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

June 24, 2009

MEMORANDUM TO: Thomas H. Boyce, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

FROM: Marlayna Vaaler, Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF APRIL 21 - 22, 2009, CATEGORY 2 MEETING WITH PROGRESS ENERGY CAROLINAS, INC., AND DUKE ENERGY CAROLINAS, LLC, TO DISCUSS TOPICS INVOLVING THE LICENSE AMENDMENT REQUESTS TO TRANSITION THE SHEARON HARRIS NUCLEAR PLANT, UNIT 1 AND THE OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3, TO THE NATIONAL FIRE PROTECTION ASSOCIATION STANDARD 805, "PERFORMANCE BASED STANDARD FOR FIRE PROTECTION"

On April 21 - 22, 2009, the U.S. Nuclear Regulatory Commission (NRC) staff hosted a meeting to discuss high level items associated with the Shearon Harris Nuclear Plant and Oconee Nuclear Station License Amendment Requests to transition to National Fire Protection Association Standard 805 (NFPA 805), "Performance-Based Standard for Fire Protection for Light-Water Reactor Electric Generating Plants." NFPA 805 allows the use of performance based methods, such as fire modeling, and risk-informed methods, such as Fire Probabilistic Risk Assessment, to demonstrate compliance with the nuclear safety performance criteria.

Regulatory audits were recently conducted at both sites, and several issues generic to both pilots were identified by the staff. The meeting was an opportunity to further discuss these issues with the pilot plant licensees, and will serve to benefit the non-pilot plants that will be undertaking this transition in the future. The meeting was held at NRC Headquarters, One White Flint North, Rockville, Maryland.

The NRC staff and several pilot plant stakeholders gave presentations relative to the issues and challenges associated with transition to NFPA 805, including the use of incipient detection, the change evaluation process scope and methodology, development of the fire modeling quality and verification and validation procedures, and the impact of recovery actions on the implementation of NFPA 805. There were no members of the public in attendance and no public meeting feedback forms were recieved.

The meeting agenda is attached as Enclosure 1, the meeting handouts are attached as Enclosure 2, and the list of attendees is attached as Enclosure 3.

Enclosures: As stated

CATEGORY 2 MEETING TO DISCUSS THE
LICENSE AMENDMENT REQUESTS TO TRANSITION
THE SHEARON HARRIS NUCLEAR PLANT, UNIT 1, AND
THE OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3,
TO THE NATIONAL FIRE PROTECTION ASSOCIATION STANDARD 805,
"PERFORMANCE BASED STANDARD FOR FIRE PROTECTION"

APRIL 21 & 22, 2009

AGENDA

APRIL 21, 2009

10:00 a.m. – 10:15 a.m.	NRC and Industry Introductory Remarks
10:15 a.m. – 11:30 a.m.	Progress Energy Discussion of the Planned Treatment of Incipient Detection
11:30 a.m. – 11:45 a.m.	Opportunity for Public Comment
11:45 a.m. – 12:30 p.m.	LUNCH
12:30 p.m. – 2:15 p.m.	Continued Discussion of the Planned Treatment of Incipient Detection
2:15 p.m. – 2:30 p.m.	Opportunity for Public Comment
2:30 p.m. – 2:45 p.m.	BREAK
2:45 p.m. – 3:45 p.m.	Pilot Plant Discussion of Fire Modeling Verification and Validation
3:45 p.m. – 4:00 p.m.	Opportunity for Public Comment
4:00 p.m. – 5:00 p.m.	Pilot Plant Discussion on the Impact of Recovery Actions - Transition of Operator Manual Actions into Recovery Actions
5:00 p.m.	ADJOURN

APRIL 22, 2009

8:00 a.m. – 9:00 a.m.	Continued Discussion on the Impact of Recovery Actions
9:00 a.m. – 9:15 a.m.	Opportunity for Public Comment
9:15 a.m. – 9:30 a.m.	BREAK
9:30 a.m. – 11:00 a.m.	Pilot Plant Discussion of Prior Approval of Fire PRA Methods to be Used in NFPA 805 Change Evaluations Post Transition
11:00 a.m. – 11:15 a.m.	Opportunity for Public Comment
11:15 a.m. – 11:45 a.m.	Discussion of License Amendment Request and NFPA 805 Infrastructure Schedules
11:45 a.m. – 12:00 p.m.	Closing Remarks and Final Opportunity for Public Comment
12:00 p.m.	ADJOURN

Harris Nuclear Plant (HNP)

Incipient Detection

HNP LAR Audit Follow-up Meeting

Washington DC

April 21-22, 2009

Vijay D'Souza, Dave Miskiewicz, Alan Holder

NGG Nuclear Generation Group

Progress Energy

Enclosure 2

Topics Covered

- Background
- Proposed Application
- Detection Capabilities
- Vendor Demonstration
- EPRI 1016735 – Incipient Fire Detection Treatment
- Operator Response to IFDS Alert / Alarm
- Fire PRA – IFDS Sensitivity
- Conclusion

BACKGROUND

Background

- Early PRA results showed higher than desired CDF results for some electrical cabinet fire scenarios
- $CDF_{scen} = IGF_{scen} * NSP_{scen} * CCDP_{scen}$
  - IGF = Source ignition frequency modified based on the scenario heat release rate and source-target characteristics
  - NSP = Effectiveness of detection and suppression to limit damage to the identified scenario target set
  - CCDP = the probability of core damage given the scenario targets are damaged to failure

Background

- CDF = IGF * NSP * CCDP
- The inherent conservatisms in the analysis methodology allow several approaches to demonstrate reduced risk
  - Enhanced circuit analysis (CCDP)
  - Detailed fire modeling (NSP, CCDP)
  - Detailed HRA analysis (CCDP)
  - Refined ignition source characterization (IGF, NSP, CCDP)
  - Implement modifications to alter the target set or suppression-detection effectiveness (IGF, NSP, CCDP)

Background

- All of the options involve a certain degree of uncertainty
  - NUREG/CR-6850 methodology provides no credit for very early stages of fire development. This impacts fire modeling and NSP (12 minutes from 0 to peak HRR)
  - NUREG/CR-6850 circuit analysis methodology provides limited credit for probability and duration of hot shorts
  - NUREG/CR-6850 methodology provides only HRA screening
  - NUREG/CR-6850 methodology does not address Incipient fire detection

Background

- Current methodology for fire PRA is generally based on bounding or conservative assumptions
- Significant items currently being addressed include
  - Ignition frequency – updated values generally 2-3 times lower
  - Manual suppression curves that allow generic treatment of brigade response already included in the curves
  - Circuit testing for probability and duration of hot shorts
  - Incipient detection effectiveness

Background

- Refining the analysis does not change the actual risk of a fire, but only our understanding or perception of the risk by reducing the uncertainty.

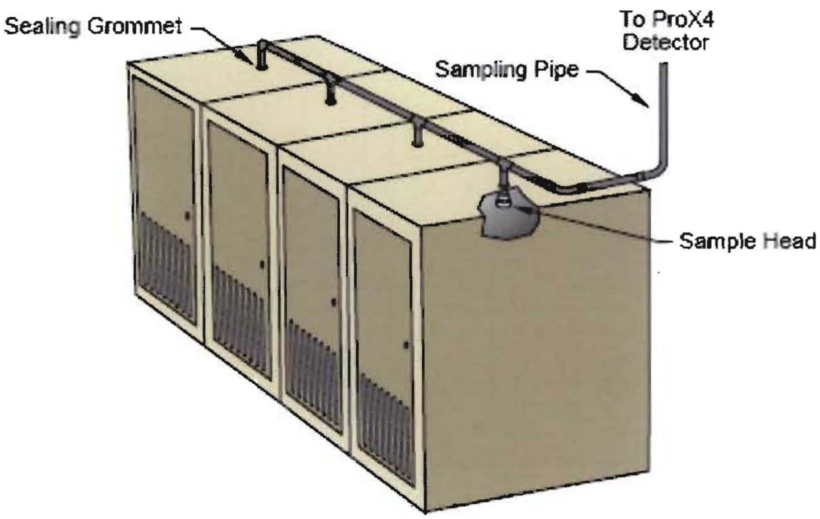
- Modifications that prevent a fire or fire damage generally involve "real" risk reduction. The uncertainty is only applicable to understanding how much.

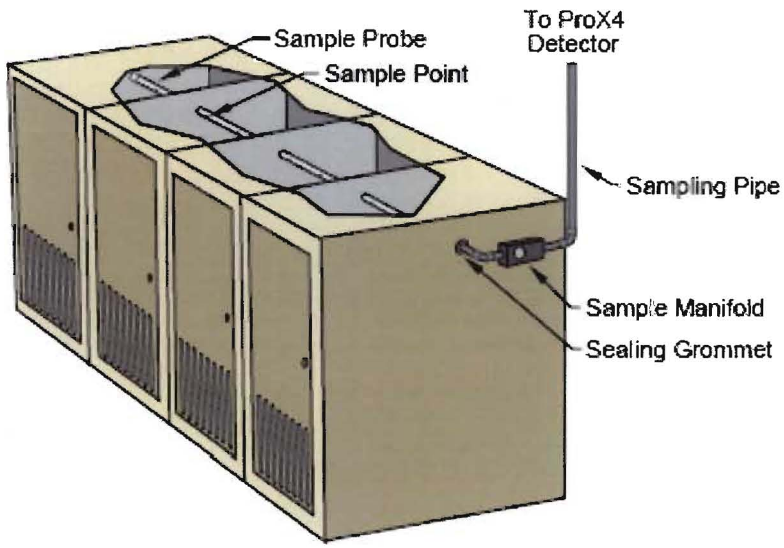
PROPOSED APPLICATION

Global Proven Track Record

- NASA
  - International Space Station
- Telecommunication Facilities
  - NFPA 76 & BS6266
- Pharmaceutical Industry
- Nuclear
  - Bruce Nuclear Generating Station (Ontario, Canada)
    - Significant use of IFDS for use in a performance based fire strategy.

Proposed In-Cabinet Application





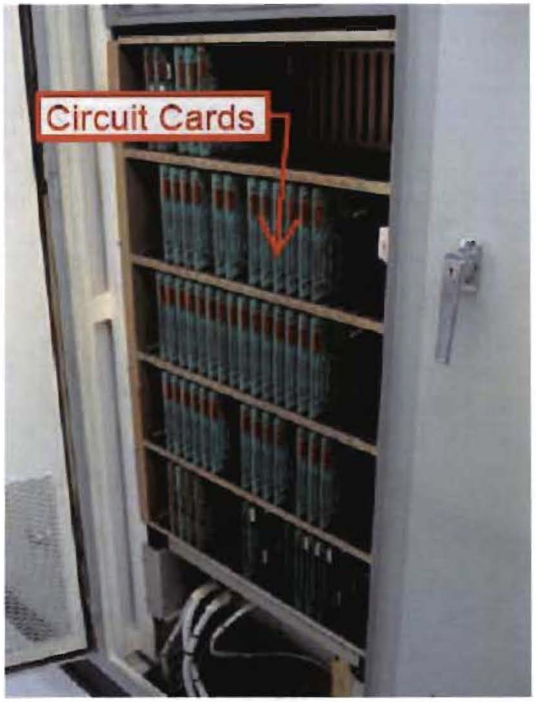
Incipient Detection - Application

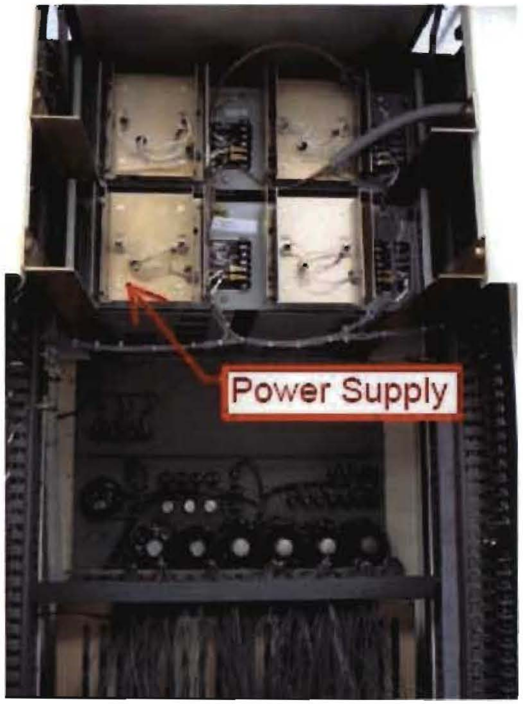
- Low voltage electrical cabinets
  - Pictures
- Ignition sites within cabinets
  - Overheated wires
  - Terminations
  - Circuit cards
  - Relays
  - Switches and Gauges
  - Small fans
  - Small transformers and power supplies

Cabinet / Panel Characterization Matrix

INCIPIENT FIRE DETECTION INSTALLATION - CABINET/PANEL IGNITION SOURCE/COMBUSTIBLE CHARACTERIZATION MATRIX									
Cabinet/Panel Type	Exposed wire insulation	Relays	Switches	Capacitors	Printed Circuit Boards	Power Supply Units	Ventilation Fan	Resistors	Fuses
Cabinet 1	X		X			X		X	X
Cabinet 2	X		X		X	X			X
Cabinet 3	X				X	X	X		X
Cabinet 4	X	X	X						X
Cabinet 5	X	X							X
Cabinet 5.1	X	X							
Cabinet 5.2	X	X	X						
Cabinet 5.3	X	X	X						X
Cabinet 5.4	X	X	X		X	X			X
Cabinet 6	X	X			X	X			X
Cabinet 7	X	X							X
Cabinet 8	X	X			X	X			X
Cabinet 9	X							X	X
Cabinet 10	X	X	X					X	X
Cabinet 11	X		X						X
Cabinet 12					X	X	X		X

Typical - Photographs





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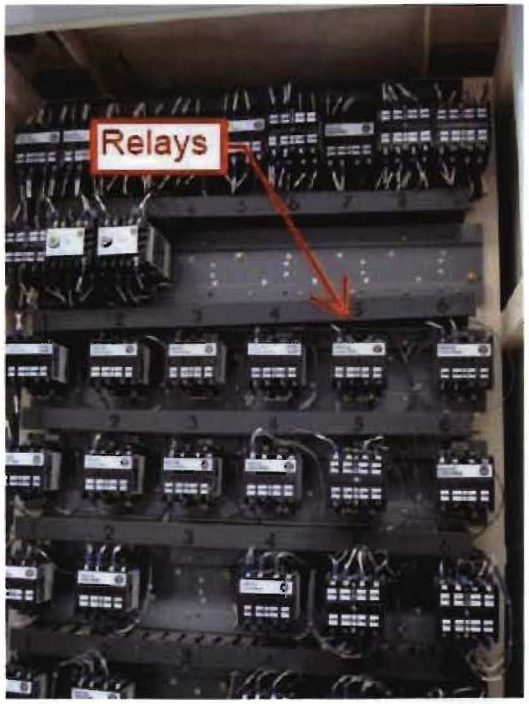

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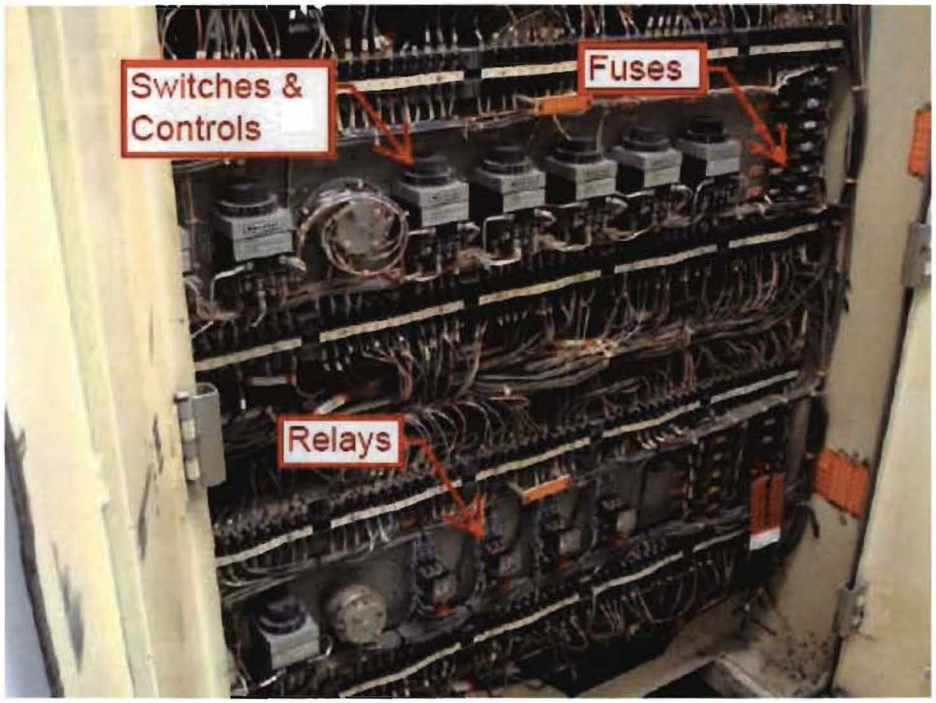

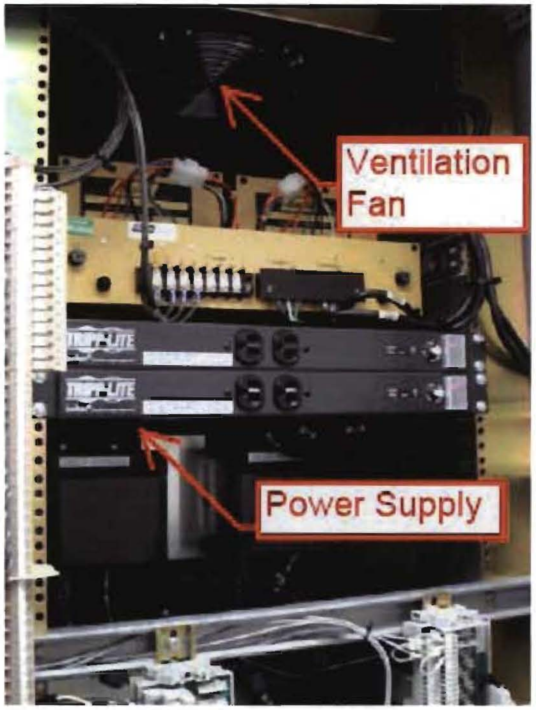

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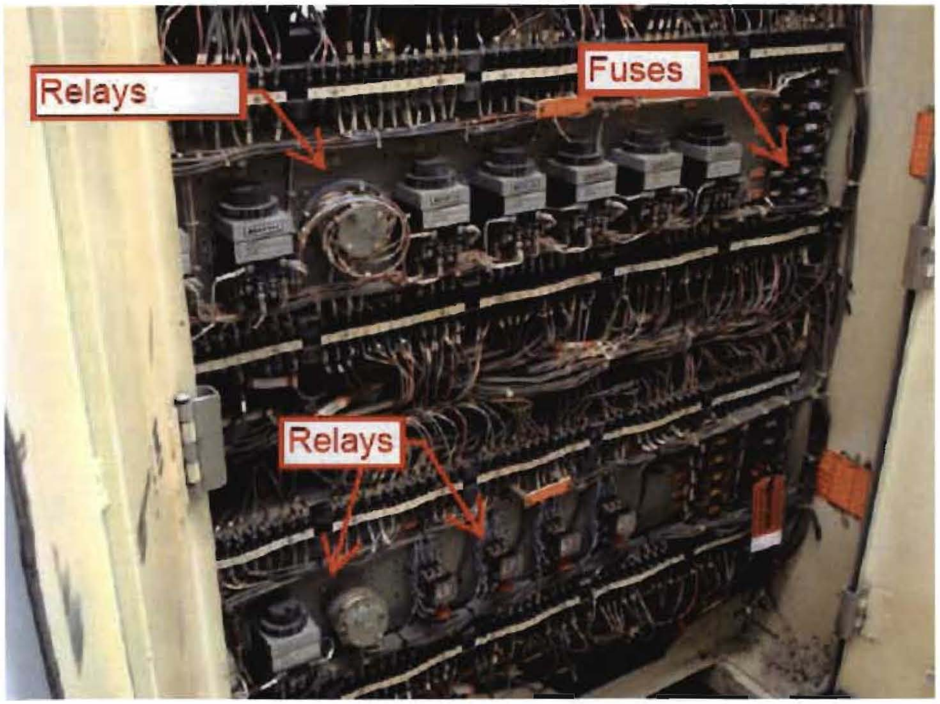
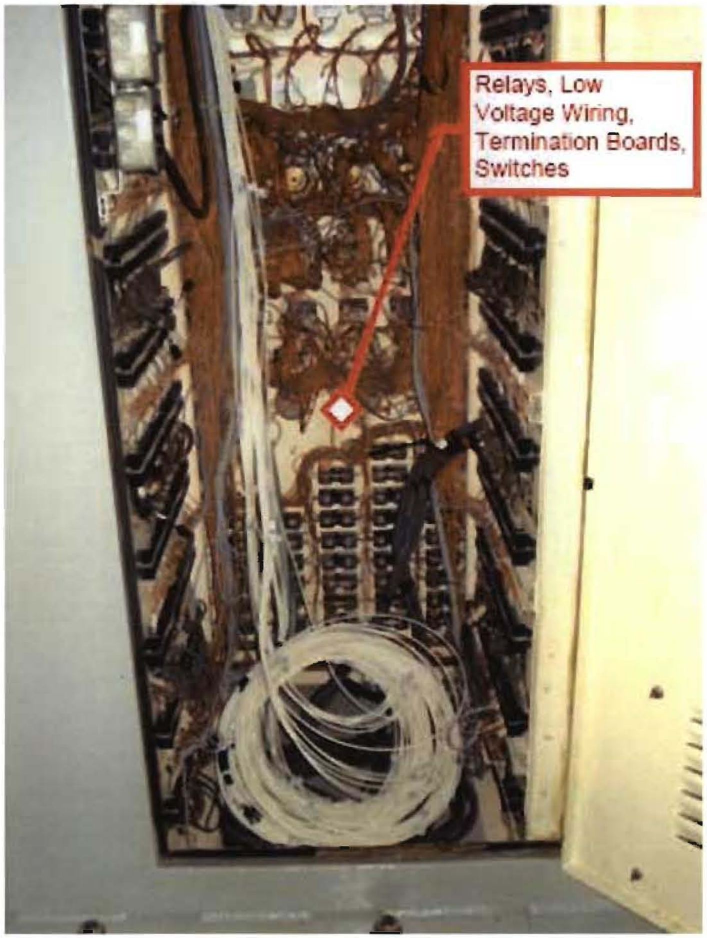
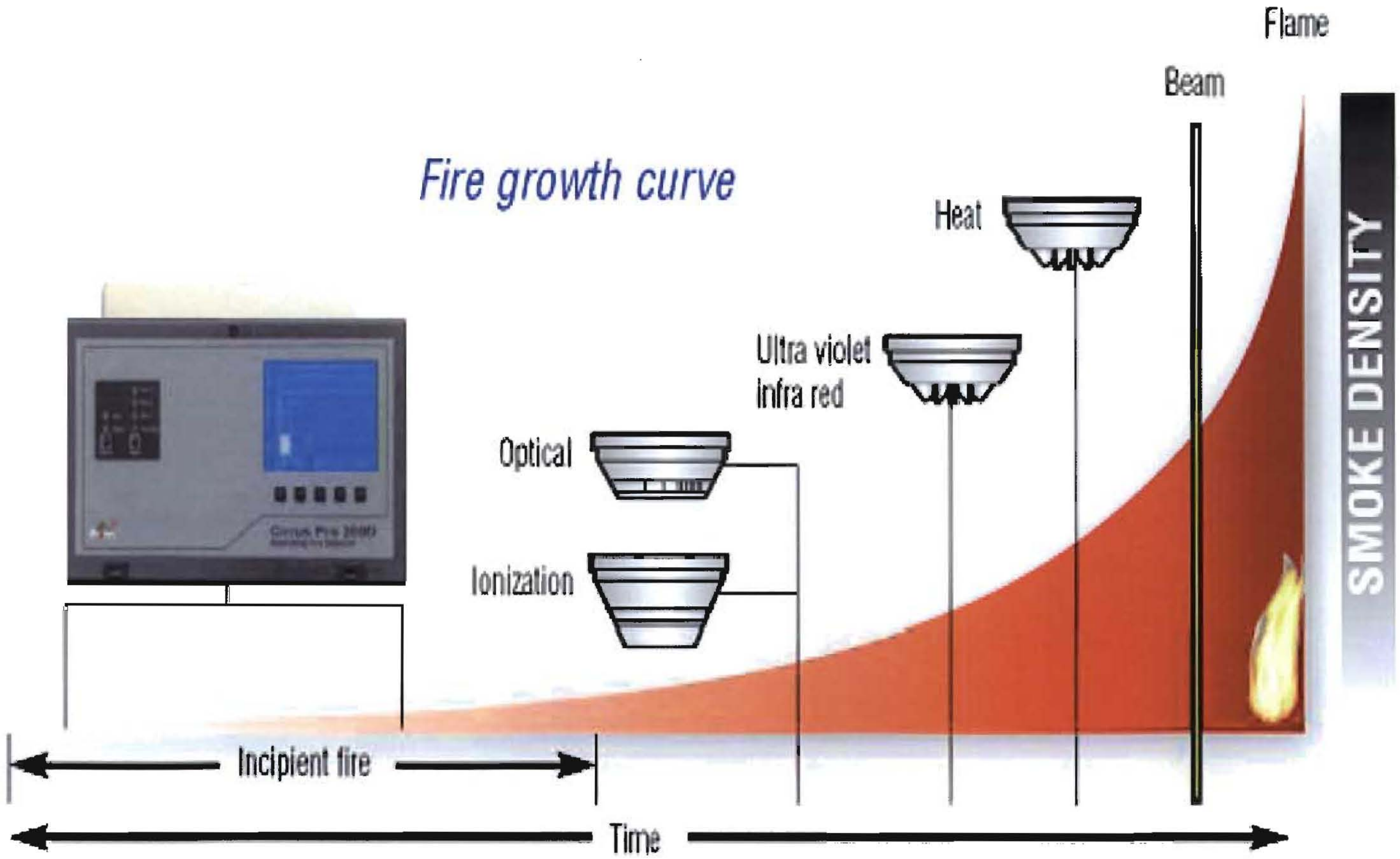




DETECTION CAPABILITIES

Incipient Fire Detection

Relationship with other forms of detection



Typical Smoke Detector Sensitivity Ranges

Typical smoke detector obscuration ratings

Type of Detector	Obscuration Level
Ionization	3%/m - 11%/m
Photoelectric	6%/m - 15%/m
Beam	3%/m
Aspirating	**0.005%/m - 20%/m**

* Up to **600 times** more sensitive than ionization detectors.

Thermal Particulate Point (TPP)

Thermal Particulate Point (TPP)

The temperature at which a material begins to thermally degrade and off-gas sub micrometer particulate in large numbers. Note that the thermal particulate temperature is as much as half the ignition temperature of many materials; thereby providing a signal that only ProSeries can detect.

	Incipient Stage (Overheating Before Smoke)	Smoke Stage (Visible and Invisible)
PVC Insulation	290°F (144°C)	944°F (507°C)
Acrylon Carpeting	340°F (171°C)	820°F (438°C)
Wool Carpeting	360°F (182°C)	1060°F (571°C)
Polyethylene	410°F (210°C)	910°F (488°C)
Copy Paper	500°F (260°C)	750°F (399°C)
Teflon	610°F (321°C)	1220°F (660°C)
Polystyrene	710°F (377°C)	1063°F (573°C)

TPP – Van Luik Data (1973)

TABLE 1. *Thermal Particulate Point in Air*

Material	*Temperature* (°*F*)
Bakelite	380
PVC insulation	290
Amerx Type NM nonmetallic cable wire insulation	420
Anaconda Wire & Cable Dutrex Type NM nonmetallic cable wire insulation	430
Anaconda Wire & Cable Dutrex Type NM nonmetallic cable outer cover	370
G.E. Flamenol	340
Acrylon carpeting	340
Wool carpeting	360
Bond writing paper	500
Pine board	320
Kentile (Vinyl) tile	370
Teflon — FEP	610
Polystyrene	710
Polyethyiene	410
RTV	340
Silicon rubber DC-93-072	335
Motor oil SAE 30	310

VENDOR DEMONSTRATION

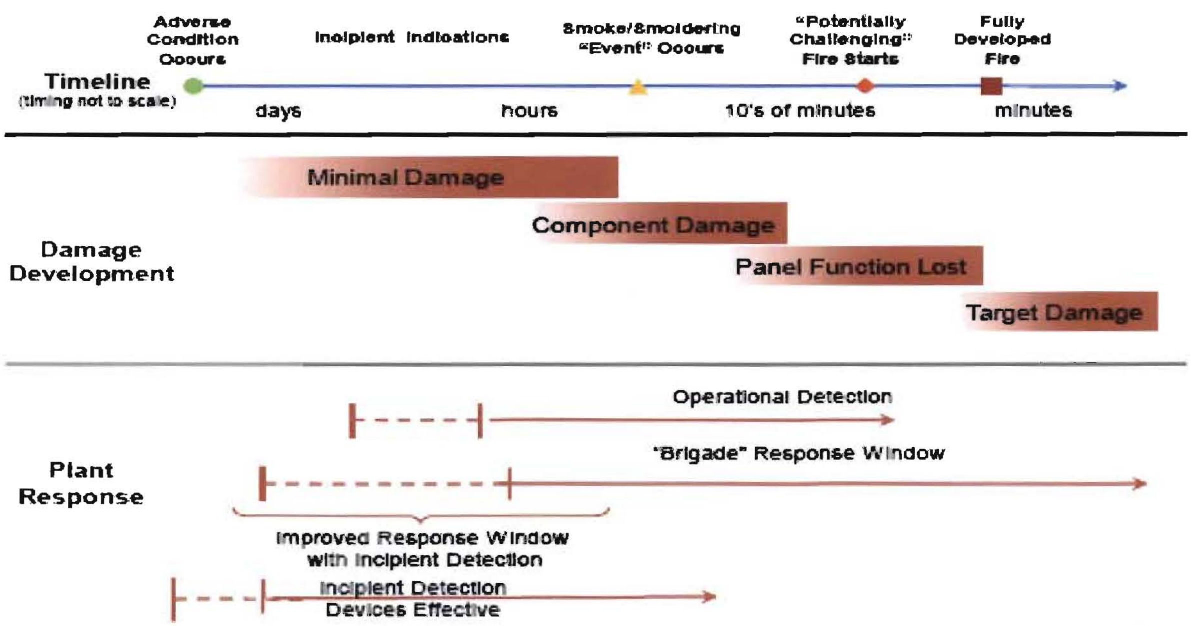
EPRI 1016735 – INCIPIENT DETECTION TREATMENT

EPRI Guidance – EPRI 1016735 Fire PRA Methods Enhancements

Incipient Fire Detection Systems:

- Significantly more effective than traditional fire detection systems credited in NUREG/CR-6850 and EPRI 1011989.

Electrical Fire Progression



EPRI Guidance – EPRI 1016735 Fire PRA Methods Enhancements

Incipient Fire Detection Systems:

Credit for reduction of ignition frequency may be taken in fire zones that have VEWFDS installed for the following components that are effectively covered by the system.

- Components of 250V or less: batteries and battery chargers (bins 1 and 10), electrical cabinets and panels (bins 4 and 15), and air compressors (bin 9)
- Components of 480V or less: cable runs (bin 11), junction boxes (bin 18), electric motors (bin 14), pumps (bin 21), and RPS MG Sets (bin 22)

The above components are considered to be effectively covered by the VEWFDS, meaning pre-combustion indications are expected to alarm the VEWFDS well before a challenging fire would develop, allowing for preemptive actions by plant fire protection and fire brigade members.

EPRI Guidance – EPRI 1016735 Fire PRA Methods Enhancements

Incipient Fire Detection Systems:

For in-cabinet installations, assume fire damage is localized to the ignition component and that circuits associated with the ignition source will be de-energized for troubleshooting purposes. Spurious operations do not need to be postulated due to the localized and limited nature of the damage.

EPRI Guidance – EPRI 1016735 Operational Experience

Incipient detection systems in operating nuclear power plants and operating experience

Plant ID	IFD System ID/#	Type	Date In Service	Locations	Reliability-Time OOS	Alarms	Malfunctions	Fire Events
Palo Verde 1,2,3	VESDA (3) (Xtralis)	Laser	8 + yrs (25 yrs total)	Spent Fuel Storage Interface Shed, SCBA Shop Unit 1, Security Computer Closet, 45 Acre lake pump house	None	A few nuisance alarms - dirt, dust on windy days	None	None
	Protec Mini (SAFE Fire)	Cloud chamber	1 + yr					
TMI 1	Cirrus (SAFE Fire)	Cloud chamber	12/31/1998 (10 yrs)		1 failure during PMT	None	PMT failure due to improper maintenance	2- detected as incipients
Millstone 3	SAFE Fire	Cloud chamber	5 + yrs	Cable spreading room	"very reliable"	1 nuisance-Aux power outside of room	None?	
Robinson	Stratos (AirSense Technology)	Laser	1998 (10 yrs reported)	RTGB Board	1/2 hour per year + 20d in 2002 + 27d in 2006	None in 10 years	Power supply failure in 2002 Battery and processor maint/replace	None?
Clinton Power Station	Cirrus-Protec (SAFE Fire)	Cloud chamber	2001 ?? (7 yrs)	SVC Building	None	None	1- battery failed PMT test, replaced	None?
Hope Creek	SAFE Fire	Cloud chamber	11/2006 (2 yrs)	Service Water Intake Structure monitoring 3 areas	Quarterly PMT OOS time-maintenance-8hrs local hot work- 15hrs	7 during hotwork 3 unknown-possibly dust, nearby brush fire	None	1 incipient-pump overheated in pump bay

EPRI Guidance – EPRI 1016735 Effectiveness of IFDS

- Components of 250V or less:
  - batteries (bin 1) – 0 out of 1 = 0.0
  - battery chargers (bin 10) – 3 of 3
  - Main Control Room panels (bin 4) - 3 out of 5 (2 due to technician error, immediately discovered by technician)
  - electrical cabinets (bin 15.1) -34 out of 35
  - air compressors (bin 9) -4 out of 4
- Components of 480V or less:
  - cable runs (bin 11) – 7 of 7
  - junction boxes (bin 18) – 2of 2
  - electric motors (bin 14) – 5 of 5
  - pumps (bin 21) – 7 of 7
  - RPS MG Sets (bin 22) – 5 of 5

EPRI Guidance – EPRI 1016735 Hughes Tests

- Smoldering Combustion Tests (13 in total)
  - Ionization detectors failed to respond.
  - 2 out of 6 of the photoelectric detectors responded to the tests.
  - The IFDS responded significantly faster than the 2 photo detectors that showed any response.
  - The IFDS system responded to every fire test.

EPRI Guidance – EPRI 1016735 Summary

- Significant benefit in low voltage (< 250 V) electrical cabinets.
- Significant benefit for area detection.
  - In-Cabinet detection would logically be even more effective.
- Common failure modes in electrical cabinets:
  - Overheating of electrical equipment and wires
  - Circuit card failure (smoking event with little to no flame)
- Capable of detecting pre-ignition conditions before:
  - Smoke
  - Flame

EPRI Guidance – EPRI 1016735 Summary

- Damage:
  - Data supports assumption that fire damage is localized to the ignition component (wire, circuit card, relay, switch, etc.).
  - Very early warning supports assumption that multiple spurious operations do not occur.
- IFDS has a much better reliability than conventional smoke detection systems.
- OE data suggests that electrical cabinet fires would have been detected well in advance with IFDS.
- Fire ignition frequency would effectively be reduced.

OPERATOR RESPONSE TO IFDS ALERT / ALARM

Alarm / Alert Setpoints

- Initial Baseline Determination
  - Vendor assisted
  - Determines normal particulate count for each zone
- Alert and Alarm Thresholds
  - Lowest acceptable Δ programmed into unit for alert/alarm notification
  - UL 268 / NFPA 72
- Sensitivity Setting is Fixed
  - Configuration controls determine process for adjusting sensitivity should baseline conditions change.

Operational Response

- Plant's Annunciator Panel Procedure(s) Provide;
  - Actions for "Alert" and "Alarm" indications
  - Immediate Response to Investigate Indications
  - Enhanced Response by Site Fire Brigade
  - Positive Determination / Disposition of Indication and Source
  - Compensatory Actions

Operational Response (cont.)

- Actions for "Alert" and "Alarm" indications;

OPERATOR ACTION: "ALERT" LEVEL INDICATION

1. CONFIRM
    a. Incipient Detection device "Alert" indication is present on Display.
    b. Determine Specific Equipment Location / Zone for "Alert" indication present.
    c. Without Delay Investigate fire detection zone to determine specific source with "Alert" indication
    d. Monitor the SAFE IFD "real-time" graphic readout at the STA desk for the zone in alert to determine if alert reading is stable, decreasing or increasing. Take appropriate actions based on this monitoring (i.e. If increasing but still below the Alarm actuation level, notify the Site Incident Commander (SIC) of the event status.

OPERATOR ACTION: "ALARM" LEVEL INDICATION

1. CONFIRM
    a. Incipient Detection device "Alarm" indication is present on Display.
    b. Determine Specific Equipment Location / Zone of "Alarm" indication present.
    c. Immediately dispatch Site Fire Brigade.

Operational Response (cont.)

- Immediate Response to Investigate Indications

OPERATOR ACTION: "ALERT" LEVEL INDICATION

1. CONFIRM
   a. Incipient Detection device "Alert" indication is present on Display.
   b. Determine Specific Equipment Location / Zone for "Alert" indication present.
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OPERATOR ACTION: "ALARM" LEVEL INDICATION

1. CONFIRM
   a. Incipient Detection device "Alarm" indication is present on Display.
   b. Determine Specific Equipment Location / Zone of "Alarm" indication present.
   c. Immediately dispatch Site Fire Brigade.

Operational Response (cont.)

- Early Response by Site Fire Brigade

OPERATOR ACTION: "ALERT" LEVEL INDICATION

1. CONFIRM
   a. Incipient Detection device "Alert" indication is present on Display.
   b. Determine Specific Equipment Location / Zone for "Alert" indication present.
   c. Without Delay Investigate fire detection zone to determine specific source with "Alert" indication
   d. Monitor the SAFE IFD "real-time" graphic readout at the STA desk for the zone in alert to determine if alert reading is stable, decreasing or increasing. Take appropriate actions based on this monitoring (i.e. If increasing but still below the Alarm actuation level, notify the Site Incident Commander (SIC) of the event status.

OPERATOR ACTION: "ALARM" LEVEL INDICATION

1. CONFIRM
   a. Incipient Detection device "Alarm" indication is present on Display.
   b. Determine Specific Equipment Location / Zone of "Alarm" indication present.
   c. Immediately dispatch Site Fire Brigade.

Operational Response (cont.)

- Positive Determination / Disposition of Indication and Source
  - If required utilize Incipient Fire Detection Pro-Locator Portable Detection Device to locate specific cabinet and internal component providing pre-ignition indication.
- Compensatory Actions
  - If source is not readily identified, post a Continuous Fire-watch in accordance with FPP-XXX until Incipient Fire Detection is RESET.

FIRE PRA – IFDS QUANTIFICATION

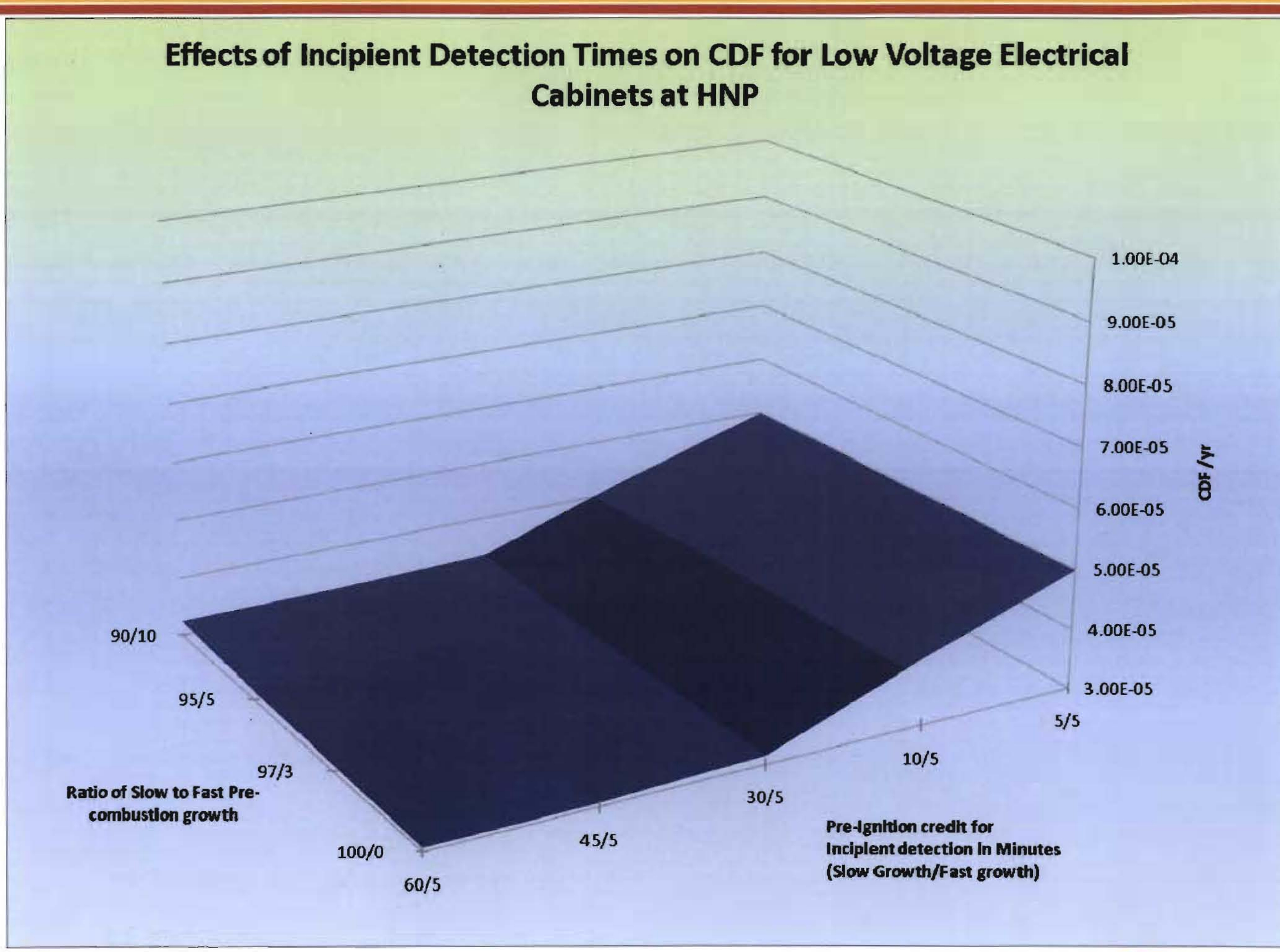
IFDS Quantification

- CDF is presented in LAR
- ΔCDF presented as -5.8E-07/yr
  - IFDS was assumed to be capable of providing early warning 100% of the time when installed inside low voltage electrical cabinets (control cabinets with no arc faults)
  - IFDS reliability was applied at 0.995
  - IFDS was analyzed as prompt suppression and adding time to find and prevent fire damage
- Consistent with basic methodology presented in EPRI 1016735

IFDS Risk Sensitivity to Time and Applicability

- Timing varied from 60 to 5 minutes
  - 5 minutes is prescribed by 6850 for in cabinet detection (incipient or otherwise)
- Applicability varied from 100% to 10%
- CDF ranged from 3.06E-05/yr to 4.98E-05/yr
- ΔCDF ranged from -5.8E-07/yr to -4.9E-07/yr
  (1.13E-06/yr to 1.22E-06/yr for VFDs only)

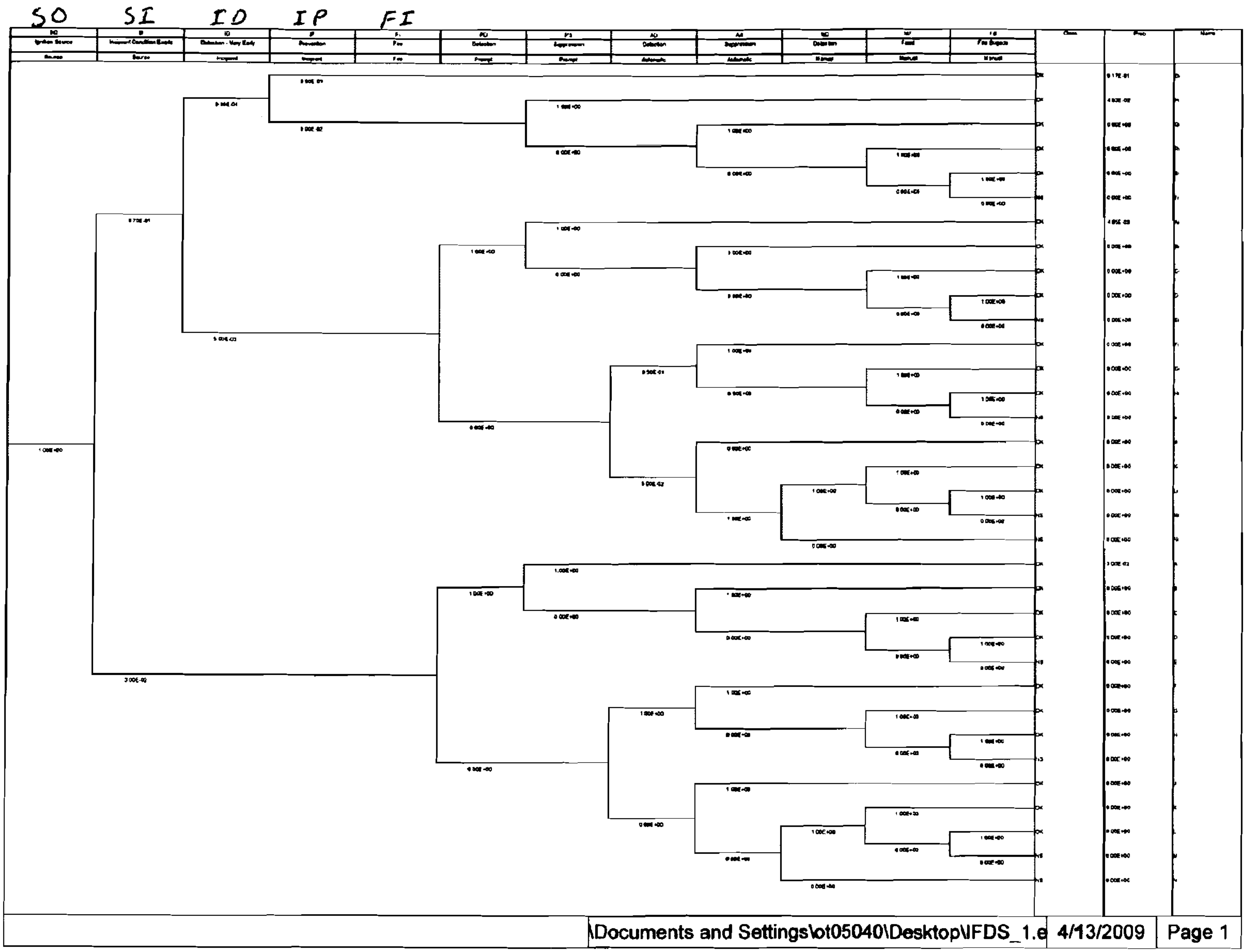
IFDS Risk Sensitivity to Time and Applicability



HNP Comparison to EPRI 1016735

- Updated NSP event tree created combining EPRI 1016735 and NUREG/CR-6850 based on application at the ignition source level
  - SI: the fraction of the source ignition frequency that would be detected early by IFDS
    (EPRI used "μ" as the fraction of ignition source components in a location)
  - ID: detector reliability
    (same as EPRI "R")
  - IP: pre-emptive response effectiveness
    (same as EPRI "P")

HNP Proposed Event Tree



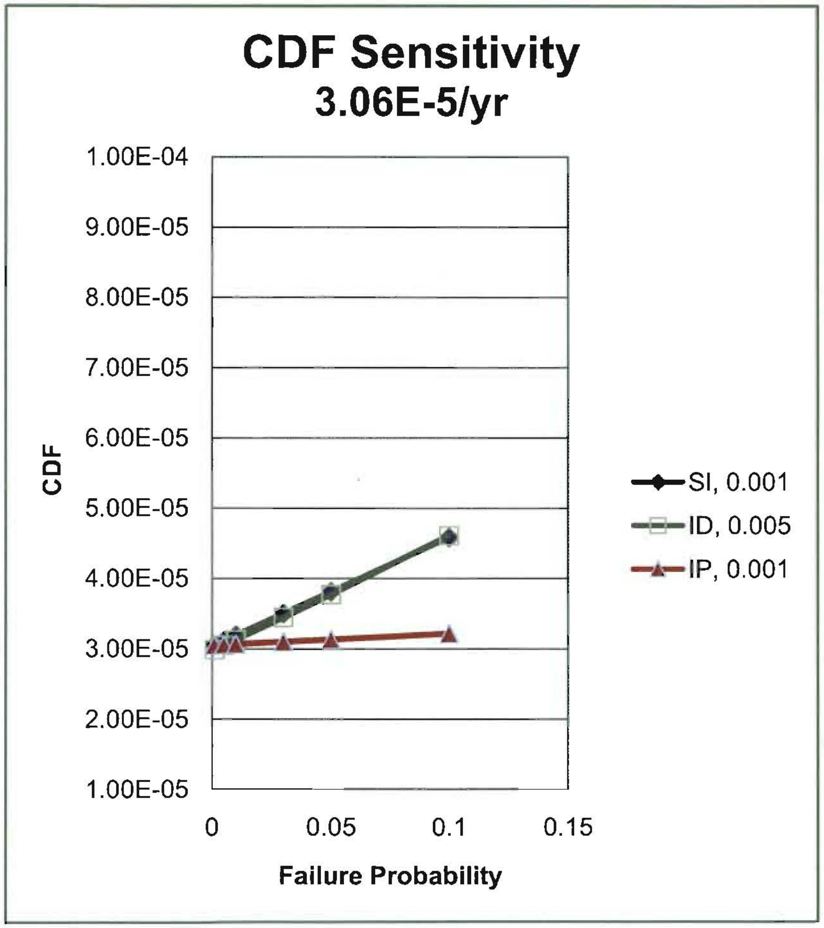
HNP Quantification with IFDS Event Tree

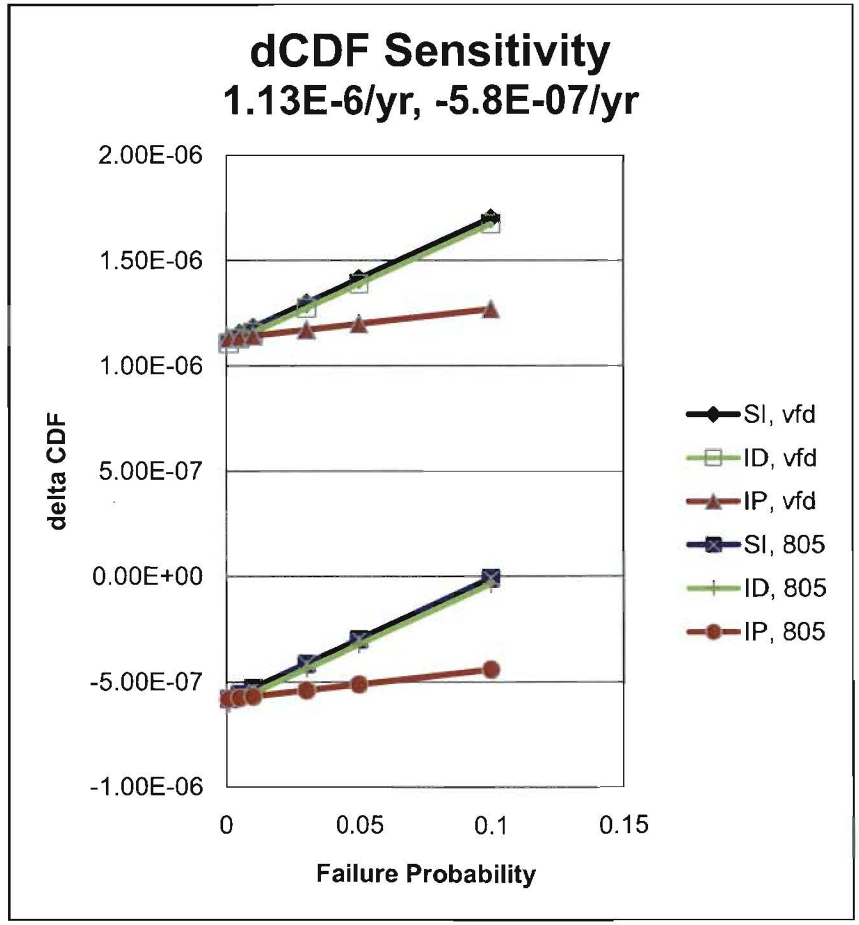
- CDF = 3.06E-5/yr
  - SI: baseline = 0.999
    - EPRI "μ" would be 1.00 for the analyzed sources (low voltage control cabinets)
  - ID: baseline = 0.995
    - based on EPRI report w/semi-annual PMT
  - IP: baseline = 0.999
    - based on EPRI report w/>45 minutes warning

IFDS Event Tree Sensitivity

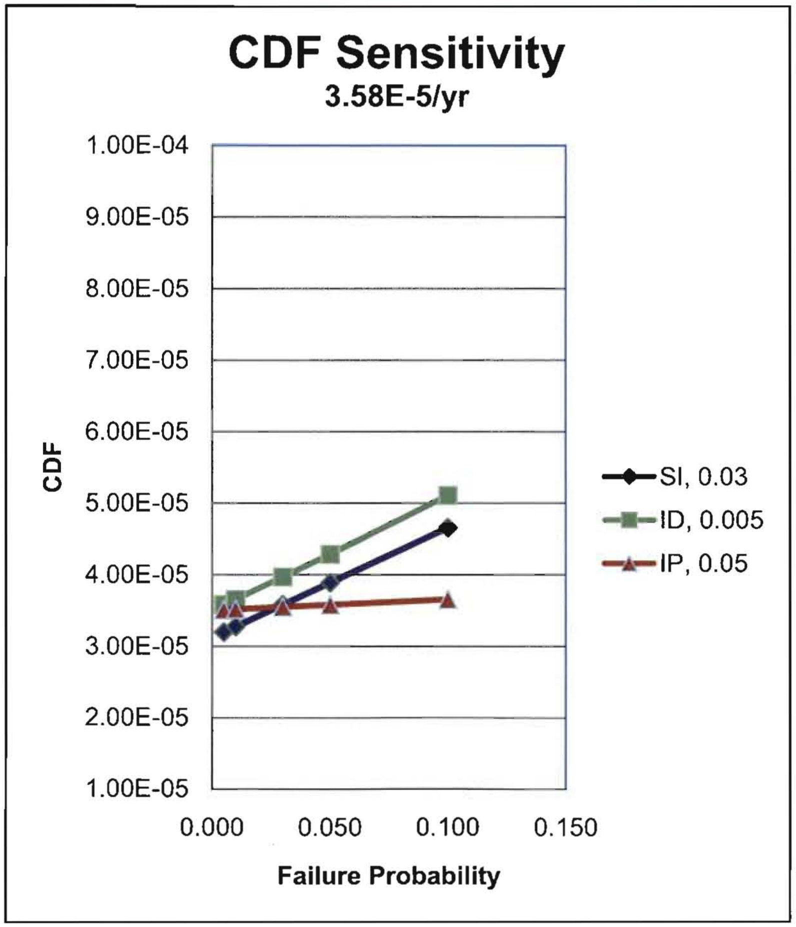
- Varied the IFDS top event probabilities
  - SI: sensitivities from 0.999 to 0.9
  - ID: sensitivities from 0.999 to 0.9
  - IP: sensitivities from 0.999 to 0.9

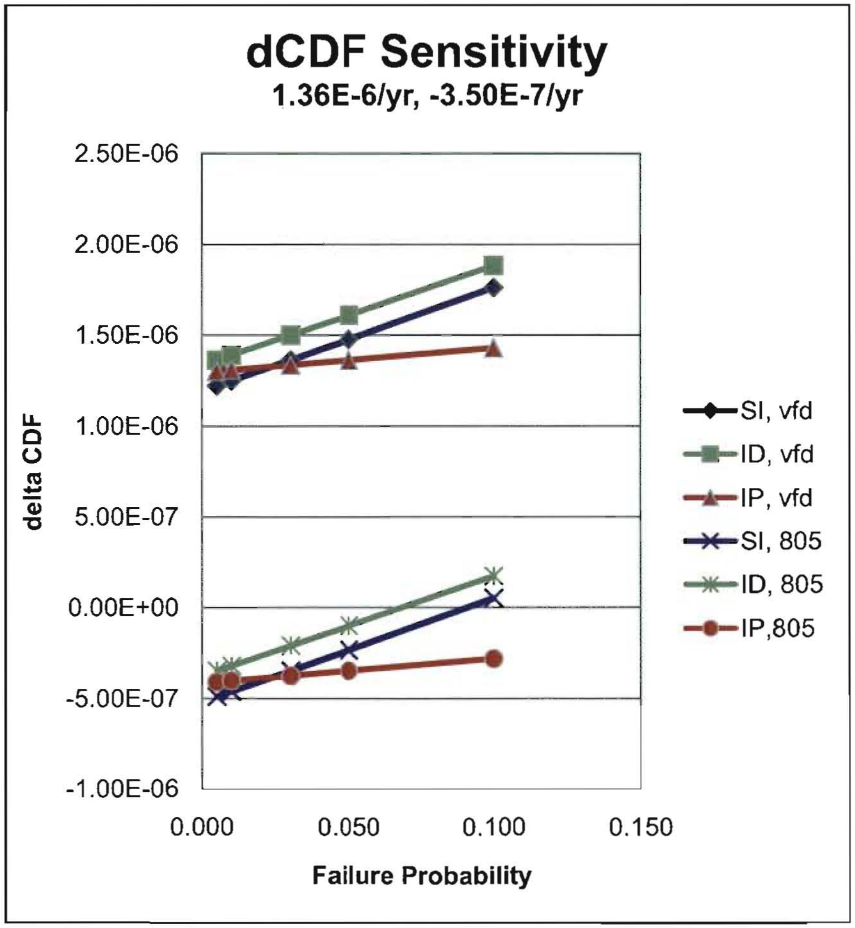
IFDS Event Tree Sensitivities



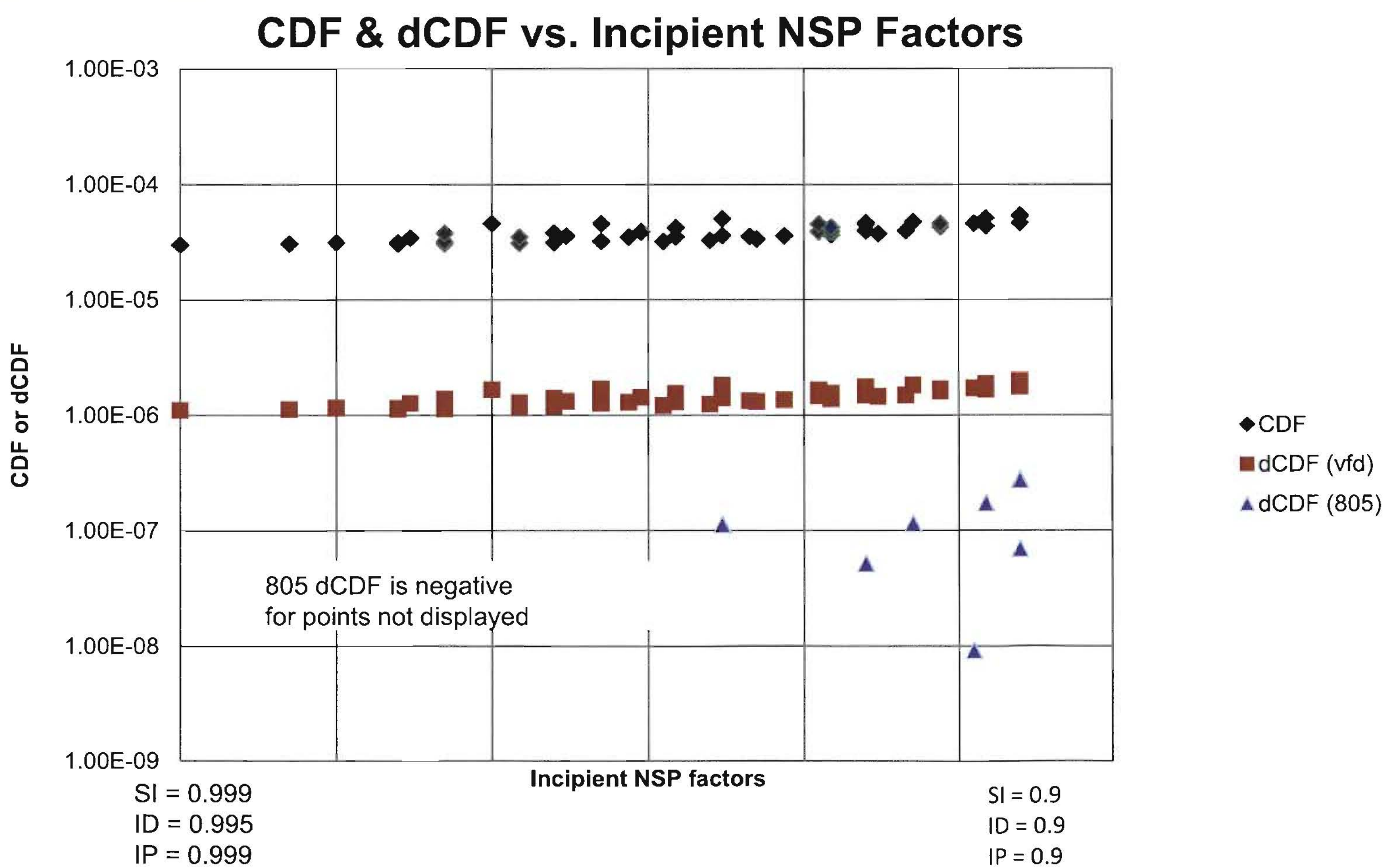


IFDS Event Tree Sensitivities (alt)





IFDS Event Tree Sensitivities



CONCLUSION

Summary

- Based on the HNP Application
  - The sources of interest will exhibit detectable incipient products prior to ignition.
  - Incipient Detection is superior to current system for this application.
  - In-cabinet detection is superior to area detection for this application.
  - Sensitivity results demonstrate that the LAR conclusions remain applicable for HNP.
  - Modifications that prevent a fire or fire damage generally involve "real" risk reduction.

Additional Discussion and Questions?

Harris Nuclear Plant
Oconee Nuclear Station
NFPA 805 Transition

Change Evaluation Scope and Methods

LAR Audit Follow-up Meeting

Washington, DC

April 21-22, 2009

David Goforth – Duke Energy NFPA 805 Technical Manager

Outline

- Outline of Presentation
  - Purpose
  - Overview
  - Cause/Effect Relationship
  - Treatment - Fire Risk Assessment
  - Relationship with RG 1.200 and PRA Standards
  - NEI 04-02, Section 5.3 and Appendix J

Purpose

- Self Approval of Post-Transition Changes is Essential for an Effective NFPA 805 Program
- NRC has Questions with Post-Transition Self-Approval of Change Evaluations (Oct. 2008 Mtg and Pilot LAR Audits)
  - Risk Evaluations Used in Support of Change Evaluations (not the Base Fire PRA)
  - Pilot LARs (Att. X – ONS and Att. Z – HNP) Address Limited Aspects of this Topic
- This Presentation Focuses on Change Evaluation Methods and Cause/Effect Treatment of Changes
- This Process (Approved via NEI 04-02/RG 1.205) Provides a Consistent Means to Meet Section 2.4.3 of NFPA 805

Overview

- Characterized by 19 General Categories
- Changes in each Category Results in Few Unique Effects
- Treatment of Each Unique Effect in Fire Risk Assessment Relatively Straightforward
- Details of Treatment Must Satisfy the RG 1.200 Process and PRA Standards
  - Capability Category for Base Fire Risk Assessment based on Departure from Realism
  - Change Evaluations can Accommodate Large Departures from Realism – Conservative/Bounding Acceptable
- Overall Process/Methodology to be Incorporated into NEI 04-02, Section 5.3 and Appendix J

Cause/Effect Relationship

Scope of Plant Change (Cause)	PRA Treatment (Effect)
1. Unprotected Cable	Target Scope Change
2. Fire Area Boundaries	Target Scope Change
3. Water Curtains	Target Scope Change
4. ERFBS Barrier Worth	Target Scope Change and/or Change in Suppression Credit
5. Transients	Initiating Event Frequency
6. Suppression	Target Scope Change and/or Change in Suppression Credit
7. Passive FP Features (dikes, curbs, etc)	Target Scope Change
8. Embedded Conduit	Target Scope Change
9. Floor Drains	Target Scope Change
10. Recovery Actions	PRA Model Change
11. NSCA Equipment and Cables	Target Scope Change, Initiating Event Frequency and/or PRA Model Change
12. Detection	Detection Credit
13. Incipient Detection	Detection/Suppression Credit and/or Initiating Event Frequency
14. Ventilation	PRA Model Change
15. Fire Brigade Program	No Specific Treatment Required
16. Feasibility Criteria	No Specific Treatment Required
17. Fire Watch Program	No Specific Treatment Required
18. Ignition Source	Target Scope Change and/or Initiating Event Frequency
19. Surveillance Intervals	Refer to Affected Component

Treatment – Fire Risk Assessment

- **Target Scope Change** – the quantification of the risk impact is performed using the same methods applied for the base Fire PRA.
- **Partitioning** – changes to plant partitioning is performed using the same methods applied for the base Fire PRA.
- **Change Suppression Credit** - use existing methods from the base Fire PRA.
- **Initiating Event Frequency** – the calculation of fire ignition frequencies are performed using the same methods as the base Fire PRA.
- **PRA Model Change** – A variety of changes can occur that require altering one or more elements of the PRA model or quantification process. Such changes would be performed using methods consistent with that applied for the base Fire PRA.
- **Detection Credit** – detection is addressed via the manual fire suppression credit applied in the Fire PRA.

Treatment – Target Scope Change

- Treatment – identified change in target scope treated by altering the scope of PRA Model Basic Events failed due to fire scenario.
  - Unprotected Cable
  - Fire Area/Zone Boundaries
  - Water Curtains
  - ERFBS Barrier Worth
  - Suppression
  - Passive FP Features (dikes, curbs, etc)
  - Embedded Conduit
  - Floor Drains
  - NSCA Equipment and Cables
  - Ignition Source

Treatment – Change Suppression Credit

- Treatment – credit can involve manual and/or automatic suppression. Represented as an Event Tree branch. Probability based on type of automatic system, time to damage, and manual non-suppression curves.
  - ERFBS Barrier Worth – affects target damage time
  - Suppression – node probability based on generic industry data, plant specific data, and developing technology – treatment subject to applicable SRs from PRA Standard
  - Incipient Detection – time available for suppression

Treatment – Initiating Event Frequency

- Treatment – changes to plant equipment population, equipment characteristics, or plant practices can affect fire scenario frequency. Changes can alter frequency for an existing fire initiating event in the base fire risk assessment or require the addition of a new initiating event.
  - Transients
  - NSCA Equipment and Cables
  - Ignition Source
  - Incipient Detection

Treatment – PRA Model Change

- Treatment – changes to some plant attributes require an altering of the base fire risk assessment logic model and/or related basic event probabilities. Changes would be assessed against applicable HLRs/SRs of the PRA Standard – such as HLR-PRM.
  - Recovery Actions
  - NSCA Equipment
  - Ventilation

Treatment – Detection Credit

- Treatment – detection affects the timing available for manual fire suppression actions. Two factors are involved - the reliability of the detection scheme and the reliability of manual suppression given the time available for that action. Changes would be assessed against applicable HLRs/SRs of the PRA Standard – such as HLR-FSS-D.
  - Detection
  - Incipient Detection

Relationship with RG 1.200 and PRA Standards

- Change Evaluation Methods used for Self-Approval
  - Self-Approval of altered condition per Fire Protection License Condition
  - Fire Risk Assessment required to reflect in-situ or planned plant condition/configuration
  - Altered condition will be evaluated against the base fire risk assessment per NEI 04-02 post-transition change process
  - Updates to the base FPRA in accordance with provisions of RG 1.200 and PRA Standards

Relationship with RG 1.200 and PRA Standards

- Base equation for change in risk:
  - $\Delta CDF = CDF_{altered} - CDF_{non\text{-}altered}$
  - $\Delta LERF = LERF_{altered} - LERF_{non\text{-}altered}$
- $CDF/LERF_{non\text{-}altered}$ acceptable based on pre-existing Peer Review
- $CDF/LERF_{altered}$ will be evaluated and Peer Reviewed as necessary
- ΔCDF/ ΔLERF thresholds for self-approval account for uncertainty

Revision to NEI 04-02, Section 5.2 and Appendix J

- Individual LAR Would Stipulate Invoking NEI 04-02 Methods and Treatments for Post-Transition Change Evaluations
- Eliminate Need for Individual LARs to Repeat Details and Provides Degree of Consistency
- Individual LARs May Supplement with Additional Items if not Addressed by NEI 04-02

Harris Nuclear Plant (HNP)

Fire Modeling Quality and V&V

LAR Audit Follow-up Meeting

Washington, DC

April 21-22, 2009

A.L. Holder

NGG Nuclear Generation Group

Progress Energy

Fire Modeling Quality and V&V (Requirements)

- NFPA 805 section 2.7.3- Quality, provides guidance regarding analysis, calculation and evaluations performed in support of the LAR, including;
  - Review
  - Verification and Validation
  - Limitations of Use
  - Qualifications of Users
  - Uncertainty Analysis (not required for deterministic)

Fire Modeling Quality and V&V (Resources)

- Fire models used in development of the LAR used fire model codes including;
  - Fire Dynamics Tools (FDT's)
  - Consolidated Model of Fire and Smoke Transport (CFAST)
  - NIST Fire Dynamics Simulator (FDS)
- Tools are considered acceptable within the range of their respective applicability as described in;
  - NUREG-1824/EPRI 1011999 – "Verification and Validation of Selected Fire Models for Nuclear Power Plant Application".

Fire Modeling Quality and V&V (Approach)

- Simplified approach incorporating fire model tools from NUREG 1824
  - Referred to as "Fire Modeling Generic Treatments"
  - Proprietary Hughes Associates, Inc. provided to NRC
    - Technical Reference Guide
    - User's Guide
    - Basis for V&V

Fire Modeling Quality and V&V (Approach)

- Detailed Fire Modeling
  - Utilized fire model tools from NUREG 1824.
  - Credited V&V from NUREG 1824 with benchmark cases applied
- Models consistent with Task 11 of NUREG-6850
  - Conducted for certain ignition sources
  - Limited areas of application
  - Better characterization of Zone of Influence for cabinets
  - Incorporated post-processing routine of data from CFAST
  - Meets the same models V&V'd by NUREG 1824

Fire Modeling Quality and V&V (Approach)

"Fire Modeling Generic Treatments"

- Provides tabulated results for specific fuel packages and configurations
- Data obtained from correlations and CFAST model results
- SFPE guides and NUREG 1824 provide validation basis for correlations and CFAST
- Detailed results presentation provides a verification of the implementation
- Sensitivity analysis demonstrates conservative configurations are used

Fire Modeling Quality and V&V (Approach)

- **Additionally,**
  - Hand calculations and CFAST runs were used for evaluating fire generated conditions in certain applications.
  - Calculations quality level is ensured through the V&V basis provided under;
    - NUREG 1824
    - ANSI N45.2.11-1974, Quality Assurance Requirements for the Design of Nuclear Power Plants

Fire Modeling Quality and V&V (Approach)

- **Progress Energy Configuration Controls include:**
  - Fire modeling calculations used (including hand calculations) are controlled under the NGG Fleet Procedure, EGR-NGGC-0017, Preparation and Control of Design Analyses and Calculations
  - Personnel qualifications are controlled and maintained under NGG Fleet Training Guide, ESG0010N, Calculation/Analysis Performance and Verification (Qual. Card)

Fire Modeling Quality and V&V (Summary)

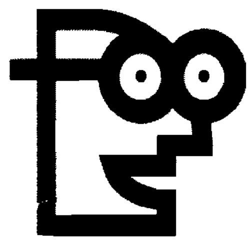
From HNP LAR Section 4.5.2,

"The use of the Generic Treatments in specific applications at Harris falls within their limitations as described in the "Generic Fire Modeling Treatments". In addition to the generic fire modeling treatments that were used in the hazard analysis, several calculations were produced that used Fire Dynamics Simulator (FDS), Consolidated Model of Fire Growth and Smoke Transport (CFAST), and the Fire Dynamics Tools (FDT)s as documented in NUREG 1824."

Conclusions

- Hand calculations were prepared using internal processes that meet ANSI N45.2.11-1974
  - Correlations used are per FDT Tools and/or other industry published sources (e.g., SFPE Guides)
- Fire Modeling software codes have been V&V'd per NUREG-1824

Fire Modeling Quality and V&V



QUESTIONS ?

Harris Nuclear Plant
Oconee Nuclear Station
NFPA 805 Transition

Impact of Recovery Actions

LAR Audit Follow-up Meeting

Washington, DC

April 21-22, 2009

Keith Began, Dave Miskiewicz, Bob Rhodes

Duke Energy[SM] Progress Energy

Impact of Recovery Actions

- Outline of Presentation
  - Terminology
  - Requirements and Guidance
  - Process Flowchart
  - Non-ASD Fire Area Approach
  - ASD Fire Area Approach
  - LAR Reporting

Impact of Recovery Actions

- Terminology
  - Operator Manual Action (OMA) – Actions performed by operators to manipulate components and equipment from outside the MCR to achieve and maintain post-fire hot shutdown, not including "repairs." OMAs comprise an integrated set of actions needed to ensure that HSD can be accomplished for a fire in a specific plant area…(RG 1.189 Rev. 1) [Pre-Transition Term]
  - Recovery Action – (NFPA 805 Sect.1.6.52) Activities to achieve the NSPC that take place outside of the MCR or outside of the primary control station(s) for the equipment being operated, including the replacement or modification of components. FAQ 07-0030/LARs (also DG-1218) clarify recovery action and primary control station scope. [Post-transition Term]
  - Defense-in-Depth Action – Actions that take place outside of the MCR or primary control station that are not categorized as "recovery actions" but are part of the FPP to ensure FP DID. FAQ 07-0030/LARs describe process. [Post-transition Term]
  - "Adverse to Risk" Review – PRA Review performed to determine if actions (recovery actions, DID actions, others) could have adverse risk consequences

Impact of Recovery Actions

- Requirements and Guidance
  - The use of recovery actions implies the use of a performance-based approach per NFPA 805 Section 4.2.3.
  - Per NFPA 805 Section 4.2.4, when the use of recovery actions has resulted in the use of the performance-based approach, the additional risk presented by their use shall be evaluated.
  - Consistent with NFPA 805 Figure 2.2 and Regulatory Guide 1.205, the Deterministic Approach of NFPA 805 includes compliance with the plant's pre-transition Current Licensing Basis (CLB).
  - For the purposes of addressing recovery actions, the pre-transition CLB is the "Deterministic Approach".

Impact of Recovery Actions

- Requirements and Guidance (cont'd)
  - Section 4.2.2 of NFPA 805 states that "for each fire area, either a deterministic or performance-based approach shall be selected…"
  - In the pilot process, it was discovered that most fire areas used a "combined approach" with a combination of deterministic approaches (including reliance on the pre-transition CLB) and PB approaches (i.e., change evaluations) where the pre-transition CLB was not met.

Impact of Recovery Actions

- Requirements and Guidance (cont'd)
  - Pilot process developed to determine which pre-transition OMAs need to be characterized as post-transition "recovery actions" (FAQ 30).
  - DID actions do not require assessment of additional risk (process submitted in LAR) but are considered part of the FPP and would be subject to the post-transition change evaluation process (if modified).
  - Recovery actions that are VFDs (FAQ 06-0012 Bin H OMAs) are evaluated using the RI-PB change process. This is consistent with Sections 4.2.4.2 "Fire Risk Evaluation" of NFPA 805, Section 2.4.4 of NFPA 805 and RG 1.205 (C.2.2, C.2.3). Change evaluation constitutes the "evaluation of additional risk".
  - Recovery actions that are not VFDs are required to be evaluated for additional risk using qualitative and/or quantitative means.
    - Quantitatively, since "allowed OMAs" that transition as recovery actions are not VFDs, there is no ΔCDF or ΔLERF, per Section 4.2.4.2 of NFPA 805.
    - Qualitative evaluation is provided in the LAR, Attachment G.
      - Consideration is taking deterministic actions at the appropriate time.

Impact of Recovery Actions

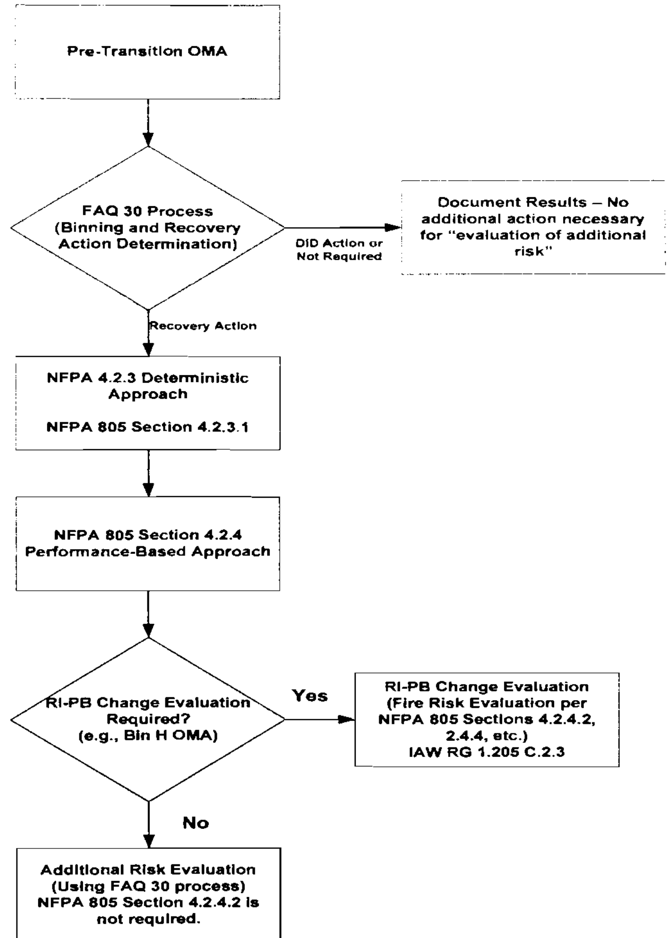
- Requirements and Guidance (cont'd)
  - NFPA 805 Section 4.2.4 describes two approaches:
    - 4.2.4.1 – Use of Fire Modeling
    - 4.2.4.2 – Use of Fire Risk Evaluation
  - Pilot plants use 4.2.4.2.
  - Fire Modeling is used as an integrated part of a Fire Risk Evaluation (Fire PRA) that supplements the Deterministic Approach.

Impact of Recovery Actions

- Process Flowchart

4.2.3 ...Use of recovery actions to demonstrate availability of a success path for the nuclear safety performance criteria automatically shall imply use of the performance-based approach as outlined in 4.2.4.

4.2.4* Performance-Based Approach. This subsection shall provide for a performance-based alternative to the deterministic approach provided in 4.2.3. When the use of recovery actions has resulted in the use of this approach, the additional risk presented by their use shall be evaluated. When the fire modeling or other engineering analysis, including the use of recovery actions for nuclear safety analysis, is used, the approach described in 4.2.4.1 shall be used. When fire risk evaluation is used, the approach described in 4.2.4.2 shall be used.



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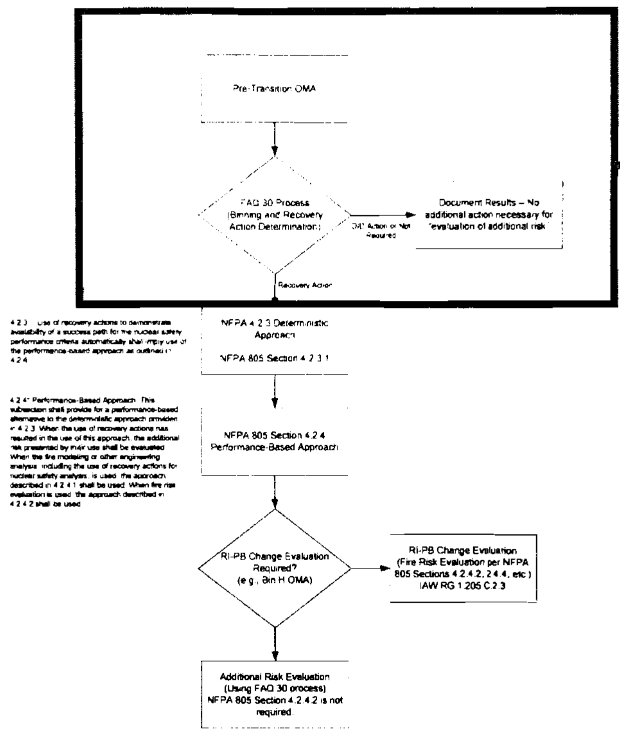
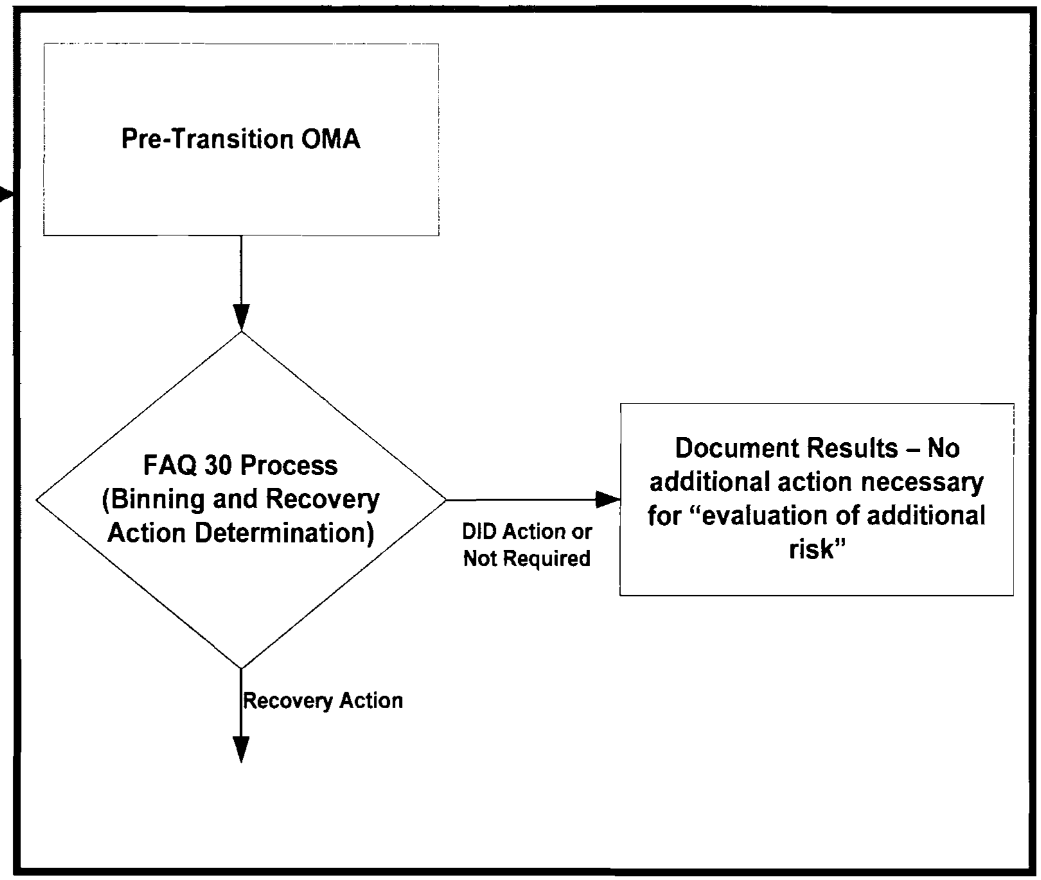
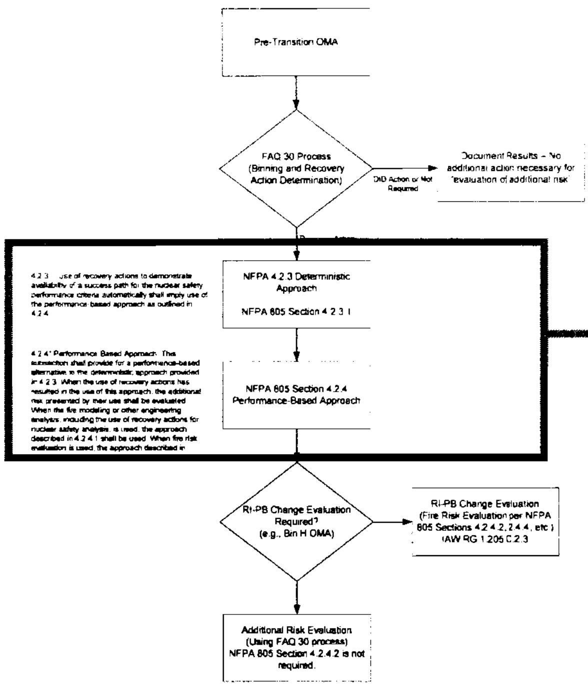
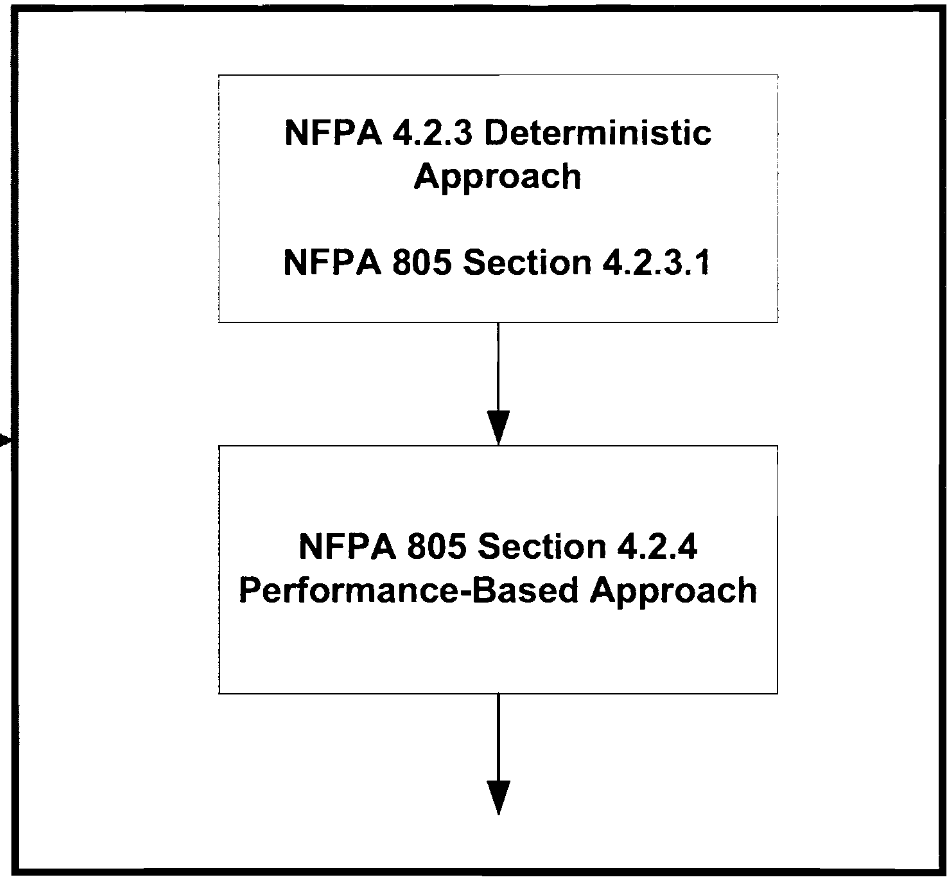
Impact of Recovery Actions



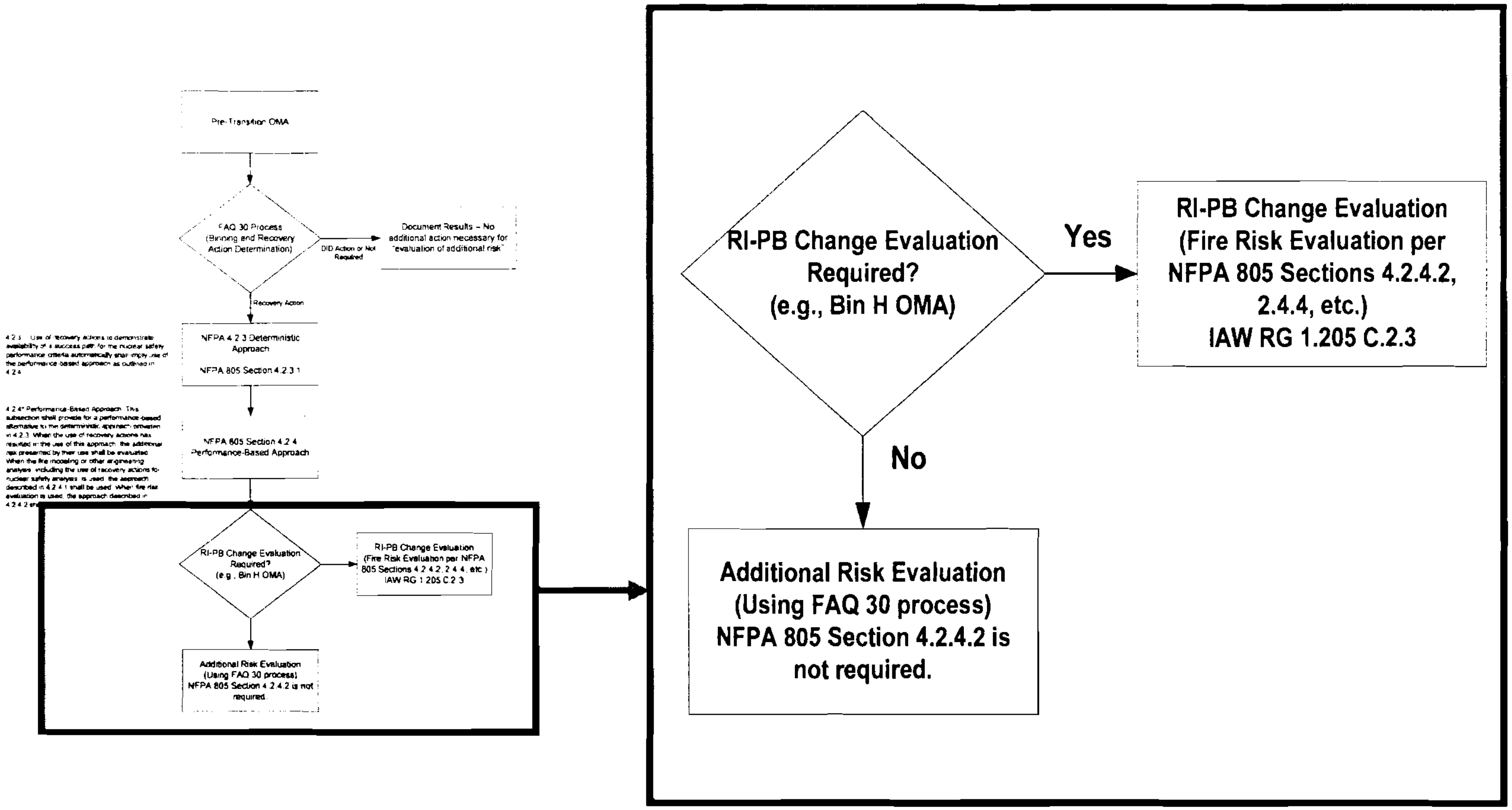


Impact of Recovery Actions





Impact of Recovery Actions



Impact of Recovery Actions

- Non-ASD Fire Area Approach
  - Fire PRA includes analysis of plant fire areas
  - A review for "adverse risk impact" for OMAs was performed. In most cases, OMAs that were determined to have potential negative risk are being revised.
  - As part of the Fire PRA development, OMAs were typically not included in the Fire PRA model unless they were desired for risk reductions, or if they resulted in an "adverse risk".
  - No Non-ASD actions were transitioned as "recovery actions" for either pilot plant, so evaluation of additional risk was not necessary.
  - Un-modeled OMAs may still be retained as non-modeled DID actions. By definition DID actions are either risk neutral or risk beneficial. Quantitative risk evaluation is not necessary.
  - If there is a need for an OMA to be modeled in the Fire PRA, it is a "recovery action" and the risk of modeled actions can be evaluated quantitatively.

Impact of Recovery Actions

- ASD Fire Area Approach
  - Key Risk Considerations
    - Environmental conditions
    - Maintain command and control (functional)
    - Procedural guidance to implement ASD

Impact of Recovery Actions

- ASD Fire Area Approach
  - Fire PRA Analysis, Non-MCR areas
    - ASD may be treated as DID unless modeling is desired for risk reduction (otherwise assume failure to abandon)
    - Failures are not recovered
    - Early abandonment is not typically modeled
      - Procedural guidance in place
      - Potential for "adverse" risk impact
        - Offset by failure to abandon assumption

Impact of Recovery Actions

- ASD Fire Area Approach
  - Fire PRA Analysis, MCR
    - Non-MCB fires are generally limited to the source
    - Abandonment timing is generally a function of environmental conditions
    - Fire spread in MCB is limited by NSP and abandonment
    - Failures are not recovered
    - Early abandonment is not typically modeled
      - Potential for “adverse” risk impact
        - Procedural guidance in place
    - HEP for ASD is modeled at 0.1

Impact of Recovery Actions

- LAR Content (Att. G)
  - Listing of pre-transition OMAs
  - Disposition of pre-transition OMAs as recovery actions, DID actions, or neither
  - Description of approach and results for fire areas that could result in control room abandonment
  - Risk importance measures for modeled recovery actions (e.g., Fussell-Vesely or qualitative assessment)
  - Summary of results for Bin H OMAs evaluated by the RI-PB change evaluation process

Impact of Recovery Actions

Questions?

LIST OF ATTENDEES

NRC
Harry Barrett
Stephen Dinsmore
Dan Frumkin
Ray Gallucci
Donnie Harrison
Andrew Howe
Naeem Iqbal
Alex Klein
Paul Lain
Steven Laur
Chuck Molton
Margaret Stambaugh
Marlayna Vaaler
Shakur Walker
Sunil Weerakkody

Progress Energy
Keith Began
Dave Corlett
Vijay D'Souza
Jeff Eltman
Alan Holder
Josée MacIntyre
Robert Rhodes

Duke Energy
David J. Goforth

Entergy (ANO)
Larry Young
Jessica Walker

ERIN
Patrick Baranowsky

KGRS
Andy Ratchford
Liz Kleinsorg

NEI
Steven Hutchins

PNNL(Battelle)
Rich Denning
Steve Short

Safe Fire Detection
Ron Robertson
Kevin Snyder

MEMORANDUM TO: Thomas H. Boyce, Chief
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

FROM: Marlayna Vaaler, Project Manager /RA/
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY OF APRIL 21 - 22, 2009, CATEGORY 2 MEETING WITH PROGRESS ENERGY CAROLINAS, INC., AND DUKE ENERGY CAROLINAS, LLC, TO DISCUSS TOPICS INVOLVING THE LICENSE AMENDMENT REQUESTS TO TRANSITION THE SHEARON HARRIS NUCLEAR PLANT, UNIT 1 AND THE OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3, TO THE NATIONAL FIRE PROTECTION ASSOCIATION STANDARD 805, "PERFORMANCE BASED STANDARD FOR FIRE PROTECTION"

On April 21 - 22, 2009, the U.S. Nuclear Regulatory Commission (NRC) staff hosted a meeting to discuss high level items associated with the Shearon Harris Nuclear Plant and Oconee Nuclear Station License Amendment Requests to transition to National Fire Protection Association Standard 805 (NFPA 805), "Performance-Based Standard for Fire Protection for Light-Water Reactor Electric Generating Plants." NFPA 805 allows the use of performance based methods, such as fire modeling, and risk-informed methods, such as Fire Probabilistic Risk Assessment, to demonstrate compliance with the nuclear safety performance criteria.

Regulatory audits were recently conducted at both sites, and several issues generic to both pilots were identified by the staff. The meeting was an opportunity to further discuss these issues with the pilot plant licensees, and will serve to benefit the non-pilot plants that will be undertaking this transition in the future. The meeting was held at NRC Headquarters, One White Flint North, Rockville, Maryland.

The NRC staff and several pilot plant stakeholders gave presentations relative to the issues and challenges associated with transition to NFPA 805, including the use of incipient detection, the change evaluation process scope and methodology, development of the fire modeling quality and verification and validation procedures, and the impact of recovery actions on the implementation of NFPA 805. There were no members of the public in attendance and no public meeting feedback forms were recieved.

The meeting agenda is attached as Enclosure 1, the meeting handouts are attached as Enclosure 2, and the list of attendees is attached as Enclosure 3.

Enclosures: As stated

<u>DISTRIBUTION:</u>

PUBLIC	DRA r/f	LPL2-2 r/f	RidsNrrPMShearonHarris
RidsNrrLACSola	RidsNrrDorlLpl2-2	RidsNrrDraAfpb	RidsOgcRp
RidsAcrsAcnw_MailCTR	PLain, NRR	HBarrett, NRR	AKlein, NRR
RidsNrrPMOconee	MStambaugh, NRR	SLaur, NRR	DHarrison, NRR

Accession Number: ML091660504 NRC-001

OFFICE	DORL/LPL2-2/PM	DORL/LPL2-2/LA	DORL/LPL2-2/BC
NAME	MVaaler (TOrf for)	CSola	TBoyce (EBrown for)
DATE	06/18/09	06/17/09	06/24/09

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