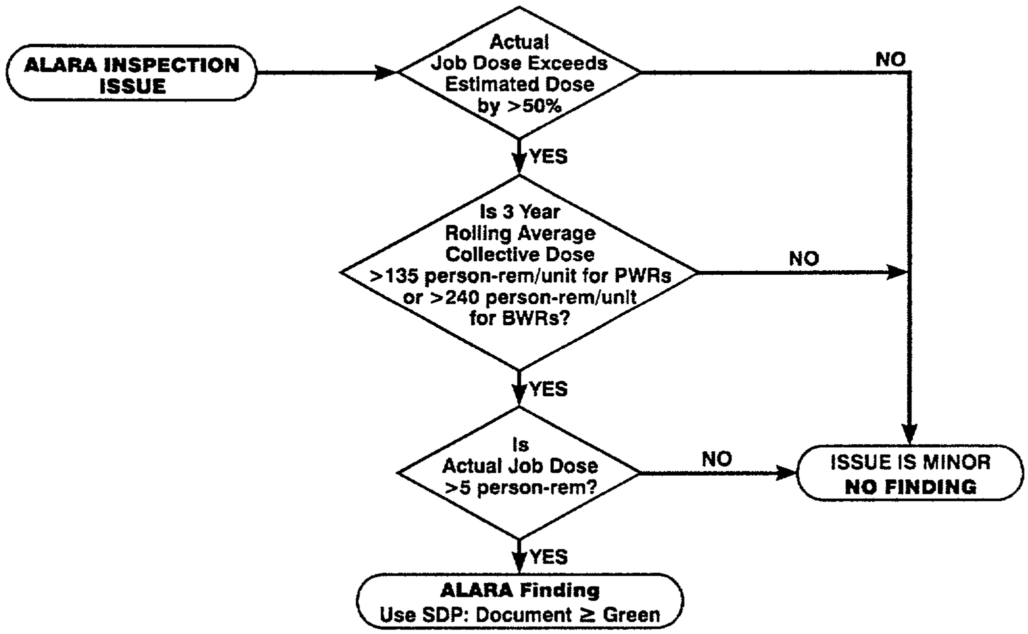
* Meetings Video-Conferenced with Regional Offices

Attachment 4

Occupational Radiation Safety SDP
(Proposed Version)

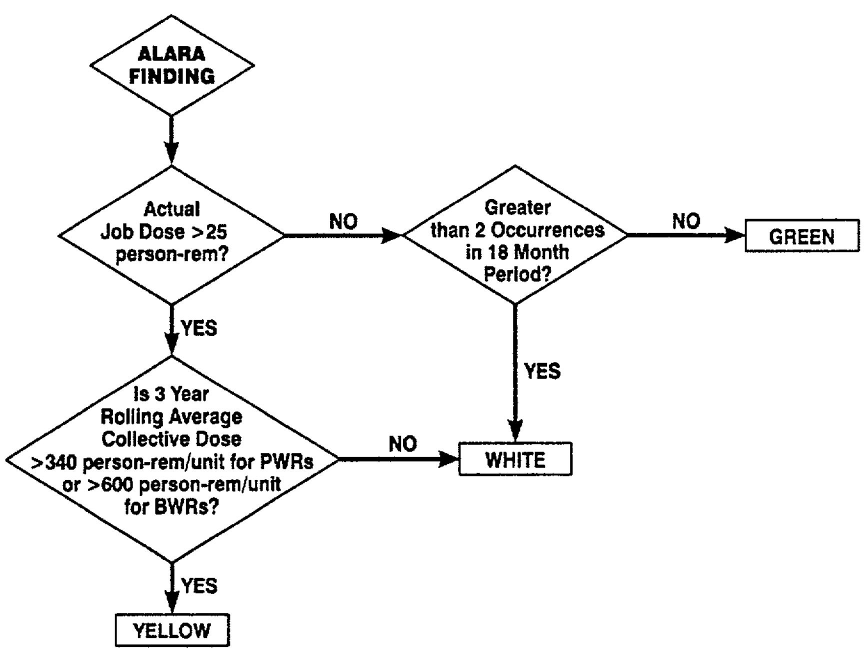


ALARA Group 2 Screening Questions



Logic for designating an ALARA inspection issue as an ALARA finding or as a minor issue.

Occupational Radiation Safety SDP - ALARA Branch



PROPOSED ALARA ASSESSMENT CHANGES

- Provide variable level of effort for ALARA Baseline Inspection based on Rolling 3 Year Average (R3YA) Collective Dose.
- Revise MC 0610* Group 2 Screening question to clarify that the basis of an ALARA finding is a program failure that results in "unplanned/unintended" collective dose for a "work activity."
- Move "> 5 person-rem" and "> 50% unplanned dose" criteria in current Group 2 question to guidance on Group 1 questions.
- Revise SDP
  - Plants with R3YA below criteria: No higher than GREEN finding.
  - Delete possibility of YELLOW finding.
- Articulate basis for GREEN and WHITE findings

INSPECTION GUIDANCE IN IP 71121 - “MORE THAN MINOR” (GROUP 1 QUESTIONS)

1) Did the unplanned, unintended collective dose exceed the planned, intended dose by greater than 50%?

2) Is the issue associated with a work activity with a total collective dose greater than 5 person-rem?

If the answer to both of these questions is YES, then the issue is more than minor and should pass the Group 1 screening in MC 0610*.

GROUP 2 QUESTION 1
UNDER OCCUPATIONAL RADIATION SAFETY

Does the occurrence involve a failure to establish, maintain, or implement, to the extent practical, procedures, or engineering controls, needed to achieve occupational doses that are ALARA*, and that resulted in unplanned, unintended occupational collective dose for a work activity?

Footnote:

***A "Yes" answer to this question does not necessarily indicate a violation of the requirement in 10 CFR Part 20.1101 (b). Compliance will be judged on whether the licensee has incorporated measures to track and, if necessary, to reduce exposures (e.g., whether the findings indicate an ALARA program breakdown).**

DEFINITIONS

Unplanned, unintended occupational collective dose: The total sum of the occupational radiation doses (collective dose) received by individuals for a work activity in excess of that collective dose planned and intended (e.g., that dose the licensee determined was ALARA) for that work activity. Examples of planned and intended collective dose include;

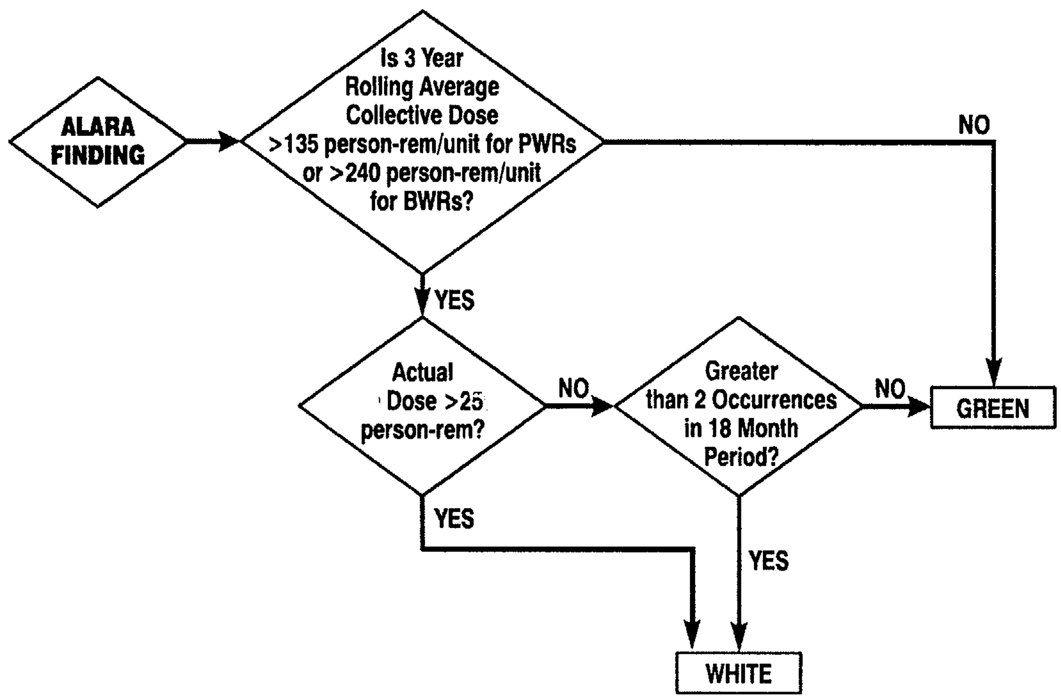
1) realistic dose estimates (or projections)* established in the ALARA planning, or

2) the dose expected by the licensee (i.e., historically achievable) for the reasonable exposure control measures specified in ALARA planning.

* These do not include "stretch goals" set by a licensee to challenge their organization to strive for excellence in ALARA performance.

Work activity: One or more closely related tasks that the licensee has identified as a unit of work for the purpose of ALARA planning and work controls.

Occupational Radiation Safety
SDP - ALARA Branch
(Proposed Version)



Fire Protection SDP Advancements

"Fire Dynamic - Scenario Development"

Calculation Tool

July 12, 2001

Mark Henry Salley,

Naeem Iqbal,

NRC/NRR/SPLB

Attachment 5

Items to cover:

- Background
- Current Philosophy
- Future Direction
- Questions/Comments

FIRE PROTECTION HANDBOOK

EIGHTEENTH EDITION

NFPA®

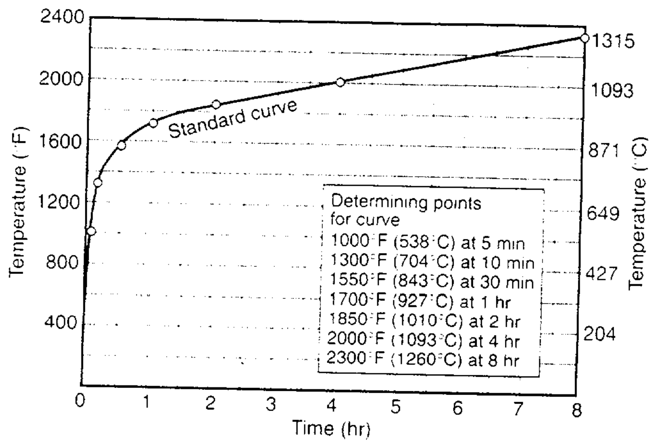


FIG. 7-5A. The standard time-temperature curve.

combustion, respectively. The maximum rate of heat transfer into fire separation barriers occurs at the point where the ventilation is just sufficient so that combustion is controlled at the fuel surface.[3] At higher ventilation rates, more heat is removed from the fire by the excess air. At lower ventilation rates, the combustion heat-release rate is less, and more unburned pyrolysis products and fuel particles are vented outside the fire area. Burning of unburned pyrolysis products outside fire compartment windows can increase the threat of floor-to-floor and building-to-building fire spread.

The possibility of failure of fire separation barriers can exist long after the fully developed fire begins to decay. However, in many real fire situations, this threat is mitigated by fire suppression activities. The decay in air temperature in a fire room has been reported as 27 to 36°F (15 to 20°C) per minute after fully developed fires of 10- to 15-min duration. Other data indicate a decay rate of 18°F (10°C) per minute for longer duration fires.[4] Cooling can be even slower in large debris piles. Fire-endurance testing in the United States does not simulate a fire decay period, although the decay period is simulated by some European testing and has been proposed in U.S. testing.

Poorly ventilated fires that are encountered in spaces such as basements, ship holds, or enclosed interior rooms often produce sufficient heat over a long period of time to penetrate separation barriers. These fires typically start with flaming combustion and, as the air in the space is consumed, revert to a state of mixed smoldering and glowing combustion with isolated or intermittent flaming. However, at present, there is no adequate experimental data or theoretical approach capable of reliably estimating the effect of these fires on fire-resistive barriers.

Standard Time-Temperature Curve

Fire-resistive barriers are evaluated in a testing furnace by exposure to a fire whose severity follows a time-varying temperature curve known as the standard time-temperature curve. The specified time-temperature history is tabulated in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*, and illustrated in Figure 7-5A. The standard time-temperature curve was adopted by the American Society for Testing and Materials (ASTM) in 1918 and has been the basis of almost all fire-resistive testing ever since.

Following adoption of the curve, the National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards (NBS), conducted a number of full-scale fire tests to determine how actual building fires compared with the temperatures represented on the curve.[5-7] The tests included two actual buildings that were allowed to burn to destruction and a series of fires in fire-resistive test buildings containing contents representative of office, record room, and household occupancies.

The principal variable considered in these occupancy fire tests was the amount of combustible materials present, which is defined as the fire load. Although the ventilation in the test buildings was not reported, the windows were equipped with steel shutters that could be adjusted to control ventilation and maximize fire severity. The quantitative importance of ventilation on fire severity was not identified until more than twenty-five years after these tests. These tests conducted by NIST provided quantitative data on the temperature history of fires that were representative of various occupancies and fire load at that period of time. Fire load was expressed as the weight of ordinary combustibles in the room divided by the floor area of the room. Loading is the average amount of ordinary combustible material per square foot (m^2) of floor area. The temperature history of the fully developed fires in three test occupancies was approximately bounded by the standard time-temperature curve.

NIST developed the concept of equivalent fire severity to define the severity of actual fires that had various temperature histories. This concept states that the area above a baseline under the time-temperature curve of a test fire, which is expressed in degree hours, is an approximate representation of the severity of a fire involving ordinary combustibles. The baseline used represents the temperature the materials can be exposed to without impairing their fire-resistive capabilities. Two fires with differing temperature histories are considered to have equivalent severity when the areas under their time-temperature curves are similar. This concept permitted comparison of any fire test data to the standard time-temperature curve by relating the area under the test curve to the area under the standard curve.

FIRE LOAD

The original concepts of fire severity and fire load are very important even though they are technically obsolete. These concepts are the basis for many of the fire-resistance requirements of building codes and for government agencies. In many cases, this original fire severity/fire load relationship was more severe than is indicated by more accurate analysis. Such results are conservative since the resultant error is on the safe side.

Analysis of NIST tests developed an approximate relationship between fire loading and an exposure to a fire severity equivalent to the standard time-temperature curve. The weight per square foot (m^2) of ordinary combustibles [wood, paper, and similar materials with a heat of combustion of 7,000 to 8,000 Btu per lb (16,282 to 18,608 J/kg)] was related to hourly fire severity, as described in Table 7-5A.

The fire severity/fire load relationship was the first method developed to predict the severity of a fire that would be anticipated in various occupancies. It was used to determine resistance required of fire barriers as well as structural components. Although the technique has its limitations, the fire severity/fire load relationship still provides an approximate but conservative estimate of the probable maximum fire severity with combustibles having a high heat-release rate and when fire conditions can produce temperatures significantly higher or lower than the standard time-temperature curve.

Fire load is a measure of the maximum heat that would be released if all the combustibles in a given fire area burned. Maximum heat release is the product of the weight of each combustible multiplied by its heat of combustion. In a typical building, the fire load includes combustible contents, interior finish, floor finish, and structural elements. Fire load is commonly expressed in terms of the average fire load, which is the equivalent combustible weight divided by the fire area in square feet (m).

TABLE 7-5A. *Estimated Fire Severity for Offices and Light Commercial Occupancies*

(Data applying to fire-resistive buildings with combustible furniture and shelving)

Combustible Content Total, Including Finish, Floor, and Trim (lb/sq ft)	Heat Potential Assumed* Btu per sq ft	Equivalent Fire Severity Approximately Equivalent to That of Test under Standard Curve for the Following Periods
5	40,000	30 min
10	80,000	1 hr
15	120,000	$1\frac{1}{2}$ hr
20	160,000	2 hr
30	240,000	3 hr
40	320,000	$4\frac{1}{2}$ hr
50	380,000	7 hr
60	432,000	8 hr
70	500,000	9 hr

*Heat of combustion of contents taken at 8,000 Btu per lb up to 40 lb/sq ft; 7,600 Btu per lb for 50 lb; and 7,200 Btu for 60 lb and more to allow for relatively greater proportion of paper. The weights contemplated by the table are those of ordinary combustible materials, such as wood, paper, or textiles.
For SI units: 1 lb/sq ft = 4.9 kg/m²; 1 Btu/sq ft = 1.14 J/m².

Equivalent combustible weight is defined as the weight of ordinary combustibles having a heat of combustion of 8,000 Btu per lb (18,608 J/kg) that would release the same total heat as the combustibles in the space. For example, the equivalent weight of 10 lb per sq ft (48.8 kg/m²) of a plastic with a heat of combustion of 12,000 Btu per lb (27,912 J/kg) would be:

10 lb per sq ft × 12,000 Btu per lb = 120,000 Btu per sq ft

120,000 Btu per sq ft ÷ 8,000 Btu per lb ordinary combustibles = 15 lb per sq ft

Technically accurate methods for calculating the actual fire severity and fire-resistance requirements are available for many common building-occupancy-contents combinations. Technical limitations are primarily related to availability of input data rather than the analytical tools. These methods have been accepted to varying degrees under performance-based building codes adopted in some countries. Such analytical approaches have not been widely or routinely accepted by code authorities in the United States.

Occupancy Fire Load

A number of surveys have identified the fire loads found in various occupancies.[5-8] (See Tables 7-5B and 7-5C.)

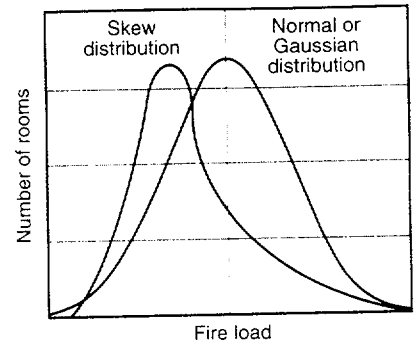


FIG. 7-5B. Expected distributions of sample fire loads.

Data from some fire-load surveys as well as the inherent nature of combustible contents likely to be encountered suggest that the dispersion of fire load within a certain class of rooms can be approximated by either a normal or moderately skewed frequency distribution curve. (See Figure 7-5B.) The standard deviation, included in Tables 7-5B and 7-5C, can be used to determine the probability that a particular fire-load value will not be exceeded in a class of rooms. A fire load that is one standard deviation above the mean value of a normal distribution curve would represent an upper boundary for 84.13 percent of the fire loads in rooms of that class. Two standard deviations above the mean would bound 97.73 percent of the fire loads in that class of rooms, and three standard deviations, 99.86 percent of the fire loads. Thus, if a fire barrier were to be designed on the basis of two standard deviations above the mean, there would be a 97.73 percent probability that this fire load would not be exceeded in a similar room.

The above percentages are exact only if the distribution of fire loads is perfectly normal. If the distribution is more accurately defined by a moderately skewed curve, the percentages only represent close approximations.

Derated Fire Loads

Ordinary combustibles that are completely or largely enclosed in steel containers will not burn completely during a room fire and therefore will not contribute a full 8,000 Btu per lb (18,608 J/kg) to the fire load. The General Services Administration (GSA) has developed guidelines for determining a derated fire load for office buildings, which can be applied to other occupancies having similar classes of combustibles.[9] The total contents fire load is divided into three categories: (1) weight of materials completely enclosed

TABLE 7-5B. *Characteristic of Fire Loads in Office Buildings*

	Government Buildings			Private Buildings		
		Total Fire Load (lb/sq ft)			Total Fire Load (lb/sq ft)	
Room Use	No. of Rooms Sampled	Mean	Std. Dev.	No. of Rooms Sampled	Mean	Std. Dev.
General	342	7.3	4.4	479	7.7	4.3
Clerical	77	5.8	5.2	146	6.8	4.0
Lobby	15	2.6	1.4	45	5.0	4.2
Conference	39	4.2	6.1	57	5.9	4.6
File	10	17.9	11.9	20	16.2	12.9
Storage	35	11.7	19.2	77	13.2	11.7
Library	2	30.2	7.8	10	23.6	10.8

NOTES: Fire in steel enclosures. Weight of combustibles was converted to an equivalent weight of combustibles having a heat of combustion of 8,000 Btu/lb.
For SI units: 1 lb/sq ft = 4.88 kg/m²

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adequately satisfied. This capability assessment should consist of a review of the plant's technical specifications (TS) and administrative control practices, outage planning and assessment processes, and discussions with plant outage and operations staff. A review of fire protection system operability requirements and transient combustible control programs should be performed to identify practices during shutdown modes. Compliance strategies for achieving the nuclear safety performance criteria can include one or more of the following:

(1) Verifying vulnerable area free of intervening combustibles while on shutdown cooling

(2) Providing fire patrols at periodic intervals when in periods of increased vulnerability due to postulated equipment out of service and physical location of equipment and cables

(3) Staging of backup equipment, repair capabilities, or contingency plans to account for increased vulnerability

(4) Prohibition or limitation of work in vulnerable areas during periods of increased vulnerability

(5) Verification of operable detection and/or suppression in the vulnerable plant areas during periods of increased vulnerability

(6) Verifying that the quantity of combustible materials in the area remains below the heat release level that would challenge equipment required to maintain shutdown cooling

Appendix C Application of Fire Modeling in Nuclear Power Plant Fire Hazard Assessments

This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 Fundamental Principles. Fire modeling is one method used to approximate the conditions within an enclosure as a result of an internal fire. This technique typically involves a mathematical description of a fire scenario and the physical parameters of the enclosure. The estimated effects of the fire conditions within the enclosure are the typical output.

Fire models can be used as engineering tools to assist in the development of a performance-based design. The models themselves do not provide the final solution, but rather assist engineers in selecting the most appropriate fire protection systems and features for a performance-based design. The models are based on the physics that attempt to describe the fire phenomenon. The proper selection and application of fire models is an important part of this process and requires the engineer to be familiar with model features and limitations.

The engineer performing the analysis should have, at minimum, a basic understanding of fire dynamics to effectively utilize a fire model in a nuclear power plant and to employ the results. Fire models, whether single equations, zone, finite element, or field models, are based on the conservation equations for energy, mass, momentum, and species. A conceptual understanding of the conservation equations is necessary to effectively understand and utilize the various fire modeling techniques. The nondimensional conservation equations can be written in vector form as follows:

Energy:

$$\left[\omega\rho\left(\frac{\partial}{\partial t}\right)+(\rho v\bullet\nabla)\right]\left[\left(\int C_p dT\right)+\alpha\Sigma hY+\left(\gamma-\frac{1}{\gamma}\right)M^2\left(\frac{v^2}{2}\right)\right]=$$

$$\left(\gamma-\frac{1}{\gamma}\right)\omega\left(\frac{\partial\rho}{\partial t}\right)+\nabla\bullet\frac{(\lambda\nabla T)}{PR}-\alpha\Sigma h[\nabla\bullet(\rho YV)]$$

$$+\frac{(\nabla\bullet q)}{B}+\frac{(\gamma-1)}{\gamma}\left(\frac{M^2}{R}\right)\nabla\bullet(v\bullet S)$$

$$+\frac{(\gamma-1)}{\gamma}\left(\frac{M^2}{F}\right)(\rho v\bullet f-\rho\Sigma YV\bullet f)$$

Mass:

$$\omega\left(\frac{\partial\rho}{\partial t}\right)+\nabla\bullet(\rho v)=0$$

Momentum:

$$\omega\left(\frac{\partial\rho v}{\partial t}\right)+\nabla\bullet(\rho vv)=-\frac{(\nabla p)}{M^2}+\frac{(\rho f)}{F}+\frac{(\nabla\bullet S)}{R}$$

Species:

$$\omega\left(\partial\frac{(\rho Y)}{\partial t}\right)+\nabla\bullet(\rho vY)=-\nabla\bullet(\rho YV)+\Sigma vDf(p,T)e^{-\beta/T}$$

$$\times\Pi X^n\left[1-\left(g\frac{(p,T)}{K}\right)e^{-\gamma/T}\Pi X^{m-n}\right]$$

where:

ω = ratio of flow time to evolution time
ρ = density
t = time
v = velocity vector
p = pressure
M = Mach number
f = body force per unit mass
F = Froude number
R = Reynolds number
C_p = specific heat
α = nondimensional heat release
h = enthalpy of formation
Y = mass fraction
X = mole fraction
γ = ratio of specific heat at constant pressure to specific heat at constant volume
λ = thermal conductivity
P = Prandtl number
V = diffusion of species
q = radiant energy flux
S = shear stress
T = temperature
B = Boltzmann number
D = Damkohlet number
v = stoichiometric coefficient
β = activation energy
m = order of backward reaction
n = order of forward reaction
f_k = nondimensional pressure and secondary temperature dependencies of foward rate at step k
g_k = nondimensional pressure and secondary temperature dependencies of equilibrium constant at step k
K = nondimensional equilibrium constant

Fire models are divided into two broad classifications: physical fire models and mathematical fire models. Physical fire models typically experiment with the ability of reducing the physical fire phenomena into simpler physical parameters.

Mathematical fire modeling generally employs a series of equations that attempt to predict the fire behavior in a physical system. Many of the currently available fire models are a combination of these two classifications. Simplified versions of some of the above equations in scalar form (usually the energy or mass equations), with empirical correlation for some phenomena (such as the air entrainment into the fire plume), provide the basis for most fire modeling methods. In most models the heat release rate (HRR) and growth of the fire over time is entered directly by the user. This parameter typically has the most significant impact on the results of the fire model; therefore, the selection of representative heat release rate characteristic (i.e., design fire) is critical in obtaining valid predictions for a potential fire environment. Likewise, many of the fire models have internal assumptions/simplifications that are necessary for the model to run. The engineer must keep these two sources of inherent uncertainty in mind when stating the results of the analysis and level of confidence in those results.

C.2 Fire Models.

C.2.1 Selection of an Appropriate Fire Model. A variety of fire modeling tools employing different features are currently available. The most appropriate model for a specific application often depends on the objective for modeling and fire scenario conditions.

Fire models have been applied in nuclear power plants in the past to predict environmental conditions inside a compartment or room of interest. The models typically try to estimate parameters such as temperature, hot smoke gas layer height, mass flow rate, toxic species concentration, heat flux to a target, and the potential for fire propagation in the pre-flashover stage of a compartment fire. Current fire models do not accurately predict post-flashover conditions, and any results after flashover should be considered indeterminate. Therefore, fire modeling calculations should be limited to the pre-flashover period of the fire. Flashover is generally considered to occur when the upper gas layer temperature in the compartment reaches approximately 1112°F (600°C) or the incident heat flux at the floor reaches 25 kW/m^2.

C.2.2 Fire Model Features and Limitations. Fire models are generally limited both by their intrinsic algorithms and coding and by other factors impacting the range of applicability of a given model or model feature. These features are inherent in the model's development and should be taken into consideration in order to produce reliable results that will be useful in decision-making. Some models might not be appropriate for certain conditions and can produce erroneous results if applied incorrectly. For example, some current fire models have difficulty predicting the environmental conditions inside compartments with large floor areas and low ceiling heights (such as corridors), compartments with high ceilings with respect to floor area (such as reactor buildings in BWRs), and compartments where mechanical ventilation is present (such as rooms in the auxiliary building of a PWR). Current models typically do not address the ignition of combustible materials or the bidirectional flow of gases through a horizontal (ceiling) vent. A thorough understanding by the engineer of a model's features and the sensitivity of the model to the various input parameters, experimental benchmarking, and the limitations and uncertainties associated with the particular model selected is essential. The degree of confidence and level of accuracy in the model is determined during the validation and verification of the model as conducted by the developer or independent party. This information can be obtained from the user's guide, other documentation provided with the model, or from available public literature. Tables C.2.2(a) and C.2.2(b) provide a brief summary and example of various model features for some common fire models.

The engineer must bear in mind that most fire models were developed for general application and not specifically for the conditions and scenarios presented in nuclear power plants. A fire model's features and ability to address these conditions should be considered when selecting an appropriate fire model. These conditions can affect the accuracy or appropriateness of the fire dynamics algorithms used for a unique analysis of a given space.

The conditions can include but are not limited to the following:

(1) The types of combustibles and heat release rates
(2) Types and location of ignition sources
(3) The quantity of cables in cable trays and other in-situ fire loads in compartments
(4) Location of fire sources with respect to targets in the compartments
(5) High-energy electrical equipment
(6) Ventilation methods
(7) Concrete building construction, large metal equipment, and cable trays that will influence the amount of heat lost to the surroundings during a fire
(8) Compartments that vary in size but typically have a large volume with high ceilings
(9) Transient combustibles associated with normal maintenance and operations activities

Table C.2.2(a) Summary of Model Features

Model	Five [C-6.1 (6)]	COMBRN IIIe [C-6.1 (2)]	CFAST [C-6.1 (1)]	LES [C-6.1 (8)]
General Features				
Type of model	Quasi-steady zone	Quasi-steady zone	Transient zone	Transient field
Number of layers	1	1–2	2	Multiple
Compartments	1	1	30	Multiple
Floors	1	1	30	Multiple
Vents	Wall (1)	Wall (1)	Wall (4 per room) Floor (1) Ceiling (1)	Multiple
Number of fires	Multiple	Multiple	Multiple	Multiple
Ignition of secondary fuels	No	Yes	Yes	Yes

The SFPE Handbook of

Fire Protection Engineering

SOCIETY OF FIRE PROTECTION ENGINEERS

National Fire Protection Association

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2nd Edition

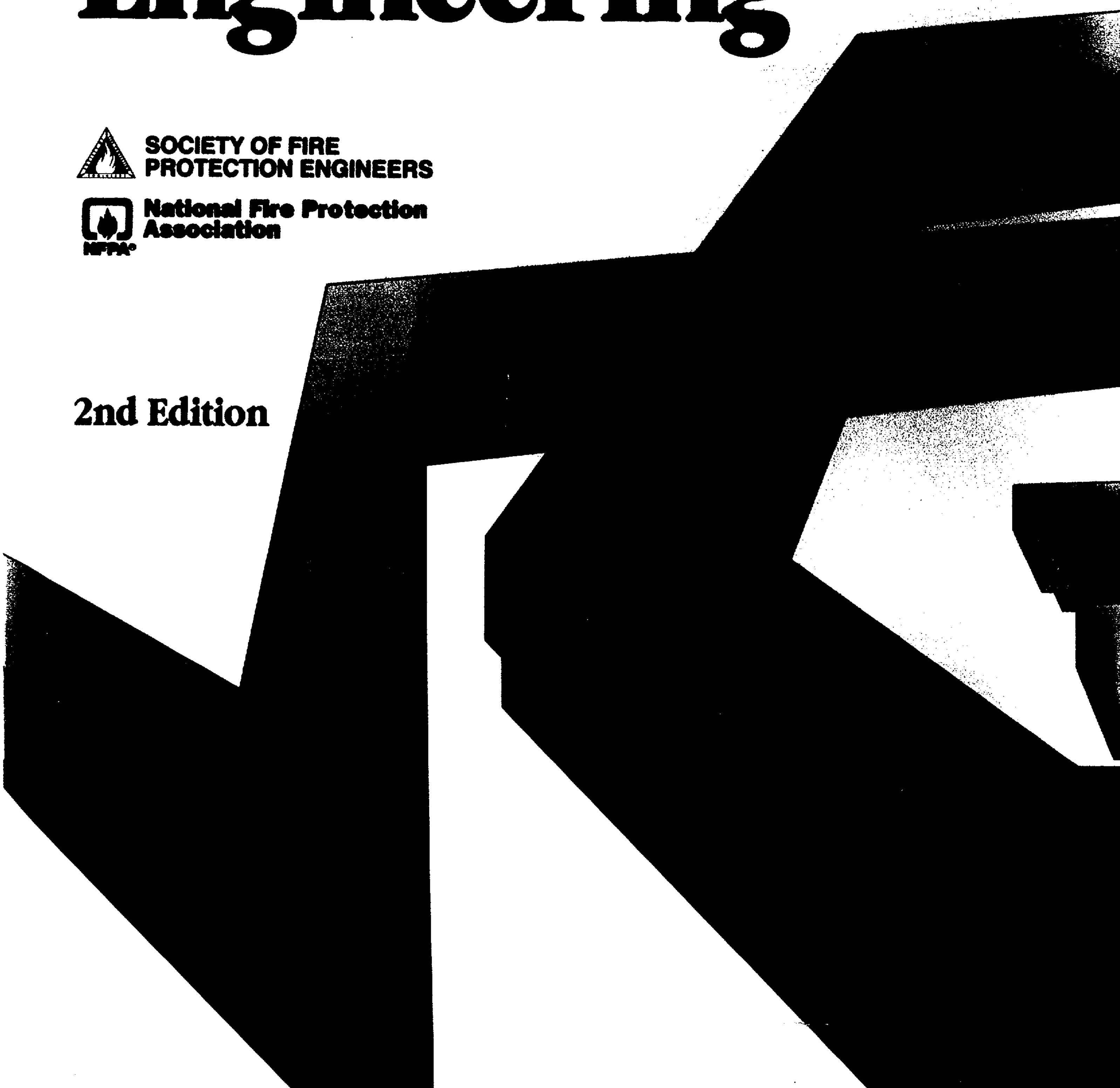


TABLE 3-6.1 ***Heat Balance Measured in Experimental Fires in a Compartment of 29 m^2 Floor Area with a Fire Load of Wood Cribs***

Fire load (kg)	Window area (m^2)	Heat release (kcal/s)	Heat loss from hot gases (%): Effluent gas	Structural surfaces	Feedback to fuel	Window radiation
877	11.2	1900	65	15	11	9
	5.6	1900	52	26	11	11
1744	11.2	3200	61	15	11	13
	5.6	2300	53	26	12	9
	2.6	1600	47	30	16	7

window area, a larger proportion of the heat released will be absorbed by the enclosing surfaces. The total heat released, assuming a complete burnout, is directly proportional to the amount of the fire load, but the rate of heat release may also be controlled by the ventilation. In this example, with the lower fire load, both window areas give sufficient ventilation for the fuel to burn at its maximum (free burning) rate but, with the doubled fire load, the burning rate is not doubled, because the window area restricts the ventilation needed.

METHODS FOR PREDICTING PRE-FLASHOVER COMPARTMENT FIRE TEMPERATURES

The solution of a relatively complete set of equations for the conservation of energy requires the solution of a large number of equations which vary with time. Although individual energy transport equations may be solved, in general there is not an explicit solution for a set of these equations. As a result, one of two approaches can be taken. The first is an approximate solution which can be accomplished by "hand" using a limiting set of assumptions. The second is a more complete solution utilizing a computer program. In either case, a number of methods have been developed. The methods presented are those which appear most widely accepted in the fire protection community. Each method employs assumptions and limitations which should be understood before employing the method. The methods presented in this chapter predict average temperatures and are not applicable to cases where prediction of local temperatures are desired. For example, these methods should not be used to predict detector or sprinkler actuation or the temperatures of materials as a result of direct flame impingement.

Method of McCaffrey, Quintiere, and Harkleroad

McCaffrey, Quintiere, and Harkleroad have used a simple conservation of energy expression and a correlation with data to develop an approximation of the upper layer temperature in a compartment.[11] Applying the conservation of energy to the upper layer yields

$$\dot{Q} = \dot{m}_g c_p (T_g - T_\infty) + q_{loss} \tag{7}$$

where

$\dot{Q}$ = energy (heat) release rate of the fire (kW)
$\dot{m}_g$ = gas flow rate out the opening (kg/s)
c_p = specific heat of gas (kJ/kg · K)
T_g = temperature of the upper gas layer (K)
T_∞ = ambient temperature (K)
q_{loss} = net radiative and convective heat transfer from the upper gas layer (kW)

The left-hand side of Equation 7 is the energy generated by the fire. On the right-hand side, the first term is the heat transported from the upper layer in the gas flow out an opening. The second term is the net rate of radiative and convective heat transfer from the upper layer, which is approximately equal to rate of heat conduction into the compartment surfaces. The rate of heat transfer to the surfaces is approximated by

$$q_{loss} = h_k A_T (T_g - T_\infty) \tag{8}$$

where

h_k = effective heat transfer coefficient (kW/m · K)
A_T = total area of the compartment enclosing surfaces (m^2)

Substituting Equation 8 into Equation 7 yields the nondimensional temperature rise in terms of two dimensionless groups

$$\frac{\Delta T_g}{T_\infty} = \frac{\dot{Q}/(c_p T_\infty \dot{m}_g)}{1 + h_k A_T/(c_p \dot{m}_g)} \tag{9}$$

where

ΔT_g = upper gas temperature rise above ambient ($T_g - T_\infty$) (K).

The mass flow rate of hot gas out of a window or door can be rewritten from Equation 3.

$$\dot{m}_g = \frac{2}{3} C_d W_0 H_0^{3/2} \rho_\infty \left[2g \frac{T_\infty}{T_g} \left(1 - \frac{T_\infty}{T_g} \right) \right]^{1/2} \left(1 - \frac{X_N}{H_0} \right)^{3/2} \tag{10}$$

where

C_d = orifice constriction coefficient
W_0 = opening width (m)
H_0 = opening height (m)
ρ_∞ = ambient air density (kg/m^2)
g = acceleration due to gravity, 9.8 m/s^2
X_N = height of neutral plane (m)

Since X_N primarily depends on T_g, $\dot{Q}$, and geometric factors (H_0 and W_0), $\dot{m}_g$ may be replaced by

$$\sqrt{g}\, \rho_\infty A_0 \sqrt{H_0}$$

in the two dimensionless variables in Equation 10, without any loss in generality. The effects of T_g and $\dot{Q}$ are incorporated into the correlation via other terms. Based on an analysis of test data, Equation 9 was written as a power-law relationship

$$\Delta T_g = 480\left(\frac{\dot{Q}}{\sqrt{g}c_p\rho_\infty T_\infty A_0\sqrt{H_0}}\right)^{2/3}\left(\frac{h_k A_T}{\sqrt{g}c_p\rho_\infty A_0\sqrt{H_0}}\right)^{-1/3} \quad (11)$$

where

A_0 = area of opening (m²)
H_0 = height of opening (m)

The numbers 480, ⅔, and −⅓ were determined by correlating the expression with the data from over 100 experimental fires. These data included both steady-state and transient fires in cellulosic and synthetic polymeric materials and gaseous hydrocarbon fuels. Compartment height ranged from 0.3 m to 2.7 m and floor areas from 0.14 m² to 12.0 m². The compartments contained a variety of window and door sizes. The term raised to the ⅔ power in Equation 11 represents the ratio of the energy released to the energy convected, and the term raised to the −⅓ power represents the energy lost divided by the energy convected.

Substituting the values for ambient conditions of

g = 9.8 m/s²
c_p = 1.05 kJ/kg · K
ρ_∞ = 1.2 kg/m³
T_∞ = 295 K

into Equation 11 yields[12,13]

$$\Delta T_g = 6.85\left(\frac{\dot{Q}^2}{A_0\sqrt{H_0}h_k A_T}\right)^{1/3} \quad (12)$$

The heat transfer coefficient can be determined using a steady-state approximation when the time of exposure, t, is greater than the thermal penetration time, t_p, by

$$h_k = k/\delta \qquad \text{for } t > t_p \quad (13)$$

The thermal penetration time is defined as

$$t_p = (\rho c/k)(\delta/2)^2 \quad (14)$$

where

ρ = density of the compartment surface (kg/m³)
c = specific heat of the compartment surface material (kJ/kg · K)
k = thermal conductivity of compartment surface (kW/m · K)
δ = thickness of compartment surface (m)
t = exposure time (s)
t_p = thermal penetration time (s)

When the time of exposure is less than the penetration time, an approximation based on conduction in a semi-infinite solid is

$$h_k = (k\rho c/t)^{1/2} \qquad \text{for } t \le t_p \quad (15)$$

If there are several wall and/or ceiling materials in the compartment, an area-weighted average for h_k should be used.

The limitations as stated by McCaffrey *et al* on the use of this method for estimating temperatures are:

1. The correlation holds for compartment upper layer gas temperatures up to approximately 600°C,
2. It applies to steady-state as well as time-dependent fires, provided the primary transient response is the wall conduction phenomenon,
3. It is not applicable to rapidly developing fires in large enclosures in which significant fire growth has occurred before the combustion products have exited the compartment,
4. The energy release rate of the fire must be determined from data or other correlations,
5. The characteristic fire growth time and thermal penetration time of the room-lining materials must be determined in order to evaluate the effective heat transfer coefficient, and
6. The correlation is based on data from a limited number of experiments and does not contain extensive data on ventilation-controlled fires nor data on combustible walls or ceilings. Most of the fuel in the test fires was near the center of the room.

Example of McCaffrey *et al* method: Calculate the upper layer temperature of a room 3 × 3 m in floor area and 2.4 m high with a door opening 1.8 m high and 0.6 m wide. The fire source is a steady 750 kW fire. The wall lining material is 0.016 m (⅝ in.) gypsum plaster on metal lath. Perform the calculation at times of 10, 60, and 600 seconds after ignition. Using Equation 11

$$\Delta T_g = 480\left(\frac{\dot{Q}}{\sqrt{g}c_p\rho_\infty T_\infty A_0\sqrt{H_0}}\right)^{2/3}\left(\frac{h_k A_T}{\sqrt{g}c_p\rho_\infty A_0\sqrt{H_0}}\right)^{-1/3}$$

where

c_p = 1 kJ/kg · K
T_∞ = 27°C (300 K)
ρ_∞ = 1.18 kg/m³
A_0 = 1.8 m × 0.6 m = 1.08 m²
g = 9.8 m/s²
H_0 = 1.8 m
$\dot{Q}$ = 750 kW

$$A_T = A_{walls} + A_{floor} + A_{ceiling} - A_{openings}$$
$$= 4 \times (3 \times 2.4) + (3 \times 3) + (3 \times 3) - 1.08$$
$$= 28.8\ m^2 + 9\ m^2 + 9\ m^2 - 1.08$$
$$= 45.72\ m^2$$

The wall heat loss coefficient, h_k, is a function of time.

a. Calculate the thermal penetration time, t_p.

$$t_p = (\rho c/k)(\delta/2)^2$$

where

ρ = wall material density (1440 kg/m³)
k = 0.48 × 10⁻³ kW/m · c
c = 0.84 kJ/kg°C
δ = 0.016 m
t_p = 161.3 s

b. Calculate h_k at 10, 60, and 600 s.

For $t < t_p$ (10, 60 s)

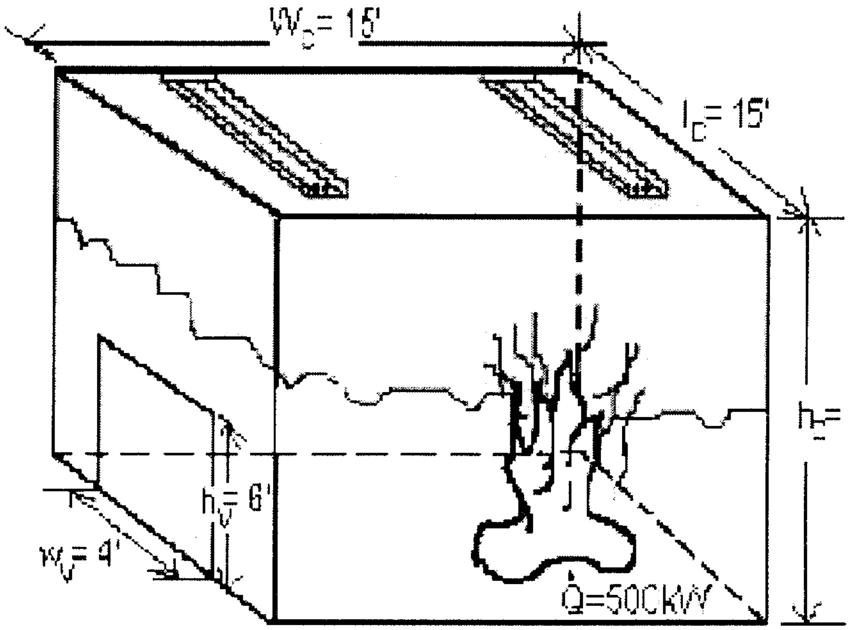
$$h_k = (k\rho c/t)^{1/2} \qquad k\rho c = 0.581$$

1. At t = 10 s.

$$h_k = (0.581/10)^{1/2} = 0.24\ kW/m \cdot K$$

SAMPLE PROBLEM

Consider a compartment 15 x 15 x 10 ft high (w_c x l_c x h_c) with a simple vent 4 x 6 ft high (w_v x h_v). The construction is essentially concrete 1 ft thick. The fire is constant at 500 kW ($\dot{Q}$ = 500 kW). Compute the hot gas temperature rise in the compartment at 100 seconds.



METHOD FOR PREDICTING TEMPERATURE IN A ROOM FIRE WITH NATURAL VENTILATION

The following calculations estimate the hot gas layer temperature in enclosure fire.
[redacted]
All subsequent values are calculated by the spreadsheet, and based on values specified in the input parameters.

INPUT PARAMETERS

COMPARTMENT INFORMATION

Compartment Width (w_c)	[redacted]	feet	4.572	m
Compartment Length (l_c)	[redacted]	feet	4.572	m
Compartment Height (h_c)	[redacted]	feet	3.048	m
Vent Width (w_v)	[redacted]	feet	1.2192	m
Vent Height (h_v)	[redacted]	feet	1.6288	m
Interior Lining Thickness (δ)	[redacted]	feet	0.3048	m

AMBIENT CONDITIONS

Ambient Air Temperature (T_0)	[redacted]	°F	25	°C
			298	K
Specific Heat of Air (c_p)	[redacted]	kJ/kg-K		
Ambient air Density (ρ_0)	[redacted]	kg/m³		

THERMAL PROPERTIES OF ENCLOSING SURFACES

Interior Lining Thermal Inertia ($k\rho c$)	[redacted]	(kW/m²-K)²-sec
Interior Lining Thermal Conductivity (k)	[redacted]	kW/m-K
Interior Lining Specific Heat (c_p)	[redacted]	kJ/kg-K
Interior Lining Density (ρ)	[redacted]	kg/m³

INTERIOR LINING TYPICAL CONSTRUCTION PROPERTIES for common materials:

Material	k (kW/m-°C)	ρ (kg/m³)	c_p (kJ/kg-K)	$k\rho c$ (kW/m²-K)²-sec
Concrete	1.4×10^{-3}	2000	0.88	2.0
Gypsum Board	5.0×10^{-4}	1440	0.84	0.60
Steel	5.0×10^{-3}	1600	0.46	150
Wood	1.5×10^{-4}	420	2.72	0.30

Reference: Quintiere, James. *Principles of Fire Behavior*. (Page 187)

FIRE SPECIFICATIONS

Fire Heat Release Rate (Q)	[redacted]	kW
Time After Ignition (t)	[redacted]	sec

METHOD OF McCAFFREY, QUINTIERE, AND HARKLEROAD (MQH)

Reference: SFPE Handbook of Fire Protection Engineering 2nd Edition (Page 3-139)

$\Delta T_g = 6.85[Q^2/(A_0(h_v)^{1/2})(A_T h_k)]^{1/3}$

Where ΔT_g = upper layer gas temperature rise above ambient (T_g-T_0) (K)
Q = heat release rate of the fire (kW)
A_0 = area of ventilation opening (m²)
h_v = height of ventilation opening (m)
h_k = heat transfer coefficient (kW/m²-K)
A_T = total area of the compartment enclosing surface boundaries (m²)

Area of Ventilation Opening Calculation

A_0 = $(w_v)(h_v)$
A_0 = 2.229673 m²

Thermal Penetration Time Calculation (Thermally Thick Materials)

t_p = $(\rho c_p/k)(\delta/2)^2$

Where ρ = interior construction density (kg/m³)
c_p = interior construction heat capacity (kJ/kg-K)
k = interior construction thermal conductivity (kW/m-K)
δ = interior construction thickness (m)

t_p = 29198.1 sec, which is over 5 hours, so the conduction will be transient for a long time

Heat Transfer Coefficient Calculation

h_k = $(k\rho c/t)^{1/2}$ for $t < t_p$

Where $k\rho c$ = interior construction thermal inertia (kW/m²-K)²-sec
(a thermal property of material responsible for the rate of temperature rise)
t = time after ignition (sec)

h_k = 0.447214 kW/m²-K

Area of Compartment Enclosing Surface Boundaries

A_T = $[2(w_c \times l_c) + 2(h_c \times w_c) + 2(h_c \times l_c)] - A_0$
A_T = 95.31852 m²

Compartment Hot Gas Layer Temperature With Natural Ventilation

$\Delta T_g = 6.85[Q^2/(A_0(h_v)^{1/2})(A_T h_k)]^{1/3}$
ΔT_g = 185.91 K
ΔT_g = T_g-T_0
T_g = ΔT_g+T_0
T_g = 483.91 K

T_g = 210.91 °C 411.64 °F ANSWER

NOTE
The above calculations are based on principles developed in the Society of Fire Protection Engineers (SFPE) Handbook of Fire Protection Engineering, 2nd Edition 1995. Calculations are based on certain assumptions and has inherent limitations. The results of such calculations may or may not have reasonable predictive capabilities for a given situation, and should only be interpreted by an informed user.

METHOD FOR PREDICTING TEMPERATURE IN A ROOM FIRE WITH NATURAL VENTILATION

The following calculations estimate the hot gas layer temperature in enclosure fire.
[redacted]
All subsequent values are calculated by the spreadsheet, and based on values specified in the input parameters.

INPUT PARAMETERS

COMPARTMENT INFORMATION

Compartment Width (w_c)	[redacted]	feet	4.572 m
Compartment Length (l_c)	[redacted]	feet	4.572 m
Compartment Height (h_c)	[redacted]	feet	3.048 m
Vent Width (w_v)	[redacted]	feet	1.2192 m
Vent Height (h_v)	[redacted]	feet	1.8288 m
Interior Lining Thickness (δ)	[redacted]	feet	0.3048 m

AMBIENT CONDITIONS

Ambient Air Temperature (T_0)	[redacted]	°F	25 °C 298 K
Specific Heat of Air (c_p)	[redacted]	kJ/kg-K	
Ambient air Density (ρ_0)	[redacted]	kg/m^3	

THERMAL PROPERTIES OF ENCLOSING SURFACES

Interior Lining Thermal Inertia ($k\rho c$)	[redacted]	$(kW/m^2\text{-}K)^2$-sec
Interior Lining Thermal Conductivity (k)	[redacted]	kW/m-K
Interior Lining Specific Heat (c_p)	[redacted]	kJ/kg-K
Interior Lining Density (ρ)	[redacted]	kg/m^3

INTERIOR LINING TYPICAL CONSTRUCTION PROPERTIES for common materials:

Matetial	k (kW/m-°C)	ρ (kg/m^3)	c_p (kJ/kg-K)	$k\rho c$ $(kW/m^2\text{-}K)^2$-sec
Concrete	1.4×10^{-3}	2000	0.88	2.0
Gypsum Board	5.0×10^{-4}	1440	0.84	0.60
Steel	5.0×10^{-3}	1600	0.46	150
Wood	1.5×10^{-4}	420	2.72	0.30

Reference Quintiere, James. *Principles of Fire Behavior.* (Page 187)

FIRE SPECIFICATIONS

Fire Heat Release Rate (Q)	1603.00	kW
Time After Ignition (t)	10.00	sec

METHOD OF McCAFFREY, QUINTIERE, AND HARKLEROAD (MQH)

Reference SFPE Handbook of Fire Protection Engineering 2nd Edition (Page 3-139)

$$\Delta T_g = 6.85[Q^2/(A_0(h_v)^{1/2})\,(A_T h_k)]^{1/3}$$

Where ΔT_g = upper layer gas temperature rise above ambient (T_g-T_0) (K)

Q = heat release rate of the fire (kW)
A_0 = area of ventilation opening (m^2)
h_v = height of ventilation opening (m)
h_k = heat trensfer coefficient (kW/m^2-K)
A_T = total area of the compartment enclosing surface boundaries (m^2)

Area of Ventilation Opening Calculation

A_0 = $(w_v)(h_v)$

A_0 = **2.229673** m^2

Thermal Penetration Time Calculation (Thermally Thick Materials)

t_p = $(\rho c_p/k)(\delta/2)^2$

Where ρ = interior construction density (kg/m^3)
c_p = interior construction heat capacity (kJ/Kg-K)
k = interior construction thermal conductivity (kW/m-K)
δ = interior construction thickness (m)

t_p = **29198.1** sec, which is over 8 hours, so the conduction will be transient for a long time

Heat Transfer Coefficient Calculation

h_k = $(k\rho c/t)^{1/2}$ for $t < t_p$

Where $k\rho c$ = interior construction thermal inertia $(kW/m^2\text{-}K)^2$-sec
(a thermal property of material responsible for the rate of temperature rise)
t = time after ignition (sec)

h_k = **0.447214** kW/m^2-K

Area of Compartment Enclosing Surface Boundaries

A_T = $[2(w_c x l_c) + 2(h_c x w_c) + 2(h_c x lc)] - A_0$

A_T = **95.31852** m^2

Compartment Hot Gas Layer Temperature With Natural Ventilation

$\Delta T_g = 6.85[Q^2/(A_0(h_v)^{1/2})(A_T h_k)]^{1/3}$

ΔT_g = **185.91** K

ΔT_g = $T_g - T_0$

T_g = $\Delta T_g + T_0$

T_g = **483.91** K

T_g= 210.91 °C 411.64 °F ANSWER

NOTE

The above calculations are based on principles developed in the Society of Fire Protection Engineers (SFPE) Handbook of Fire Protection Engineering, 2nd Edition 1995. Calculations are based on certain assumptions and has inherent limitations. The results of such calculations may or may not have reasonable predictive capabilities for a given situation, and should only be interpreted by an informed user.

METHOD FOR PREDICTING TEMPERATURE IN A ROOM FIRE WITH NATURAL VENTILATION

[redacted]

INPUT PARAMETERS

COMPARTMENT INFORMATION

Compartment Width (w_c)	[redacted]	feet	4.572 m
Compartment Length (l_c)	[redacted]	feet	4.572 m
Compartment Height (h_c)	[redacted]	feet	3.048 m
Vent Width (w_v)	[redacted]	feet	1.2192 m
Vent Height (h_v)	[redacted]	feet	1.8288 m
Interior Lining Thickness (δ)	[redacted]	feet	0.3048 m

AMBIENT CONDITIONS

Ambient Air Temperature (T_0)	[redacted]	°F	25 °C 298 K
Specific Heat of Air (c_p)	[redacted]	kJ/kg-K	
Ambient air Density (ρ_0)	[redacted]	kg/m^3	

THERMAL PROPERTIES OF ENCLOSING SURFACES

Interior Lining Thermal Inertia ($k\rho c$)	[redacted]	$(kW/m^2\text{-}K)^2$-sec
Interior Lining Thermal Conductivity (k)	[redacted]	kW/m-K
Interior Lining Specific Heat (c_p)	[redacted]	kJ/kg-K
Interior Lining Density (ρ)	[redacted]	kg/m^3

INTERIOR LINING TYPICAL CONSTRUCTION PROPERTIES for common materials:

Material	k (kW/m-°C)	ρ (kg/m^3)	c_p (kJ/kg-K)	$k\rho c$ $(kW/m^2\text{-}K)^2$-sec
Concrete	1.4×10^{-3}	2000	0.88	2.0
Gypsum Board	5.0×10^{-4}	1440	0.84	0.60
Steel	5.0×10^{-2}	1600	0.46	150
Wood	1.5×10^{-4}	420	2.72	0.30

Reference: Quintiere, James. *Principles of Fire Behavior*. (Page 187)

FIRE SPECIFICATIONS

Fire Heat Release Rate (Q)	[redacted]	kW
Time After Ignition (t)	[redacted]	sec

METHOD OF McCAFFREY, QUINTIERE, AND HARKLEROAD (MQH)

Reference: SFPE Handbook of Fire Protection Engineering 2nd Edition (Page 3-139)

$\Delta T_g = 6.85[Q^2/(A_0(h_v)^{1/2})(A_T h_k)]^{1/3}$

Where ΔT_g = upper layer gas temperature rise above ambient (T_g-T_0) (K)
Q = heat release rate of the fire (kW)
A_0 = area of ventilation opening (m^2)
h_v = height of ventilation opening (m)
h_k = heat trensfer coefficient (kW/m^2-K)
A_T = total area of the compartment enclosing surface boundaries (m^2)

Area of Ventilation Opening Calculation

$A_0 = (w_v)(h_v)$

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$t_p = (\rho c_p/k)(\delta/2)^2$

Where ρ = interior construction density (kg/m^3)
c_p = interior construction heat capacity (kJ/Kg-K)
k = interior construction thermal conductivity (kW/m-K)
δ = interior construction thickness (m)

t_p = **29198.1** sec. which is over 8 hours, so the conduction will be transient for a long time

Heat Transfer Coefficient Calculation

$h_k = (k\rho c/t)^{1/2}$ for $t < t_p$

Where $k\rho c$ = interior construction thermal inertia $(kW/m^2\text{-}K)^2$-sec
(a thermal property of material responsible for the rate of temperature rise)
t = time after ignition (sec)

h_k = **0.447214** kW/m^2-K

Area of Compartment Enclosing Surface Boundaries

$A_T = [2(w_c \times l_c) + 2(h_c \times w_c) + 2(h_c \times lc)] - A_0$

A_T = **95.31852** m^2

Compartment Hot Gas Layer Temperature With Natural Ventilation

$\Delta T_g = 6.85[Q^2/(A_0(h_v)^{1/2})(A_T h_k)]^{1/3}$

ΔT_g = **185.91** K

$\Delta T_g = T_g - T_0$

$T_g = \Delta T_g + T_0$

T_g = **483.91** K

[redacted] ANSWER

NOTE

The above calculations are based on principles developed in the Society of Fire Protection Engineers (SFPE) Handbook of Fire Protection Engineering, 2nd Edition 1995. Calculations are based on certain assumptions and has inherent limitations. The results of such calculations may or may not have reasonable predictive capabilities for a given situation, and should only be interpreted by an informed user.

METHOD FOR PREDICTING TEMPERATURE IN A ROOM FIRE WITH NATURAL VENTILATION

[redacted]

INPUT PARAMETERS

COMPARTMENT INFORMATION

Compartment Width (w_c)	[redacted]	feet	4.572 m
Compartment Length (l_c)		feet	4.572 m
Compartment Height (h_c)		feet	3.048 m
Vent Width (w_v)	[redacted]	feet	1.2192 m
Vent Height (h_v)		feet	1.8288 m
Interior Lining Thickness (δ)	[redacted]	feet	0.3048 m

AMBIENT CONDITIONS

Ambient Air Temperature (T_0)	[redacted]	°F	25 °C 298 K
Specific Heat of Air (c_p)	[redacted]	kJ/kg-K	
Ambient air Density (ρ_0)		kg/m^3	

THERMAL PROPERTIES OF ENCLOSING SURFACES

Interior Lining Thermal Inertia ($k\rho c$)	[redacted]	(kW/m^2-K)^2-sec
Interior Lining Thermal Conductivity (k)		kW/m-K
Interior Lining Specific Heat (c_p)		kJ/kg-K
Interior Lining Density (ρ)		kg/m^3

INTERIOR LINING TYPICAL CONSTRUCTION PROPERTIES for common materials:

Matetial	k (kW/m-°C)	ρ (kg/m^3)	c_p (kJ/kg-K)	$k\rho c$ (kW/m^2-K)^2-sec
Concrete	1.4×10^{-3}	2000	0.88	2.0
Gypsum Board	5.0×10^{-4}	1440	0.84	0.60
Steel	5.0×10^{-3}	1600	0.46	150
Wood	1.5×10^{-4}	420	2.72	0.30

Reference Quintiere, James. *Principles of Fire Behavior.* (Page 187)

FIRE SPECIFICATIONS

Fire Heat Release Rate (Q)	[redacted]	kW
Time After Ignition (t)		sec

METHOD OF McCAFFREY, QUINTIERE, AND HARKLEROAD (MQH)

Reference SFPE Handbook of Fire Protection Engineering 2nd Edition (Page 3-139)

$$\Delta T_g = 6.85[Q^2/(A_0(h_v)^{1/2})\,(A_T h_k)]^{1/3}$$

Where ΔT_g = upper layer gas temperature rise above ambient (T_g-T_0) (K)

Q = heat release rate of the fire (kW)
A_0 = area of ventilation opening (m^2)
h_v = height of ventilation opening (m)
h_k = heat trensfer coefficient (kW/m^2-K)
A_T = total area of the compartment enclosing surface boundaries (m^2)

Area of Ventilation Opening Calculation

$A_0 = (w_v)(h_v)$

$A_0 =$ **2.229673** m^2

Thermal Penetration Time Calculation (Thermally Thick Materials)

$t_p = (\rho c_p/k)(\delta/2)^2$

Where ρ = interior construction density (kg/m^3)
c_p = interior construction heat capacity (kJ/Kg-K)
k = interior construction thermal conductivity (kW/m-K)
δ = interior construction thickness (m)

$t_p =$ **29198.1** sec, which is over 8 hours, so the conduction will be transient for a long time

Heat Transfer Coefficient Calculation

$h_k = (k\rho c/t)^{1/2}$ for $t < t_p$

Where $k\rho c$ = interior construction thermal inertia $(kW/m^2\text{-}K)^2$-sec
(a thermal property of material responsible for the rate of temperature rise)
t = time after ignition (sec)

$h_k =$ **0.447214** kW/m^2-K

Area of Compartment Enclosing Surface Boundaries

$A_T = [2(w_c x l_c) + 2(h_c x w_c) + 2(h_c x l c)] - A_0$

$A_T =$ **95.31852** m^2

Compartment Hot Gas Layer Temperature With Natural Ventilation

$\Delta T_g = 6.85[Q^2/(A_0(h_v)^{1/2})(A_T h_k)]^{1/3}$

$\Delta T_g =$ **185.91** K

$\Delta T_g = T_g - T_0$

$T_g = \Delta T_g + T_0$

$T_g =$ **483.91** K

[redacted] **ANSWER**

NOTE

The above calculations are based on principles developed in the Society of Fire Protection Engineers (SFPE) Handbook of Fire Protection Engineering, 2nd Edition, 1995. Calculations are based on certain assumptions and has inherent limitations. The results of such calculations may or may not have reasonable predictive capabilities for a given situation, and should only be interpreted by an informed user.

DRAFT

STRAWMAN FOR DISCUSSION [NOT AN NRC STAFF POSITION]

LICENSEE SELF-ASSESSMENT PROCESS

Prepared for the July 12, 2001 NRC/NEI Working Group Meeting by IIPB/DIPM/NRR

Note: This draft strawman is intended to focus industry, public, and NRC discussion on the possibility of allowing, within the new ROP, voluntary licensee self-assessments in lieu of selected NRC inspections. This draft strawman does not represent an NRC staff "negotiating position." This strawman is intended to precipitate focused dialogue on the topic of licensee self-assessments (LSAs). The existence of this strawman does not signal the intention of the NRC to necessarily change the ROP or reduce inspection hours in the near-term at licensed reactor facilities. However, the NRC staff's LSA initiative could potentially provide for increased regulatory effectiveness while improving efficiency and reducing regulatory burden.

LSA Process Draft Strawman Structure:

- Licensees, at their option, may apply to the NRC for six year LSA approval in selected topical areas for specific reactor sites. All application materials will be treated as public, docketed, non-proprietary. The NRC will review the LSA applications against a public set of criteria, and publish the approvals, denials and associated rationales. [Six year re-approval was somewhat arbitrarily chosen as a common multiple of the one, two and three year periodicities of major NRC baseline inspection procedures.]

- In the selected baseline inspection topical areas of Fire Protection (IP 71111-05), Permanent Plant Modifications (IP 71111.17), Safety System Design and Performance Capability (IP 71111-21), Post-maintenance Testing (IP 71111-22), and Identification and Resolution of Problems (IP 71152), the NRC may approve licensees to conduct LSA activities similar in scope and equivalent (or better) in effect to NRC conduct of the subject topical area inspection procedures.

  [Since it is not the intent of LSA approval to "deputize" licensees to replicate existing NRC inspection activities, licensees need not, and probably should not, perform self-assessments using the NRC's new ROP inspection procedures nor necessarily their inspection techniques. Rather, it is only important that the significant, major elements of NRC inspection procedures be addressed during the LSA processes, something that will be addressed during NRC staff's LSA application reviews. For example, in fire protection, risk is used by the NRC to select reactor plant areas for inspection. The NRC application review process may well ensure that the licensee has a process for conducting a risk-informed plant area selection process. The details of such LSA application review criteria are to be determined.]

Attachment 6

- Licensees of reactor plants in the Regulatory Response, Degraded Cornerstone, Multiple/Repetitive Degraded Cornerstone, and Unacceptable Performance columns of the Action Matrix would be ineligible for any LSA approvals. Stated conversely, only licensees within the Licensee Response column of the ROP Action Matrix are eligible for LSA approval.

- Any topical LSA approvals in effect when a given licensee becomes ineligible for LSA approval (licensee not in the Licensee Response column of the Action Matrix) will be immediately voided. Re-application will be required for each voided LSA certification.

- Every third normally scheduled NRC inspection in a topical area will be conducted solely by NRC staff personnel and/or NRC contractors (no LSA activity).

- Barring unforseen interfering operational events, all LSA activities will be completed within one (two, three?) month(s) of the same calendar quarter as the regularly scheduled NRC baseline inspection.

- At most 40% of the LSA man-hours applied in the topical area of Identification and Resolution of Problems will be from non-site personnel (i.e., 60% of the the LSA effort will be from qualified off-site personnel, such as knowledgeable individuals from the Institute of Nuclear Power Operation, corporate staff, or other NRC licensed reactor sites which may or may not be owned by the LSA approved licensee). This requirement for an "independent audit" component exists only for LSA activities in the Identification and Resolution of Problems topical area.

- The NRC will selectively monitor/observe a licensee's LSA effort, and/or review a licensee's in-process LSA results, at any point in the LSA process.

- Final LSA results will be issued by the licensee to the NRC as public, docketed, non-proprietary documents within 45 days of the completion of the LSA activity.

- Final LSA results will be reviewed by the NRC staff, and certain LSA identified issues may be transformed into NRC inspection findings in a subsequent NRC issued inspection report. Enforcement credit will be given for LSA self-identification of issues, but the enforcement process for LSA results transformed into inspection findings will otherwise be unaffected.

- The NRC will conduct standard ROP Significance Determination Process analyses on all LSA results which the NRC staff has chosen to transform into NRC inspection findings, and any resultant "colored findings" will be inputs into the ROP Action Matrix.

- Licensee corrective action, NRC resident inspection, licensee immediate notification, licensee event report (LER), performance indicator, SDP and Action Matrix processes will all be unaffected by the the conduct of approved LSA activities (e.g. LSA results transformed into inspection findings may ultimately contribute to a degraded cornerstone).

- Every three years, the NRC will study the national LSA process to determine the efficacy of continuing the LSA approval program (as compared to reverting to the traditional 100% NRC conduct of NRC inspection procedures).

Pro and Con Discussion Points:

Licensee self-assessments, in lieu of NRC inspection activity, could have the effect of increasing NRC efficiency while enhancing licensee ownership of the quality of activities. In terms of the four pillars of nuclear regulation, it would appear that the NRC's regulatory effectiveness and efficiency would be enhanced, licensee regulatory burden would be reduced, safety may be unaffected or enhanced, but public confidence could possibly be marginally reduced (due to the "regulatory relaxation" appearance of the LSA process). It is clear that an NRC approved licensee self-assessment program would have the potential effect of reducing the number of NRC personnel engaged in major technical reactor team inspections.

DISCUSSION POINTS - DRAFT

LICENSEE SELF-ASSESSMENT PROGRAM FOR NRC INSPECTIONS

GOALS

- Maintain public confidence
- Reduce unnecessary regulatory burden
- More effectively utilize NRC and licensee resources while preserving NRC option to inspect

PROPOSED STRATEGY

- Build on prior experience and successes:
  - Implementation of NRC Administrative Letter 94-03, "Announcing an NRC Inspection Procedure on Licensee Self-Assessment Programs for NRC Area-Of-Emphasis Inspections"
  - Inspection Manual Chapter 40501, "Licensee Self-Assessments Related to Team Inspections"
  - Initial year implementation of the NRC Reactor Oversight Process
  - Implementation of voluntary initiatives
- Update existing NRC guidance to reflect the NRC Reactor Oversight Process
- Conduct multiple (2-3) pilot programs during Year 2 of ROP implementation; "Team Inspections" should be given first priority
- Proceed in parallel with Safeguards Performance Assessment Pilot Program

WHAT ARE PROPOSED CRITERIA FOR PARTICIPATION?

- Voluntary initiative by one or more licensees (e.g., Owners Group initiative)
- Licensee has an effective corrective action and self-assessment program
- Licensee(s) docket formal request
- NRC formally accepts docketed licensee self-assessment plan as being equivalent in scope and depth to NRC inspection

WHAT INSPECTIONS ARE "GENERICALLY ELIGIBLE"?

- Baseline inspections with frequencies of one year or longer

WHAT INSPECTIONS ARE ELIGIBLE ON A CASE-BY-CASE BASIS?

- Supplemental inspections

WHAT INSPECTIONS ARE GOOD CANDIDATES FOR PILOT PROGRAMS?

Top 2 Candidates:

- IMC 71111.05, Fire Protection Triennial
- IMC 7111.21, Safety System Design and Performance Capability

DISCUSSION POINTS - DRAFT

Second Tier Candidates:

- IMC 71111.02, Evaluation of Changes, Tests and Experiments (after 2/02)
- IMC 71121, Occupational Radiation Safety
- IMC 71111.11, Licensed Operator Requalification
- IMC 71111.12, Maintenance Rule Implementation (after 11/01)
- IMC 71111.17, Permanent Plant Modifications

WHAT ARE POTENTIAL POLICY, PROCESS, OR PROGRAM ISSUES?

- What objective criteria should the NRC use to determine if a licensee is eligible to participate?

- Will use of NRC inspection manual guidance be appropriate to ensure "consistent scope and depth" ?

- Will industry self-assessment "standards" or guidance be needed to ensure "consistent scope and depth" with NRC IMC Chapter?

- Will licensee self-assessment reports be required to be docketed or made public?

- How will results of self-assessments be treated under the ROP?

  - Will issues identified by the licensee be run through the SDP?

  - Will the NRC issue Findings or Violations?

  - How will the results be treated in the Action Matrix?

  - Will violations of regulations identified by the licensee be subject to Enforcement?

  - How will "management" or "business" recommendations be handled?

- What are potential unintended consequences?

PROPOSED CHANGES TO THE MONTHLY OPERATING REPORT

REMOVE FROM TECHNICAL SPECIFICATIONS

PROVIDE DATA ON A QUARTERLY BASIS INSTEAD OF MONTHLY

PROVIDE DATA ELECTRONICALLY

POSSIBLE ELECTRONIC DATA OPTIONS -

OPTION 1) ADD DATA STREAM TO EXISTING PERFORMANCE INDICATOR DATA FROM NEI DATA BASE. CURRENTLY, NEI PROVIDES THE DATA TO LICENSEES, WHO THEN SUBMIT THE DATA TO NRC INDIVIDUALLY ON A QUARTERLY BASIS

OPTION 2) LICENSEES PROVIDE THE DATA TO INPO'S EPIX DATABASE (OR ITS SUCCESSOR). INPO WOULD GRANT NRC ACCESS TO THE DATA. NRC WOULD THEN EXTRACT THE DATA FROM THE DATABASE.

NRC IS WILLING TO DISCUSS OPTIONS WITH NEI/INPO TO WORK OUT DETAILS OF ELECTRONIC DATA TRANSFER

A SUBSTANTIAL MAJORITY OF INDUSTRY BUY-IN IS NEEDED TO MAKE THIS EFFORT WORTHWHILE

CONTINUE TO SUPPLY DATA DISCUSSED IN GL 97-02, "REVISED CONTENTS OF THE MONTHLY OPERATING REPORT." NO CHANGE IN THE AMOUNT OF DATA PROVIDED

DRAFT

REACTOR POWER REDUCTIONS PER 7,000 CRITICAL HOURS

Purpose
This indicator monitors the number of reductions in reactor power of greater than 20 percent of full power. It may provide leading indication of risk-significant events but is not itself risk-significant. The indicator is calculated per 7,000 critical hours to monitor the number of plant power changes for a typical year of operation.

Indicator Definition
The number of reductions in reactor power of greater than 20 percent of full power during the previous four quarters per 7,000 critical hours.

Data Reporting Elements
The following data are reported for each reactor unit:

- the number of reductions in reactor power of greater than 20 percent of full power in the previous quarter
- the number of critical hours in the previous quarter

Calculation
The indicator is determined using the values for the previous four quarters as follows:

$$\text{value} = \frac{\text{(number of power reductions in the previous 4 qtrs)}}{\text{(number of critical hours in the previous 4 qtrs)}} \times 7{,}000 \text{ hrs}$$

Definition of Terms
Reductions in reactor power include all power reductions, whether controlled or uncontrolled, planned or unplanned, scheduled, or unscheduled, except for those excluded below.

Clarifying Notes
7,000 hours is used because it represents one year of reactor operation at about an 80% availability factor.

2,400 critical hours is the minimum number of critical hours in four consecutive quarters for which an indicator value is calculated. Rate indicators can produce misleadingly high values when the denominator is small; for critical hours under 2,400, as few as two power reductions can produce a value that crosses the green-white threshold. Therefore, the displayed value will be N/A. All data elements must nevertheless be reported.

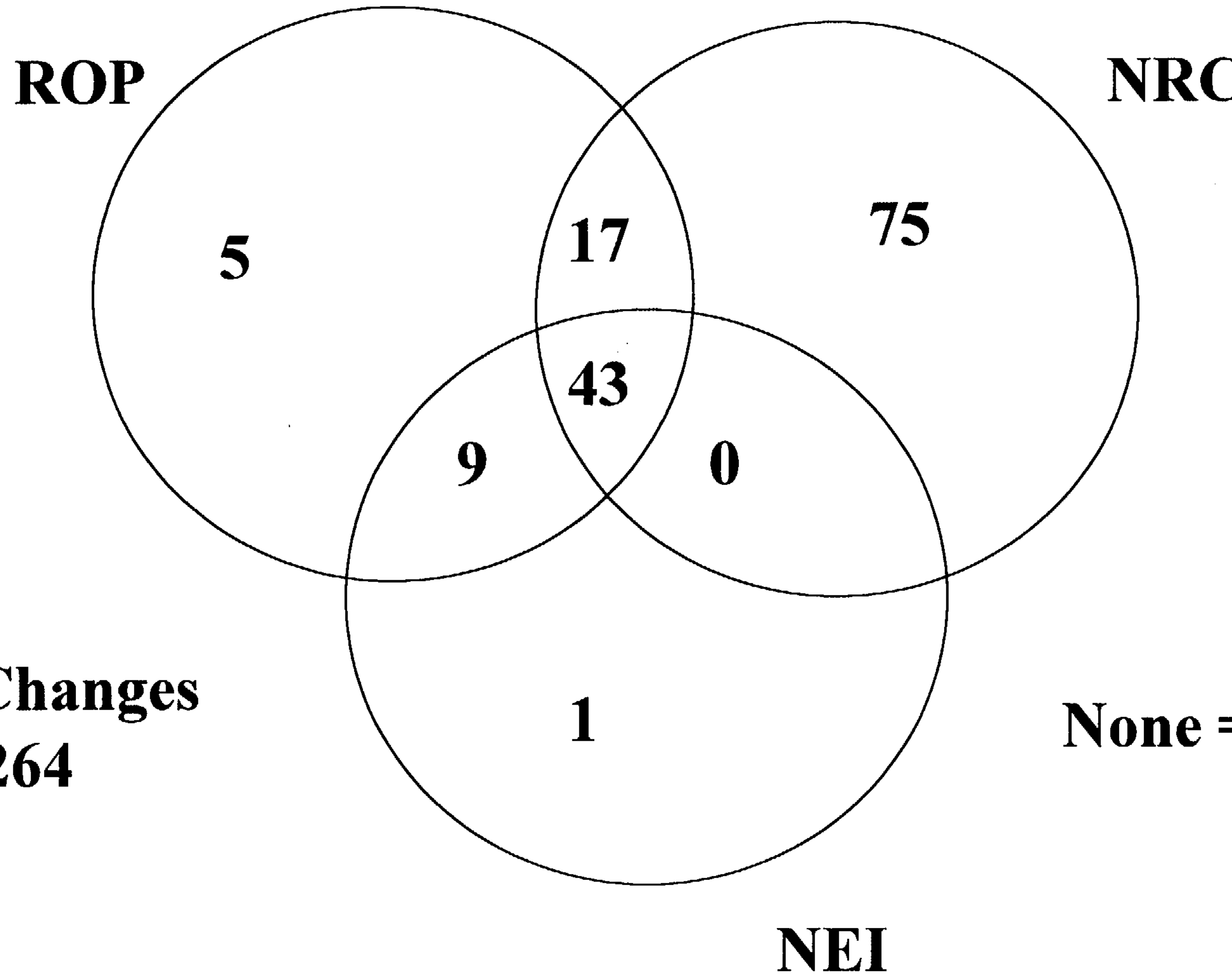
Reductions in reactor power that <u>are not</u> counted are (1) those that are scheduled prior to startup from a refueling outage (i.e., mid-cycle maintenance outages and the next refueling outage); (2) those that are directed by the load dispatcher under normal operating conditions due to load demand and economic reasons, or for grid stability or nuclear plant safety concerns arising from external events outside the control of the nuclear unit; (3) anticipatory unit power reductions due to external events, such as hurricanes, tornadoes, or range fires, that threaten

Attachment 7

the safety of the nuclear unit or its transmission lines; (4) certain proceduralized unit power reductions in response to expected problems, such as accumulation of marine debris or biological contaminants in certain seasons (each situation is different and should be identified to the NRC for a determination as to whether it should be counted); (5) power reductions to perform routine evolutions or tests that are necessary and/or required for continued plant operation, are regularly scheduled plant activities, and are conducted in accordance with normal plant procedures; (6) additional power reductions that follow the initial reduction (without an intervening increase in power) to address the same plant problem; (7) end-of-cycle coastdown: and (8) those that are included in the unplanned scram indicator.

Unit power reductions that <u>are</u> counted are all those not excluded above.

IE 03 Power Change Indicator Comparison
4/1/00 - 3/31/01 (45 units)



 # Power Changes > 20% = 264

None = 114

Attachment 8

FAQ Log 15				
Temp No.	**PI**	**Question/Response**	**Status**	**Plant/ Co.**
15.12	MS01 MS02 MS03 MS04	**Question:** 1. Should support system unavailability be counted in the monitored safety system unavailability PI if analysis or engineering judgement has determined that the support system can be restored to available status such that the monitored system remains available to perform its intended safety function? 2. Do the criteria for determining availability described in NEI 99-02, Revision 0, page 26 lines 31-40 apply to this situation?	Introduced 10/31 12/5/00 – NEI, Licensee proposed response added. 3/2/01 – Discussed. FAQ to be discussed as part of SSU focus group.	ComEd
		Licensee Proposed Response: 1. No. During both testing and non-testing situations, the criteria described in NEI 99-02, Revision 0, page 33, lines 7-9 should apply, "In these cases, analysis or sound engineering judgment may be used to determine the effect of support system unavailability on the monitored system." If the analysis or engineering judgment determines that the unavailability of the support system does not impair the ability of the monitored system to perform its intended safety function, then the support system unavailability should not be counted in the monitored system PI. For example, if engineering analysis determines that the unavailability of a ventilation support system for the emergency diesel generator does not adversely impact the availability of the emergency diesel generator to perform its intended function, the unavailability of the support system would not be counted in the emergency diesel generator PI. The engineering analysis must evaluate such things as; the length of time between an event and the time the ventilation system is required to be available to support the safety function of the emergency diesel generator, the complexity the actions required by plant operators to restore the availability of the ventilation system, and the probability of success for the restoration actions. Restoration actions should be contained in a written procedure and must not require diagnosis or repair. The engineering analysis must provide a high degree of assurance that the unavailability of the ventilation support system does not impact the ability of the emergency diesel generator to perform its safety function. This treatment is consistent with maintenance rule and PRA. 2. No. In NEI 99-02, Revision 0, page 26, lines 31-40, criteria for exclusion of planned unavailability for testing activities of monitored systems are described. The criteria established in this section describe required actions or barriers which must be in place during *testing* so that unavailability of the monitored system is not counted in the monitored system PI.		

Attachment 9

Attachment 9

FAQ Log 16

Temp No.	PI	Question/Response	Status	Plant/ Co.
16.11	MS02 MS04	**Question:** **Appendix D** At our ocean plant we periodically recirculate the water in our intake structure causing the temperature to rise in order to control marine growth. **Marine mollusks, if allowed to grow larger than ¾" in size, can clog the condenser and component cooling water heat exchangers.** This process is carried out over a six hour period in which the temperature is raised slowly in order to **encourage** ~~chase~~ fish **to move** toward the fish elevator so they can be removed from the intake. ~~and thus minimize the consequential fish kill.~~ Temperature is then reduced and tunnels reversed to start the actual heat treat. Actual time with warm water in the intake is less than half of the evolution. A dedicated operator is stationed for the evolution, and by procedure at any point, can back out and restore normal intake temperatures by pushing a single button to reposition a single circulating water gate. The gate is large and may take several minutes to reposition and clear the intake of the warm water, but a single button with a dedicated operator, in close communication with the control room initiates the gate closure. During this evolution, one train of service water, a support system for HPSI and RHR, is aligned to the opposite unit intake and remains fully Operable in accordance with the Technical Specifications. The second train is aligned to participate in the heat treat, and while functional, has water beyond the temperature required to perform its design function. This design function of the support system is restored with normal intake temperatures by the dedicated operator realigning the gate with a single button if needed. Gate operation is tested before the start of the evolution and restoration actions are virtually certain. ~~The ability of the safety systems HPSI and RHR to actuate and start is not impaired by these evolutions.~~ Does the time required to perform these evolutions on a support system need to be counted as unavailability for HPSI and RHR? **Licensee Proposed Response:** No. **The period of heat treatment will not be considered as "unavailable" for the HPSI and RHR systems because of the utility's actions to limit the environmental impact of heat treatments.** As described in the question, the ability of safety systems HPSI and RHR to actuate and start is not impaired by these evolutions. There are no unavailable hours.	Introduced 12/6 12/6 Discussed. HOLD needs more clarity in the question 2/5/01 – need to know design basis	San Onofre

FAQ Log 16

Temp No.	**PI**	**Question/Response**	**Status**	**Plant/ Co.**
16.14	MS03	**Question:** **Appendix D Question** Davis-Besse has an independent mo or-driven feedwater pump (MDFP) that is separate from the two trains of 100% capacity turbine-driven auxiliary feedwater pumps. The piping for the MDFP (when in the auxiliary feedwater mode) is separate from the auxiliary feedwater system up to the steam generator containment isolation valves. The MDFP is not part of the original plant design, as it was added in 1985 following our loss-of-feedwater event to provide "a diverse means of supplying auxiliary feedwater to the steam generators, thus improving the reliability and availability of the auxiliary feedwater system" (quote from the DB Updated Safety Analysis Report). The resolution to FAQ 182 was that Palo Verde should count the unavailability hours for their startup feedwater pump. However, since the DB MDFP is manually initiated, DB has not been reporting unavailability hours for the MDFP due to the exception stated on page 69 of NEI 99-02 Revision 0. The DB MDFP is non-safety related, non-seismic, and is not Class 1E powered or automatically connected to the emergency diesel generators. The DB MDFP is required by the Technical Specifications to be operable in modes 1 - 3. However, the Tech Specs do not require the MDFP to be aligned in the auxiliary feedwater mode when below 40 percent power. (The MDFP is used in the main feedwater mode as a startup feedwater pump when less than 40% power). The DB auxiliary feedwater system is designed to automatically feed only an intact steam generator in the event of a steam or feedwater line break. Manual action must be taken to isolate the MDFP from a faulted steam generator. The MDFP is included in the plant PRA, and is classified as high risk-significant for Davis-Besse Per the DB Tech Specs, the MDFP and both trains of turbine-driven auxiliary feedwater pumps are required in Modes 1-3. The MDFP does not fit the NEI definition of either an "installed spare" or a "redundant extra train" per NEI 99-02, Rev. 0, pages 30 - 31. Should the Davis-Besse MDFP be reported as a third train of Auxiliary Feedwater, even though it is manually initiated? (Note: this FAQ is similar to Appendix D questions for Palo Verde and Crystal River regarding the auxiliary feedwater system)	Introduced 12/6 5/2 Discussed 5/31 Discussed	Davis-Besse
		Response: Based on the information provided, this pump should be considered a third train of auxiliary feedwater for NEI 99-02 monitoring purposes. See the Palo Verde Appendix D question.		

Temp No.	PI	Question/Response	Status	Plant/ Co.
18.1	MS01 MS02 MS03 MS04	**Question:** Should surveillance testing of the safety system auto actuation system (e.g. Solid State Protection System testing, Engineered Safety Feature testing, Logic System Functional Testing) be considered as unavailable time for all the affected safety systems? During certain surveillance testing an entire train of safety systems may have the automatic feature inhibited. **Response:**	Introduced 2/8 3/2/01 – Discussed. To be discussed by SSU focus group and NEI task force.	Southern
18.2	MS01 MS02 MS03 MS04	**Question:** When reporting safety system unavailable time there are periodic (such as weekly) evolutions that although they may not be simple actions to restore a safety system, they result in the safety system being unavailable for no more than several minutes. Is this level of tracking unavailable time required?	Introduced 2/8 3/2/01 – Discussed. To be discussed by SSU focus group and NEI task force.	Southern
18.6	IE03	**Question:** On January 6th and 7th, the FitzPatrick Nuclear Power Plant performed unscheduled power reductions in excess of 20% due to environmental conditions. Lake temperature, wind speed and wind direction combined to create conditions resulting in the main condenser water box fouling which required the power reductions to correct. These power reductions have not been included in the "Unplanned Power Change per 7,000 Critical Hours" Performance Indicator based on previous FAQ's concerning unscheduled power reductions arising from external conditions. On 01/06/01 power was reduced to 60% to allow the A2 waterbox to be cleaned & inspected. The "C" traveling screen was removed from service and the remaining waterboxes were de-fished. A recommendation to clean the forebay when divers became available was made to the Shift. Because the availability of divers was expected to be 24 to 96 hours, normal power level was restored. Divers arrived on site 01/07/01, and preparations for forebay cleaning were ongoing. After "C" traveling screen was returned to service condenser delta T and delta P rose slightly. Subsequent lowering of a stop-log (to isolate "A" traveling screen for forebay cleaning) caused condenser delta T and delta P to rise and condenser vacuum dropped. The Shift responded by raising the stop-log, reducing power to 60 percent and de-fishing the waterboxes. Previously, these stop-logs have been lowered without significant effect on condenser performance. Divers confirmed that a large amount of silt and zebra mussel shells had collected in the forebays, which had been cleaned during RO-14. As outlined above, power was reduced on these two successive occasions 01/06/01 (for ~15 hours) and 01/07/01 due to waterbox fouling caused by external environmental conditions. The 01/07/01 down power was an unexpected evolution to be implemented based on when divers were available to perform the cleaning operation. Therefore, both power reductions were the result of the same environmentally caused influx of debris into the forebay. The initial mitigating action (de-fishing) was known to be a temporary measure to allow full power operation until long-term corrective action could be implemented. Since the second power reduction was also caused by zebra mussels and environmental conditions, and prior intake cleaning evolutions were done at full power, should this count as an unplanned power change?	Introduced 2/8 Need more information 4/23 Question revised 5/2 Discussed	FitzPatrick

Temp No.	PI	Question/Response	Status	Plant/ Co.
		Response: No. When external conditions are the fundamental cause of the power reduction it should not count in the Performance Indicator regardless of the period of time between power reductions		

TempNo.	PI	Question/Response	Status	Plant/ Co.
19.3	MS04	**Question:** **(Potential Appendix D question –** Analysis has shown that when RHR is operated in the Suppression Pool Cooling (SPC) Mode, the potential for a waterhammer in the RHR piping exists for design basis accident conditions of LOCA with simultaneous LOOP. SPC is used during normal plant operation to control suppression pool temperature within Tech Spec requirements, and for quarterly Tech Spec surveillance testing. We do not enter an LCO when SPC mode is used for routine suppression pool temperature control or surveillance testing because, as stated in the FSAR, the system's response to design basis LOCA/LOOP events while in SPC configuration determined that a usage factor of 10% is acceptable. The probability of the event of concern is 6.4 E-10. If the specified design basis accident scenario occurs while the RHR system is in SPC mode, there is a potential for collateral equipment damage that could subsequently affect the ability of the system to perform the safety function. If the time RHR is run in SPC mode must be counted as unavailability, then our station RHR system indicator will be forever white due to the number of hours of normal SPC run time (approximately 300 hours per year). This would tend to mask any other problems, which would not be visible until the indicator turned yellow at 5.0%. Should our station count unavailability for the time when RHR is operated in SPC mode for temperature control or surveillance testing? **Response:** No, because the plant is being operated in accordance with technical specifications.	Introduced 3/1 5/2 Discussed 5/31 Tentative Approval	Susquehanna

TempNo.	PI	Question/Response	Status	Plant/ Co.
19.4	IE03	**Question:** In February 2000, a leak was identified in main generator hydrogen cooler No. 34. At that time the leak rate was considered low enough for continued plant operation in accordance with Main Generator Gas System Operating Procedure (SOP-TG-001). Development of an Action Plan and outage schedule was initiated, daily trending of the hydrogen leakage rate was initiated, and plans for repair formulated. By the end of February 2000, an outage schedule was developed, Work Requests planned, material identified and orders placed. The schedule and work package was set aside for use if it became necessary to effect repairs prior to Refueling Outage 11 (scheduled for April 2001). In October 2000, the hydrogen leak rate increased (exceeded approximately 500 cu ft per day) and in accordance with the procedure additional monitoring via a special log was initiated. The approved Action Plan recommended that hydrogen coolers No. 33 and 34 be replaced with available spares. The leak continued to increase and after a maintenance shutdown October 25, the leakage increased to 843 cu ft per day by November 1. By the beginning of December the leak had increased to approximately 1200 cu ft per day and on December 18, the hydrogen leak rate increased to 2054 cu-ft per day. After assessing the condition, plant management decided to shut down the plant and perform the repairs as detailed in the outage schedule based on holiday resource scheduling. On December 19, the plant was shut down prior to reaching the procedural limitation of 4000 cu-ft per day which would have required an operability determination. This limitation is also less than the leakage specification specified by the vendor for continued operation. The 4000 cu-ft per day was considered a threshold for re-evaluation of the condition as required by the procedure. Repairs made and the unit returned to service close to the original outage schedule. This forced outage was evaluated for determining if it was applicable under the classification rules for an unplanned outage. In accordance with the guidelines of NEI-99-02, if the outage was planned more than 72 hours in advance, the outage could be classified as planned. Since the off-normal condition (leak) was identified in February and planning developed, although not all details completed, the shutdown met the criteria of identifying and planning 72 hours prior to the shutdown, and it was classified as a "planned" shutdown. The additional clarification in NEI-99-02, under FAQ No. 6 reinforced that determination. The shutdown was planned and per the examples in NEI-99-02, the time period between discovery of the off-normal condition exceeded 72 hours allowing assessment of plant conditions, preparation and review in anticipation of an orderly power reduction and shutdown. Does this event qualify as a unplanned shutdown? **Response:** No, the degraded condition was identified in February 2000, and an Action Plan was developed to address the condition, including a outage schedule, Work Request, material identification and procurement. Therefore, the degraded condition was identified and planning had been performed more than 72 hours prior to the initiation of plant shutdown. The increased leak rate in December 2000 was not a different condition, only a continuing degradation of the off-normal condition discovered in February 2000. The December leak rate did not exceed procedural limits requiring assessment of operability and plant shutdown and did not require a rapid response.	Introduced 3/1 5/2 Discussed 5/31 Tentative Approval	IP3

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19.6	MS01 MS02 MS03 MS04	**Question** **(Potential Appendix D Question)** At Prairie Island, the three safeguards Cooling Water (service water) pumps were declared inoperable for lack of qualified source of lineshaft bearing water. This required entry into Technical Specifications 3.0.c (motherhood). The plant requested and received a Notice of Enforcement Discretion (NOED) that allowed continued operation of both units until installation of a temporary modification to provide a qualified bearing water supply to two of the three pumps was complete (14 days). Compensatory measures were implemented to ensure continued availability of water to the lineshaft bearings. The Cooling Water System is required to mitigate design basis transients and accidents, maintain safe shutdown after external events (e.g. seismic event), and maintain safe shutdown after a fire (Appendix R).The only events for which the Cooling Water System function could have been compromised are the loss of off-site power (LOOP) and a design basis earthquake (DBE). These two events are limiting because they both involve the loss of off-site power. If off-site power continues to power the non-safeguards buses, then the Cooling Water System function is not lost. Our Risk Assessment determined that the initiating event frequency for a DBE during the 14 day NOED period was so low that it was not a concern. Therefore, this discussion will focus on the LOOP event. The bearing water supply was not fully qualified for LOOP because the power to the automatic backwash for strainers in the system was not safeguards. The concern was that system strainers would plug eventually. However, for this initiating event, function is not lost immediately – it takes time for the strainers to plug. The time it takes is a function of river water quality. Based on an estimate of worst-case river water quality, there are 4 to 7 hours before function would be lost (strainers plug). In fact, testing around the period of the event, showed river water quality was such that the strainers did not plug after 48 hours. Given the time available there is high probability that operators could complete recovery actions before function was lost. A specific probabilistic risk assessment of the local operator actions determined that the probability of failure was less than 1%. The NOED was requested to preclude a two unit shutdown. As part of the request for the NOED, compensatory measures to assure that the Cooling Water System function is maintained were proposed. In summary, the compensatory measures were to: • use a hose (pressure-rated) to connect a safety related source of Cooling Water to the lineshaft bearing supply piping for a Cooling Water Pump • post a dedicated operator locally in the screenhouse near the Cooling Water Pumps • pre-stage equipment and tools in the screenhouse • place identification tags at the connection locations • train the dedicated operator(s) on the procedure for connecting the hose	Introduced 3/1 5/23/01 Question and Response revised. 5/31 Tentative Approval as revised	Prairie Island

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		The need to implement the compensatory measures would have been identified to the Control Room operator by a loss of bearing flow alarm. As stated earlier, this condition is not expected to occur until a filter becomes plugged 4 to 7 hours after the loss of off site power. The Control Room operator would notify the dedicated operator to perform the procedure. The walkdown of the procedure determined that bearing flow could be established in less than 10 minutes. The pump is capable of operating for approximately one hour without bearing flow. When bearing flow is established, the Control Room alarm will clear, thereby giving the Control Room operator confirmation that the procedure has been performed. The procedure also required an independent verification of the bearing flow restoration within one hour of receiving the loss of bearing water flow alarm. The Cooling Water System is a support system and it's unavailability affects: High Pressure Safety Injection, Auxiliary Feedwater, Residual Heat Removal, and Unit 1 Emergency AC (Unit 2 Emergency AC is cooled independent of Cooling Water). Using NEI 99-02 criteria, Prairie Island included the time that the Cooling Water Pumps were declared inoperable, approximately 300 hours, as unplanned unavailability in our PI data report. This resulted in two White Indicators (one on each unit), two other systems (one per unit) on the Green/White threshold, and two systems (again, one per unit) close to the Green/White threshold. However, the cause for these Performance Indicators changing from Green to White is a direct result of the lack of qualified bearing water to the Cooling Water pumps. The lack of qualified bearing water was evaluated through the SDP and resulted in a White finding. A root cause evaluation was performed and corrective actions identified. Since the change in the performance Indicators from Green to White was a direct result of the unqualified bearing water, no additional corrective action is planned. This event does not fit into the guidance given in NEI 99-02. In Rev. 0, page 26, the Clarifying Notes address testing and Control Room operator actions. In Rev. 1, page 28, the Clarifying Notes only allow operator actions taken in the Control Room. We have also reviewed Catawba's FAQ 254. However, their situation addressed maintenance activity results not operator action. Initially, unavailable hours were recorded from the time of discovery until completion of a Temporary Modification that provided a qualified bearing water supply. This resulted in counting approximately 300 unavailable hours per pump. Since the compensatory actions would have maintained the Cooling Water System function, should the unavailable hours be counted only from the time of discovery until the compensatory measures were in place?		

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		Response: Yes, the unavailable hours should be counted only from the time of discovery until the time that the compensatory measures were in place and remained in place. The actions required to restore the Cooling Water System function were simple and had a high probability of success. This is based upon the following factors: • A probabilistic risk assessment of the local operator actions calculated less than a 1% probability of failure. • There is control room alarm to alert the Control Room operator of the need for the compensatory measures. • There are at least two means of communication between the Control Room and the local operator. • Recovery action for each pump was simple - connect a hose to two fittings and position two valves. • Time to complete the recovery action was estimated to be about 10 minutes, based on walk-throughs. Failure to successfully complete the recovery action was not expected to preclude the ability to make additional attempts at recovery. • A dedicated operator was stationed in the area to complete the recovery action. • The operator had a procedure and training for accomplishing the recovery action. • All necessary equipment for recovery action was pre-staged and the fittings and valves were readily accessible. • Indication of successful recovery actions was available locally and in the Control Room. Note: This FAQ is specific to the plant and the circumstances, which included NRC approval of compensatory measures and an SDP review. Other licensees should not unilaterally apply this FAQ result, but should submit a plant specific FAQ.		

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20.3	MS04	**Question:** FAQ for Mitigating System MS04 concerning CE Designed NSSS systems, "Alternative historical data correction method to convert 2 trains to 4 trains." Calvert Cliffs, Fort Calhoun, Millstone 2, Pallisades, Palo Verde, San Onofre, St. Lucie, and Waterford 3 In FAQ # 172, approved on May 2, 2000 for use by CE plants (now in Appendix D), two methods for changing historical data from an initial 2 train report to a revised 4 train report were outlined. Specifically, the change report methodology was to perform one of the following changes to historical data: **1. Maintain Train 1 and Train 2 historical data as is. For Train 3 and 4, repeat Train 1 and Train 2 data.** **2. Recalculate and revise all historical data using this guidance.** For CE plants incorporating method 1, a non-performance related degradation in the PI calculation for Trains 3 and 4 (and the overall PI) was subsequently observed. This degradation occurred due to a decrease in the required hours in the denominator as the historical data was replaced by typically zero (0) or low required hours reported in the revised data (post Jan, 2000) in combination with artificially high unavailability hours in the numerator (due to the doubling of non-shutdown cooling related unavailability hours from the historical data). As a result, PI values would generally degrade over time regardless of performance until the historical data drops from the PI calculation. In some cases, plants projected a fall below the GREEN/WHITE threshold in 2002, even if perfect performance was used in the projection. **Licensee Proposed Response:** To address the calculation anomaly in the determination of the RHR PI, a third alternative is suggested for the estimation of Train 3 and Train 4 data: **3) Maintain Train 1 and Train 2 historical data as is. For Train 3 and Train 4, make a best effort to collect and report the number of unavailable hours and required hours for the historical data period. If data is not available an estimate may be provided.** If changes to historical data are made, then provide comments with the change report to identify the manner in which the historical data has been revised.	4/4 – Discussed. Need CE owners to provide additional input. 5/2 Discussed 5/31 Tentative Approval	CE Plants
20.4	PP01	**Question:** Scheduled Equipment Upgrade During a recent NRC Security Inspection (IP 71130.03), NRC Contractors were able to defeat the Intrusion Detection System (IDS) in several areas, by using assisted jumps. An engineering evaluation was issued and formal Modification/ upgrade action was initiated that directed the installation of additional razor wire to prohibit attempts to circumvent the IDS system without being detected. Is a physical modification to a protected area boundary, that is designed to prohibit the defeat of a Intrusion Detection System (IDS) component considered to be a system/ component modification or upgrade as stated in the Clarifying Notes to NEI 99-02 under Scheduled Equipment Upgrade (and as augmented by FAQ 259)?	4/4 - Introduced and discussed. **5/2 Tentative Approval**	Turkey Point

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		Response: Yes. A physical modification to a protected area boundary is considered to be a system/ component modification or upgrade that deters or prohibits the defeat of the IDS system components. The conditions of the clarifying notes must be met to stop counting compensatory hours.		
21.2	MS01 -04	Question: Removing (Resetting) Fault Exposure Hours Question being reviewed Licensee Proposed Response:		Ginna
21.4	MS01 -04	Question: By the NEI guidance, fault exposure hours can only be removed for "a single item" when the fault exposure hours associated with the item are greater than or equal to 336 hours. How are multiple failures of the same component handled when some of the failures have fault exposure hours less than 336 hours, yet the total of all the failures attributed to the same failed component are greater than 336 hours.? Proposed Response: Concerning groups of fault exposure hours that sum to greater than 336 hours, but are individually less than 336: Fault exposure hours may be removed on a case-by-case basis, provided the following criteria are met: • The applicable failures are associated with the same specific component and have the same root cause • Portions of the fault exposure hours are associated with management's conservative decision to increase the surveillance testing frequency in an attempt to verify effective corrective action and a failure occurred during the increased surveillance frequency • All other NEI 99-02 criteria for removing fault exposure hours have been met • The NRC supplemental inspection considered the failures associated with the condition • The removal received concurrence with the NRC via the FAQ process • A comment is placed in the comment field of the data submitted indicating more than one failure was considered in resetting the fault exposure hours	5/2 Discussed. Response to be revised 5/31 Discussed	Southern Co.
21.6	IE02	Question: Some plants are designed to have a residual transfer of the non-safety electrical buses from the generator to an off-site power source when the turbine trip is caused by a generator protective feature. The residual transfer automatically trips large electrical loads to prevent damaging plant equipment during reenergization of the switchgear. These large loads include the reactor feedwater pumps, reactor recirculation pumps, and condensate booster pumps. After the residual transfer is completed the operators can manually restart the pumps **from the control room**. The turbine trip will result in a reactor scram. Should the trip of the reactor feedwater pumps be counted as a scram with a loss of normal heat removal? Response In this instance, the electrical transfer scheme performed as designed following a scram and thea residual transfer. **In addition the pumps can be started from the control room.** ; therefore**Therefore,** this would not count as a scram with a loss of normal heat removal	5/2 Introduced	Nine Mile

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21.7	MS02 MS04	Question NEI 99-02, Rev. 0 states in the Definition and Scope section for PWR High Pressure Safety Injection Systems that: "Because the residual heat removal system has been added to the PWR scope, the isolation valve(s) between the RHR system and the HPSI pump suction is the boundary of the HPSI system. The RHR pumps used for piggyback operation are no longer in HPSI scope." It is further stated later in the same section that the function monitored for HPSI is: "the ability of a HPSI train to take a suction from the primary water source (typically, a borated water tank), or from the containment emergency sump, and inject into the reactor coolant system at rated flow and pressure." These two statements appear to conflict. For our plant design the RHR / HPSI piggyback mode is the only path available for HPSI to get water from the containment sump and inject it into the RCS. Therefore, we have been counting unavailability of the RHR system upstream of the isolation valves between the RHR system and the HPSI pump suction as unavailability for RHR and HPSI. This would include component unavailability for containment sump isolation valves, RHR heat exchangers and the isolation valves between the RHR and HPSI systems. Should the RHR and HPSI systems be treated independently such that RHR system unavailability should not count against HPSI even though the RHR system is required for the HPSI system to fulfill the function of taking a suction from the containment sump? If so, should unavailability of the isolation valves between the RHR and HPSI pumps' suction be only counted against HPSI?	5/2 Introduced 5/31 Tentative Approval	Kewaunee
		Response Because RHR and HPSI are monitored as separate systems with each having its own performance indicator, there is no need to cascade RHR system unavailability into HPSI. RHR system unavailability includes the system upstream of the RHR system to HPSI system isolation valves. Unavailability of the isolation valves between the RHR system and the HPSI pump suction are only counted against the HPSI system.		

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21.8	MS01,02,03,04	Question NEI 99-02, Rev. 0 states in the Support System Unavailability section that "If the unavailability of a single support system causes a train in more than one of the monitored systems to be unavailable, the hours the support system was unavailable are counted against the affected train in each system. For example, a train outage of 3 hours in a PWR service water system caused the emergency generator, the RHR heat exchanger, the HPSI pump, and the AFW pump associated with that train to be unavailable also. In this case, 3 hours of unavailability would be reported for the associated train in each of the four systems." This example may have led some stations to automatically count monitored systems unavailability when the associated train of support system is unavailable even though the redundant train of support system could support either train of the monitored systems. ~~In the ROP Lessons Learned Workshop (held March 26-28, 2001), handout on page 2 of the Reactor Safety Performance Indicator Issues section under Proposed Resolution "c." it states: "...the support system is available if a single train of that system is available (i.e., support systems are not required to be single failure proof)." The NEI guideline does not contain any information that would lead one to the conclusion that support system unavailability is anything other than a train-to-train relationship to the monitored systems.~~ Our plant design incorporates two service water (SW) trains made up of two pumps per train. If one pump is out-of-service, the entire train of SW is declared out-of-service. Our technical specifications allow for a 72 hour LCO which we may use to take one train out for periodic maintenance or pump replacement. Normally, only one pump of a train is taken out-of-service at a time. The SW headers are normally cross connected which would provide design flow to either train of the monitored systems. While cross connected, if a safety injection signal is received, the SW trains will be automatically isolated from each other. If we have one SW pump out-of-service when we receive the safety injection signal, we would be left with two SW pumps serving one train and one serving the other. The SW trains can be returned to the cross-connected status using a few simple steps. Thus providing the capability to support either train of the monitored mitigating systems. 1) If, while one train of a support system is unavailable, and the opposite train of the support system has the capability to support either train of the monitored systems, is unavailability counted against the monitored systems? 2) Does this single support system train capability to support either train of the monitored systems need to be automatic or promptly established.	5/31 Discussed. Need additional information **HOLD**	Kewaunee
		Response 1) No. As long as the support system train that is available is capable of supporting either train of the monitored systems, no unavailability is counted against the monitored systems. 2) 2) No. The automatic or promptly established only applies to the monitored systems during testing.		

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21.9	MS01	Question: NEI 99-02 Revision 0, Page 1, INTRODUCTION, line 22 states: "Performance indicators are used to assess licensee performance in each cornerstone." Consider the situation where a certified vendor supplied a safety related sub-component for a standby diesel generator. This sub-component was refurbished, tested and certified by the Vendor with missing parts. The missing parts eventually manifested themselves as a sub-component failure that lead to a main component operability test failure. The Vendor issued a Part 21 Notification for the condition after notified by the Licensee of the test failure. (The licensee conducted a successful post maintenance surveillance and two subsequent successful monthly surveillances before the test failure. Thus there was fault exposure and unplanned maintenance unavailability incurred.) If a licensee is required to take a component out of service for evaluation and corrective actions related to a Part 21 Notification or if a Part 21 Notification is issued in response to a licensee identified condition (i.e. Report # 10CFR21-0081), should the licensee have to count the fault exposure and unplanned unavailability hours incurred? Response:	5/2 Introduced 5/31 Discussed	FitzPatrick
22.1	IE02	Question Should the following reactor trip described in the scenario below be reported as a "Scram with Loss of Normal Heat Removal?" A loud noise was heard in the Control Room from the Unit 2 Turbine Building. Operators noted a steam leak, but could not determine the source of the steam because of the volume of steam in the area. It was suspected that the leak was coming from the No. 21 or 22 Moisture Separator Reheater (MSR). The steam prevented operators from accessing the MSR manual isolation valves. Due to the difficulty in determining the exact source of the leak, the potential for personnel safety concerns, and the potential for equipment damage due to the volume of steam being emitted into the Turbine Building, operators manually tripped the Unit. After the manual trip, a large volume of steam was still being emitted, and the shift manager had the main steam isolation valves (MSIVs) shut. Once the MSIVs where shut, the operators identified a ruptured 2-inch diameter vent line from No. 21 MSR second stage to No. 25A Feedwater Heater. The operators shut the second stage steam supplies and isolated the leak. Once the leak was isolated, the MSIVs were opened and normal heat removal was restored. The majority of the steam that was emitted following the trip was due to all the fluid in the MSR and feedwater heater escaping from the pipe. Response No. Complete closure of the MSIVs was easily recoverable from the Control Room without the need for diagnosis or repair to restore the normal heat removal path. The normal heat removal path was easily recoverable from the Control Room by reopening the MSIVs. The leak, by itself, did not affect the normal heat removal function. The shift manager could have alternatively had the Turbine Building cleared and had the MSIVs reopened if the heat removal safety function was threatened. For this event, the secondary heat sink was not lost.	5/31 Discussed	Calvert Cliffs
22.2	IE02	Question Should the following reactor trip described in the scenario below be reported as a "Scram with Loss of Normal Heat Removal?" Following a reactor trip, No. 11 Moisture Separator/Reheater second-stage steam source isolation valve (1-MS-4025) did not close. The open valve increased the cooldown rate of the Reactor Coolant System. Control Room Operators closed the main steam isolation valves and used the atmospheric dump valves to control Reactor Coolant System temperature. Within three hours, 1-MS-4025 was shut manually. Control Room Operators opened the main steam isolation valves, and Reactor Coolant System temperature control using turbine bypass valves was resumed. Response No. Operators intentionally took actions to control the reactor cooldown rate by closing the main steam isolation valves. The normal heat removal path was easily recoverable from the Control Room without the need for diagnosis or repair to restore the normal heat removal path.	5/31 Discussed	Calvert Cliffs

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23.1	MS01 -04	**Question** Can credit be taken for manual operator actions performed outside the control room to recover a failed support system function when the manual actions, while not a single action, are proceduralized and do not require diagnosis or repair?		
23.2	MS01 -04	**Question** When assessing the failure of a system or component to perform its safety function, can mission time be defined with reference to the station's probabilistic risk assessment (PRA)?		