May 12, 2000

Mr. Robert M. Bellamy
Site Vice President
Entergy Nuclear Generation Company
Pilgrim Nuclear Power Station
600 Rocky Hill Road
Plymouth, Massachusetts 02360-5599

SUBJECT: PILGRIM NUCLEAR POWER STATION, UNIT 1 - NOTIFICATION OF CONDUCT OF A TRIENNIAL FIRE PROTECTION BASELINE INSPECTION

Dear Mr. Bellamy:

The purpose of this letter is to notify you that the U.S. Nuclear Regulatory Commission (NRC) Region I staff will conduct a triennial fire protection baseline inspection at Pilgrim Nuclear Power Station, Units 1 in August, 2000. The inspection team will be lead by Roy Fuhrmeister, a fire protection specialist from the NRC Region I Office. The team will be composed of personnel from NRC Region I, and Contracted National Laboratory. The inspection will be conducted in accordance with IP 71111.05, the NRC's baseline fire protection inspection procedure.

The schedule for the inspection is as follows:

- Information gathering visit - July 18-20, 2000
- Week of onsite inspection - August 14-18, 2000.

The purposes of the information gathering visit are to obtain information and documentation needed to support the inspection, to become familiar with the Pilgrim Nuclear Power Station, Units 1 fire protection program, fire protection features, and post-fire safe shutdown capabilities and plant layout, and, as necessary, obtain plant specific site access training and badging for unescorted site access. A list of the types of documents the team may be interested in reviewing, and possibly obtaining, are listed in Enclosure 1.

During the information gathering visit, the team will also discuss the following inspection support administrative details: office space size and location; specific documents requested to be made available to the team in their office spaces; arrangements for reactor site access (including radiation protection training, security, safety and fitness for duty requirements); and the availability of knowledgeable plant engineering and licensing organization personnel to serve as points of contact during the inspection.

We request that during the onsite inspection week you ensure that copies of analyses, evaluations or documentation regarding the implementation and maintenance of the Pilgrim Nuclear Power Station, Unit 1 fire protection program, including post-fire safe shutdown capability, be readily accessible to the team for their review. Of specific interest are those

Mr. , President
Licensee Nuclear Department
Licensee Corporation or Company
Address

SUBJECT: SELECTED NUCLEAR POWER STATION, UNITS 1 AND 2 - NOTIFICATION OF CONDUCT OF A TRIENNIAL FIRE PROTECTION BASELINE INSPECTION

Dear Mr. :

The purpose of this letter is to notify you that the U.S. Nuclear Regulatory Commission (NRC) Region # staff will conduct a triennial fire protection baseline inspection at Selected Nuclear Power Station, Units 1 and 2 in Month, 20##. The inspection team will be lead by First Last, a fire protection specialist from the NRC Region # Office. The team will be composed of personnel from NRC Region #, and Contracted National Laboratory. The inspection will be conducted in accordance with IP 71111.05, the NRC's baseline fire protection inspection procedure.

The schedule for the inspection is as follows:

- Information gathering visit - Month ##-##, 20## [Note - this date is pre-coordinated with the licensee]
- Week of onsite inspection - Month ##, 20##.

The purposes of the information gathering visit are to obtain information and documentation needed to support the inspection, to become familiar with the Selected Nuclear Power Station, Units 1 and 2 fire protection programs, fire protection features, and post-fire safe shutdown capabilities and plant layout, and, as necessary, obtain plant specific site access training and badging for unescorted site access. A list of the types of documents the team may be interested in reviewing, and possibly obtaining, are listed in Enclosure 1.

During the information gathering visit, the team will also discuss the following inspection support administrative details: office space size and location; specific documents requested to be made available to the team in their office spaces; arrangements for reactor site access (including radiation protection training, security, safety and fitness for duty requirements); and the availability of knowledgeable plant engineering and licensing organization personnel to serve as points of contact during the inspection.

We request that during the onsite inspection week you ensure that copies of analyses, evaluations or documentation regarding the implementation and maintenance of the Selected Nuclear Generating Station, Units 1 and 2 fire protection program, including post-fire safe shutdown capability, be readily accessible to the team for their review. Of specific interest are those documents which establish that your fire protection program satisfies NRC regulatory requirements and conforms to applicable NRC and industry fire protection guidance. Also, personnel should be available at the site during the inspection who are knowledgeable regarding those plant systems required to achieve and maintain safe shutdown conditions from inside and outside the control room (including the electrical aspects of the relevant post-fire safe shutdown analyses), reactor plant fire protection systems and features, and the Selected Nuclear Power Station fire protection program and its implementation.

Your cooperation and support during this inspection will be appreciated. If you have questions concerning this inspection, or the inspection team's information or logistical needs, please contact First Last, the team leader, in the Region # Office at ###-###-####.

Sincerely,

Docket Nos.: 50-###
and 50-###

Enclosure: As stated (1)

Reactor Fire Protection Program Supporting Documentation

[Note: This is a broad list of the documents the NRC inspection team may be interested in reviewing, and possibly obtaining, during the information gathering site visit.]

1. The current version of the Fire Protection Program and Fire Hazards Analysis.

2. Current versions of the fire protection program implementing procedures (e.g., administrative controls, surveillance testing, fire brigade).

3. Fire brigade training program and pre-fire plans.

4. Post-fire safe shutdown systems and separation analysis.

5. Post-fire alternative shutdown analysis.

6. Piping and instrumentation (flow) diagrams showing the components used to achieve and maintain hot standby and cold shutdown for fires outside the control room and those components used for those areas requiring alternative shutdown capability.

7. Plant layout and equipment drawings which identify the physical plant locations of hot standby and cold shutdown equipment.

8. Plant layout drawings which identify plant fire area delineation, areas protected by automatic fire suppression and detection, and the locations of fire protection equipment.

9. Plant layout drawings which identify the general location of the post-fire emergency lighting units.

10. Associated circuit analysis performed to assure the shutdown functions and alternative shutdown capability are not prevented by hot shorts, shorts to ground, or open circuits (e.g., analysis of associated circuits for spurious equipment operations, common enclosure, common bus).

11. Plant operating procedures which would be used and describe shutdown from inside the control room with a postulated fire occurring in any plant area outside the control room, procedures which would be used to implement alternative shutdown capability in the event of a fire in either the control or cable spreading room.

12. Maintenance and surveillance testing procedures for alternative shutdown capability and fire barriers, detectors, pumps and suppression systems.

13. Maintenance procedures which routinely verify fuse breaker coordination in accordance with the post-fire safe shutdown coordination analysis.

14. A sample of significant fire protection and post-fire safe shutdown related design change packages (including their associated 10 CFR 50.59 evaluations) and Generic Letter 86-10 evaluations.

15. The reactor plant's IPEEE, results of any post-IPEEE reviews, and listings of actions taken/plant modifications conducted in response to IPEEE information.

16. Temporary modification procedures.

17. Organization charts of site personnel down to the level of fire protection staff personnel.

18. If applicable, layout/arrangement drawings of potential reactor coolant/recirculation pump lube oil system leakage points and associated lube oil collection systems.

19. A listing of the SERs and actual copies of the 50.59 reviews which form the licensing basis for the reactor plant's post-fire safe shutdown configuration.

20. Procedures/instructions that control the configuration of the reactor plant's fire protection program, features, and post-fire safe shutdown methodology and system design.

21. A list of applicable codes and standards related to the design of plant fire protection features and evaluations of code deviations.

22. Procedures/instructions that govern the implementation of plant modifications, maintenance, and special operations, and their impact on fire protection.

23. The three most recent fire protection QA audits and/or fire protection self-assessments.

24. Recent QA surveillances of fire protection activities.

25. A listing of open and closed fire protection condition reports (problem reports/NCRs/EARs/problem identification and resolution reports).

26. Listing of plant fire protection licensing basis documents.

27. A listing of the NFPA code versions committed to (NFPA codes of record).

28. A listing of plant deviations from code committments.

29. Actual copies of Generic Letter 86-10 evaluations.

END

Fire Protection
Significance Determination Process

F.1 Introduction

The fire protection defense-in-depth (DID) elements are:

1. Prevent fires from starting.

2. Rapidly detect and suppress those fires that do occur.

3. Protect structures, systems, and components important to safety so that a fire that is not promptly extinguished by fire suppression activities will not prevent the safe shutdown of the plant[1].

A fire protection program finding can generally be classified as a weakness associated with meeting the objectives of one of the preceding DID elements. As a result, the Fire Protection Risk Significance Screening Methodology (FPRSSM), a two-phase screening methodology, was developed to evaluate the potential fire risk significance of any fire protection DID weaknesses that are important to post-fire safe shutdown. If no DID related findings against a fire protection feature or system are observed, the fire protection feature and system is considered to be capable of performing its intended function and in its normal (standby) operating state.

Phase 1 of the FPRSSM is a screening method that is used by the resident or regional inspector to screen out fire protection findings (e.g., impairments to any fire protection feature) that are primarily unrelated to fire protection systems and features used to protect safe shutdown (SSD) capability. Phase 1 is used as an oversight process to monitor operational conditions affecting fire protection systems and features. This monitoring process identifies conditions that could have a potential impact on the capability to maintain one SSD success path[2] free of fire damage.

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[1] Fire protection features sufficient to protect against the fire hazards in the area, zone, or room under consideration must be capable of assuring that necessary structures, systems, and components needed for achieving and maintaining safe shutdown are free of fire damage (see Section III.G.2a, b, and c of Appendix R to 10 CFR Part 50); that is, the structure, system, or component under consideration is capable of performing its intended function during and after the postulated fire, as needed.

[2] An SSD success path must be capable of maintaining the reactor coolant process variables within those predicted for a loss of AC power , and the fission product boundary integrity must not be affected (i.e., there must be no fuel cladding damage, rupture of any primary coolant boundary, or rupture of the containment boundary).

Findings that do not screen out as result of the Phase 1 screening should be subjected to the more detailed Phase 2 analysis. The Phase 2 analysis evaluates the synergistic impact that these findings may have on risk by treating them collectively for a fire area. The phase 2 analysis allows for equipment beyond Appendix R to mitigate core damage. Because of the integrated approach taken by the Phase 2 analysis, this analysis is generally performed, with technical support from NRC fire protection engineers and risk analysts, to better understand the potential fire risk significance posed by the identified DID Phase 1 findings. For those cases where Phase 2 method determines that the inspection findings have potential risk significance, Phase 3, which is a more refined analysis, can be performed.

F.2 Guidance

The purpose of this two-phase screening methodology is to (1) focus resources on monitoring the performance and effectiveness of those fire protection mitigation features that are important to protecting post-fire safe shutdown capability; (2) establish a threshold method (Phase 1 method is described in **Section 4.0**) that will assist in recognizing which fire protection mitigation findings may have the potential to affect post-fire safe shutdown capability; and (3) determine the potential fire risk significance of observed findings associated with fire protection mitigation features and systems used to protect SSD capability by performing screening assessment (Phase 2 method is described in **Section 5.0**) of the as-found condition(s). The Phase 2 screening analysis portion evaluates the "as-found" conditions associated with each fire protection mitigating element of the fire protection DID philosophy (e.g., detection, suppression, and passive protection separating post-fire SSD functions) within each of the DID elements. The potential fire risk significance of the as-found condition(s) is determined by performing an integrated assessment of the fire protection mitigation findings and the potential impact they may have on SSD capability.

The Phase 2 methodology can also be used by an NRR fire protection reviewer or a regional inspector as an aid for determining the potential risk/safety significance of: (1) a fire protection design condition that deviates from the intent of the facilities licensing/design basis; or (2) a Generic Letter 86-10 or 10 CFR 50.59 engineering evaluation documenting a change in a licensee's fire protection program.

For the purpose of this guidance, weaknesses or findings will be defined as conclusions or factual observations of those "in-plant" conditions that do not meet regulatory requirements, do not conform to the facilities operating license fire protection condition, or are considered to have risk implications due to an inherent fire protection/post-fire safe shutdown system design weakness (degradations) of critical elements associated with a fire protection feature or system ability to promptly react to, passively resist, control, or suppress a fire. The fire protection industry has developed design and installation codes and standards that govern the design and installation of fire protection features and systems. The fire protection standard or codes-of-record establishes the minimum design, performance, and acceptance criteria a given fire protection system or feature must meet. This minimum design, installation, and acceptance criteria establish the assurance that the feature or system, when called upon, will perform its intended fire detection, control, suppression, and extinguishment function.

F.3 Scope

The scope of Phase 1 is to present a process that can help inspectors determine whether a particular fire protection finding is important to the protection of the safe shutdown capability and has the potential of being risk significant.

Fire protection DID findings that have been determined to imply potential risk by the Phase 1 screening method are subjected to a Phase 2 review. The scope of Phase 2 is to present a process for regional and headquarters fire protection engineers and risk analysts to further evaluate how a particular fire protection DID finding or set of findings affects SSD capability. In order to evaluate the potential risk significance, Phase 2 integrates the "as-found" degradations or findings and evaluates their potential affects on fire mitigation effectiveness and SSD capability. Phase 2 is focused on the following specific areas of fire mitigation:

- fire barrier effectiveness
- fire detection/automatic suppression system effectiveness
- manual suppression effectiveness
- safe shutdown capability

F.4 Fire Protection Risk Significance Screening Methodology—Phase 1

Not all plant fire protection systems and features are considered to be important to the protection of post-fire SSD capability. The results of the fire IPEEE (individual plant evaluation of external events) can provide a relative ranking of the plant areas that are the major contributors to fire risk. The top ten areas identified by this IPEEE/PRA (probabilistic risk assessment) ranking are generally important to post-fire SSD. (If the control room, cable spreading room, and switchgear room are not included in the top ten, theses rooms should be considered potentially important since they generally are risk significant[3].) These plant areas also present the greatest challenges with respect to separation of redundant trains of post-fire SSD capability, protection of this capability, and the ability to perform the operator actions necessary to achieve and maintain post-fire SSD conditions.

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[3] Draft NRC NUREG, Preliminary Perspectives Gained from 24 Individual Plant Examination of External Events (IPEEE) Submital Reviews, December 10, 1997.

Phase 1 method consists of two steps. Step 1 is a screening evaluation of a fire protection finding or a set of findings and is intended to screen out findings that do not impact the effectiveness of a fire protection DID element. For those findings that impact the effectiveness of one or more of the DID elements, Step 2 is performed. Step 2 integrates the findings with the SSD capability provided for the fire area, zone, or room of concern and then presents insights with respect to the potential importance that these fire protection findings have on maintaining one success path of SSD capability free from fire damage.

The steps that follow describe the general process for implementing Phase 1.

Step 1: Screening of Fire Protection Findings

The Step 1 screening process is described by Figure 4-1. This process identifies those fire protection findings that impact the mitigation effectiveness of one fire protection DID element. Findings that impact the effectiveness of one or more of the fire protection DID elements potentially have risk implications[4]. Once identified, findings affecting one or more of the DID elements require further screening in order to determine if they are potentially important to maintaining one success path of SSD capability free of fire damage. This screening is performed by Step 2 below.

Making judgments regarding how effective a fire brigade can be in extinguishing a challenging plant fire requires an evaluator to have a comprehensive understanding of manual fire fighting techniques and operations. It is not the intent of Step 1 to expect resident inspectors to have the expertise to evaluate fire brigade effectiveness and performance. In most cases, fire brigade performance can be important to mitigating a fire and reducing its potential risk and should be considered when performing a Phase 2 evaluation. Reliance on fire brigade performance and its effectiveness as a sole means of maintaining one success path of SSD capability free of fire damage is not viewed as an acceptable practice. In those cases in which manual fire fighting (i.e., fire brigade) is used as the sole means to control and extinguish a fire, one success path of SSD capability is generally maintained free of fire damage by a passive fire barrier having a fire resistive rating of 3-hours. In Step 2, where fire barriers or fire barriers in combination with an automatic fire suppression system are used as the primary protection scheme for maintaining an SSD success path free of fire damage, manual fire fighting performance or effectiveness is not considered the dominant protective element of the primary protection scheme. For those protection schemes that use passive fire barriers as primary protection, findings related to only manual firefighting or fire brigade effectiveness typically do not warrant the performance of a Phase 2 evaluation.

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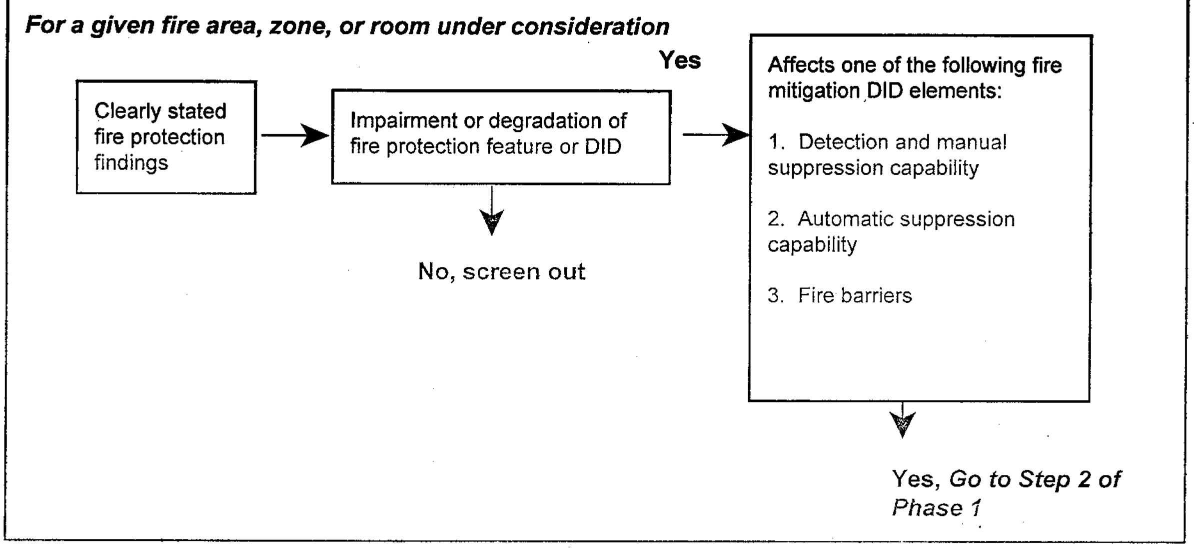
[4] Rigorous compensatory measures that are functionally equivalent (e.g., temporary fire barrier penetration seal, extension of fire hose from an operable hose station to provide fire finghting capability for those areas affected by an inoperable hose station) may offset the loss of the DID related fire protection feature or system. The technical merits of these compensatory measures to perform in a equivalent manner to the inoperable or degraded functions should be evaluated on a case-by-case basis.

Figure 4-1: Screening Process Phase 1 (Step 1)



Step 2: Safety Importance Determination

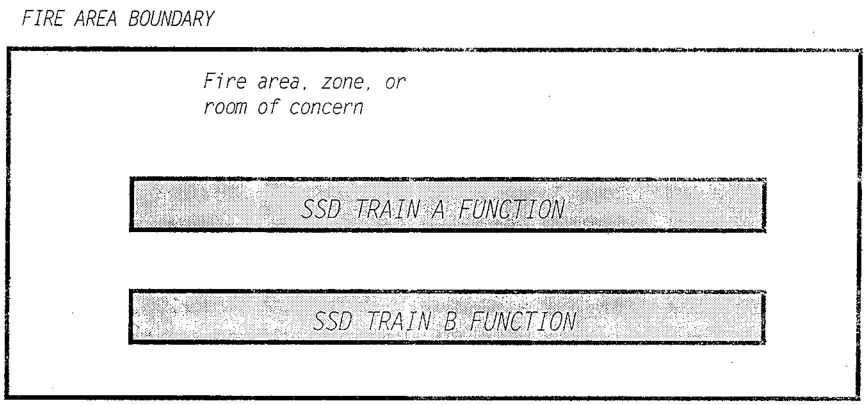
When findings affect one or more of the fire protection DID elements in a given fire area, zone, or room of concern, it is necessary to perform an additional screening. In order to implement this screening step and determine if the findings are potentially risk significant, the post-fire SSD capability for the fire area, zone, or room of concern and the fire protection schemes used to maintain one SSD success path free of fire damage will have to be determined. For those findings that do not screen out[5], a Phase 2 evaluation will be performed.

The SSD determination can be made by reviewing the plant's Fire Safe Shutdown Analysis (FSSA). Using the FSSA information, the method and equipment being used to achieve and maintain post-fire SSD for each fire area, zone, or room of concern can be determined. In addition, the FSSA will identify fire protection schemes used to protect the analyzed SSD success path. Depending on the degree of physical and electrical separation provided for the various SSD success paths, different fire protection schemes are used to ensure that one SSD success path is free of fire damage. Figures 4-2 through 4-5 below, presents additional screening guidance for determining if the fire protection DID findings are potentially significant. If a question is not asked about a DID principle along a specific screening path, the assumption is that the DID elements not being questioned are capable of performing their intended function (normal operating state) and their designs meet the minimum criteria established by the code-of-record. Therefore, if a degradation in a DID element exists in the fire area, room, or zone, the path containing the query about the condition of that DID

[5]Findings that do screen out should not be disregarded, they should be referred to the licensee and placed in the licensee corrective action program.

element(s) must be explicitly followed in the flow chart, or the analyst will underestimate the risk associated with that finding(s).

SSD system with redundancy is located in the area, zone, or room of concern. The remaining recovery capability is none. No additional recovery capability exists for performing the essential SSD functions external to the area, zone, or room of concern.



No remaining capability exists for performing essential SSD functions external to the area, zone, or room of concern.

Figure 4-2

For the SSD interaction as noted in Figure 4-2 above (which corresponds to 0 column in table 5.8), the following three basic fire protection schemes are used outside of primary containment to protect and maintain one train of SSD capability free from fire damage:

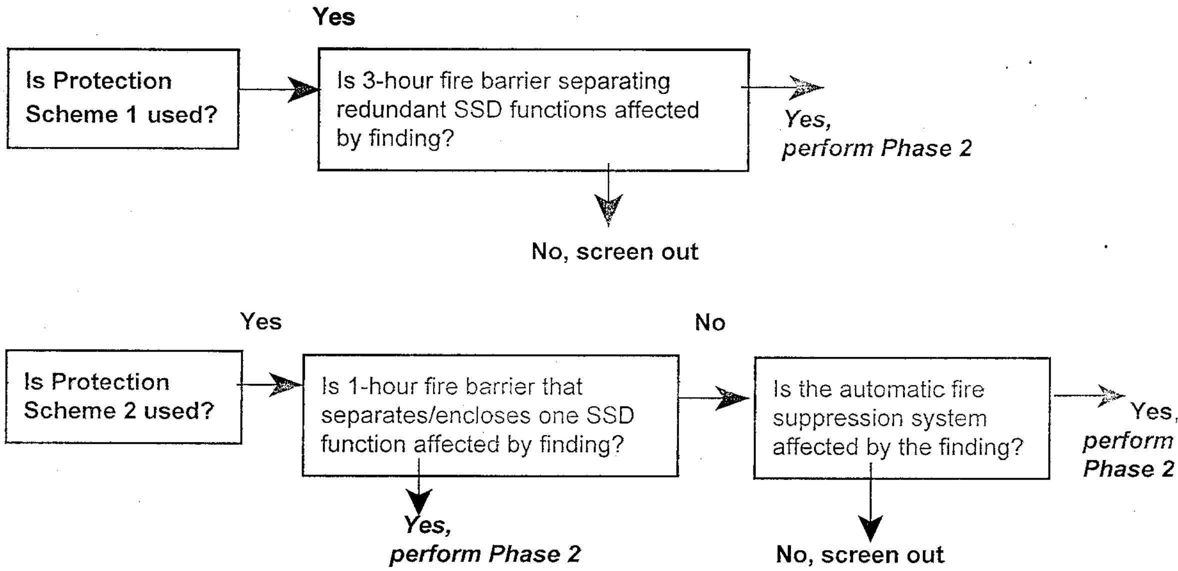
Scheme 1 Provide a 3-hour fire barrier separation that either encloses one SSD train or provides wall-to-wall and floor-to-floor separation between the redundant trains; or

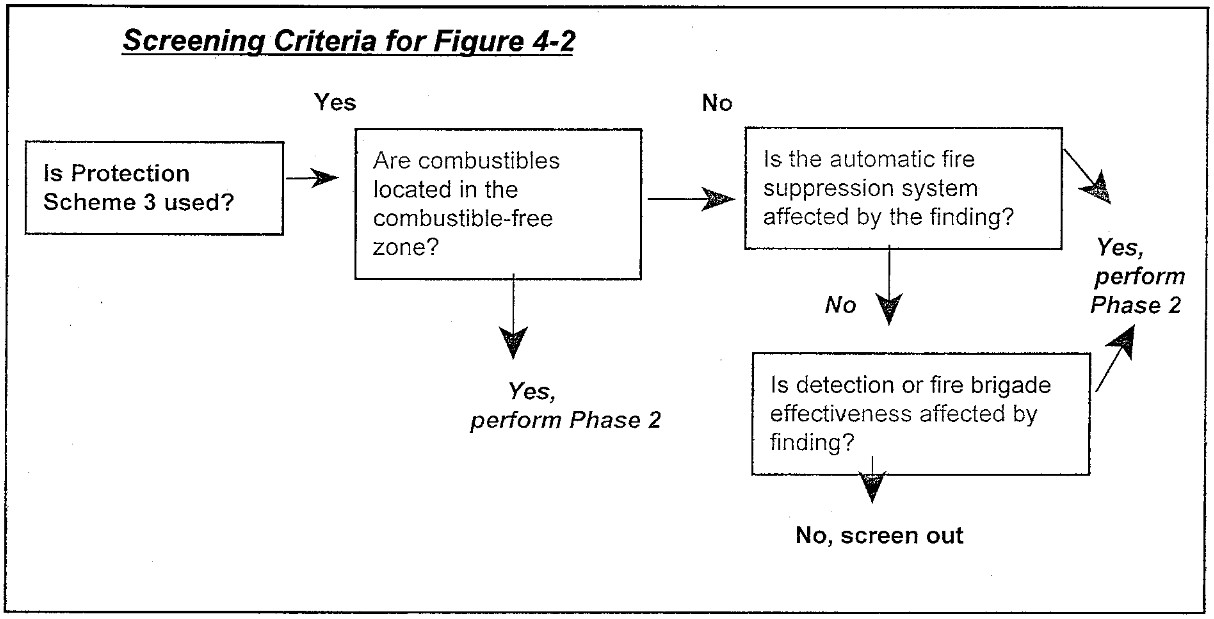
Scheme 2 Provide a 1-hour fire barrier enclosing one of the SSD trains. The area must be protected by automatic fire detection and suppression systems; or

Scheme 3 Provide more than 20 feet of horizontal separation between the redundant SSD trains. The spatial separation between the redundant SSD trains must be free of intervening combustibles. The area must be protected by automatic fire detection and suppression systems.

Determine which protection scheme is used.

Screening Criteria for Figure 4-2





SSD system with redundancy is located in the area, zone, or room of concern. Remaining mitigation capability is recovery of one fire-affected SSD train (e.g., alternative shutdown method for the control room).

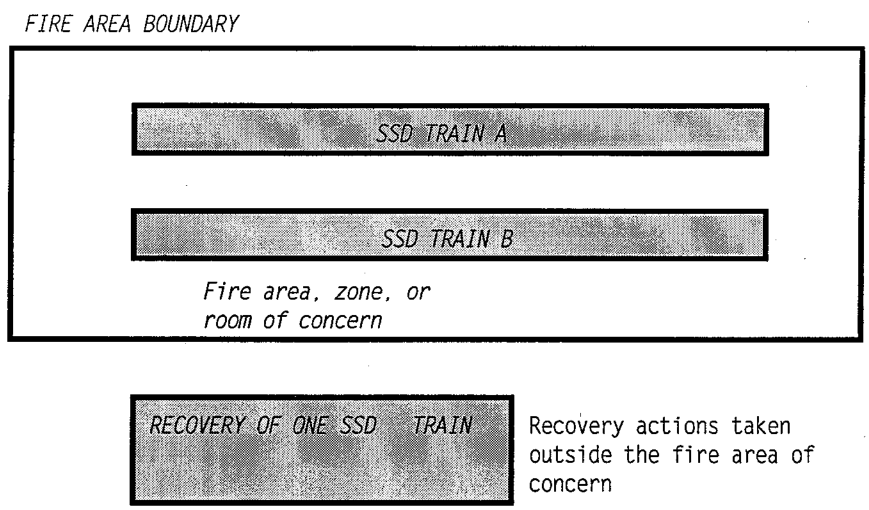
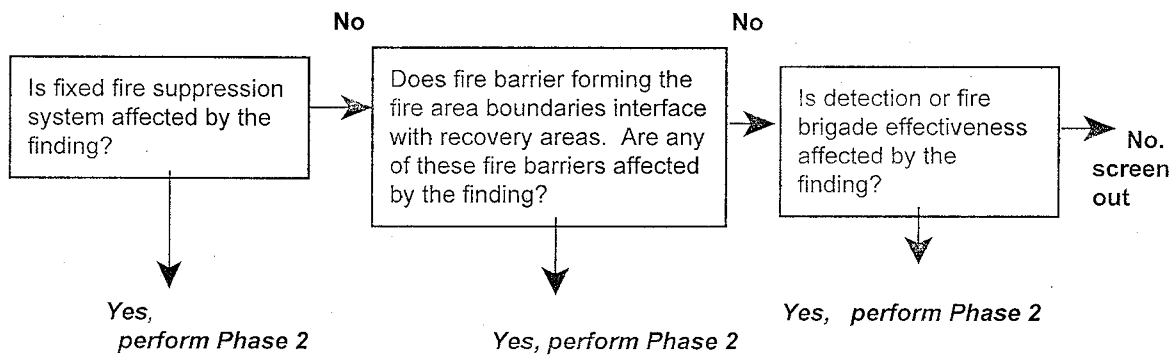


Figure 4-3

For the post-fire SSD interaction noted in Figure 4-3 above (which corresponds to the -1 column in table 5.8), one basic type of fire protection scheme is generally used.

Scheme This scheme minimizes fire damage to the preferred SSD trains by providing automatic detection and fixed suppression in the fire area, zone, or room of concern (the control room is an exception, no fixed fire suppression is provided). In addition, this scheme provides an alternative shutdown system that is electrically and physically independent of the fire area, zone, or room of concern.

Screening Criteria for Figure 4-3



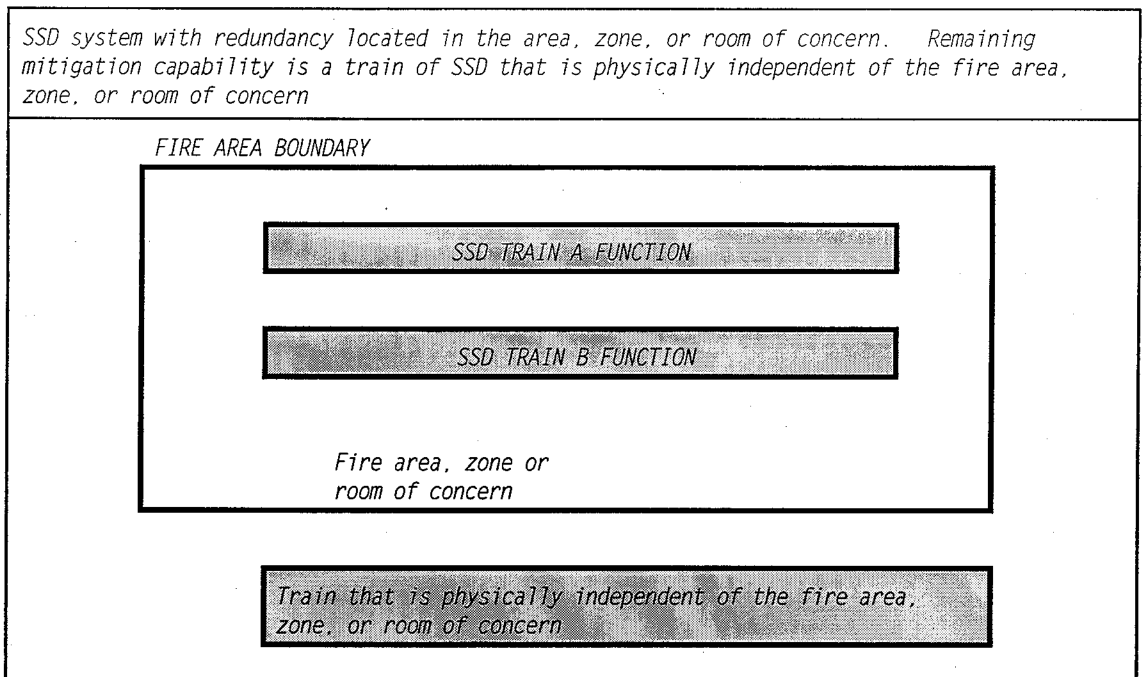
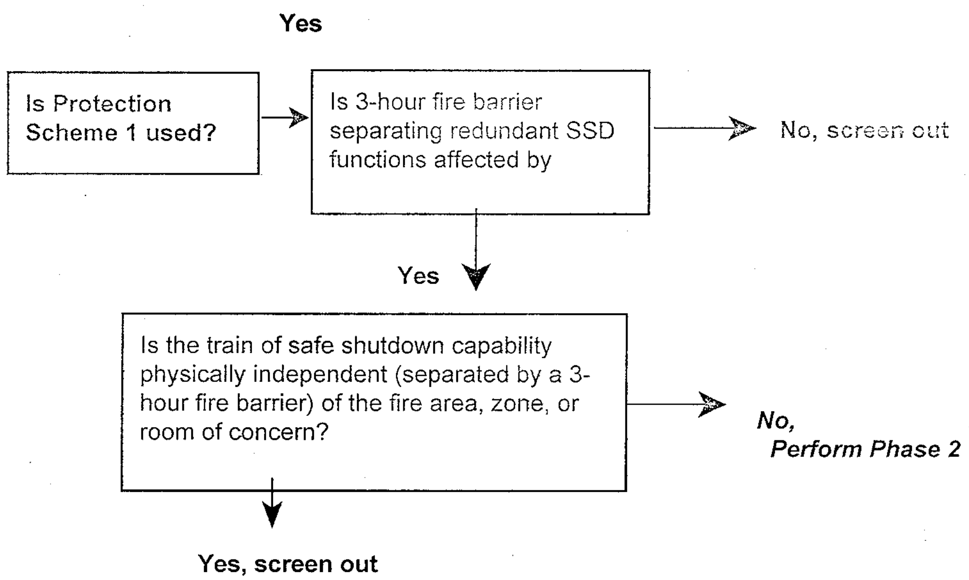


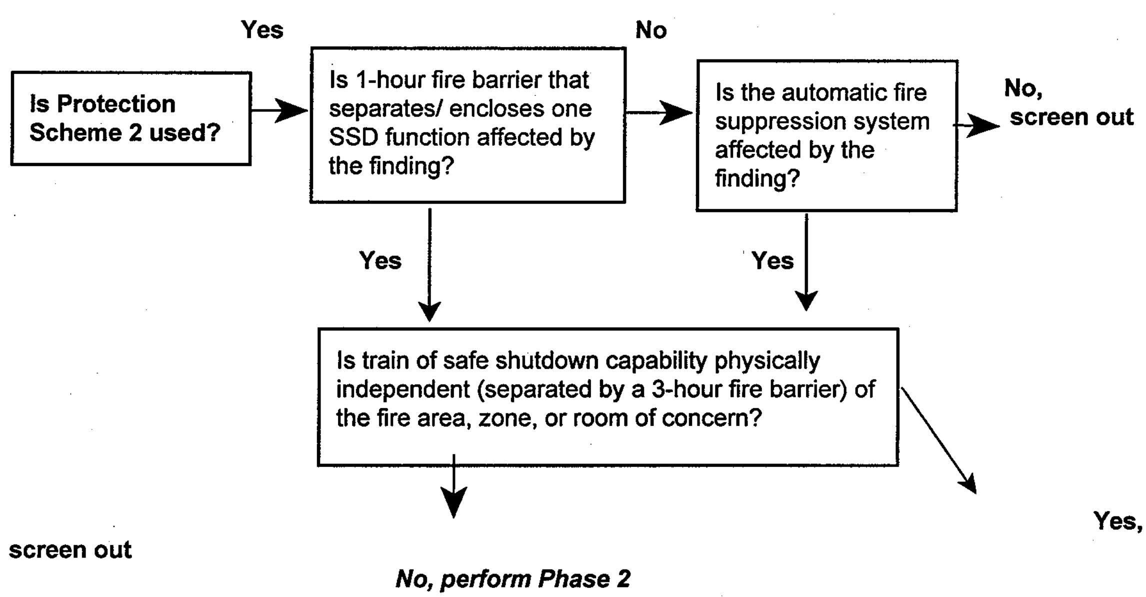
Figure 4-4

For the post-fire SSD interaction noted in Figure 4-4 above (which corresponds to the -2 column in table 5.8), three basic types of fire protection schemes are used to protect one train of SSD from fire damage within the area of concern. These fire protection schemes are the same as those described for Figure 4-2. Determine which protection scheme is used.

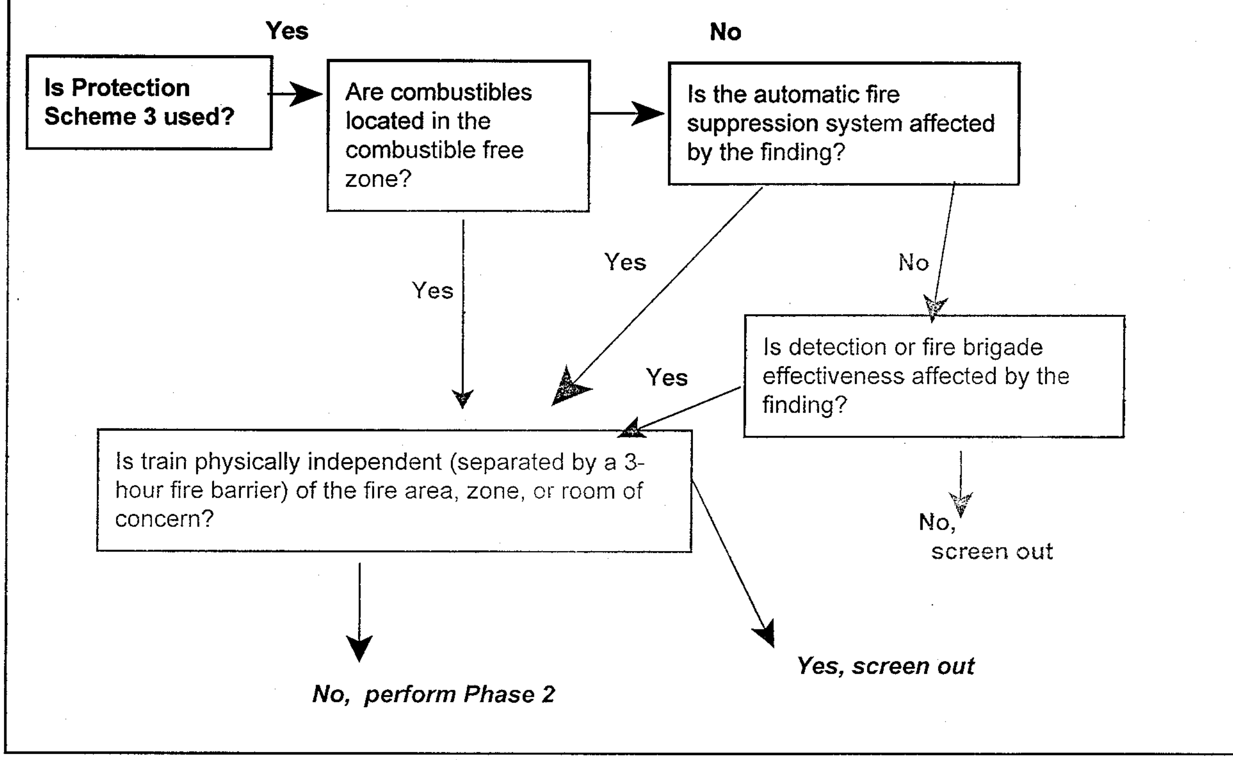
Screening Criteria for Figure 4-4



Screening Criteria for Figure 4-4



Screening Criteria for Figure 4-4



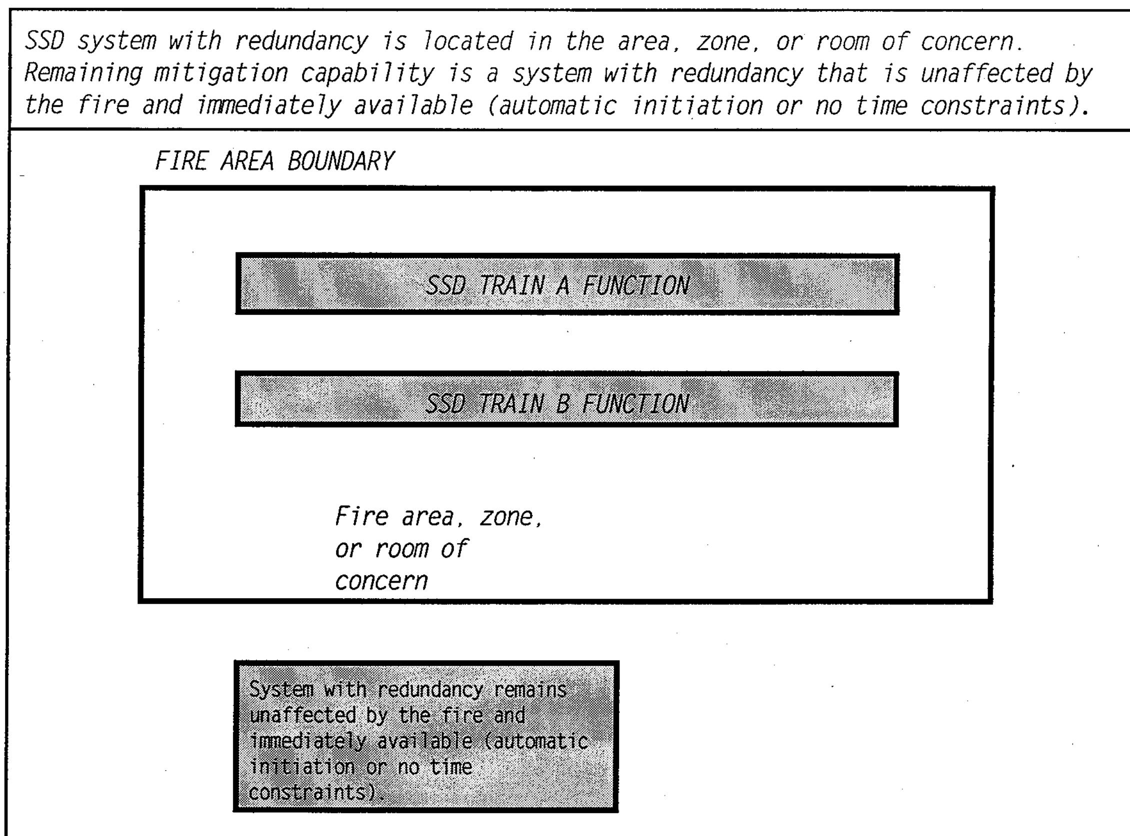
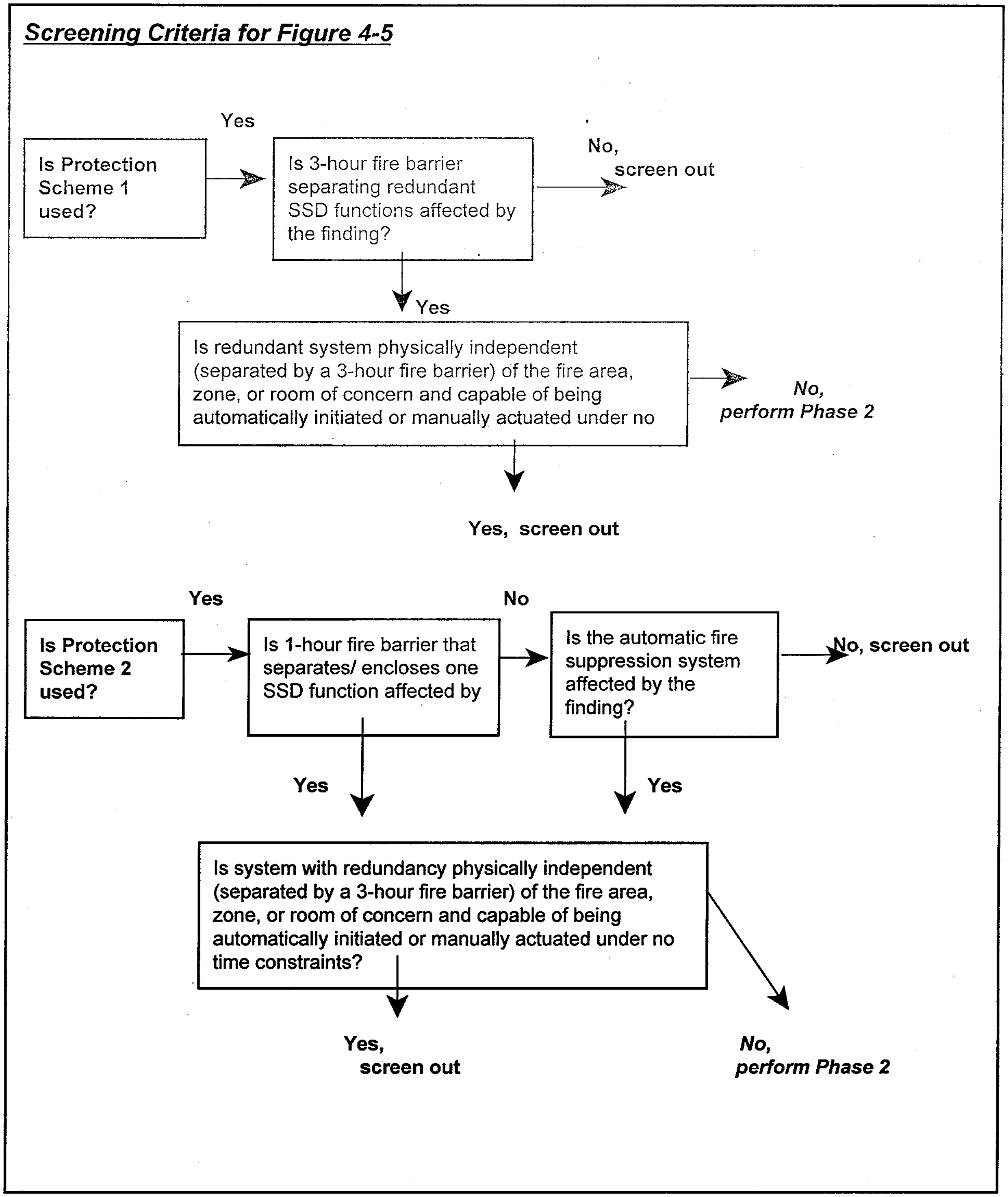
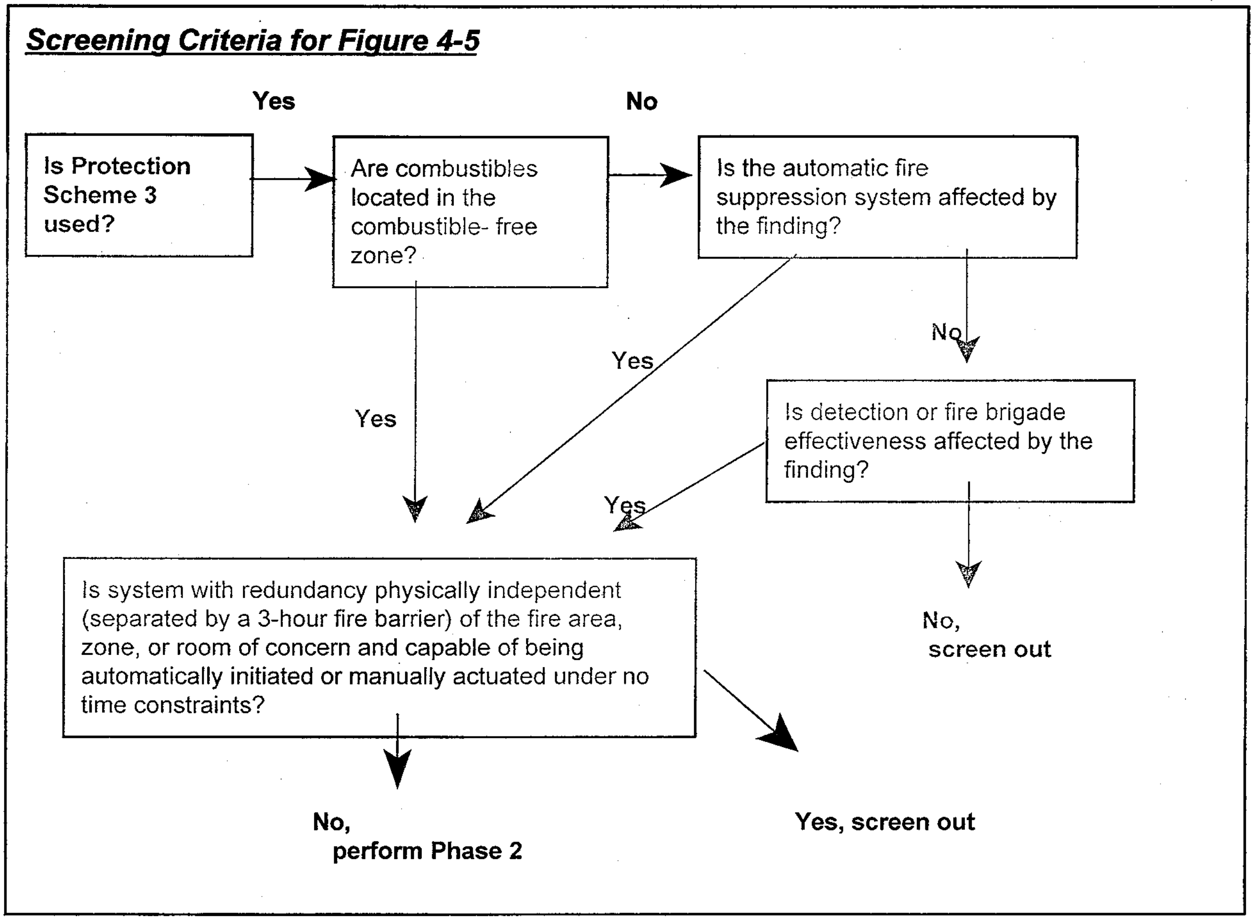


Figure 4-5

For the post-fire SSD interaction noted in Figure 4-5 (which corresponds to column -3 in table 5.8) above, three basic types of fire protection schemes are used to protect one train of SSD from fire damage within the area of concern.



These fire protection schemes are the same as those described for Figure 4-2. Determine which protection scheme is used.



F.5 Fire Protection Risk Significance Screening Methodology—Phase 2

The FPRSSM is an integrated process that can be used to assess the relative risk significance of identified weaknesses in the fire protection DID elements in a given fire area, zone, or room under consideration. The following steps describe the general process that should be followed when implementing this methodology **(see Figure 5-1, "Fire Protection Risk Significance Screening Methodology—Process Diagram").** In the case that the Phase 2 method determines that the assessed findings have potential risk significance, Phase 3, which is a more refined analysis, can be performed.

Step 1: Grouping of Fire Protection and Post-fire Safe Shutdown Findings

The specific fire protection inspection findings affecting the fire protection mitigation DID features are grouped according to each specific fire area, zone, or room which they impact. Then an area-specific fire damage scenario is defined and its effects are postulated. Step 2 provides guidance for defining fire scenarios. Step 1 and Step 2 should be performed during an inspection in an integrated manner (i.e., observations of a fire protection degradation and the related fire hazards in the area of concern).

Step 2: Define the Fire Scenario

In order to properly support the FPRSSM risk estimates, the inspector or the reviewer will need to develop a postulated fire damage scenario that describes the fire and its potential for propagation (see Inspection Procedure (IP) 64700, Fire Protection Supplemental Inspection (FPSI), for further guidance) within the fire area, zone, or room under consideration. Under this postulated scenario, the inspector or reviewer must make deterministic/qualitative judgments regarding the effectiveness of various degraded fire protection mitigation features or systems and their ability to protect a post-fire safe shutdown path and maintain it free from fire damage. Postulated fires involving fuel sources in an area under consideration are deemed important if they are capable of developing a plume and/or a hot gas layer that has the potential to directly affect components of equipment that are important to safety.

Step 3: Qualitative Evaluation of Findings

Once the various inspection DID findings and a meaningful fire scenario have been established for the fire area, zone or room of concern, the individual findings must be evaluated with respect to their ability to satisfy the performance objective established by the applicable DID element. Upon determining which DID elements have been affected by the specific fire protection finding, a qualitative evaluation of each finding and its effects on accomplishing the DID objective is performed. It should be noted that many inspection findings can contribute to a degradation in a DID element. For example, poor training, poor fire brigade/operational drill performance, improperly installed detection, and inadequate hose coverage of a fire area can all contribute to the degradation rating assigned to manual suppression. Therefore, in order to perform this step, the existing plant conditions as noted by the inspection finding are evaluated against the deterministic/qualitative evaluation guidance and degradations categorization criteria established in IP 64700, Fire Protection Supplemental Inspection.

The output from this deterministic/qualitative evaluation, results in a degradation rating (DR) being assigned to each DID element.

Step 4: Integrated Assessment of DID Findings (Excluding SSD) and Fire Ignition Frequency

Once Step 3 has been completed, the respective DID findings for a given fire area, zone, or room of concern are assessed collectively by summing, using the following formula, the fire Ignition Frequency (IF) and the DR for each of the fire protection DID elements. This value is called the Fire Mitigation Frequency (FMF) and inputs into the Significance Determination Process (SDP) (NUREG/CR-5499) to determine the change in risk.

FMF = IF + FB + MS + AS + CC (when appropriate)

where IF = Fire Ignition Frequency
FB = Fire Barrier (used for DRT only; see Step 9)
MS = Manual Suppression/Detection

AS = Automatic Suppression/Detection
CC = Dependencies/Common Cause Contribution

Table 5.6 below shows the association between the FMF and the approximate frequency in Table 5.7 (same as SDP Table 1,"Estimated Likelihood Rating for Initiating Event Occurrence During Degraded Period").

Step 5: Assignment of Quantitative Values

From Step 3, "Qualitative Evaluation of the Findings," a DR is assigned to each DID element. Once the DRs for a DID element have been determined, they are quantified by assigning a value from Table 5.1.

Table 5.1 Quantification of Degradation Ratings (DR) of the Individual DID Elements[6]

Level of Degradation	*3-Hour Fire Barrier*	*1- Hour Fire Barrier*	*20-feet Separation*	*Automatic Fire Suppression Effectiveness*	*Manual Fire Fighting Effectiveness (Fire Brigade)*	
					Outside Control Room	Inside Control Room
High	0	0	0	0	-0.25	-0.75
Moderate	-1.25	-0.5	N/A	-0.75	-0.5	-1
Normal Operating State	-2 (door(s), or multiple dampers, or damper & door)) -2.5 (damper or multiple penseals or both) -3	-1	-2	-1.25	-1	-1.5

The normal operating state category reflects full compliance with existing regulations and regulatory guidance. Specified by the existing regulations and regulatory guidance is the need for fire protection systems and features to meet fire protection industry codes and standards. A fire protection system or feature is considered to be in a normal operating state when its design conform

[6] Each of these values in Tables 5.1, 5.2, and 5.3 is approximately an exponent of 10.

with the minimum design, installation, and performance criteria specified by the code-of-record.

Rigorous[4] compensatory measures for the DID elements are credited. The credit given for an rigorous compensatory measure to a DID element is the credit provided for a moderate degradation of the DID element.

The bases for the failure probabilities in Table 5.1 follow. The normal operating state probability for the 3 hour barrier is found in several NRC and industry documents (e.g. EPRI Fire PRA Implementation Guide, NUREG/CR-4550). The normal operating state probability for automatic suppression is found in EPRI FIVE methodology and in EPRI Fire PRA Implentation Guide. The 1 hour barrier provides less protection than the 3 hour barrier, and the credit is assigned appropriately. Credit given for the normal operating state 20-foot separation relies on NUREG/CR-3192, and is substantial. The normal operating state probability for non-control room manual suppression is from FIVE, and is used approximately in IPEEEs to characterize manual suppression reliability for fire areas. One basis for control room manual suppression unreliability is the estimate of suppression failure prior to forced evacuation due to smoke impaired visibility.[5] Also credit for manual suppression, in general, is limited since it is not viewed as reliable as an uncomplicated operator action.

Manual suppression capability is credited even when it is highly degraded, unlike other DID elements. This credit is based upon the potential for early detection and suppression of fires by personnel using hand-held fire extinguishers. Quantitatively, the credit provided for the control room comes from the control room severity factor which is partially based on detection and suppression by personnel inhabiting the control room. Less credit is given for a high degradation of non-control room areas since those are not normally manned continuously.

Dependencies exist between certain DID elements. Those dependencies and their values are expressed in **Table 5.2** below.

---

[5] J.C. Chavez and S.P. Nowlen, "An Experimental Investigation of Internally Ignited Fires in Nuclear Power Plant Cabinets, Part II - Room Effects Tests," NUREG/CR-4527 Vol. 2, Sandia National Laboratories, Albuquerque, NM, October 1988. J.C. Chavez, "An Experimental Investigation of Internally Ignited Fires in Nuclear Power Plant Cabinets, Part I - Cabinet Effects Tests," NUREG/CR-4527 Vol. 1, Sandia National Laboratories, Albuquerque, NM, April 1987. J. Lambright et al., "Analysis of the LaSalle Unit 2 Nuclear Power Plant: Risk Methods Integration and Evaluation Program," NUREG/CR-4832, Vol. 9, Sandia National Laboratories, Albuquerque, NM, March 1993. J. Lambright et al., "A Review of Fire PRA Requantification Studies Reported in NSAC/181," Sandia National Laboratories, April 1994, NUDOCS accession number 9409220104.

Table 5.2 Quantification of Dependencies Between DID Elements		
Automatic Fire Suppression Effectiveness Degradation	*Manual Fire Fighting Effectiveness Degradation*	*Adjustment Due to Dependency*
Medium	High	+0.75
Low	High	+0.5

These dependencies are based on the fact that automatic suppression merely controls the fire, and the fire brigade is needed to completely extinguish the fire. The resulting adjustment has the effect of providing partial credit for automatic suppression when it has a low degradation and is paired with a high degradation of manual fire fighting capability. No credit is provided for automatic suppression when it has a medium degradation and is paired with a high degradation of manual fire fighting capability.

Table 5.3 Quantification of Common Cause Contribution Between Sprinkler Systems and Manual Fire Fighting Hose Stations		
Automatic Fire Suppression Effectiveness Degradation	*Manual Fire Fighting Effectiveness Degradation*	*Adjustment Due to Common Cause*
Low	Low	+0.25

The **Table 5.3** adjustment is made since a common water delivery and supply system exists for both automatic and manual water-based systems.

Step 6: Determination of Fire Ignition frequency

The next step is to determine the fire ignition frequency for the fire area, zone, or room of concern. If a fire ignition frequency can be obtained for the specific fire area, zone, or room of concern from the plant-specific IPEEE, it should be used. However, if the IPEEE does not provide it, then it may be selected from **Table 5.4**[6].

[6] Generic ignition frequencies for specific buildings or rooms are provided in Table 4.4a (taken from AEOD data base, NRC's "Special Study: Fire Events—Feedback of U.S. Operating Experience—Final Report," June 19, 1997).

Table 5.4 Generic Ignition Frequencies Plant Buildings or Rooms		
Building or Room	*Ignition Frequency (IF) / Yr*	*Log of Ignition Frequency*
Control Room	7E-3	-2.2
Cable Spreading Room	4E-3	-2.4
Diesel Generator Room	3E-2	-1.5
Switchgear Room	1E-2	-2.0
Battery Room	3E-3 to 1E-2	-2.5 to -2.0
Reactor Building[7]	2E-2	-1.7
Auxiliary Building[7]	4E-2	-1.4
Turbine Building	6E-2	-1.2
Containment	9E-3	-2.1

Table 5.6 *Association of FMF to Table 5.7 (SDP Table 1) Approximate Frequencies for Calculation of Delta CDF*	
Fire Mitigation Frequency (FMF)	Table 5.7 Approximate Frequencies (per year)
FMF > -2	1 per 10 to 10^2
-2 ≥ FMF >-3	1 per 10^2 to 10^3
-3 ≥ FMF >-4	1 per 10^3 to 10^4
-4 ≥ FMF >-5	1 per 10^4 to 10^5
-5 ≥ FMF >-6	1 per 10^5 to 10^6
FMF ≤ -6	Less than 10^6

The approximate frequency is adjusted in **Table 5.7** by the length of time that the degradation existed. In practice, as part of the initial assessment, the inspector should assume that the degradations are simultaneous, and that all occur for the length of time associated with the longest degradation. This is a conservative approach, and if desired, can be refined. (The refinement of this approach is to consider whether the DID degradations overlap in time, and perform the analysis accordingly.) To adjust the time of the degradation, a letter is

[7] The building frequency is likely to be over-conservative for the fire area of concern which is a subset of the building. Therefore, a multiplier which considers the ignition sources (pumps, electrical cabinets) is used to scale the building frequency to the area of concern. The multiplier is the number of ignition sources in the area of concern divided by the number of ignition sources in the building. Therefore, the ignition frequency for the area of concern is the ignition frequency of the building times the multiplier.

selected on the basis of the degradation time from **Table 5.7**. The degradation of 3-30 days decreases the frequency by 10, and the degradation of less than 3 days decreases the frequency by 100.

Table 5.7 Estimated Likelihood Rating for Initiating Event Occurrence During Degraded Period

Approx. Freq.	Estimated Likelihood Rating		
>1 per 1 - 10 yr	A	B	C
1 per 10 - 10^2 yr	B	C	D
1 per 10^2 - 10^3 yr	C	D	E
1 per 10^3 - 10^4 yr	D	E	F
1 per 10^4 - 10^5 yr	E	F	G
1 per 10^5 -10^6 yr	F	G	H
<1 per 10^6yr	G	H	H
Source: SDP Table 1, NUREG/CR-5499	> 30 days	30-3days	<3 days
	Exposure Time for Degraded Condition		

Step 7: Integration of Adjusted FMF with SSD

The FMF, which has been adjusted by the length of degradation, represents the integration of IF with the DR associated with each of the fire protection DID elements. In this step, the FMF is integrated with the SSD capability that is free from fire damage.

The SSD capability is developed by using the Reactor Safety Full Power Level 1 plant-specific event trees (worksheets) which identify the internal event initiating events and the respective sequences which lead to core damage. By understanding the systems that could be potentially affected by a fire in the area of concern, a fire induced initiating event determination (e.g. reactor trip, LOOP, or small break LOCA) can be made, and the appropriate internal events event tree worksheet selected for the fire area analysis. After this determination, the number of plant systems or recovery actions available to prevent core damage are mapped onto the sequences for the appropriate event trees.

The SSD capability per sequence is combined with the FMF to determine the proper color of the sequence according to Table 5.8 (same as SDP Table 2), "Risk

Significance Estimation Matrix. As is directed by the internal events SDP, three green sequences represented by greens immediately to the left of a white in Table 5.8 may be added to produce a white. The basis for this addition is that multiple sequences in a PRA are added to produce the overall CDF. Generally, it is expected that addition of greens will be limited to a single fire area, but hardware degradations in fire protection systems, equipment, or components which affect DID in multiple fire areas may require addition of greens for those multiple fire areas to calculate the change in CDF.

In selecting the proper worksheet, the analyst must realize that the SORV (stuck open PORV) worksheet must be used with either the reactor trip, or LOOP, event tree worksheet. The reason is that either a reactor trip or a LOOP may cause a PORV to be challenged, which may in turn stick open. The probability associated with the PORV being challenged and stuck open is -2 (log space) or 0.01. The SORV is not generally expected to be dominant unless a spurious actuation occurs since a spurious actuation has a failure probability above the random failure probability. However, the importance of the stuck open PORV must be evaluated for each reactor trip or LOOP fire-induced initiating event to verify it is not important. An example of considering the SORV tree simultaneously with the Reactor Trip tree is included in the example 2.

In the FPRSSM, the CDF associated with the impact of the DID findings is strictly what is calculated. However, for purposes of using this model, the CDF due to the DID findings will be considered as the ΔCDF. This is conservative since the CDF due to the DID findings is greater than ΔCDF. Note that in the columns of SSD as the mitigating equipment increases in **Table 5.8**, failure probabilities decrease by a factor of 10.

<u>Step 8: Modifications Necessary To Add Impact of Spurious Actuations</u>

Spurious actuations are accounted for by impacting the relevant sequences identified on the Reactor Safety Full Power internal events worksheets. For each train which experiences fire damage only in the form of spurious actuations, the train is considered failed in the sequence. A factor of -1 is then added to the cutset that is impacted by spurious actuations. (This is equivalent to saying that multiple spurious actuations occur with a probability of 0.1).

A more complicated solution exists for addressing the more difficult case where a train fails due to direct fire damage, and consequently has its recovery complicated by spurious actuations. In this case, the different sequences associated with the non-recovery without spurious actuations, and nonrecovery with spurious actuations must be calculated. For example, assume that a sequence consists of failure of two trains A and B. Assume each of those trains is damaged by fire. Also assume train B is subject to failure due to spurious actuations also. The first sequence associated with this example is failure of A and B with failure to recover each train, excluding the impact of spurious actuations. This sequence is the normal sequence which one would get without spurious actuations. The second sequence involves the impact of spurious actuations. The logic that follows in the development of this sequence is that recovery of train B occurs; however, immediately afterwards, train B experiences a spurious actuation which fails the train. Then the operators attempt to recover train B from the spurious actuation. As a result, the sequence is failure to recover train A without spurious actuations, success in recovering train B without spurious actuations, failure of train B due to spurious actuations, failure to recover train B from spurious actuations.

Step 9: General Rules for Applying FPRSSM

Since a fire barrier failure is represented by a probability, the ΔCDF for a fire area is a combination of two contributions: a contribution from barrier failure, and one from the barrier success. Table 5.1 can be used to calculate both of these terms. For purposes of discussion, the term referring to the case in which the barrier between the two fire areas fails will be called the double room term (DRT) and the case in which the barrier between the two fire areas succeeds in preventing fire damage beyond the area of fire origin will be called the single room term (SRT). The SRT is defined as the combination of the FMF and safe shutdown (SSD) capability free of fire damage due to success of the barrier, and the DRT is the FMF and SSD capability free of fire damage due to failure of the barrier. The SRT and DRT are shown by the figures 8.1 and 8.2 below. (Note that although the SRT and DRT concept is demonstrated in Figures 8.1 and 8.2 for a 3 hour barrier, it also applies to 1 hour barriers.)

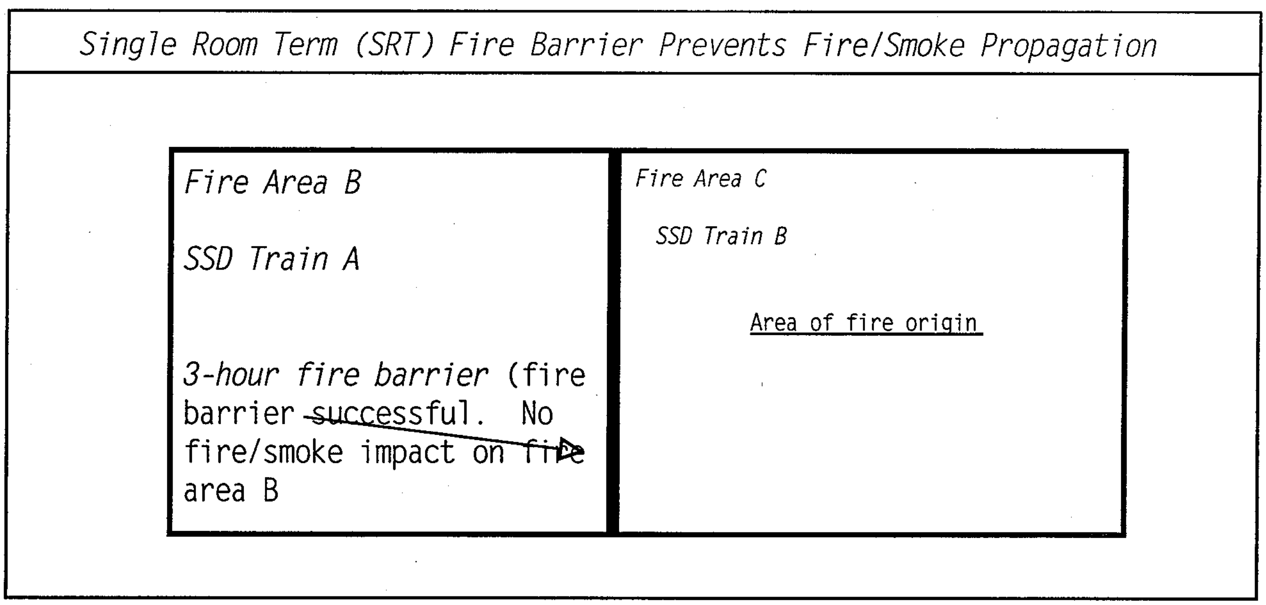


Figure 8.1

Double Room Term (DRT) Fire Barrier Fails to Prevent Fire/Smoke Propagation

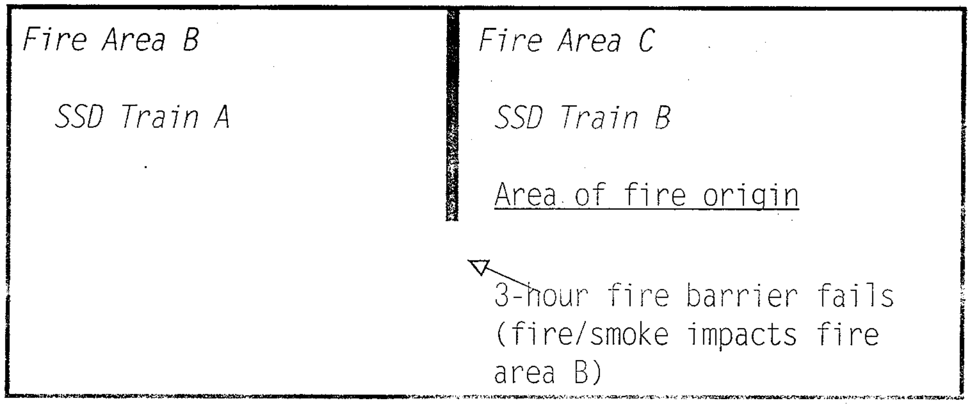


Figure 8.2

For the SRT, all equipment, cables, and actions in the area of fire origin (fire area C) are assumed to fail. As a result, safe shutdown for the SRT (i.e. SSD(SRT)) is the combination of mitigating equipment, associated cables, and actions which remain free of fire damage given that fire damage is limited to fire area C. For the DRT, all equipment, cables, and actions in the area of fire origin, and in the area protected by the barrier, i.e. (Fire areas B and C), are assumed to fail. As a result, safe shutdown for the DRT (i.e. SSD(DRT)) is the combination of mitigating equipment, cables, and actions free of fire damage after all equipment, cables, and actions in both fire areas B and C are lost.

The SSD impact can be different depending on whether the SRT or DRT is calculated. The equipment which mitigates core damage for the DRT is a subset of (or can be equal to) the mitigation equipment for the SRT. The logic is a follows: All the equipment in B and C fail for the DRT, and only that equipment in C fails for the SRT. Thus, more equipment is available to mitigate core damage for a fire which is confined to the area of fire origin (SRT) than one that fails the barrier and damages equipment on the other side of the barrier (DRT).

Other than SSD, the only other part of the CDF determination which will have different values between the SRT and DRT is the credit for the fire barrier. In the DRT, the fire barrier credit comes from Table 5.1. For instance, a medium degradation of a 3 hour barrier utilizes -1.25 as the probability of the barrier in failing to prevent fire propagation into the neighboring fire area (DRT). Yet, for the SRT no credit is given for a barrier since no barrier protects safe shutdown equipment in the room of fire origin. Therefore, for the SRT , the FB is eliminated from the FMF equation.

Both the SRT and DRT are not needed in all cases. The following rules provide guidance on when to use these terms in calculating the ΔCDF for a fire area, and are primarily for the analyst's convenience (since the SRT and DRT may be calculated and summed to get the change in CDF whenever a barrier has either a medium degradation or is in normal operating condition).

(Rule 1) If the fire barrier has a high degradation, just use the DRT to calculate ΔCDF.

(Rule 2) For a 1 hour barrier in either a medium degradation or in its normal operating state, use DRT only as long as SSD(DRT) ≥ 10 times SSD(SRT). Otherwise use SRT + DRT.

(Rule 3) If the 3 hour fire barrier has a medium degradation, use the SRT only if SSD(DRT) ≤ 10 times SSD(SRT). Otherwise, use DRT only.

(Rule 4) If the 3 hour fire barrier is in its normal operating state and has no door, no damper, and does not have multiple penseals, use only the SRT as long as SSD(DRT) ≤ 1000 times SSD(SRT). Otherwise use DRT only.

If the 3 hour fire barrier is in its normal operating state and has at least a door, or a damper, or multiple penseals, use only SRT if SSD(DRT) ≤ 100 times SSD(SRT). Otherwise, use DRT only.

(Therefore, it is expected that a 3 hour fire barrier in its normal operating state will often only require evaluation of the SRT. However, as more safe shutdown related equipment is protected by the 3 hour fire barrier, the fire barrier (and therefore the DRT) will become more important.)

As a result, it is recognized that the DRT is solely needed for a high degradation of a fire barrier. Also, the DRT is likely to dominate in most cases where any degradation exists in a 1 hour fire barrier. However, the SRT is likely to dominate whenever a 3 hour barrier exists in its normal operating state. In other words, as the barrier effectiveness decreases (e.g. from the normal operating state for a 3 hour barrier to either the moderate barrier degradation or normal operating state of 1 hour barrier), the DRT takes on more and more significance until it exclusively represents the high degradation of either barrier.

The other component of the above rules is the safe shutdown related equipment protected by the barrier. Equipment with higher reliability are more important to mitigating core damage than equipment with low reliability. Therefore, a barrier is more important if it is protecting a set of equipment with high reliability. As a result, a combination of the barrier failure probability and the failure probability of the set of equipment protected by the barrier are factored into the rules, via the comparison of SSD(SRT) and SSD(DRT) for a given barrier having a particular failure probability.

For example, since the ratio of SSD(DRT) and SSD(SRT) depicts the reliability of that equipment protected by the fire barrier, the relationship SSD(DRT) ≥ 100 times SSD(SRT) requires a set of higher reliability equipment be protected by the fire barrier than SSD(DRT) ≥ 10 times SSD(SRT). In other words, the larger SSD(DRT) is relative to SSD(SRT), then the higher the reliability of the equipment protected by the barrier. The importance of this equipment for a given barrier with its failure probability determines whether the SRT, DRT, or both are needed to calculate ΔCDF.

The SSD(SRT) and SSD(DRT) should be calculated for all sequences corresponding to the appropriate initiator(s) from the internal events SDP worksheet for the fire area to perform the above comparison which determines if both SRT and DRT are needed. Once it is established which terms (either DRT, or SRT, or both) are needed to calculate ΔCDF (by the SSD comparison) for the fire area, those terms (i.e. DRT, or SRT, or both) which consist of both the FMF and SSD (<u>for all sequences in the event tree</u>) are calculated to represent the change in CDF for the fire area.

Note that if the finding in the fire area is *solely* against the fire barrier, the inspector will need to validate that the equipment protected by that degraded barrier is an important contributor to core damage. A criteria which may be used to determine the importance of a degraded fire barrier is SSD(DRT) ≥ 10 times SSD(SRT). As indicated earlier, the importance of the barrier is dependent on the reliability of the set of equipment it protects, i.e. the higher the reliability of the equipment being protected by the barrier, the more important the barrier. For example, this criteria (SSD(DRT) ≥ 10 times SSD (SRT)) means that either the redundant train, diverse train, or recovery action in the dominant sequence is protected by the fire barrier. If this criteria is met, the degraded barrier is important. If this criteria is not met, a more refined analysis must be done to validate the importance of the degraded barrier.

Example 1 in the attachment demonstrates the difference between the SRT and DRT for the case where the cable spreading room (non-divisionalized) is adjacent to the fire area with the Remote (alternative) Shutdown Panel. Various cases of different levels of degradation exist for DID in example 1. Once the rules in example 1 are understood, the analyst should be capable of exercising the model to determine whether the SRT or DRT or both are needed. However, the analyst should realize that in order to make the determination whether the SRT or DRT or both are needed, most of the work to calculate both terms must be done to make the SSD comparisons in the rules. As a result, the real role the rules play is to identify under which circumstances only the DRT is absolutely necessary (i.e. DRT only for high degradation of barrier); and to counter arguments that only the DRT is necessary to utilize the model under all cases (since the SRT may dominate when the barrier considered is a 3 hour barrier in its normal operating state).

The analyst should remember that the SRT + DRT may be used in place of the rules whenever a moderate barrier degradation or normal operating state barrier condition exists.

Table 5.8 - Risk Significance Estimation Matrix

Initiating Event Likelihood	Remaining Mitigation Capability Rating (with Examples)						
	-6	-5	-4	-3	-2	-1	0
	3 diverse trains OR 2 multi-train systems OR 1 train + 1 multi-train system + recovery of failed train	1 train + 1 multi-train system OR 2 diverse trains + recovery of failed train	2 diverse trains OR 1 multi-train system + recovery of failed train	1 train + recovery of failed train OR 1 multi-train system OR Operator action + recovery of failed train	1 train OR Operator action OR Operator action under high stress + recovery of failed train	Recovery of failed train OR Operator action under high stress	none
A	Green	White	Yellow	Red	Red	Red	Red
B	Green	Green	White	Yellow	Red	Red	Red
C	Green	Green	Green	White	Yellow	Red	Red
D	Green	Green	Green	Green	White	Yellow	Red
E	Green	Green	Green	Green	Green	White	Yellow
F	Green	Green	Green	Green	Green	Green	White
G	Green	Green	Green	Green	Green	Green	Green
H	Green	Green	Green	Green	Green	Green	Green

Figure 5.1 Fire Protection Risk Significance Screening Methodology (FPRSSM) Determination Process of Potential Risk Significance of Fire Protection Inspection Findings

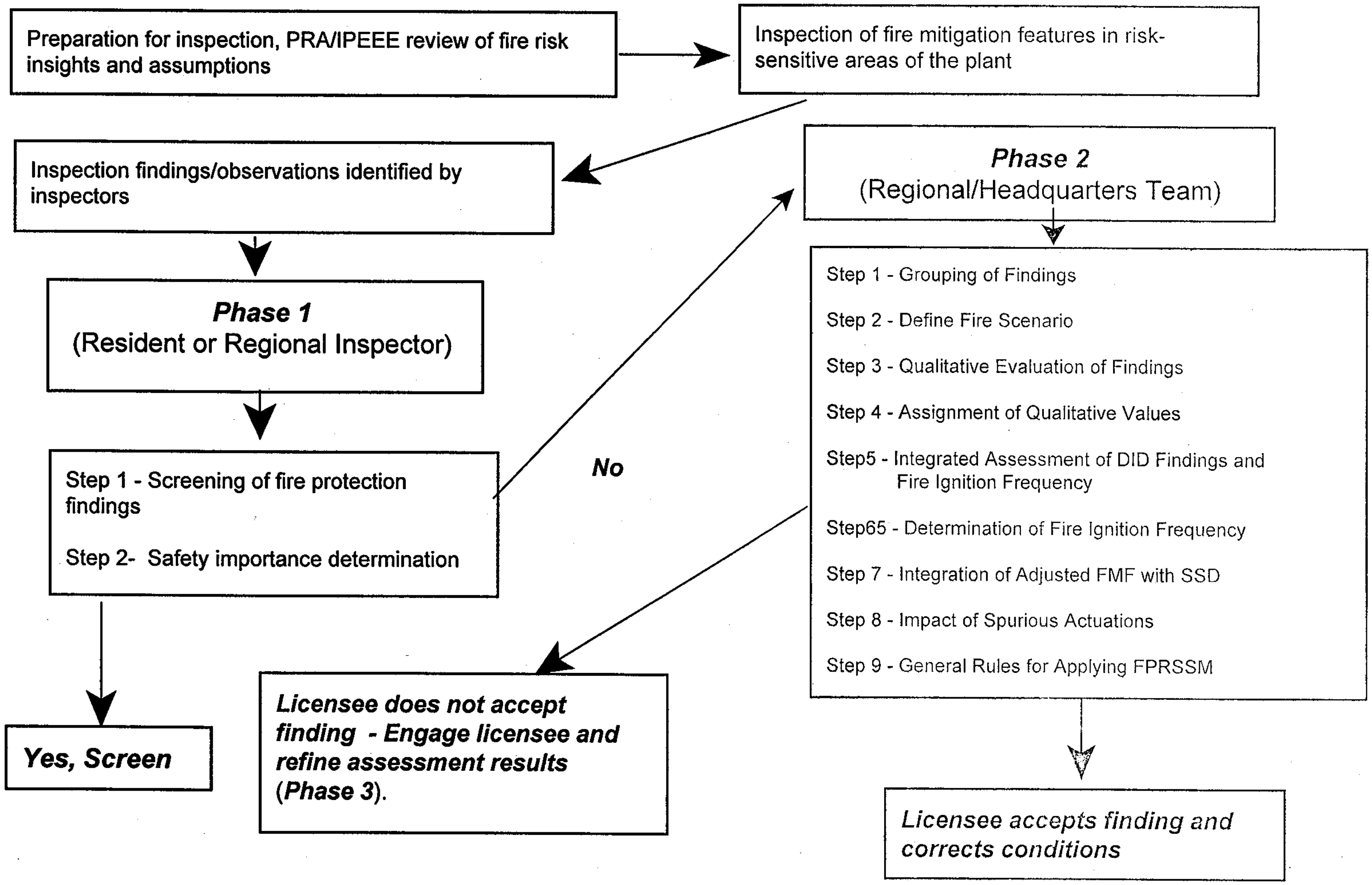


Table 3 - Remaining Capability Rating Values

documents which establish that your fire protection program satisfies NRC regulatory requirements and conforms to applicable NRC and industry fire protection guidance. Also, personnel should be available at the site during the inspection who are knowledgeable regarding those plant systems required to achieve and maintain safe shutdown conditions from inside and outside the control room (including the electrical aspects of the relevant post-fire safe shutdown analyses), reactor plant fire protection systems and features, and the Pilgrim Nuclear Power Station fire protection program and its implementation.

I have included copies of the Fire Protection inspection procedure and Fire Protection Risk Significance Screening Methodology, since these are not yet available on the NRC's Electronic Public Reading Room.

Your cooperation and support during this inspection will be appreciated. If you have questions concerning this inspection, or the inspection team's information or logistical needs, please contact Roy Fuhrmeister, the team leader, in the Region I Office at 610-337-5059.

Sincerely,

William H. Ruland, Chief
Electrical Engineering Branch
Division of Reactor Safety

Docket No.: 50-293

Enclosures:
1. List of Reactor Fire Protection Program Supporting Documents
2. Inspection Procedure 71111, Attachment 5, "Fire Protection"
3. Fire Protection Significance Determination Process
4. Fire Protection Significance Determination Process Evaluation Criteria

cc w/encl:
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J. Alexander, Director, Nuclear Assessment Group
D. Tarantino, Nuclear Information Manager
S. Brennion, Regulatory Affairs Department Manager
J. Fulton, Assistant General Counsel
R. Hallisey, Department of Public Health, Commonwealth of Massachusetts
The Honorable Therese Murray
The Honorable Vincent DiMacedo
Chairman, Plymouth Board of Selectmen
Chairman, Duxbury Board of Selectmen
Chairman, Nuclear Matters Committee
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J. Miller, Senior Issues Manager
A. Nogee, MASSPIRG
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ENCLOSURE 1

Reactor Fire Protection Program Supporting Documentation

[Note: This is a broad list of the documents the NRC inspection team may be interested in reviewing, and possibly obtaining, during the information gathering site visit.]

1. The current version of the Fire Protection Program and Fire Hazards Analysis.

2. Current versions of the fire protection program implementing procedures (e.g., administrative controls, surveillance testing, fire brigade).

3. Fire brigade training program and pre-fire plans.

4. Post-fire safe shutdown systems and separation analysis.

5. Post-fire alternative shutdown analysis.

6. Piping and instrumentation (flow) diagrams showing the components used to achieve and maintain hot standby and cold shutdown for fires outside the control room and those components used for those areas requiring alternative shutdown capability.

7. Plant layout and equipment drawings which identify the physical plant locations of hot standby and cold shutdown equipment.

8. Plant layout drawings which identify plant fire area delineation, areas protected by automatic fire suppression and detection, and the locations of fire protection equipment.

9. Plant layout drawings which identify the general location of the post-fire emergency lighting units.

10. Associated circuit analysis performed to assure the shutdown functions and alternative shutdown capability are not prevented by hot shorts, shorts to ground, or open circuits (e.g., analysis of associated circuits for spurious equipment operations, common enclosure, common bus).

11. Plant operating procedures which would be used and describe shutdown from inside the control room with a postulated fire occurring in any plant area outside the control room, procedures which would be used to implement alternative shutdown capability in the event of a fire in either the control or cable spreading room.

12. Maintenance and surveillance testing procedures for alternative shutdown capability and fire barriers, detectors, pumps and suppression systems.

13. Maintenance procedures which routinely verify fuse breaker coordination in accordance with the post-fire safe shutdown coordination analysis.

14. A sample of significant fire protection and post-fire safe shutdown related design change packages (including their associated 10 CFR 50.59 evaluations) and Generic Letter 86-10 evaluations.

15. The reactor plant's IPEEE, results of any post-IPEEE reviews, and listings of actions taken/plant modifications conducted in response to IPEEE information.

16. Temporary modification procedures.

17. Organization charts of site personnel down to the level of fire protection staff personnel.

18. If applicable, layout/arrangement drawings of potential reactor coolant/recirculation pump lube oil system leakage points and associated lube oil collection systems.

19. A listing of the SERs and actual copies of the 50.59 reviews which form the licensing basis for the reactor plant's post-fire safe shutdown configuration.

20. Procedures/instructions that control the configuration of the reactor plant's fire protection program, features, and post-fire safe shutdown methodology and system design.

21. A list of applicable codes and standards related to the design of plant fire protection features and evaluations of code deviations.

22. Procedures/instructions that govern the implementation of plant modifications, maintenance, and special operations, and their impact on fire protection.

23. The three most recent fire protection QA audits and/or fire protection self-assessments.

24. Recent QA surveillances of fire protection activities.

25. A listing of open and closed fire protection condition reports (problem reports/NCRs/EARs/problem identification and resolution reports).

26. Listing of plant fire protection licensing basis documents.

27. A listing of the NFPA code versions committed to (NFPA codes of record).

28. A listing of plant deviations from code commitment.

29. Actual copies of Generic Letter 86-10 evaluations.

INSPECTABLE AREA: Fire Protection

CORNERSTONES: Initiating Events (10%)
Mitigating Systems (90%)

INSPECTION BASES: Fire is generally a significant contributor to reactor plant risk. In many cases, the risk posed by fires is comparable to or exceeds the risk from internal events. The fire protection program shall extend the concept of defense in depth (DID) to fire protection in plant areas important to safety by (1) preventing fires from starting, (2) rapidly detecting, controlling, and extinguishing those fires that do occur, and (3) providing protection for structures, systems, and components important to safety so that a fire that is not promptly extinguished by fire suppression activities will not prevent the safe shutdown of the reactor plant. If DID is not maintained by an adequately implemented fire protection program, overall plant risk can increase.

This inspectable area verifies aspects of the Initiating Events and Mitigating Systems cornerstones for which there are no performance indicators to measure licensee performance.

LEVEL OF EFFORT: Routine Inspection: The resident inspector will tour six to twelve plant areas important to reactor safety (on a plant specific basis) each calender quarter to observe conditions related to: (1) licensee control of transient combustibles and ignition sources; (2) the material condition, operational lineup, and operational effectiveness of fire protection systems, equipment and features; and (3) the material condition and operational status of fire barriers used to prevent fire damage or fire propagation.

Annual Inspection: In addition, for approximately two hours each year, the resident inspector will observe a plant fire drill.

Triennial Inspection: Every 3 years, an inspection team consisting of a fire protection specialist, a reactor systems engineer, and an electrical engineer will select three to five plant areas and conduct a design-based, plant specific, risk-informed, onsite inspection of the DID elements used to mitigate the consequences of a fire, with emphasis on the fire protection features provided for maintaining at least one safe shutdown success path free of fire damage.

Identification and Resolution of Problems: Effort will include a review of licensee's problem identification and resolution of fire protection program.

71111.05-01 INSPECTION OBJECTIVES

01.01 The resident inspector inspection objective is to determine if the licensee has implemented a fire protection program that adequately controls combustibles and ignition sources within the plant, provides effectively maintained fire detection and suppression capability, maintains passive fire protection features in good material condition, and puts adequate compensatory measures in place for out-of-service, degraded or inoperable fire protection equipment, systems or features. The resident inspector approaches this effort from an operational status and material condition point of view.

01.02 The triennial team inspection objective is to assess whether the licensee has implemented a fire protection program that adequately controls combustibles and ignition sources within the plant, provides adequate fire detection and suppression capability, maintains passive fire protection features in good material condition, puts adequate compensatory measures in place for out-of-service, degraded or inoperable fire protection equipment, systems or features, and ensures that procedures, equipment, fire barriers, and systems exist so that the post-fire capability to safely shut down the plant is ensured. The triennial team approaches this effort from a design point of view, as well as from the operational status and material condition points of view.

71111.05-02 INSPECTION REQUIREMENTS

02.01 Routine Inspection. The resident inspector will tour six to twelve plant areas important to safety (not necessarily limited to the top few contributors to overall plant fire risk) to assess the material condition of reactor plant active and passive fire protection systems and features, their operational lineup and operational effectiveness. For the areas selected, as applicable to the area of concern, conduct the following lines of inspection inquiry:

a. Control of Transient Combustibles and Ignition Sources

1. Observe if any transient combustible materials are located in the area. If transient combustible materials are observed, verify that they are being controlled in accordance with the licensee's administrative control procedures.

2. Observe if any welding or cutting (hot work) is being performed in the area. Verify that hot work is being done in accordance with the licensee's administrative control procedures.

b. Fire Detection Systems. Observe the physical condition of the fire detection devices and note any that show physical damage. Determine from licensee administrative controls the known material condition and operational status of the system, and verify that any observed conditions do not affect the operational effectiveness of the system (see compensatory measures section below).

c. Fire Suppression Systems

1. Sprinkler Fire Suppression Systems. Observe that sprinkler heads are not obstructed by major overhead equipment (e.g., ventilation ducts). Verify through visual observation or surveillance record review that the water supply control valves to the system are open and that the fire water supply and pumping capability is operable and capable of supplying the water supply demand of the system. Observe any material conditions that may affect performance of the system, such as mechanical damage, painted sprinkler heads, corrosion, etc.

2. Gaseous Suppression Systems. Observe that the gaseous suppression system (e.g. Halon or CO2) nozzles are not obstructed or blocked by plant equipment such that gas dispersal would be significantly impeded. Observe and verify that the suppression agent charge pressure is within the normal band, extinguishing agent supply valves are open, and that the system is in the automatic mode. Observe and verify that the dampers/doors are unobstructed so that they will be permitted to close automatically upon actuation of the gaseous system. Observe and verify that the room penetration seals are sealed and in good condition. Observe and note any material conditions that may affect performance of the system, such as mechanical damage, corrosion, damage to doors or dampers, open penetrations, or nozzles blocked by plant equipment.

d. Manual Fire fighting Equipment and Capability

1. Fire Extinguishers. Ensure that portable fire extinguishes are provided at their designated locations in or near the area being

inspected, and that access to the fire extinguishers is unobstructed by plant equipment or other work related activities. Observe and verify that the general condition of fire extinguishes is satisfactory (e.g., pressure gauge reads in the acceptable range, nozzles are clear and unobstructed, charge test records indicate testing within the normal periodicity).

2. Hose Stations and Standpipes. Observe that fire hoses are installed at their designated locations. Observe and verify that the general condition of hoses and hose stations is satisfactory (e.g., no holes in or chafing of the hose, nozzle not mechanically damaged and not obstructed, valve hand wheels in place). Observe and verify that the water supply control valves to the standpipe system are open and that the fire water supply and pumping capability is operable and capable of supplying the water flow and pressure demand. Ensure that access to the hose stations is unobstructed by plant equipment or work-related activities.

e. Passive Fire Protection Features

1. Electrical Raceway Fire Barrier Systems. Observe the material condition of electrical raceway fire barrier systems (e.g. cable tray fire wraps) and determine if there are any cracks, gouges, or holes in the barrier material, that there are no gaps in the material at joints or seams, and that banding, wire tie, and other fastener pattern and spacing appears appropriate. Where the fire barrier is a wrap or blanket-type material, observe that the material has no tears, rips, or holes in any of the visible layered material, that there are no gaps in the material at joint or seam locations, and that banding spacing is such that the material is held firmly in place. If plant modifications have recently been conducted, establish that fire barriers removed as interference have been restored.

2. Fire Doors. Observe the material condition of the fire door in the area being inspected. Observe that selected fire doors close without gapping (e.g. due to fire door damage from previous obstructions), and that the door latching hardware functions securely.

3. Ventilation System Fire Dampers. To the extent practical and safe, directly observe the condition of the accessible ventilation fire dampers in the areas being inspected (to ensure fusible link fire dampers are not prematurely shut or obstructed). For those dampers which can not be readily observed in the selected plant areas, review the licensee's surveillance efforts directed towards verifying the continuing operability of ventilation fire dampers.

4. Structural Steel Fire Proofing. Observe the material condition of the structural steel fire-proofing (fibrous or concrete encapsulation) within the areas being inspected. Observe that this material is installed and that the structural steel is uniformly covered (no bare areas).

5. Fire Barrier and Fire Area/Room/Zone Electrical Penetration Seals. Tour plant areas being inspected and observe accessible electrical and piping penetrations. Observe whether any seals are missing from locations in which they appear to be needed to complete a fire barrier or area/room/zone wall, and determine that seals appear to be properly installed and in good condition. Selectively verify through review of installation records that material of an appropriate fire resistence rating (equal to the overall rating of the barrier itself) has been used to fill the opening/penetration .

f. Compensatory Measures. Verify that adequate compensatory measures are put in place by the licensee for out-of-service, degraded or inoperable fire protection equipment, systems or features (e.g. detection and suppression systems and equipment, passive fire barrier features, or safe shutdown functions or capabilities). Short term compensatory measures should be adequate to compensate for the degraded function or feature until appropriate corrective action can be taken. Review licensee effectiveness in returning the equipment to service in a reasonable period of time (typically days or weeks).

02.02 Annual Inspection. During the annual observation of a fire brigade drill in a plant area important to safety, evaluate the readiness of the licensee's personnel to prevent and fight fires, including the following aspects:

a. Protective clothing/turnout gear is properly donned.

b. Self-contained breather apparatus (SCBA) equipment is properly worn and used.

c. Fire hose lines are capable of reaching all necessary fire hazard locations, that the lines are laid out without flow constrictions, the hose is simulated being charged with water, and the nozzle is pattern (flow stream) tested prior to entering the fire area of concern.

d. The fire area of concern is entered in a controlled manner (e.g., fire brigade members stay low to the floor and feel the door for heat prior to entry into the fire area of concern).

e. Sufficient fire fighting equipment is brought to the scene by the fire brigade to properly perform their firefighting duties.

f. The fire brigade leader's fire fighting directions are thorough, clear, and effective.

g. Radio communications with the plant operators and between fire brigade members are efficient and effective.

h. Members of the fire brigade check for fire victims and propagation into other plant areas.

i. Effective smoke removal operations were simulated.

j. The fire fighting pre-plan strategies were utilized.

k. The licensee pre-planned the drill scenario was followed, and that the drill objectives acceptance criteria were met.

02.03 <u>Triennial Inspection</u>. Every three years, an inspection team will conduct risk-informed inspection of the licensee's fire protection program with emphasis on post-fire safe shutdown capability and the fire protection features provided for ensuring that at least one post-fire safe shutdown success path is maintained free of fire damage.

a. <u>Inspection Preparation</u>

Select three to five plant areas important to risk for review. Obtain necessary information for determining post-fire safe shutdown capability and the fire protection features for maintaining at least one post-fire safe shut down path free of fire damage.

b. <u>Inspection Conduct</u>. For the plant areas selected for review, conduct the following inspection efforts:

1. <u>Systems Required to Achieve and Maintain Post-fire Safe Shutdown</u>

Consider whether the licensee's shutdown methodology has properly identified the components and systems necessary to achieve and maintain safe shutdown conditions for each fire area, room and/or zone selected for review. Specifically determine the apparent adequacy of the systems selected for reactivity control, reactor coolant makeup, reactor heat removal, process monitoring and support system functions.

If the above high level performance criteria are not met, review the licensee's engineering and/or licensing justifications (e.g., NRC guidance documents, license amendments, technical specifications, SERs, exemptions, deviations).

To the extent that it is confirmed that a postulated fire in an area under consideration can cause the loss of offsite power, verify that hot and cold shutdown from outside the control room can be achieved and maintained with off-site power not available.

2. <u>Fire Protection of Safe Shutdown Capability</u>

Evaluate the separation of systems necessary to achieve safe shutdown, and verify that fire protection features are in place to satisfy the separation and design requirements of Section III.G of Appendix R (or, for reactor plants reviewed under the Standard Review Plan, license specific requirements).

Verify that the fire detectors and automatic fire suppression systems, associated with 1-hour fire barriers and/or 20 foot areas free of intervening combustibles required by Section III.G.2 of Appendix R (or, for reactor plants reviewed under the Standard Review Plan, license specific requirements), have been adequately installed. Review licensee evaluations which confirm, and verify through observation in the reactor plant, that selected installed automatic detection and suppression systems are installed in accordance with the code of record and would adequately control and suppress fires associated with the hazards of each selected area.

For the plant areas selected, verify that redundant trains of systems required for hot shutdown located in the same fire area are not subject to damage from fire suppression activities or from the rupture or inadvertent operation of fire suppression systems. Determine each of the following:

(a) How the licensee has addressed whether a fire in a single location may, indirectly, through the production of smoke, heat, or hot gases, cause activation of potentially damaging fire suppression for all redundant trains,

(b) How the licensee has addressed whether a fire in a single location (or inadvertent actuation or rupture of a fire suppression system) may, through local fire suppression activity, indirectly cause damage to all redundant trains (e.g., sprinkler-caused flooding of other than the locally affected train), and

(c) How the licensee has addressed whether a fire in a single location may cause damage to all redundant trains through the utilization of manually controlled fire suppression systems.

For the plant areas selected, review the adequacy of the design (fire rating) of fire area boundaries (i.e., able to contain the fire hazards of the area), raceway fire barriers, equipment fire barriers, and fixed fire detection and suppression systems.

Evaluate licensee operator recovery action capabilities, plans and timing estimates for smoke removal, dewatering of spaces, controlled re-energization, and return to service of equipment in fire-affected areas) for fires in each plant area under consideration.

The observation of a fire brigade drill for a simulated fire in a plant area important to risk may be necessary in certain situations to assess the effectiveness of manual fire fighting capability. If a fire brigade drill is observed, consider the lines of inspection inquiry of Section 02.02 above.

3. Post-fire Safe Shutdown Circuit Analysis

Verify that safety-related and non-safety-related cables for equipment in selected fire areas have been identified by the licensee and analyzed to show that they would not prevent safe shutdown because of hot shorts, open circuits, or shorts to ground. Inspect the licensee's electrical systems and electrical circuit analyses with respect to the following:

(a) Common Power Supply/Bus Concern.

(1) On a sample basis, verify that the licensee has addressed the potential cumulative effect of simultaneous (multiple) high impedance faults which may adversely affect the availability of post-fire safe shutdown power supplies.

(2) On a sample basis, verify that circuit breaker coordination and fuse protection have been analyzed and provided.

(b) Common Enclosure Concern. On a sample basis, review electrical fault protection from nonessential circuits routed in common enclosures (e.g. fire wrapped electrical raceways) with required safe shutdown circuits.

(c) Spurious Signal Concern. On a sample basis review fire-induced hot shorts, shorts to ground, and open circuits and their potential effects on post-fire safe shutdown capability.

4. Alternative Shutdown Capability

Determine whether the licensee's alternative shutdown methodology has properly identified the components and systems necessary to achieve and maintain safe shutdown conditions for each fire area, room and/or zone selected for review. Specifically determine the apparent adequacy of the systems selected for reactivity control, reactor coolant makeup, reactor heat removal, process monitoring and support system functions.

If the above high level performance criteria are not met, review the licensee's engineering and/or licensing justifications (e.g., NRC guidance documents, license amendments, technical specifications, SERs, exemptions, deviations).

Verify that hot and cold shutdown from outside the control room can be achieved and maintained with off-site power available or not available.

Verify that the transfer of control from the control room to the alternative location has been demonstrated to not be affected by fire-induced circuit faults (e.g. by the provision of separate fuses and power supplies for alternative shutdown control circuits).

5. <u>Operational Implementation of Alternative Shutdown Capability</u>

Verify that the training program for licensed and non-licensed personnel has been expanded to include alternative or dedicated safe shutdown capability.

Verify that personnel required to achieve and maintain the plant in hot shutdown following a fire using the alternative shutdown system can be provided from normal onsite staff, exclusive of the fire brigade.

Verify that adequate procedures for use of the alternative shutdown system exist. Verify the implementation and human factors adequacy of the alternative shutdown procedures by independently "walking through" the procedural steps. Ensure that adequate communications are available for the personnel performing alternative or dedicated safe shutdown. Verify that the operators can reasonably be expected to perform the procedures within applicable shutdown time requirements.

Establish whether the licensee conducts periodic operational tests of the alternative shutdown transfer capability and instrumentation and control functions. In addition, establish whether these tests are adequate to show that if called upon, the alternative shutdown capability would be functional upon transfer.

6. Communications

Verify through inspection of the contents of designated emergency storage lockers and review of alternative shutdown procedures, that portable radio communications and/or fixed emergency communications systems are available, operable, and adequate for the performance of alternative safe shutdown functions. Assess the capability of the communication systems to support the operators in the conduct and coordination of their required actions (e.g., consider ambient noise levels, clarity of reception, reliability, coverage patterns, and survivability). If specific, risk-significant issues arise relating to alternative shutdown communications adequacy, then, on a not-to-interfere with operational safety basis, observe licensee conducted communications tests in the subject plant area or areas.

7. Emergency Lighting

Review emergency lighting provided, either in fixed or portable form, along access routes and egress routes, at control stations, plant parameter monitoring locations, and at manual operating stations:

(a) If emergency lights are powered from a central battery or batteries, verify that the distribution system contains protective devices so that a fire in the area will not cause loss of emergency lighting in any unaffected area needed for safe shutdown operations.

(b) Review the manufacturer's information to verify that battery power supplies are rated with at least an 8-hour capacity.

(c) Determine if the operability testing and maintenance of the lighting units follow licensee procedures and accepted industry practice.

(d) Verify that sufficient illumination is provided to permit access for the monitoring of safe shutdown indications and/or the proper operation of safe shutdown equipment.

(e) Verify that emergency lighting unit batteries are being properly maintained (observe the unit's lamp or meter charge rate indication, and specific gravity indication).

8. Cold Shutdown Repairs

Verify that the licensee has dedicated repair procedures, equipment, and materials to accomplish repairs of damaged components required for cold shutdown, that these components can be made operable, and that cold shutdown can be achieved within time frames specified by Appendix R to 10 CFR Part 50 (or, for reactor plants reviewed under the Standard Review Plan, license specific requirements). Verify that the repair equipment, components, tools, and materials (e.g., pre-cut cable connectors with prepared attachment lugs) are available on site.

9. Reactor Coolant Pump Oil Collection Systems

   If applicable, verify that the licensee has installed a reactor coolant pump oil collection system which is designed to and does collect oil leakage and spray from all potential reactor coolant pump oil system leakage points.

10. Fire Protection Systems, Features and Equipment

   In selected plant locations, review the material condition, operational lineup, operational effectiveness and design of fire detection systems, fire suppression systems, manual fire fighting equipment, fire brigade capabilities, and passive fire protection features. Establish that selected fire detection systems, sprinkler systems, gaseous suppression systems, portable fire extinguishers and hose stations are installed in accordance with their design, and that their design is adequate given the current equipment layout and plant configuration.

11. Verify that adequate compensatory measures are put in place by the licensee for out-of-service, degraded or inoperable fire protection and post-fire safe shutdown equipment, systems or features (e.g. detection and suppression systems and equipment, passive fire barrier features, or pumps, valves or electrical devices providing safe shutdown functions or capabilities). Short term compensatory measures should be adequate to compensate for the degraded function or feature until appropriate corrective action can be taken. Review licensee effectiveness in returning the equipment to service in a reasonable period of time (typically days or weeks).

02.04 Identification and Resolution of Problems. During routine (quarterly and annual) resident inspection and triennial team inspection, verify that the licensee is identifying issues related to this inspection area at an appropriate threshold and entering them in the corrective action program. For a sample of selected issues documented in the corrective action program, verify that the corrective actions are appropriate. See Inspection Procedure 71152, "Identification and Resolution of Problems," for additional guidance.

General Guidance

Routine Inspection. See Attachment 1.

The main focus of the resident inspector's activities is on the material condition and operational status of fire detection and suppression systems and equipment, and fire barriers used to prevent fire damage or fire propagation. The six to twelve plant areas to be inspected should be selected on the basis of site-specific risk worksheets.

Triennial Inspection

Objective. The triennial inspection is primarily a risk-informed look at the mitigation elements of fire protection defense in depth (DID) (i.e., detection, suppression, and confinement of fires through passive barriers, and the fire protection features and procedures which establish the licensee's ability to achieve and maintain post-fire safe shutdown conditions during and after a fire). The triennial inspection is uniquely that portion of the baseline inspection program that focuses on the design of reactor plant fire protection and post-fire safe shutdown systems, features, and procedures. The inspection team leader will manage and coordinate the conduct of an inspection emphasizing post-fire safe shutdown. The team will use plant-specific risk, event, and technical information (including the results of licensee self-assessments) to confirm that at least one train of safe shutdown equipment (capable of providing reactivity control, reactor coolant makeup, reactor heat removal, and process monitoring and support functions) is free of fire damage.

Inspection Approach. The inspection of post-fire safe shutdown capability and its associated fire protection features can be either plant area-based and/or safe shutdown system-based, depending on the structure of the licensee's analysis.

Inspection Team and Responsibilities. The team assigned to conduct the multi-disciplinary triennial fire protection inspection would include a fire protection inspector, an electrical inspector, and a reactor systems/mechanical systems inspector.

1. Reactor Systems/Mechanical Systems Inspector (RSI). The reactor systems/mechanical systems inspector (RSI) will assess the capability of reactor and balance-of-plant systems, equipment, operating personnel, and procedures to achieve and maintain post-fire safe shutdown and minimize the release of radioactivity to the environment in the event of fire. Therefore, the inspection team leader will ensure that he is knowledgeable regarding integrated plant operations, maintenance, testing, surveillance and quality assurance, reactor normal and off-

normal operating procedures, and BWR and/or PWR nuclear and balance-of-plant systems design.

2. Electrical Inspector (EI). The EI will identify electrical separation requirements for redundant train power, control, and instrumentation cables. He will verify that the licensee has adequately demonstrated that fire-induced circuit failures(hot shorts, shorts to ground, and open circuits) will not prevent safe shutdown operation. He will review alternative shutdown panel electrical isolation design to establish the panels' electrical independence from postulated fire areas. He will also review required and associated circuits of concern for the elimination of fire-induced faults that can cause spurious signals which could interfere with post-fire safe shutdown, and in regard to common enclosure concerns and common power supply concerns. Therefore, the inspection team leader will ensure that he is knowledgeable regarding reactor plant electrical and instrumentation and control (I&C) design and is familiar with industry ampacity derating standards

3. Fire Protection Inspector (FPI). The FPI will work with other team members in determining the effectiveness of the fire barriers and systems that establish the reactor plant's post-fire safe shutdown configuration and maintain it free of fire damage. He will determine whether suitable fire protection features (suppression, separation distance, fire barriers, etc.) are provided for the separation of equipment and cables required to ensure plant safety. Therefore, the inspection team leader will ensure he is knowledgeable regarding reactor plant fire protection systems, features and procedures.

Regulatory Requirements and Licensing Bases. The regulatory requirements and licensing bases against which post-fire safe shutdown capability is assessed are as follows:

1. Plants licensed before January 1, 1979. Effective February 17, 1981, the NRC amended its regulations by adding Section 50.48 and Appendix R to 10 CFR Part 50 to require certain provisions for fire protection in nuclear power plants licensed to operate before January 1, 1979. This action was taken to resolve certain contested generic issues in fire protection safety evaluation reports (SERs), and (1) to require all applicable licensees to upgrade their plants to a level of fire protection equivalent to the technical requirements in Sections III.G, J, L, and O of 10 CFR Part 50, Appendix R, and (2) to require all applicable licensees to meet all other requirements of Appendix R to the extent that comparable items had not been closed out in pre-Appendix R SERs (under Appendix A of the Branch Technical Position). Licensees were required to meet the separation requirements of Section III.G.2, the alternative or dedicated shutdown capability requirements of Sections III.G.3 and III.L, or to request an exemption in accordance with 10 CFR 50.48. Alternative or dedicated safe shutdown capabilities were required to be submitted to

the Office of Nuclear Reactor Regulation (NRR) for review. NRR approvals are documented in SERs.

2. Plants licensed after January 1, 1979: These plants are subject to requirements similar to those in 10 CFR part 50, Appendix R, as specified in the conditions of their facility operating license, commitments made to the NRC, or deviations granted by the NRC. These reactor plants licensed after January 1, 1979, are subject to 10 CFR 50.48 (a) and (e) only.

   The fire hazards analysis (FHA) ("Fire Protection Review, Fire Protection Evaluation") document of the reactor plants licensed after January 1, 1979, may have been reviewed under Appendix A to Branch Technical Position APCSB 9.5-1, "Guidelines for Fire Protection for Nuclear power Plants Docketed Prior to July 1, 1976," of August 23, 1976 (in which case, the licensee conducted an Appendix R comparison and justified final safety analysis report (FSAR) or FHA differences from the specific provisions of Appendix R). It is possible also that licensee submittals for plants licensed after January 1, 1979, were reviewed under the Standard Review Plant, NUREG-0800, and Branch Technical Position (BTP) CMEB 9.5-1 (formerly BTP ASB 9.5-1), "Guidelines for Fire Protection for Nuclear Power Plants," Rev. 2 (July 1981) (in which case, licensee submittals were reviewed according to requirements that closely paralleled the provisions of Appendix R).

   The actual fire protection requirements applicable to a given reactor plant licensed after January 1, 1979, arise from the specific license conditions in the facility operating license. These license conditions possibly refer to SERs and their supplements. Section 9.5 of such an SER delineates which licensee submittals were reviewed (e.g., a fire hazards analysis would be such a submittal).

3. All changes to fire protection license conditions which have been placed in the reactor plant's FSAR/USAR may be conducted under 10 CFR 50.59.

Inspection Process

1. Licensee Notification Letter. The licensee should be notified of the triennial inspection in writing at least three months in advance of the onsite week. The information gathering visit shall be conducted no fewer than three weeks in advance of the onsite inspection week. The letter should discuss the scope of the inspection, request an information-gathering visit to the licensee reactor site/engineering offices, discuss documentation and licensee personnel availability needs during the onsite inspection week, and request a pre-inspection conference call to discuss administrative matters and finalize inspection activity plans and schedules. A template for an NRC to licensee triennial fire protection baseline inspection notification letter is provided as Attachment 2.

2. Information-gathering Site Visit. The inspection team leader **should conduct** a two to three day information gathering site. The purposes of the information gathering site visit are to (1) gather site-specific information important to inspection planning, (2) conduct initial discussions with licensee representatives regarding administrative items and inspection activity plans and schedules, and (3) have the team members receive site specific access training and badging for unescorted site access. In advance of the information-gathering site visit, the team leader should provide the licensee with a list of information and documents that may be needed for the team to prepare for and conduct the triennial inspection, as well as a list of any planned requests for licensee conducted evolutions (e.g., emergency lighting tests, communication tests, fire drills, shutdown walkthroughs, etc.).

3. Information Required/Preparation The team members should gather sufficient information to become familiar with the following during preparation period:

   (a) The reactor plant's design, layout, and equipment configuration.

   (b) The reactor plant's current post-fire safe shutdown licensing basis through review of 10 CFR 50.48, 10 CFR Part 50 Appendix R (if applicable), NRC safety evaluation reports (SERs) on fire protection, the plant's operating license, updated final safety analysis report (UFSAR), and approved exemptions or deviations.

   (c) The licensee's strategy and methodology, and derivative procedures, for accomplishing post-fire safe shutdown conditions. Among the sources of information are the updated final safety analysis report (UFSAR), the latest version of the fire hazards analysis (FHA), the latest version of the post-fire safe shutdown analysis (SSA), fire protection/post-fire safe-shutdown related 10 CFR 50.59 and Generic Letter 86-10 review documentation and modification packages, plant drawings, emergency/abnormal operating procedures, and the results of licensee internal audits (e.g., self assessments and quality assurance (QA) audits in the fire protection and post-fire safe shutdown areas).

   (d) The historical record of plant-specific fire protection issues through review of plant-specific documents such as previous NRC inspection results, internal audits performed by the reactor licensee (e.g., self-assessments and quality assurance audits), corrective action system records, event notifications submitted in accordance with 10 CFR 50.72, and licensee event reports (LERs) submitted in accordance with 10 CFR 50.73.

   (e) The safe shutdown systems and support systems credited by the licensee's analysis for each fire area, room, or zone for accomplishing of the required shutdown functions (e.g., reactivity control, reactor coolant makeup, reactor heat removal, and process monitoring and support functions) as necessary to comply with the safe shutdown requirements of 10 CFR 50.48(a) and plant-specific licensing requirements. The shutdown logic for each area, room, or zone to be inspected must be thoroughly understood by the team members.

(f) The licensee's analytical approach for electrical circuits separation analyses, and the licensee's methodology for identification and resolution of associated circuits of concern. The team's electrical review should include addressing the assumptions and boundary conditions used in the performance of the licensee's analyses.

Specific Guidance

03.01 Inspection Requirement 02.01. The resident inspector should not attempt to address all plant areas each inspection. The routine plant tour should focus on six to twelve plant areas important to risk. The resident inspector should note transient combustibles and ignition sources (and compare these with the limits provided in licensee administrative procedures). The resident inspector should also note the material condition and operational status (rather than the design) of fire detection and suppression systems, and fire barriers used to prevent fire damage or fire propagation.

03.02 No specific guidance provided

03.03 Inspection Requirement 02.03 a.

1. Prior to the inspection information gathering trip, the team leader should contact the regional senior reactor analyst (SRA) to obtain summary of plant specific fire risk insights (e.g., fire risk ranking of the rooms/plant fire areas, conditional core damage probabilities (CCDPs) for those rooms and areas, and transient sequences for these rooms). After considering the focus of past fire protection and post-fire safe shutdown inspections, the team leader should select three to five areas important to risk for inspection

2. The fire protection and post-fire safe shutdown information gathered should focus on the samples selected.

3. After the information gathering site visit, the team leader should use the SRA developed fire risk insights, as well as technical input from the other team members, to develop an inspection plan addressing (for the selected three to five plant areas, rooms or zones) post-fire safe shutdown capability and the fire protection

features for maintaining one success path of this capability free of fire damage.

Inspection Requirement 02.03b2: Short term compensatory measures should be adequate to compensate for the degraded function or feature until appropriate corrective action can be taken.

03.04 Identification and Resolution of Problems.

No specific guidance is provided.

71111.05-04 RESOURCE ESTIMATE

The resource to perform this inspection procedure is estimated to be, on average, 33 hours per year for routine inspection including approximately 2 hours for annual observation of a fire drill and 200 hours every 3 years for the triennial inspection regardless of the number of reactor units at the site.

71111.05-05 REFERENCES

The SDP Guideline "Appendix 4 - Determining Potential Risk Significance of Fire Protection and Post-fire Safe Shutdown Inspection Findings."

Appendix H of the Fire Protection Supplemental Inspection Procedure (FPSI) "Guidance for Making a Qualitative Assessment of Fire Protection Inspection Findings, Fire Protection Risk Significance Screening Methodology" [FPRSSM])

Inspection Procedure 71152, "Identification and Resolution of Problems."

Generic Letter 91-18 "Information to Licensees Regarding Two NRC Inspection Manual Sections on Resolution of Degraded and Non-conforming Conditions and on Operability."

Information Notice 97-48 "Inadequate or Inappropriate Interim Fire Protection Compensatory Measures," July 9, 1997

NRC Internal Memorandum dated August 17, 1998, from John N. Hannon to Arthur T. Howell titled "Response to Region IV Task Interface Agreement (TIA) (96TIA008) - Evaluation of Definition of Continuous Fire Watch (TAC No. M96550).

Individual Plant Examination of Externally Initiated Events(IPEEE)

END

ATTACHMENT 1
ROUTINE INSPECTION GUIDANCE TABLE

CORNERSTONE	RISK PRIORITY	EXAMPLES
INITIATING EVENTS	Equipment or actions that could cause or contribute to initiation of fires in plant areas important to safety or near equipment required for safe shutdown.	Transient combustibles (rags, wood, ion exchange resin, lubricating oil, or Anti-Cs) are not in areas where transient combustibles are prohibited. Transient combustible amounts in other areas do not exceed administrative controls. Ignition sources (welding, grinding, brazing, flame cutting) have a fire watch. Planning includes precautions and additional fire prevention measures where these activities are near combustibles.

MITIGATING SYSTEMS	Functionality of fire barriers in plant areas important to safety. Functionality of detection systems in plant area important to safety. Functionality of automatic suppression systems in plant areas important to safety. Fire brigade manual suppression effectiveness. Compensatory measures for degraded fire detection systems, fire suppression features, and barriers to fire propagation.	Doors and dampers that prevent the spread of fires to/or between plant areas important to safety remain in place and are functional. Electrical raceway fire barriers and penetration seals that protect the post-fire safe-shutdown train are not damaged. Fire detection and alarm system is functional for plant areas important to safety. Automatic suppression system sprinklers are functional and their sprinkler head patterns are not blocked by plant equipment. Fire brigade performance indicates a prompt response with proper fire fighting techniques for the type of fire encountered. Manual fire suppression equipment is of the proper type and has been tested. Degraded fire detection equipment, suppression features and fire propagation barriers are adequately compensated for on reasonably short-term bases.

Application of Fire Protection Risk-Significant Screening Methodology to Hypothetical Cases

Case 1: Cable Spreading Room

A single CSR exists in a plant. The CSR is located adjacent to a fire area that contains the remote shutdown panel (RSP). A 3-hour barrier separates the two fire areas. The CSR has an automatic carbon dioxide suppression system. A credible fire scenario can be developed that will damage cables and expose the barrier to fire. The ignition frequency for the CSR found in the IPEEE is 5E-3/yr.

The only safe shutdown methodology for the CSR fire is the RSP. Note that no Reactor Safety Internal Events SDP Worksheet exists for this example, since shutting down via remote shutdown operations is peculiar to fire risk analysis. This worksheet was developed and follows Example 2, and demonstrates the one sequence, i.e. LOOP-RSP, for this particular CSR fire.

Example 1A

The 3-hour fire barrier wall has a high degradation. The automatic carbon dioxide suppression system has also a moderate degradation. The fire brigade is in its nominal operating state (NOS). Each of these degradations has lasted longer than 30 days.

Since the fire barrier has a high degradation, only the DRT is used for SSD according to the rules. Since the DRT is used, the appropriate value for the fire barrier is chosen from Table 5.1.

The fire mitigation frequency (FMF) = IF + FB + AS + MS + CC

where IF = ignition frequency
FB = fire barrier
AS = automatic suppression/detection
MS = manual suppression/detection
CC = dependencies/ common cause Contribution

Thus FMF = -2.3 + 0 - 0.75 - 1 = -4.05 since CC is not appropriate for this example.

From Table 5.6 note that an FMF of -4.05 converts to an approximate frequency of 1E-4/yr to 1E-5/yr.

From **Table 5.7** (SDP Table 1) locate the Approximate Frequency = 1E-4/yr to 1E-5/yr. Since the degradation is greater than 30 days, select E from the table.

Now SSD(DRT) must be determined. Since all equipment, cables, and human actions on both sides of the barrier are damaged for the DRT, no credit is given for the RSP. Since the RSP is the only means to mitigate a challenging fire in the cable spreading room, SSD(DRT) is none (0) in Table 5.8. As a result, the color representing the change in CDF is Yellow.

Example 1B

Suppose the 3-hour fire barrier wall has been improved to a moderate degradation. All other degradations remain the same. According to the rules, both SSD(DRT) and SSD(SRT) must be calculated to determine if more than the SRT must be used to determine ΔCDF.

As before SSD(DRT) = 1E-0 = 1.

Now to calculate SSD(SRT). For the SRT, fire does not propagate beyond the area of fire origin. Therefore, the RSP which is on the other side of the fire barrier, is not damaged by fire. The value assigned for the random failure probability of the RSP is 0.1 or 1E-1. Therefore, SSD(SRT) = 0.1 or 1E-1.

Since SSD(DRT) = 10 * SSD(SRT) only the SRT is necessary.

The SRT for example 1B is done as follows:

FMF = IF + AS + MS (with FB term eliminated).

FMF = -2.3 - 0.75 - 1 = - 4.05

Using Tables 5.6 and 5.7 produces an E.

Utiilizing Table 5.8 with SSD(SRT) = -1 yields a white for the CDF.

Notes for Examples 1A and 1B

It is recognized that the approximation used to determine if only the SRT needed in Example 1B underpredicts the CDF since the true impact on risk is the sum of the SRT + DRT. However, to counter that underprediction of risk, the CDF due to the inspection findings is used as the ΔCDF in the Phase 2 which is conservative. As a result, these two factors counter one another.

As an aside, IF, AS, and MS always remain the same for the DRT and SRT. In fact, the only difference between the FMF for the DRT and SRT is the credit provided for FB. For the SRT, FB does not enter into the equation for FMF since no credit is given for a barrier protecting safe shutdown equipment in the area of fire origin. For the DRT, credit for the FB is taken out of the Table 5.1. And of course, SSD(DRT) usually differs from the SSD(SRT) since more equipment is available to mitigate core damage if the fire is constrained to the area of fire origin (than if it fails the barrier between the two fire areas).

Example 1C

Suppose the 3-hour fire barrier wall (with a door) is repaired so that it is in its normal operating state. The automatic suppression continues to have a medium degradation.

Since the 3-hour fire barrier wall is in its normal operating state, the relationship between SSD(DRT) and SSD(SRT) from examples 1B and 1C needs to be used. As you will remember, the SSD(DRT) is none or 0(in log space) as before. The SSD(SRT) is 0.1 or 1E-1 or -1(in log space) as before. So it is clear that SSD is dependent on the configuration, i.e. what is in the room of fire origin, and what is on the other side of the barrier. In the case of the 3 hour barrier in its normal operating state, we see the SSD(DRT) is not greater than 100 times the SSD(SRT), therefore, use the SRT in this case.

As a result, we use the SRT as in Example 1B: Therefore the FMF for the SRT is again: FMF = IF + AS + MS = -2.3 - 0.75 - 1 = -4.05

From **Table 5.7** (SDP Table 1) locate Approximate Frequency = E-4 to 1E-5. Since all degradations lasted longer than 30 days, select E from **Table 5.7**.

Given that the SSD(SRT) is -1, Table 2 produces a White condition.

Note For Comparing Examples 1B and 1C:

The ΔCDF for examples 1B and 1 C are the same within the resolution of the Phase 2 model. This is because both examples for 1B and 1C use only the SRT (according to the rules) which ignores the improvement of the fire barrier. If this Example 1B result (which ignores the improvement of the barrier) concerns the analyst, this concern may be rectified (i.e. see the decrease in risk denoted by improving the barrier) by noting that the ΔCDF is actually the sum of the SRT and DRT, and do that calculation. Note that if safe shutdown equipment with a higher reliability were in the place of the RSP, then the DRT would have been used for example 1B (since barrier would have played a more important role by protecting more reliable equipment), and the fire barrier improvement would have shown up in the calculation done for the Phase 2.

Summary of Case 1: Cable Spreading Room

Example 1A: 3 hour Fire Barrier = High; Autosuppression = Moderate; Fire Brigade = NOS (normal operating state)

- Color = Yellow (via DRT)

Example 1B: 3 hour Fire Barrier = Moderate; Autosuppression = Moderate; Fire Brigade = NOS

- Color = White (via SRT)

Example 1C: 3 hour Fire Barrier = Low; Autosuppression = Moderate; Fire Brigade = NOS

- Color = White (via SRT)

As a result, any finding against a cable spreading room which is adjacent to the RSP where only one CSR exists per unit will be risk significant under Phase 2 application. This occurs, in most cases, even if this risk baseline of -5.55(log space) or 3E-6/yr for the CSR/RSP configuration is subtracted from the CDF (with a DID degradation) to get the ΔCDF. As a reminder, Phase 2 considers the ΔCDF to be the CDF due to inspection findings alone. The baseline is not subtracted off in the Phase 2 methodology. The point here is even if the baseline were subtracted off, most findings against this CSR/RSP configuration would still be white since the ΔCDF threshold for a white is 1E-6/yr.

Case 2: Auxiliary Feedwater Room

Example 2A

An AFW fire area contains a turbine auxiliary feedwater (TDAFW) pump and MDAFW train A. The only other AFW pump, the motor driven auxiliary feedwater (MDAFW) train B pump, is located in a different fire area. The MDAFW B pump cabling runs through the AFW room, but is protected by a 1-hour fire barrier. The AFW room is protected by an automatic sprinkler system. The cables for the MFW pumps have not been traced. The ignition frequency for the AFW room is 3E-3/yr, according to the IPEEE.

In this case, the initiator that the fire produces is a plant transient condition. A plant transient is assumed since the postulated challenging fire (which can occur in the fire area due to the regional fire protection assessment) is assumed to produce at least a manual scram. As a result, the transient worksheet is used to calculate SSD capability for the AFW fire area. (Also remember that the SORV worksheet is used also to assess the impact of a potentially stuck open PORV due to the reactor trip. These worksheets follow the examples) Three sequences exist on the transient SDP worksheet. To evaluate the sequences, the analyst must know whether he can credit the systems in each sequence. The first rule is that no credit can be given for a train if the cables associated with that train have not been traced. For this example, assume that MFW cables have not been traced; however cabling locations for all other systems identified in the sequences are known.

Assume the degradation in DID for the fire area are as follows: Moderate degradation for the 1 hour barrier; Medium degradation of the sprinkler system.

Since we have a moderate degradation in the 1 hour barrier, it is expected that at least the DRT will be needed. However, to determine that is the only term needed we will need to compare SSD(DRT) and SSD(SRT). Note that for the SRT, all equipment in the AFW fire area except that protected by the barrier, is assumed to fail. For the DRT, all equipment in the AFW fire area included that protected by the barrier is assumed to fail.

First we will look at the transient sequences. Since feed/bleed, high pressure injection, and high pressure recirculation are not mentioned as being in the AFW fire area, it is assumed that they will be free of fire damage. Thus we will only assume their random failure probabilities in the SDP transient worksheet.

To evaluate the DRT, the equipment that fails is the equipment in the area of fire origin not protected by the barrier i.e. TDAFW and MDAFW A, plus the equipment protected by the barrier i.e. MDAFW B. And of course since the MFW system cables have not been traced, no credit can be taken for that system. Therefore for the DRT, sequence 1 produces a SSD due to bleed only. Sequence 2 provides SSD due to all of high pressure injection. Sequence 3 provides SSD due to high pressure recirculation only. Therefore for sequence 1 SSD = -2 due to operator action; sequence 2 produces SSD = -3 due to multi-train system; sequence 3 produces SSD = -2 due to HPR being an operator action.

If we evaluate the SORV tree, several sequences have at most SSD(DRT) = -4 since the probability of a PORV being challenged and sticking open is -2 and the probability of the block valve failing is -2. Therefore the transient tree dominates. (In fact, if the reader looks at the SORV sequences which follow, they are even lower than -4 due to the other equipment credited to mitigate core damage.)

To evaluate the SRT, the equipment that fails is only that equipment in AFW fire area that is not protected by the 1 hour fire barrier. Thus if we look at those three transient sequences again, we realize that sequence 1 has a SSD = -4 (1 train of AFW and bleed). Sequence 2 has SSD = -5 due to the train of AFW and multi-train system. Sequence 3 has SSD = -4 due to the train of AFW and HPR.
Note that the SORV tree produces even smaller values for the SSD(SRT).

Therefore, let us only compare the DRT and SRT for the transient worksheet (since transient worksheet in the case of SRT and DRT dominates the SORV worksheet). Remember that the DRT consisted of three values of SSD. They were -2, -3, and -2. For the SRT the SSDs were for those sequences -4, -5 and -4. Remembering that these values are exponents of ten, the analyst can see that the DRT is 100 times larger than the SRT. (Note this is because of the additional train of AFW available for the SRT, and that AFW is in every sequence) Thus we have validated that the DRT is all that is necessary, even though in making that evaluation we did most of the work to calculate the CDF from both DRT and SRT.

Now to calculate the FMF for the DRT, we do the following: IF = -2.5 (log of 3E-3), MS = -1 (normal operating state), AS = -0.75 (moderate degradation of sprinkler), FB = -0.5 (moderate degradation of a 1 hour barrier), no CC term. Therefore FMF for the DRT = -4.75. Go to table 5.6 and note this FMF refers to 1E-4 to 1E-5, then to table 5.7 and choose E since the degradations have lasted more than 30 days. Now for sequence number 1, note that SSD = -2 and E intersect in table 5.8 at Green. For sequence number 2, note SSD = -3 and E intersect at Green. For sequence number 3, SSD = -2 and E intersect in table 5.8 at Green. Only two of these Greens is beside a White, therefore there is no potential for Greens to sum to be a White. (Remember that three Greens each to the left of a white may sum to be a white).

Example 2B

The 1-hour barrier has a high degradation. The automatic sprinkler suppression system has a high degradation. The fire brigade is in its normal operating state. Each of these degradations has lasted longer than 30 days.

Only the DRT is needed since the barrier has a high degradation.

The SSD done for the DRT in example 2A (in both transient and SORV worksheets) holds here since the same equipment exists in the AFW fire area, included that protected by the 1 fire hour barrier. (In fact, if the SRT was needed here, it would have been the same as done in example 2A also. But the SRT is not appropriate for the case with a high degradation of a barrier) Therefore, we only need to calculate the FMF.

IF = -2.5, MS = -1, AS = 0, FB = 0. Therefore FMF = -2.5 + -1 + 0 + 0 = -3.5

For each case, from Table 5.6, FMF = -4 corresponds to 1E-3 to 1E-4 approximate frequency. Therefore select D from table 5.7.

For sequence 1 of the transient worksheet SSD = -2 as before. Sequence 2 has SSD = -3. Sequence 3 has SSD = -2. Therefore from table 5.8, sequence 1 produces a white, sequence 2 produces a green, and sequence 3 produces a white.

Example 2C - Spurious Actuations

Take example 2A and assume that in addition to the other findings in the AFW room, that an inspector discovered that the licensee had not protected against the possibility of a spurious actuation in the AFW room. We will assume that this cabling was not protected by the 1 hour fire barrier. Assume this spurious actuation could cause the PORV to open and make it unable to be closed.

In this case SSD(DRT) and SSD(SRT) will need to be reevaluated to see if the SORV sequence contributions are significant now. Since the PORV sticking open has no impact on the transient sequences, the SRT and DRT for those sequences remain the same. As you will remember in example 2A, the SORV sequences were smaller than the transient sequences.

In this case instead of using the random failure probability for the PORV being challenged and sticking open (random failure probability for PORV being challenged is 0.1; random failure probability for PORV sticking open is 0.1; therefore random failure probability for both happening is 0.01), the PORV is considered failed in the SORV sequences. Credit is still given for the block valves according to the SDP worksheet. For each sequence where the PORV is considered, the sequence after its evaluation is adjusted by -1.

Therefore, let us do the DRT. First of all, sequence 1. The SORV event is considered failed. The high pressure injection is not impacted by the fire. Therefore since the high pressure injection is a multitrain system, -3 credit is given for it. -2 is given for the block valve, and since the sequence is impacted by spurious actuations, another -1 is added to the sequence. Therefore sequence 1 is represented by SSD = -3 -2 -1 = -6.

For sequence 2, the SORV is assumed failed. Credit is given for the block valve (-2) and bleed (-2) and spurious actuations (-1). Therefore sequence 2 is represented by SSD = -5. (Note that bleed here is represented by the manual actions necessary to maintain pressurizer level with the high pressure pumps. After all, the PORV is stuck open due to the initiator.) For sequence 3, the SORV event is assumed failed again. HPR is considered an operator action which is equal to -2. The block valve is -2. Since the PORV is affected by the spurious actuation, add -1 to the sequence. Therefore, SSD for sequence 3 is -5.

Therefore for the DRT for the SORV we have SSD = -6, -5 and -5 for the three sequences. In example 2A we saw that SSD for the transient sequences were -2, -3, and -2. Since these are exponents of 10, it is clear that the transient sequence still dominates the DRT for the AFW fire area.

For the SRT for the transient worksheets, in example 2A, we had SSD = -4, -5, -4 for the three sequences. For the SRT with the SORV, sequence number 1 is -6 since we still have all high pressure injection, the block valve, and the -1 assigned for spurious actuation of the PORV. Sequence number 2 is SORV failed, auxiliary feedwater = -2, block valve = -2, and bleed = -2, and spurious actuation = -1. Therefore sequence number 2 is represented by -7. Sequence number 3 is SORV failed, block valve = -2, high pressure recirculation = -2, adjustment for spurious actuations = -1. So the SSD(SRT) for the SORV is -6 , -7, -5.

So the SSD(SRT) for the SORV is still less than that SSD(SRT) of the transient.

Since the SSD(SRT) of the transient still dominates the SSD(SRT) of the SORV, and since SSD(DRT) of the transient still dominates SSD(DRT) of the SORV, it is only necessary to use the transient to determine if the DRT is all that is needed. In fact since the DRT is still approximately 100 times the SRT, only the DRT is needed. Therefore, we use the DRT of the transient to do the calculation. Therefore, the PORV which spuriously actuates has no impact in this situation since the SORV contribution was always smaller than the transient contribution. (Actually, prior to determining the DRT is all that is needed, the analyst could have determined that the spurious actuation had no impact in this example. After all, the SORV is still dominated by the transient worksheet in both the SRT and DRT cases. This is noted prior to the comparison of SRT versus DRT.)

<u>Summary of Case 2: Auxiliary Feedwater Room</u>

Example 2A: 1 hour Fire Barrier = Moderate; Autosuppression = Moderate; Fire Brigade = NOS (normal operating state)

- Color = Green (via DRT)

Example 1B: 1 hour Fire Barrier = High; Autosuppression = High; Fire Brigade = NOS

- Color = White (via DRT)

Example 1C: 1 hour Fire Barrier = Moderate; Autosuppression = Moderate; Fire Brigade = NOS

- Color = Green since spurious actuations had no risk significant impact on safe shutdown capability

Note that the significance of these findings in Case 2 is much lower than in Case 1 despite the DID degradations being comparable. However, since Case 2 has much more safe shutdown capability than Case 1, the DID findings in Case 2 are not as significant.

ADDITIONAL SEQUENCES

Sample LOOP sequences are provided for completeness since it is expected that the attached sheets are the ones most commonly used. However, note that sequences for transient, LOOP, and SORV will be plant specific, so these generic sequences are not applicable to any specific plant. It is expected that additional plant specific sequences for other initiators will be developed by the Reactor Systems SDP team. If these initiators can be fire induced, then it may be more appropriate to use one of these additional initiators in place of those identified here. The authors cannot comment specifically on this issue since these additional initiators are in development.

FINAL NOTE ON DRT AND SRT

Remember that only the DRT is needed for high degradation of a barrier. As the barrier effectiveness gets better, the opportunity for the SRT to be important grows, until at the 3 hour barrier in its normal operating state, the SRT often dominates. For the case where a medium degradation or normal operating state exists for a barrier, the analyst can simply add the SRT and DRT to get the change in CDF without doing the comparison between SSD(SRT) and SSD(DRT). However, to use the model, the analyst will need to know how to calculate both the SRT and DRT.

DETAIL ON ADDITION OF SORV TO TRANSIENT OR LOOP SEQUENCES

The authors recognize that addition of SORV sequences to the transient or LOOP sequences must be done such that those SORV sequences are not overcounted. Overcounting of SORV sequences will occur when those SORV sequences which are added to the transient or LOOP sequences are non-minimal. (Non-minimal is a PRA term which essentially says that the sequence is already contained in another sequence.) For example, on the transient sequences, the failure of AFW-PCS-FB constitutes a core damage sequence. Therefore, to count SORV-BLK-AFW-PCS-FB as a different core damage sequence is not permitted since the failure of AFW-PCS-FB is in both sequences. However practically speaking, since the transient or LOOP sequence will dominate the non-minimal SORV sequence as long as the SORV and block valve do not both fail due to direct (as opposed to spurious actuation) fire damage, the quantification of non-minimal SORV sequences under those conditions will have no significant impact on CDF. Example 2 demonstrates that the quantification of the non-minimal sequence is insignificant for the conditions where no simultaneous direct fire damage occurs to SORV and the block valve.

FIRE WHICH REQUIRES REMOTE SHUTDOWN OPERATIONS (RSO)
LOOP/TRANS

DRT FOR CABLE SPREADING ROOM (EXAMPLES 1A, 1B, 1C)
Estimated Frequency (Table 1 Row)
Exposure time ________________ Table 1 result (circle): A B C D E F G H

Safety Functions Needed: — *Full* Creditable Mitigation Capability for each Safety Function:

Safety Functions Needed	Full Creditable Mitigation Capability for each Safety Function
Remote Shutdown Operations (RSO)	Manual actions are consistent with Note 1, shutdown can be performed by available equipment (Random failure of RSO= -1)

Circle affected functions	Remaining Mitigation Capability	Sequence Color
1 LOOP/TRANS - RSO	NONE (0)	

Identify any human actions for the RSO which may occur within areas that are affected by fire or smoke:

Note 1: If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available

FIRE WHICH REQUIRES REMOTE SHUTDOWN OPERATIONS (RSO)
LOOP/TRANS

SRT FOR CABLE SPREADING ROOM (EXAMPLES 1B, 1C) Estimated Frequency (Table 1 Row) Exposure time ______________ Table 1 result (circle): A B C D E F G H		
Safety Functions Needed: Remote Shutdown Operations (RSO)	*Full* Creditable Mitigation Capability for each Safety Function: Manual actions are consistent with Note 1, shutdown can be performed by available equipment (Random failure of RSO= -1)	
Circle affected functions 1 LOOP/TRANS - RSO	Remaining Mitigation Capability RSO (-1)	Sequence Color
Identify any human actions for the RSO which may occur within areas that are affected by fire or smoke: Note 1: If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available		

DRT FOR AFW ROOM (EXAMPLES 2A, 2B, 2C) Estimated Frequency (Table 1 Row) ____________
Exposure Time ____________ Table 1 Result (circle): A B C D E F G H

Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Power Conversion System (PCS)	1 / 2 Feedwater trains and 1/3 condensate pump (Operator action)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 ASD Train)
Primary Heat Removal, Feed/Bleed (FB)	2 / 2 PORVs open for Feed/Bleed (operator action)
High Pressure Injection for FB (EIHP)	1 / 4 Charging or SI trains (multi-train system)
High Pressure Recirculation (HPR)	1 / 4 Charging or SI trains taking suction from 1 / 2 LPSI trains with successful switchover to sump (operator action)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining* Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TRANS - AFW - PCS - FB		**FB (-2)**	
2 TRANS - AFW - PCS -EIHP		EIHP (-3)	
3 TRANS - AFW - PCS - HPR		HPR (-2)	

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available.

PHASE 2 RISK ESTIMATION WORKSHEET FOR PWR Transients (Reactor Trip)

SRT FOR AFW ROOM (EX. 2A, 2C) Exposure Time ________	Estimated Frequency (Table 1 Row) ________ Table 1 Result (circle): A B C D E F G H
Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Power Conversion System (PCS)	1 / 2 Feedwater trains and 1/3 condensate pump (Operator action)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 ASD Train)
Primary Heat Removal, Feed/Bleed (FB)	2 / 2 PORVs open for Feed/Bleed (operator action)
High Pressure Injection for FB (EIHP)	1 / 4 Charging or SI trains (multi-train system)
High Pressure Recirculation (HPR)	1 / 4 Charging or SI trains taking suction from 1 / 2 LPSI trains with successful switchover to sump (operator action)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining* Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TRANS - AFW - PCS - FB		**AFW (-2) FB (-2)**	
2 TRANS - AFW - PCS -EIHP		AFW (-2) EIHP (-3)	
3 TRANS - AFW - PCS - HPR		AFW (-2) HPR (-2)	

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available.

DRT FOR AFW ROOM (EX. 2A, 2B) Exposure Time ____________	Estimated Frequency (Table 1 Row) ____________ Table 1 Result (circle): A B C D E F G H
<u>Safety Functions Needed</u>:	<u>*Full* Creditable Mitigation Capability for each Safety Function</u>:
Closure of Block Valve (BLK)	To close the block valve if the PORV stuck open or failed to reclose in response to an initiator (operator action)
Early Inventory, HP Injection (EIHP)	1 / 4 Charging or SI trains (multi-train system)
Power Conversion System (PCS)	1/3 condensate pump (operator action)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 diverse train)
Primary Heat Removal, Feed/Bleed (FB)	1 / 2 PORVs open for Feed/Bleed (operator action)(1)
High Pressure Recirculation (HPR)	1 / 4 Charging or SI trains taking suction from 1 / 2 LPSI trains with successful switchover to sump (operator action)

<u>Circle Affected Functions</u>	**<u>Recovery of Failed Train</u>**	**<u>*Remaining* Mitigation Capability Rating for Each Affected Sequence</u>**	**<u>Sequence Color</u>**
1 SORV - BLK - EIHP		**SORV (-2) BLK (-2) EIHP (-3)**	
2 SORV - BLK - AFW - PCS - FB		SORV (-2) BLK (-2) FP (-2)	
3 SORV - BLK - HPR		SORV (-2) BLK (-2) HPR (-2)	

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available. FB refers to the manual actions necessary to control HPI.

SRT FOR AFW ROOM (EX. 2A) Time ______________	Estimated Frequency (Table 1 Row) ______________ Table 1 Result (circle): A B C D E F G H	Exposure

Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Closure of Block Valve (BLK)	To close the block valve if the PORV stuck open or failed to reclose in response to an initiator (operator action)
Early Inventory, HP Injection (EIHP)	1 / 4 Charging or SI trains (multi-train system)
Power Conversion System (PCS)	1/3 condensate pump (operator action)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 diverse train)
Primary Heat Removal, Feed/Bleed (FB)	1 / 2 PORVs open for Feed/Bleed (operator action)[1]
High Pressure Recirculation (HPR)	1 / 4 Charging or SI trains taking suction from 1 / 2 LPSI trains with successful switchover to sump (operator action)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining* Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SORV - BLK - EIHP		**SORV (-2) BLK (-2) EIHP (-3)**	
2 SORV - BLK - AFW - PCS - FB		SORV (-2) BLK (-2) AFW (-2) FB (-2)	
3 SORV - BLK - HPR		SORV (-2) BLK (-2) HPR (-2)	

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available.

DRT WITH SPURIOUS ACTUATION (EX. 2C) Estimated Frequency (Table 1 Row) ______________ Exposure Time ______________ Table 1 Result (circle): A B C D E F G H

Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Closure of Block Valve (BLK)	To close the block valve if the PORV stuck open or failed to reclose in response to an initiator (operator action)
Early Inventory, HP Injection (EIHP)	1 / 4 Charging or SI trains (multi-train system)
Power Conversion System (PCS)	1/3 condensate pump (operator action)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 diverse train)
Primary Heat Removal, Feed/Bleed (FB)	1 / 2 PORVs open for Feed/Bleed (operator action)[1]
High Pressure Recirculation (HPR)	1 / 4 Charging or SI trains taking suction from 1 / 2 LPSI trains with successful switchover to sump (operator action)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining* Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SORV - BLK - EIHP		**BLK (-2) EIHP (-3) SPURIOUS (-1)**	
2 SORV - BLK - AFW - PCS - FB		BLK (-2) FB (-2) SPURIOUS (-1)	
3 SORV - BLK - HPR		BLK (-2) HPR (-2) SPUROUS (-1)	

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available.

SRT WITH SPURIOUS ACTUATION (EX. 2C) Estimated Frequency (Table 1 Row) ____________
Exposure Time ____________ Table 1 Result (circle): A B C D E F G H

Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Closure of Block Valve (BLK)	To close the block valve if the PORV stuck open or failed to reclose in response to an initiator (operator action)
Early Inventory, HP Injection (EIHP)	1 / 4 Charging or SI trains (multi-train system)
Power Conversion System (PCS)	1/3 condensate pump (operator action)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 diverse train)
Primary Heat Removal, Feed/Bleed (FB)	1 / 2 PORVs open for Feed/Bleed (operator action)(1)
High Pressure Recirculation (HPR)	1 / 4 Charging or SI trains taking suction from 1 / 2 LPSI trains with successful switchover to sump (operator action)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining* Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SORV - BLK - EIHP		**BLK (-2) EIHP (-3) SPURIOUS (-1)**	
2 SORV - BLK - AFW - PCS - FB		BLK (-2) AFW (-2) FB (-2) SPURIOUS (-1)	
3 SORV - BLK - HPR		BLK (-2) HPR (-2) SPURIOUS (-1)	

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available.

SAMPLE WORKSHEET

Exposure Time ______________ Estimated Frequency (Table 1 Row) ______________

Table 1 Result (circle): A B C D E F G H

Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Emergency AC Power (EAC)	2 / 3 Emergency Diesel Generators (3 EDGs = 1 multi-train system, 2 EDG = 1 diverse train) or 1 Gas Turbine Generator (1 diverse train)
Recovery of AC power in < 6 hrs (REC6)	Recovery of or source of AC including Turbine Generator (Operator action)
Recovery of AC Power in < 2 hrs (REC2)	Recover a source of AC to allow primary injection (Operator action under high stress)
Failure of PORV to Re-close after it opened (SORV)	2/2 PORVs Re-close after opening (1 train system)
Closure of Block Valve (BLK)	To close the block valve if the PORV stuck open (operator action)
Early Inventory, HP Injection (EIHP)	1 / 4 Charging or SI trains (1 multi-train system)
Secondary Heat Removal (AFW)	1 TDAFW train (1 train) or 1 / 2 MDAFW trains (1 multi-train system)
Primary Heat Removal, Feed/Bleed (FB)	2 / 2 PORVs open for Feed/Bleed (operator action)
High Pressure Recirculation (HPR)	1 / 4 Charging or SI trains taking suction from 1 / 2 LPSI trains (with successful recirculation (operator action)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining* Mitigation Capability Rating for Each Affected Sequence**	Sequence Color
1 LOOP - EAC - REC6			
2 LOOP - EAC - REC2 - TDAFW			
3 LOOP - EAC - EIHP (RCP seal LOCA, AC recovered in 6			
4 LOOP - EAC - REC2 - HPR (RCP seal LOCA, AC recovered in 6			

5 LOOP - AFW - FB (AC initially available or become available <2 hrs)			
6 LOOP - AFW - EIHP (AC initially available or become available <2 hrs)			
7 LOOP - AFW - HPR (AC initially available or become available <2 hrs)			
9 LOOP - SORV - BLK - EIHP[(1)] (Emergency AC available)			
10 LOOP - SORV - BLK - HPR[(1)] (Emergency AC available)			

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available.

END

ENCLOSURE 4

FIRE SDP EVALUATION CRITERIA

XXXXX.03-03 INSPECTION GUIDANCE

General Guidance

Fire Scenario Considerations:

In order to perform a screening risk significance estimate of the fire protection DID findings the inspector must develop a reasonable fire scenario, based on in situ conditions and allowed operational practices. It is the inspector's responsibility to develop a fire scenario for the fire area, zone, or room of concern. This will include evaluating the available fuel, its distribution, and its relationship to post-fire SSD mitigation systems, equipment, and components, and potential ignition sources. Do not assume that all equipment is arbitrarily lost by a postulated fire. The inspector is required to consider a more realistic impact of fire on the equipment. This fire scenario should consider the relative location of fire sources and their relationship to SSD and accident mitigation equipment, the heat release rates of these combustibles, and if the amount of material available to sustain a fire for an appreciable duration.

The following may be used as guidance to assist with the development of a postulated fire scenario:

a. The maximum transient fuel loads allowed by administrative controls can be considered an initiating fuel package.

b. The presence of external ignition sources (e.g., welding, cutting, grinding, temporary wiring) allowed by administrative controls can be present and can be considered a potential ignition source.

c. Plant electrical equipment (e.g. motor control centers, switchgear, relay panels, termination cabinets, motors, MG sets, transformers) can be a source of ignition and part of the fuel load.

d. Fires in electrical cabinets that have ventilation openings or are unsealed at the top can expose and ignite the cables above the cabinets.

e. Faults in high and medium voltage switchgear can breach a metal cabinet and cause faults in adjacent switchgear.

f. Exposure fires involving transient combustibles have an equal probability of occurring anywhere in the space being evaluated or inspected. Fires involving fixed (in situ) combustibles can occur at the site of the combustible material and propagate accordingly within and along a contiguous fuel package.

g. Hydrocarbon fuels (e.g., plastic) when burning can give off dense smoke within a short period of time (fill room or rooms from floor to ceiling with smoke). Smoke transport by HVAC and through fire barrier leakage may impact fire brigade and operator actions that have to occur in areas adjacent to the room or area under consideration.

h. If unprotected (no fire resistive barrier) SSD and recovery equipment/components that are in the fire's plume or located in the ceiling region are damaged.

Fire Scenario Evaluation Guidance:

The first step in determining changes to overall reactor plant fire risk is to identify a fire scenario for a given fire area, zone, or room of concern. This will require that the general location of the post-fire SSD systems, equipment, and components and any recovery (EOP type) systems, equipment, and components be identified within the given fire area, zone, or room of concern. Proximity of combustibles and their relationship to SSD and recovery equipment must be identified. For example, is the SSD and recovery equipment of concern located near the ceiling, and are the in situ fuel packages (combustibles), such as cables in cable trays, located within this same region of the room[1] ?

SSD and/or systems, equipment, and components are considered to be targets that are subject to fire damage. These targets can be in the ceiling jet layer (upper hot gas layer portion of the room) that forms directly beneath the ceiling, or in the fire's plume region, or in the sub-layer that is beneath the ceiling jet layer.

Generally, a fire presents the greatest challenge when it is located directly beneath a target such as the case of a floor-based exposure-type fire involving transient combustibles. For fixed (insitu) combustibles, actual geometry of the fuel packages (along the wall, in the corner, near the ceiling) between the fire source and the target should be assessed in order to determine if the targets of concern are located within the fire plume or in the ceiling jet region. Note that a fire that burns up against a wall burns at twice the intensity of those that burn in the center of the room. Fires that burn in the corner of a room burn at four time the intensity of those that burn in the center of the room. A fire that burns near the ceiling will develop a ceiling jet and a hot gas layer more quickly than fires that burn in the center of the room.

Assuming ignition, the characteristics of the fuel packages should be evaluated (for example, the state of the fuel (solid, liquid, gas), type and quantity, configuration and location, rate of heat release, rate of fire growth, and production rate of combustion products). As a fire begins to grow in intensity in the initial fuel package, it can produce sufficient convective, conductive, and radiant energy to ignite adjacent fuel packages (e.g., floor based fire exposes one bank of cable trays in the upper regions of a room then this burning bank of cable

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[1] It should be noted that this type of assessment of the fuel configuration and distribution is not the same as the fuel loading (BTUs/sq. ft) calculations performed for the plant-specific Fire Hazards Analysis (FHA).

trays ignites a second and adjacent bank of cable trays within the same upper region). This is one way a fire scenario can develop.

Basic ignition of secondary fuel packages is generally attributed to convection, conduction, radiation, or a combination of these energy (heat) transfer methods. Conduction occurs when the fuel packages are in direct contact with each other and heat is directly transferred from one package to the other. Convection occurs when heat in the fire plume carries heat to the secondary fuel packages and radiation typically transfers heat to adjacent fuel packages (e.g., two adjacent fuel packages at the floor level and not in contact with one another). Radiation is dependent on the size of the flame, temperature, emissivity of the flame, absorptivity of the fuel package (combustible) surface, geometric viewing factor between the flames and the fuel package surface, and its ignition characteristics.

Specific Guidance

03.01 Inspection Requirement 02.02 Fire Detection and Alarm Systems.

a. Automatic Fire Detection Effectiveness

The inspectors should inspect the critical attributes of the fire detection system against the design and installation criteria specified by the code-of-record. The following is supplemental guidance and may be used by the inspector to assist in making qualitative judgements relating to the general effectiveness of certain automatic fire detection features used to detect an incipient fire within the fire area, zone, or room under consideration.

The fire detection element is critical in that it senses a potential fire condition and completes the logic of the system that provides notification to the control room to alert the operators of a pending fire condition and in some cases it actuates fire suppression systems. The following supplemental guidance[2] is provided in order to establish this understanding:

A review of the layout and placement of the detection (initiating) devices within those fire areas, zones, or rooms under consideration will be required in order to evaluate the effectiveness of the detection system.

Generally, two basic types of fire detection devices are used. They are products of combustion (POC) type detector or thermal detectors. For example, the majority POC detectors are ionization or photoelectric spot (smoke) type and they are listed by Underwriter's Laboratories (UL) to be placed on a smooth ceiling, with a height that does not exceed 15 feet 9 inches and a maximum spacing of 30 feet between

[2] Refer to the NFPA National Fire Alarm Code Handbook, 1993 Edition, for further guidance

detectors. The detectors, during their listing approval tests, are not subject to any air movement and there are no physical obstructions between the detector and the fire source.

With respect to thermal detectors, generally there are two types fixed temperature and rate compensated. The UL listing for a fixed temperature and rate compensated is related to an area of coverage. For example, a fixed temperature detector can be used to protect a maximum of 225 square feet and a rate compensated detector can be used to protect a maximum of 2500 square feet with a 50 foot spacing factor.

b. <u>Spot Type Thermal Detector Placement - Minimum Design Inspection Factors</u>

Spot type detectors shall be located on the ceiling not less than 4 inches from the side wall or on the side walls between 4 and 12 inches from the ceiling.

Reduced spacing shall be considered and may be required due to structural obstructions and characteristics of the area being protected. For smooth ceilings the distance between detectors shall not exceed their UL listed spacing and there shall be a detector within one half of the listed spacing, measured at right angle, from all walls or partitions extending to within 18 inches of the ceiling, or all points on the ceiling shall have a detector within a distance equal to 0.7 times the listed spacing.

The maximum linear spacing on smooth ceilings for spot type heat (rate of rise or compensated) detectors are determined by full scale fire tests. These tests assume that the detectors are to be installed in a pattern of one or more squares, each side of which equals the maximum spaced as determined in the test. The distance from the detector to the fire shall be maintained always at the test spacing multiplied by 0.7. (See table below)

TEST SPACING	MAXIMUM TEST DISTANCE FROM FIRE TO DETECTOR
50 X 50 FEET	35 FEET
40 X 40 FEET	28 FEET
30 X 30 FEET	21 FEET
25 X 25 FEET	17.5 FEET
20 X 20 FEET	14 FEET
15 X 15 FEET	10.5 FEET

On ceilings 10 feet to 30 feet high heat detector spacing shall be reduced in accordance with the table below:

CEILING HEIGHT (FT)	UP TO	PERCENT OF UL LISTED SPACING
0	10	100
10	12	91
12	14	84
14	16	77
16	18	71
18	20	64
20	22	58
22	24	52
24	26	46
26	28	40
28	30	34

A ceiling shall be treated as a smooth ceiling if the beams project no more than 4 inches below the ceiling. If the beams project more than 4 inches below the ceiling, the spacing of spot type heat detectors shall be at right angles to the direction of the beam travel and shall not be more than 2/3 of the smooth ceiling spacing. If the beams project more than 18 inches below the ceiling and are more than 8 feet on center each bay formed by the beams shall be treated as a separate area and have at least one detector installed within the bay.

Location and spacing of heat detectors should consider beam depth, ceiling height, beam spacing, HVAC vents and effects, obstructions, and fire size.

If the ratio of beam depth (D) to ceiling height (H) (D/H) is greater than 0.10 and ratio of beam spacing (W) to ceiling height (H) (W/H) is greater than 0.40, heat detectors should be placed in each beam pocket.

If either the ratio of beam depth to ceiling height is less than 0.10 or the ration of beam spacing to ceiling height is less than 0.40, heat detectors should be installed on the bottom of the beams.

c. Spot Type POC Detector Placement - Minimum Design Inspection Factors

Spot type detectors shall be located on the ceiling not less than 4 inches from the side wall or on the sidewall between 4 and 12 inches down from the ceiling to the top of the detector.

On smooth ceilings, spacing of 30 feet shall be permitted to be used as an initial criteria. All points on the ceiling shall have a detector within a distance equal to 0.7 times the selected spacing. General guidance for spacing of spot type smoke detectors on smooth ceilings 10 feet to 30 feet high[8] is provided in the table below:

Fire Size (Btus/second) and Growth Rate	*Maximum Ceiling height (feet)*	*Maximum Spacing (ft)*
100 btus/sec - fire growing at a slow rate	10	22
	15	15
	18	12
250 btus/sec - fire growing at a slow rate	10	40
	15	35
	18	30
MEDIUM RATE		
100 btus/sec - fire growing at a medium rate	10	18
	15	12
	18	N/A
MEDIUM RATE		
250 btus/sec - fire growing at a medium rate	10	35
	15	28
250 btus/sec - fire growing at a medium rate	20	24
	25	18
	28	12
FAST RATE		
100 btus/sec - fire growing at a fast rate	10	12
	15	N/A
FAST RATE		
250 btus/sec - fire growing at a fast rate	10	28

8 It is assumed that the ratio of the gas temperature rise to the optical density of the smoke is a constant and that the detector will actuate at a constant value of temperature rise equal to 20°F, which is considered indicative of concentration of smoke from a number of common fuels that would cause detection by a relatively sensitive detector.

Fire Size (Btus/second) and Growth Rate	Maximum Ceiling height (feet)	Maximum Spacing (ft)
	15	20
	20	14

Ceiling construction where beams are 8 inches or less in depth shall be considered equivalent to a smooth ceiling. If the beams are more than 8 inches in depth the spacing of spot type detectors in the direction perpendicular to the beams shall be reduced. If the beams are less than 12 inches in depth and less than 8 feet on center spot type detectors shall be permitted to be installed on the bottom of beams.

If the beams project more than 18 inches below the ceiling and are more than 8 feet on center each bay formed by the beams shall be treated as a separate area and have at least one detector installed within the bay.

Location and spacing of heat detectors should consider beam depth, ceiling height, beam spacing, and fire size. To detect a flaming fire (strong plumes), detectors should be installed as follows:

> Condition 1: If the ratio of beam depth (D) to ceiling height (H) (D/H) is greater than 0.10 and ratio of beam spacing (W) to ceiling height (H) (W/H) is greater than 0.40, heat detectors should be placed in each beam pocket.
>
> Condition 2: If either the ratio of beam depth to ceiling height is less than 0.10 or the ration of beam spacing to ceiling height is less than 0.40, heat detectors should be installed on the bottom of the beams.

To detect smoldering fires (weak or no plumes), detectors shall be installed as follows:

- If air mixing into the beam pockets is good (e.g., air flow parallel to long beams) and condition (1) exists as above, detector shall be located in each beam pocket.
- If air mixing into the beams pockets is limited or condition (2) exists above, detectors should be located on the bottom of the beams.

The radius of a fire plume where it impinges on the ceiling is approximately 20 percent of the ceiling height (0.20H) above the fire source and the minimum depth of the ceiling jet is approximately 10 percent of the ceiling height (0.10H) above the fire source. For ceilings with beams deeper than the jet depth and spaced wider that the plume width, detectors will respond faster in the beam pocket because they will be in either the plume of ceiling jet. For ceiling with beams of less depth than the ceiling jet or spaced closer that the plume width, detector response will not be enhanced by placing detectors in each beam pocket, and the detectors may perform better on (for spot-type detectors) the bottom of the beams.

Where plumes are weak, ventilation and mixing into the beam pockets will determine detector response. Where beams are closely spaced and air flow is perpendicular to the beam, mixing into the beam is limited and detectors will perform better on the bottom of the beams.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the fire detection system to perform its intended function:

- The detection system for the fire area, zone, or room under consideration is inoperable.

- Insufficient number of detectors as required by the spacing and placement criteria established by the code-of-record.

- The placement and spacing of 25 percent of the detectors within the fire area, zone, or room under consideration do not meet the spacing/placement conditions specified by the code-of-record or by their UL listing.

The following is an example of a observed condition that may represent a moderate impact (degradation) on the ability of the fire detection system to perform its intended function:

- The placement and spacing of 10 percent of the detectors within the fire area, zone, or room under consideration do not meet the spacing/placement conditions specified by the code-of-record or by their UL listing.

The following is an example of a normal operating state:

- The layout and placement of fire detection devices within the fire area, zone, or room under consideration meet industry codes and the conditions specified by the code-of-record or by their UL listing.

03.02 <u>Inspection Requirement 02.03a</u> Fixed/Automatic Fire Suppression Systems.

a. <u>Automatic Sprinkler System Water Curtains</u>

The following evaluation guidance should be used for making qualitative judgments relating to the effectiveness of a water curtain's (connected to an automatic sprinkler system's) ability to promptly detect and prevent a fire within the fire area, fire zone, or compartment under consideration from spreading through the otherwise unprotected opening.

General Assumptions

- If the water curtain is supplied by a preaction sprinkler or deluge system, it will be necessary to evaluate the detection system (which controls the actuation of the pre-action sprinkler/deluge system, see Section 3.01) in order to evaluate the effectiveness of the automatic water curtain. This assumption does not apply to water curtains connected to automatic wet pipe or dry pipe systems.

- Where required, the proper design and operation of the detection system is essential to the success or failure of the water curtain.

- The design and installation of the draft curtain surrounding the unprotected opening is essential to successful operation of the water curtain.

- It is assumed that the system was constructed from listed components and the design and installation met the NFPA code of record (COR) and followed the applicable technical guidance presented in the COR appendices.

- It is assumed that the system met start-up testing requirements and is maintained in accordance with the vendor's manual and the COR .

Evaluation Guidance

Water curtains are a special extension of the plant's water-based suppression system. The water curtains serve an important function of reducing the likelihood that convective heat and the flames of a fire will pass through vertical and horizontal openings in wall and ceiling fire barriers. In order for the water curtain to be effective, the system must possess the following three attributes: (1) the system must actuate in the early stage of the fire. For pre-action and open-head water-based systems, single-zoned thermal detectors (of the appropriate temperature rating) or single/cross zoned smoke detectors are generally found acceptable (see Section 3.01 for guidance on evaluating detection systems). Slow-acting detection systems such as cross-zoned thermal detectors are typically too slow to be effective in actuating a water curtain in a timely manner (2) The system must deliver the minimum amount of water to close off the opening (3) The draft stop enclosure (in order to support the first two objectives) must remain tight to the opening and be designed deep enough to stop the natural buoyant flow of heat and smoke through the unprotected opening diverting it to the detectors and sprinkler heads (thus ensuring their operation.) The draft stop also forms the deflector for the sprinkler head discharge to form the cascading water wall. Failure of any of these three criteria may greatly reduce the effectiveness of the water curtain to perform its intended function.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the water curtain to perform its intended function:

- The system for the fire area, zone, or compartment under consideration is inoperable.

- The system's supply valve is closed.

- For systems requiring detection to actuate, the detection system is inoperable or too slow to react (see Section 3.01).

- The system does not provide adequate coverage or discharge for the unprotected opening.

- The draft stop enclosure is not tight enough, or deep enough to ensure proper operation.

- Sprinkler heads are missing, wrong type, or are damaged.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the water curtain to perform its intended function:

- Sprinkler heads are out of position or are slightly obstructed by other plant equipment.

- Degradation to the detection system is medium (see Section 3.01).

- Minor gap between the draft stop and the ceiling.

The following is an example of a normal operating state:

- The system design (including detection where applicable and the draft stop) installation, and maintenance are within industry codes and standards requirements.

b. <u>Automatic Sprinkler System</u>

The inspectors should inspect the critical attributes of a sprinkler system against the design and installation criteria specified by the code-of-record. The following is supplemental guidance[9] and may be used by the inspector to assist in making qualitative judgements relating to the general effectiveness of certain automatic sprinkler system features used to control a fire within the fire area, zone, or room under consideration:

- Sprinklers shall be installed in accordance with their UL listing.

- Ordinary-temperature-rated sprinklers shall be used throughout Nuclear power plant buildings. Where maximum ceiling temperatures exceed 100°F, sprinklers with temperature ratings in accordance with the maximum ceiling temperatures[10] noted below shall be used:

Maximum Ceiling Temperature (F)	Sprinkler Temperature rating (F)	Sprinkler temperature classification	Sprinkler temperature rating	Glass bulb colors
100	135 to 170	Ordinary	Uncolored	Orange or Red
150	175 to 225	Intermediate	White	Yellow or Green
225	250 to 300	High	Blue	Blue
300	325 to 375	Extra High	Red	Purple
375	400 to 475	Very Extra High	Green	Black

- Early suppression fast response sprinklers shall be used only in wet pipe sprinkler systems.

- The distance from sprinklers to walls shall not exceed one-half of the allowable distance between sprinklers. Sprinklers shall be located a minimum of 4 inches from wall.

- Non-continuous obstructions at or very near the ceiling and close to the sprinkler such as columns, cable trays, light fixtures, large pipes, HVAC ducts shall be treated as vertical obstructions. The minimum separation between vertical obstructions and a sprinkler shall be as follows:

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[9] Refer to Automatic Sprinkler System Handbook, Sixth Edition, for additional guidance

[10] The maximum ceiling temperature is equated to the temperature that would be experienced at the ceiling on the hottest summer day (Summer High)

Minimum distance from vertical obstruction	
Maximum dimension of obstruction	*Maximum horizontal distance sprinkler shall be placed away from obstruction*
½ to 1 inch	6 inches
Greater than 1 inch and less than 4 inches	12 inches
Greater than 4 inches	24 inches

– The minimum separation of a sprinkler from a horizontal obstruction (beams, HVAC ducts) shall be determined by the height of the sprinkler deflector above the bottom of the obstruction shall be as follows:

Position of sprinkler deflector when located above bottom of obstruction	
Distance from sprinkler to side of obstruction	**Maximum allowable distance of deflector above bottom of obstruction**
less than 1 ft.	0 in.
1 ft to less than 1 ft-6 in.	1 in.
1 ft-6 in. to less than 2 ft.	1 in.
2 ft. to less than 2 ft-6 in.	2 in.
2 ft-6 in. to less than 3 ft.	3 in.
3 ft. to less than 3 ft-6 in.	4 in.
3 ft-6 in. to less than 4 ft..	6 in.
4 ft. to less than 4 ft.-6 in.	7 in.
4 ft-6 in. to less than 5 ft	9 in.
5 ft. to less than 5 ft.-6 in.	11 in.
5 ft.-6 in. to less than 6 ft.	14 in.

– Under obstructed construction, the distance between the sprinkler deflector and the ceiling shall not be less 6 inches and more than 12 inches.

– Sprinklers shall be positioned with respect to lighting fixtures, cable trays, pipes, ducts and obstructions more than 24 inches wide and located entirely below the sprinkler so that the minimum distance from the near side of the obstruction to the center of the sprinkler is not less than the value specified below:

Position of sprinklers in relation to obstruction located entirely below the sprinklers	
Distance of deflector above the bottom of the bottom of the obstruction	Minimum distance to side of obstruction (ft)
Less than 6 inches	1 ½ feet
6 inches to less than 12 inches	3 feet
12 inches to less than 18 inches	4 feet
18 inches to less than 24 inches	5 feet
24 inches to less than 30 inches	6 feet

- Where the bottom of the obstruction is located 24 inches or more below the sprinkler deflector: (a) Sprinklers shall be positioned so that the obstruction is centered between adjacent sprinklers; (b) The obstruction shall be limited to a maximum width of 24 inches. Where the obstruction is greater than 24 inches wide, one or more lines of sprinklers shall be installed below the obstruction; and (c) The obstruction shall not extend more than 12 inches to either side of the midpoint between sprinklers. When the extensions of the obstruction exceed 12 inches, one or more lines of sprinklers shall be installed below the obstruction.

- In the special case of an obstruction running parallel to and directly below a branch line:(a) The sprinkler shall be located at least 36 inches above the top of the obstruction; (b) The obstruction shall be limited to a maximum width of 12 inches; and (c) The obstruction shall be limited to a maximum of 6 inches to either side of the centerline of the branch line.

- A minimum of 18 inches of clear space below the sprinkler deflector shall be maintained.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the sprinkler system to perform its intended function:

- The system is out of service or inoperable

- The system is actuated by the fire detection system and the fire detection system is inoperable or its critical detection attributes (detector placement and spacing) capabilities does not meet the code-of-record.

- Sprinkler head distance from the ceiling exceeds the limits specified above.

- Two or more adjacent sprinkler heads in a combustible free zone are affected obstructions (horizontal, vertical, or obstructions located below) and are without adjacent obstruction heads below obstruction.

- The placement and spacing of 25 percent of the sprinklers within the fire area, zone, or room under consideration do not meet the spacing/placement conditions of their UL listing or that specified by the code-of-record.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the sprinkler system to perform its intended function:

- Improper assessment of system performance or evaluation of internal system corrosion.

- The placement and spacing of 10 percent of the detectors within the fire area, zone, or room under consideration do not meet the spacing/placement conditions of their UL listing or that specified by the code-of-record.

- Based on the specified ceiling temperature limits, the sprinkler head temperature ratings exceed the maximum temperature set-points recommended.

The following is an example of a normal operating state:

- The sprinkler system layout and head placement within the fire area, zone, or room under consideration meets or exceeds the minimum industry code requirements and the conditions of the sprinkler head UL listing and testing approvals.

c. Automatic Spray Systems

The following evaluation guidance is to be used for making qualitative judgments relating to the effectiveness of an automatic water spray system's ability to promptly detect and control a fire within the fire area, fire zone, or compartment under consideration.

General Assumptions

- It is assumed that the system was constructed from UL-listed components and the design and installation met the NFPA code of record (COR).

- It is assumed that the system met start-up testing requirements and is maintained in accordance with the licensee's fire protection program .

Evaluation Guidance

Water spray extinguishing systems are specialized fire extinguishing systems. Water spray systems are typically used to protect such specific hazards as grouped cable trays. Detection and subsequent actuation is often provided by special means such as linear thermal detector wire (e.g., Protecto wire, Thermistor wire.) Single-zoned thermal detectors (of the appropriate temperature rating) or single/cross-zoned smoke detectors are also acceptable. The detection system evaluation guidance is presented in Section 3.01. Slow-acting detection systems such as cross-zoned thermal detectors are typically too slow to be effective in actuating a water spray system in a timely manner. In addition, a water spray system must deliver the minimum water spray density on the hazard.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the automatic water spray system to perform its intended function:

- The system for the fire area, zone, or compartment under consideration is inoperable.

- The system's water supply valve is closed.

- The detection system is inoperable or reacts too slowly.

- The system does not provide adequate water spray density or coverage for the in situ hazard.

- Waterspray nozzles are missing, wrong type, or damaged.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the automatic water spray system to perform its intended function:

- Spray nozzle is out of position or slight obstruction.

- The detection system is degraded to a medium degree (see Section 3.01).

The following is an example of a normal operating state:

- The system design (including detection) installation, and maintenance are within industry codes and standards requirements.

d. Automatic Halon System

The following evaluation guidance is to be used for making qualitative judgments relating to the effectiveness of an automatic Halon system's ability to promptly detect and control a fire within the fire area, fire zone, or compartment under consideration.

General Assumptions

- It is assumed that the system was constructed from UL-listed components and the design and installation met the NFPA code of record (COR).

- It is assumed that the system met start-up testing requirements and is maintained in accordance with the licensee's fire protection program .

Evaluation Guidance

Halogenated agent extinguishing systems are specialized fire extinguishing systems. The halogenated agent (typically Halon 1301) fire extinguishing mechanism is not completely understood. Theoretically, a physicochemical inhibition of the combustion process takes place, i.e., the Halon breaks the chain reaction between the fuel and oxygen and dissociates in the flame into two radicals. In order for the Halon system to be effective, the total flooding system must possess the following attributes: (1) The system must actuate in the early stage of the fire. Single-zoned thermal detectors (of the appropriate temperature rating) or single/cross-zoned smoke detectors are acceptable. The detection system evaluation guidance is presented in Section 3.01. Slow-acting detection systems such as cross-zoned thermal detectors are typically too slow to be effective in actuating a Halon system in a timely manner (2) The system must deliver the minimum amount of agent in the specified time. Surface-burning fires (e.g., flammable liquids) typically require 5 percent to 8.2 percent.[11] Deep-seated fires (e.g., cables, Class A combustibles) typically require a minimum 6 percent held in the enclosure for 10 to15 minutes,[12] and (3) the enclosure must remain tight to contain the halogenated agent.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the automatic halon system to perform its intended function:

- The system for the fire area, zone, or compartment under consideration is inoperable.

- The system's supply valve is closed or the supply tanks do not contain adequate agent.

- The detection system is inoperable or too slow to react (see Section 3.01).

- The system does not provide adequate concentration or soak time for the in situ hazard.

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[11]See NFPA 12A "Standard on Halon 1301 Fire Extinguishing Systems"

[12]See NUREG/CR-3656 "Evaluation of Suppression Methods for Electrical Cable Fires" Section3.3 "Halon 1301 Suppression of Fully Developed Cable Fires," 1986

- The enclosure is not tight enough, or has more leakage paths than originally tested (e.g., no ventilation system isolation, removed or missing dampers).

- Discharge nozzles missing, wrong type or are damaged.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the automatic halon system to perform its intended function:

- Discharge nozzle is out of position or is slightly obstructed.

- The detection system is degraded to a medium degree (see Section 3.01).

- The enclosure's ability to maintain gas concentration is minimally degraded (e.g., worn-out fire door weather stripping, minimal penetration seal degradation — minor cracks).

The following is an example of a normal operating state:

- The system design (including detection) installation and maintenance are within industry codes and standards requirements.

e. Automatic Carbon Dioxide (CO_2) Systems

The following evaluation guidance is to be used for making qualitative judgments relating to the effectiveness of an automatic carbon dioxide system's able to promptly detect and control a fire within the fire area, fire zone, or compartment under consideration.

General Assumptions

- It is assumed that the tightness of the enclosure and the ability to control ventilation systems are essential to successful operation of the carbon dioxide system

- It is assumed that the system was constructed from UL-listed components and the design and installation met the vendor's manual and the COR.

- It is assumed that the system met start-up testing requirements and is maintained in accordance with the licensee's fire protection program .

Evaluation Guidance

Carbon dioxide agent extinguishing systems are specialized fire extinguishing systems. Carbon dioxide extinguishes a fire by displacing the normal atmosphere, thus reducing the oxygen content below the minimum 15 percent necessary for continued diffusion flame production. In order for the carbon dioxide system to be effective, the total flooding system must possess the following attributes: (1) The system must actuate in the early stage of the fire. Single-zoned thermal detectors (of the appropriate temperature rating) or single/cross-zoned smoke detectors are acceptable. The detection system evaluation guidance is provided in Section 3.01. Slow-acting detection systems such as cross-zoned thermal detectors are typically too slow to be effective in actuating a CO_2 suppression system in a timely manner (2) The system must deliver the minimum amount of agent in the specified time. Surface-burning fires (e.g., flammable liquids) require between 30 percent to 66 percent.[13] Deep-seated fires (e.g., cables, Class A combustibles) require a minimum 50 percent held in the enclosure for 10 to 15 minutes;[14] and (3) the enclosure must remain tight to contain the CO_2 .

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the CO2 system to perform its intended function:

- The system for the fire area, zone, or compartment under consideration is inoperable.

- The system's supply valve is closed or the supply tanks do not contain adequate agent.

- The detection system is inoperable or is too slow to react (see Section 3.01).

- The system does not provide adequate concentration or soak time for the in situ hazard.

- The enclosure is not tight enough or has more leakage paths than originally tested (e.g., no ventilation system isolation, removed or missing dampers).

- Discharge nozzles missing, wrong type of are damaged.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the CO2 system to perform its intended function:

- Discharge nozzle is out of position or there is a slight obstruction.

- The detection system is degraded to a medium degree (see Section 3.01).

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[13]See NFPA 12, "Standard on Carbon Dioxide Fire Extinguishing Systems"

[14] See NUREG/CR-3656, "Evaluation of Suppression Methods for Electrical Cable Fires" Section 3.6 "Carbon Dioxide Tests on Fully Developed Cable Fires," 1986.

- The room enclosure's ability to maintain gas concentration is minimally degraded (e.g., worn-out fire door weather stripping, minimal penetration seal degradation — minor cracks).

The following is an example of a normal operating state:

- The system design (including detection) installation, and maintenance are within industry codes and standards requirements.

03.03 <u>Inspection Requirement 02.03b</u> Fire Pumps and Water Supply System.

The following evaluation guidance must be used for making qualitative judgments relating to the effectiveness of the fire protection pumps and water supply system's ability to supply automatic and manual fire suppression systems necessary to promptly control a fire within the fire area, fire zone, or compartment under consideration.

General Assumptions

- It is assumed that a minimum two, 100 percent capacity or three, 50 percent capacity fire pumps are installed, with a minimum 100 percent capacity always available.

- It is assumed that one of the redundant minimum 2 hours of fireprotection water supply (sized for the largest design flow plus hose stream requirements) is always available.

- It is assumed that the water supply, distribution, and pumping systems were constructed from UL-listed components and the design and installation met the NFPA code of record (COR).

- It is assumed that the system met start-up testing requirements and is maintained in accordance with the licensee's fire protection program .

Evaluation Guidance

A functional fire protection water supply system is essential to the safety of the nuclear power plant (NPP). The success of automatic fire protection systems such as sprinkler systems, and manual firefighting systems, such as standpipes, depend on the water supply system. The majority of NPP's have redundant supply and pumping capacity. A minimum 100 percent pumping capacity and 100 percent water supply must always be available.

The distribution piping network should have been designed so that a single impaired section (e.g., a section isolated for leak repair) will not prevent the system from delivering the required capacity at the required pressure for the individual automatic and manual suppression systems.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the fire protection water supply system to perform its intended function:

- The fire protection water supply system for the automatic/manual suppression systems in the fire area, zone or room of concern is inoperable.

- The primary water supply valves (e.g., tank discharge, pump suction/discharge, main feeds, etc.) are closed.

- The pump controller is inoperable or is not in the auto start position.

- The system does not have an adequate water supply for the largest design basis hazard.

- The distribution piping network has excessive micro biologically induced corrosion (MIC)/debris (clams) such that it cannot meet its largest design-basis flow.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the fire protection water supply system to perform its intended function:

- A diesel-driven fire pump has enough fuel for more than 1-1/2 hours of operation, but less than the COR requirement.

- Minor system corrosion/debris routinely clogs up the strainers.

- Inoperable system pressure maintenance pumps (jockey pumps) cause the main fire pumps to run and pressurize the system.

- There is excessive leakage in the system underground supply piping network so that the reliability of the system may be questionable.

The following is an example of a normal operating state::

- The water supply system design, installation, and maintenance are within industry codes and standards requirements.

- A minimum 100 percent water supply and 100 percent pumping capacity are available.

03.03 <u>Inspection Requirement 02.04</u> Manual fire suppression equipment and systems, hose station and standpipes.

The following evaluation guidance is to be used for making qualitative judgments relating to the effectiveness of standpipe and hose system's ability to supply water for fire fighting within the fire area, fire zone, or compartment of concern.

General Assumptions

- It is assumed that the system was constructed from UL-listed components and the design and installation met the NFPA code of record (COR).

- It is assumed that the system met start-up testing requirements and is maintained in accordance with the licensee's fire protection program.

Evaluation Guidance

The standpipe and hose systems are extensions of the plant's water-based suppression system. The purpose of the standpipe and hose system is to provide connections to the water supply for manual fire suppression. Some systems, are equipped with hoses and nozzles (Class II, III), while others (Class I) require the fire brigade to supply such equipment during the fire. In order for the standpipe and hose systems to be effective, they must possess the following attributes:(1) The system must be able to supply sufficient water at adequate pressures (2) The system should be supplied by connections to the piping network that are independent from automatic suppression systems for that fire area, fire zone, or compartment under consideration. This is important to prevent a single failure (e.g., one closed sectional valve) from defeating both primary (automatic suppression systems) and back-up system (e.g., standpipe) for the fire area, fire zone, or compartment under consideration (3) The hose connections must be spaced such that adequate coverage is provided for all plant areas. Typically, the hose stations are equipped with 100 feet of hose. The system will also typically develop a 30-foot water stream, so a standpipe hose connection will effectively cover an area 130-feet of area from the connection. Obstructions caused by large equipment and barriers should be considered when evaluating the area of coverage.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the standpipe and hose system to perform its intended function:

- The system for the fire area, zone, or room of concern is inoperable.

- The system's supply valve is closed.

- The attached 100 feet of fire hose (plus the 30 foot for water stream) do not cover the complete area including the overhead. (Note: If the hose station is equipped with more than 100 feet of fire hose and a hydraulic analysis has been performed to demonstrate acceptable performance, this does not apply.)

- Damaged, missing, clogged, or incorrect nozzles (non UL/FM electric safe nozzles) are attached to the system.

- There is an improperly calibrated/adjusted pressure reduction device (25 percent and greater calibration/adjustment error).

- A damaged fire hose is in the hose rack.

- The standpipe/hose system distribution piping network has excessive MIC/debris (clams) so that it cannot meet its design-basis flow.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the standpipe and hose system to perform its intended function::

- Hydrostatic testing is missing (less than 3 years) on the installed fire hose.

- There is an improperly calibrated/adjusted pressure reduction device (less than 25 percent calibration/adjustment error).

- The hose station is obstructed.

The following is an example of a normal operating state:

- The system design (including attached fire hose and nozzle where applicable), installation, and maintenance are within industry codes and standards requirements.

03.04 Inspection Requirement 02.05 a. Minimum Staffing Levels.

Section 50.54(m) of 10 CFR Part 50 addresses minimum staffing levels of licensed personnel, but does not address minimum personnel availability during reactor events.

Generic Letter (GL) 77-02, "Nuclear Plant Fire Protection Functional Responsibilities, Administrative Controls and Quality Assurance," addressed plant fire brigade positions by providing guidance supplemental to Appendix A to Branch Technical Position 9.5-1 (sections A.1, B and C) and Regulatory Guide (RG) 1.120 (Sections C.1, C.2 and C.3). The supplemental information provided in GL 77-02 was that:

- Fire brigade positions should be responsible for fighting fires. The authority and responsibility of each fire brigade position relative to fire protection should be clearly defined.

- These responsibilities of each fire brigade position should correspond with the actions required by the fire fighting procedures.

- The responsibilities of the fire brigade members under normal plant conditions should not conflict with their responsibilities during a fire emergency.

- The minimum number of trained fire brigade members available onsite for each operating shift should be consistent with the activities required to combat the most significant fire. The size of the fire brigade should be based upon the functions required to fight fires with adequate allowance for injuries.

No less than five personnel should be assigned to the fire brigade on each shift.

- NFPA 600 (formerly NFPA 27) and the publications it references provide appropriate criteria for organizing, training and operating a plant fire brigade.

Section H, "Fire Brigade," of Appendix R to 10 CFR Part 50, (not backfit to plants licensed prior to January 1, 1979, to the extent that fire protection features proposed or implemented by the licensee had been accepted by the staff), contained the following requirements:

- Adequate manual fire fighting capability shall be provided.

- The fire brigade shall be at least 5 members on each shift.

- The shift supervisor shall not be a member of the fire brigade.

- Appendix R was silent on conflicting duties of fire brigade members other than the shift supervisor. Reactors not subject to Appendix R received licensing reviews against similar criteria.

NRC Information Notice (IN) 91-77, "Shift Staffing at Nuclear Power Plants," addressed adequate shift staffing following any event (not necessarily a fire). IN 91-77 stated that:

- The number of staff on each shift is expected to be sufficient to accomplish all necessary actions to ensure a safe shutdown of the reactor following an event. Those actions include implementing emergency operating procedures, performing required notifications, establishing and maintaining communications with the NRC and plant management, and any additional duties assigned by the licensee's administrative controls.

An August 30, 1991, memorandum from William T. Russell, Associate Director for Inspection and Technical Assessment, Office of Nuclear Reactor Regulation (NRR), to Thomas T. Martin, Regional Administrator, Region I, reiterated the above IN 91-77 guidance and provided the following amplification regarding event response:

- Licensees should document actual staffing needs in administrative procedures based on plant specific analyses to account for potential emergency situation at any time, including the backshift... the staff considers those licensee's practice of using the STA (Shift Technical Advisor) to man the fire brigade or to provide support for other special occurrences to degrade the licensee's ability to adequately respond to an event.

IN 95-48, "Results of Shift Staffing Study," provided licensees with findings resulting from extensive interviews with site personnel. Licensees were asked to consider these insights when considering their capabilities to accomplish safety functions following an event.

It should be noted that the NRC does not require dedicated fire brigades (fire fighting personnel who have no event related operational responsibilities). However, licensees are responsible for establishing controls to ensure shift staffing is sufficient to accomplish all necessary functions required by an event.

03.05 Inspection Requirement 02.05c Fire Brigade Drills and Exercises.

Manual fire fighting effectiveness under severe fire conditions is complex and difficult to assess. Generally, event history has demonstrated that when faced with a challenging fire condition the effectiveness of plant fire brigades, in the absence of assistance from either fixed plant fire protection features or offsite fire fighting support, have shown conditional limitations which have impeded their ability to be effective. For example, weaknesses in actual fire brigade performance is often a reflection of ineffective training, minimal fire brigade drill performance expectations, incomplete fire fighting strategies (pre-plans), poor fire ground communications, improper or inappropriate specialized fire fighting equipment and extinguishing agents, poor application and logistics/stagging of specialized fire fighting equipment, inappropriate staffing, poor fire ground command and control, physical limitations of individual fire brigade members, etc.

In addition, manual fire fighting is affected by several time factors. Manual fire fighting effectiveness is directly affected by how long (time) it takes for plant operations to accept or acknowledge the fire alarm and confirm that there is a fire. Once, plant operations has made the decision to respond the fire brigade (5 to 10 minutes), the fire brigade has to react and then report to the fire brigade equipment locker(s) (5 to 10 minutes) and don protective clothing, SCBA, and prepare the appropriate special fire fighting equipment to take with them to the fire area, zone or room under consideration (7 to 15 minutes). Upon completing the donning of the appropriate protective equipment and selecting the initial fire fighting equipment to responded with, the brigade responds to the area of concern (5 to 15 minutes before the complete team is assembled near the area of concern). Once in the area, the fire brigade deploys and readies its equipment to fight the fire (5 to 15 minutes). Once the equipment is setup, the brigade then make its an effort to control and suppress the fire (7 to 30 minutes under ideal conditions). Once the fire has been placed under control complete fire extinguishment can be accomplished (30 minutes to 3 hours). Therefore, it is assumed that it takes from 34 minutes to 1 hour and 35 minutes for a fire brigade to control a challenging fire under ideal conditions. Time is a factor for fire growth and smoke development.

Time is an important factor that needs to be considered. In addition to time, judgements will have to be made with regard to the skill of the fire brigade under strenuous conditions. Their ability to cope with the stress of a serious fire challenge and implement the guidance provided by the fire fighting (pre-fire plan) strategy are an equally important factors. These integrated factors (time, skill/equipment utilization) are best evaluated by witnessing a unannounced fire brigade drill.

The inspectors should inspect the critical attributes of fire brigade performance. The fire brigade's performance under drill conditions can be a good indicator of how effective a fire brigaded will perform under actual plant fire conditions. The fire brigade composition, its equipment, and its ability to handle plant fire emergencies should be evaluated against the plants licensing basis.

The following is supplemental guidance and may be used by the inspector to assist in making qualitative judgements relating to the general effectiveness of the fire brigade:

- Review the adequacy of the fire brigade communications equipment. Individual radios with lapel microphones through a repeater function the best, while cell phones, regular phones, and message runners provide minimal capability.

- Review the adequacy of the fire brigade fire fighting equipment. Specialized fire fighting nozzles, hoses, and fittings should be provided where appropriate. Site-wide fire hazards should be identified and appropriate fire fighting and specialized extinguishing agents should be provided in the vicinity of the subject fire hazards. Smoke removal equipment should be available and its room-by-room application considered in the fire pre-plan. Specialized equipment, such as thermography equipment, should be provided for deducing fire locations. Appropriate search and rescue equipment, such as self-contained breathing apparatus (SCBA) and spare air cylinders, should be available to the fire brigade. Personal protective equipment (turnout coats, pants, and helmet) should meet industry and OSHA standards. Standpipe installed hoses should capable of reaching all areas without being excessively long (greater than 100 feet in length).

- Evaluate the fire brigade fire fighting (pre-fire plans) strategies. These fire fighting strategies should as a minium address the following for each fire area containing safety-related equipment or components: fire hazards, extinguishants, direction of suppression attack, heat sensitive plant systems, plant equipment sensitive to suppression agent damage, fire brigade specific duties, potential toxic and radiation hazards, smoke control and management/ventilation systems, special operational instructions (such as managing access through security doors), and determination of room fire involvement before actual entry (e.g. use of thermography equipment).

- Assess how the smoke removal/ventilation plan will provide needed access to the redundant shutdown equipment, and assess whether the plan takes into consideration how areas immediately adjacent to the fire area, zone, or room under consideration will be maintained habitable.

- If an unannounced fire brigade drill is conducted, verify that the fire brigade leader command and control, teamwork, communications techniques, utilization of support from other resource groups, and proper selection of suppressants. Review the adequacy of the fire brigade's capability to locally control HVAC systems/dampers in the fire area. Review the licensee planning for post-fire habitability of important operating spaces (e.g., ventilation, room cooling). The drill should realistically simulate the use of fire fighting equipment for the specific type of fire in the drill scenario, and should simulate the specific challenging environmental conditions presented by the burning materials under consideration.

- Observe that: protective clothing and SCBA are properly utilized, hose lines are properly deployed, safe entry into the fire affected room is accomplished, the fire brigade leader's directions are thorough, precise and effective, communications with the control room are adequate, the fire brigade checked for fire propagation into adjacent areas, the fire brigade utilized the fire fighting pre-plan strategies, the fire brigade effectively performed smoke removal operations, the fire brigade brought sufficient equipment to the scene to properly perform fire fighting operations, and the fire brigade established "back-up" hose lines to protect fire brigade members.

- Note the time of the alarm, the time the fire brigade is fully assembled, the time the fire brigade reaches the scene, and the time the fire is placed under control.

- Verify that the pre-fire plans accurately depict the conditions in the identified risk important fire areas.

The following are examples of observed conditions that may represent a high negative impact (degradation) on the ability of the fire brigade to effectively carry out its manual fire fighting control and suppression function:

- Delayed response by one or more fire brigade members (e.g., greater than 15 minutes)
- Fire brigade members did not perform satisfactorily as a team
- General weaknesses associated with the proper use of personal protective equipment and fire fighting equipment and its deployment
- More than one fire brigade member did not use proper fire fighting techniques or agents to fight the simulated fire
- More than one fire brigade member did not properly use their full protective equipment including SCBA
- Pre-fire plans and their goals were not fully implemented
- Communications were not satisfactory.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the fire brigade to effectively carry out its manual fire fighting control and suppression function:

- Fire fighting (pre-fire plans) are less than comprehensive and do not establish the minimum guidance needed to support the necessary fire fighting operations.

- Fire brigade equipment not state-of the-art or good practice, specialized fire fighting agents not provided for special hazards or adequately staged, response and transport schemes for fire fighting equipment not well defined, and noted weaknesses in the material condition of fire brigade equipment.

The following are examples of observed conditions represent indicators of effective fire brigade performance (normal operating state):

- Drill scenario was well planned and the observed fire brigade performance was satisfactory when evaluated against the guidance above.

- No apparent weakness in fire brigade equipment or the stagging of this equipment, specialized fire extinguishing agents for special hazards are maintained in the appropriate areas of concern.

- Fire fighting (pre-fire plans) strategies are comprehensive and exceed minimum NRC guidance.

03.06 Inspection Requirement 02.06 - Passive Fire Protection Features

The following evaluation guidance is to be used for making qualitative judgements relating to the general effectiveness of passive fire protection features used to protect post-fire safe shutdown capability or prevent a fire from spreading from one fire area, zone or room to another:

- The inspector should determine that the fire wall, ceiling, floor or raceway/equipment fire barrier of concern provides passive fire resistive separation for redundant trains of systems, components, or equipment required for plant shutdown. The barrier should be intact.

- The in-situ fire load could be in a configuration that represents a challenge to the passive fire barrier or fire resistive device under consideration.

- For inspection findings (degradations) related to silicone foam penetration seals[15] see the table at the end of this section.

The following are examples of observed conditions that may represent a high impact (degradation) on the ability of the fire barrier or passive device to perform its intended function:

- Completely removed or missing fire barrier protecting or separating redundant safe shutdown systems or components.

- Breach in a electrical raceway fire barrier system which is contained with in a fuel package (barrier system is in a cable tray stack)

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[15] The guidance table for penetration seal degradations assumes that the silicone material is mixed and its cell structure is in accordance with the manufacturers recommendations and guidelines.

- Fire barrier system design which is mis-applied or with a indeterminate[16] fire resistive rating.

- Ceiling fire barrier system with unsealed openings.

- Un-analyze unprotected openings in a fire area/barrier wall and these openings fall within the upper half of the wall.

- In operable fire door or damper in a fire area/ barrier wall.

- Blocked open fire door.

The following are examples of observed conditions that may represent a moderate impact (degradation) on the ability of the fire barrier or passive device to perform its intended function:

- Fire dampers assemblies installed in a fire barrier which is not qualified to close under the anticipated ventilation system air flow.

- Fire dampers installed in fire barrier assemblies which are not installed with the required thermal expansion clearances as determined by the conditions of its qualification testing.

- Temperature set-point of the fusible link is excessively high or the fusible link has been improperly installed. These links are generally used to activate fire door / damper closure.

- Bent or warped fire door.

- Fire door with a single side through hole.

- Excessive fire door to frame and door to floor clearance gaps.

- Improperly installed or qualified fire door hardware.

- Raceway or equipment fire barrier assembly which has been mechanically damaged and the fire barrier wall thickness has been reduced by 25 percent over a total of 6 square inches.

- Penetration seal assembly which are not qualified by test or analysis (e.g., thermal penetration mass is greater than that tested) to withstand the fire conditions anticipated in the room, zone or area under consideration.

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[16] In order to be able to assess the fire resistive worth of a indeterminate fire barrier assembly and its ability to provide protection under the fire conditions anticipated , the licensee must demonstrate by analysis of fire endurance test data for similar barrier designs that the design under consideration will perform as good as a design that has been qualified by subjecting it to a standard-time-temperature test fire exposure.

The following are examples of observed conditions that represent a normal operating state:

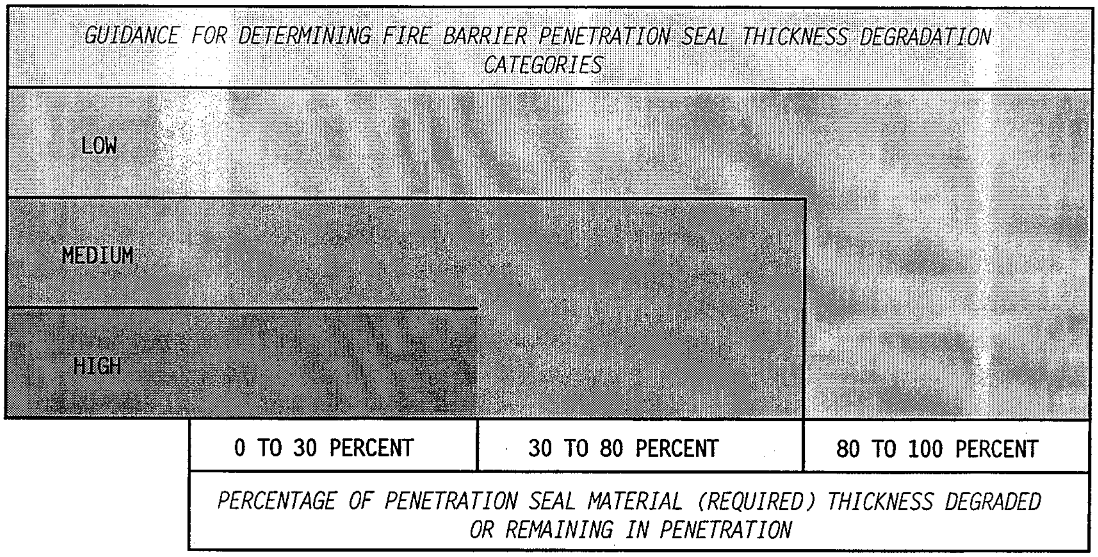
- Fire door installed and maintained in accordance with the code-of-record.

- Fire damper installed and maintained in accordance with the code-of record.

- Fire barrier penetration seal installed in accordance with the construction attributes and conditions qualified by fire tests.

- Raceway and equipment fire barrier assemblies installed in accordance with the construction attributes and conditions qualified by fire tests.

- Fire walls/barrier assemblies installed in accordance with the construction attributes and conditions qualified by fire tests.



03.07 <u>Inspection Requirement 02.06 g.</u> IN 94-58, "Reactor Coolant Pump Lube Oil Fire," discussed a Haddam Neck reactor coolant pump (RCP) lube oil fire event and a Millstone Unit 2 RCP lube oil leak which was not collected by the oil collection system. Approved exemptions in this technical area almost exclusively deal with collection tank capacity (sizing for complete leakage from one RCP, with (low probability) multiple RCP leakage overflow going to a non-hazardous location in containment).