Resolution of Comments on NFPA 805 FAQ 08-0046 NRC Draft Interim Position

Source	Comment	Resolution	NRR Comments
Industry Comment # 1	*Limitation to Low Voltage Control Cabinets:* A major conservative qualification is the limitation of credit for incipient phase detectability to low voltage (less than or equal to 250V) control cabinets. The EPRI Interim TR 1016735 had already proposed a conservative interim limit on AC voltage of 480 to be consistent with the observation that no high energy arcing faults had been identified at this voltage level in the EPRI Fire Events Data Base (FEDB). The voltage limit also restricts application credit for 480 VAC cable runs, junction boxes, and powered equipment which have not had such "fast acting" fires reported in the FEDB operating experience. No realistic mechanisms for fast acting cable or junction box fires been identified, as supported by the absence of such fires from the FEDB be taken into account.	Not incorporated. NUREG/CR-6850 Task 6 and Appendix M discuss High Energy Arcing Faults (HEAFs). Appendix M states: "Switchgear, load centers, and bus bars/ducts (440V and above) are subject to a unique failure mode and, as a result, unique fire characteristics. In particular, these types of high-energy electrical devices are subject to high-energy arcing fault (HEAF)." The events discussed in Appendix M include 4 events involving 480VAC equipment (switchgear/MCCs).	NUREG/CR-6850 considers 480VAC equipment susceptible to HEAF.
Industry Comment # 2	The draft interim position states that 480 volt electrical cabinets and rotating equipment have a "higher probability of not exhibiting incipient behavior," yet no technical basis is provided. Moreover, the actual data from the FEDB show no incidence of the postulated behavior. It is not clear how events that have never occurred can lead to a "higher probability of not exhibiting incipient behavior."	Not incorporated. Events 1, 2, 10 and 13 involved 480V equipment. Based on the occurrence of these events, there is a higher probability of not exhibiting incipient behavior.	HEAFs have occurred involving 480V equipment. By definition, a HEAF will not exhibit an incipient stage. Based on the level of information provided in the FEDB, one can not tell if the fires that have occurred involving rotating equipment would have exhibited incipient stage or not.

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Industry Comment # 3	*"Fast Acting" Fires:* Another conservative qualification is that there is no credit proposed for VEWFDS for rotating equipment nor fans plus electrical cabinet components considered susceptible to "fast acting" fires unless some other undefined technical basis is provided. The term "fast acting" is not defined in the context of fire growth stages. There appears to be a mix of the notion of fast fire growth after flaming starts and the incipient stages of fire development which are not fast acting. Prompt ignition without incipient growth stages would require an enabling condition such as a severe electrical transient, an electromechanical failure with attendant arcing, or some other substantial external heat source. The NRC has not identified any of the "variety of failure mechanisms" that it claims could reasonably be expected to lead to "fast acting" fires. Moreover, the FEDB data shows that all fires identified for electric pumps, MG sets, other electric motors, and air compressors could have reasonably been detectable by VEWFDS. Fans, even at lower voltages, are explicitly excluded in the draft interim position even though the experience indicates that VEWFDS could be effective.	Partially Incorporated. In the NRC Event Tree, the factor for the percentage of components that exhibit an incipient phase has been deleted. A paragraph explaining the fact that the non-conservatism in ignoring the fast acting components is compensated for in the conservatism that some of the fires will be prevented in the incipient stage. The applicability of the paper is still limited to electrical cabinets. Motors and Motor-Generator Sets are still not covered by the paper due the issues discussed in the NRR comments.	The staff's understanding of the concept used to justify the VEWFDS early warning time frame is that through the degradation process of electrical insulators, the fire detection system can detect very small changes of particles suspended in the air. In the staff's opinion, the use of this mechanism for prediction of electrical circuit failures that could result in a fire is acceptable. If the industry wants to propose an additional split fraction approach to address the electrical failure portion of motor failures, the staff is receptive to reviewing it. However, this technology has not been shown to be sensitive to mechanical binding, which can manifest itself in a variety of failure modes for rotating equipment (pumps, MG sets, fans, etc.). Insufficient justification has been provided that these failure modes will follow the long time frame, predictability of electrical insulation degradation. Although VEWFDS may be able to sense some changes brought about by mechanical problems, there is insufficient research and a lack of data demonstrating this ability.

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Industry Comment # 4	*Alarm Response:* The draft interim position also includes conservative qualifications regarding alarm response. For example, the draft interim position states that the alarm response needs to be accurately modeled, which mischaracterizes the situation when VEWFDS is used in place of spot detection systems. Due to the far superior ability to detect incipient fire conditions well before smoke and/or flame occur, the corrective actions are much more like an immediate corrective maintenance action. That is, the response to the VEWFDS alarm is more of a preventive action before gross failure than a mitigation action after gross failure to prevent spreading the failure. While some small fraction of incipient fire conditions may require more rapid response to prevent propagation of fire damage to other SSCs, the vast majority will have the character and time of more deliberate preventive/corrective maintenance actions.	Not incorporated.	There is insufficient data to be able to accurately predict the duration and ability to detect incipient degradation behavior. While the range of time available to perform corrective actions may span from days to seconds, the lack of data to be able to accurately predict how long is really available requires the staff to maintain its current position.

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Source	Comment	Resolution	NRR Comments
Industry Comment # 5	*Alarm Response HEP:* The draft interim position goes on to set the baseline human response to an incipient detection system alert or alarm at 10^{-2} without justification. This is equivalent to saying that a response to a fire alarm by trained staff with specific procedures requiring a response will not be taken one in one hundred times. This includes first an "alert" notification level of the VEWFDS, and then an "alarm" level indication. The conservative, screening approach to HRA in the SPAR-H methodology provides a baseline execution error rate of 10^{-3} for nominal operator response. A value of 10^{-2} would require existence of multiple degradations of performance shaping factors to occur. The draft interim position provides no basis for believing that any such factors would exist for the VEWFDS scenarios. To the contrary, the draft interim position and EPREI Interim TR 1016735 call for training and procedures to ensure high quality and reliable response to VEWFDS alerts and alarms. Therefore, it appears that the choice of this HEP is extremely conservative.	Not Incorporated.	While the simplified description provided in the industry comment attempts to point out that this value should be conservative, there are several additional factors that must be considered. In addition to the probability that the operator will not respond to the alarm, this number also takes into consideration the ability to locate the electrical cabinet in question. Depending upon the number of cabinets being monitored, finding the incipient condition could take from several minutes to many minutes (30 minutes or longer if there are a large number of cabinets monitored by one unit). If the installed equipment is addressable such that the alarm can be associated with only one or two cabinets, a lower failure number could be used.

Source	Comment	Resolution	NRR Comments
Industry Comment # 6	*Corrective Action Response:* The draft interim position additionally includes a conservative assessment regarding plant operational staff corrective action response after the alarm has been properly responded to. The NRC position is that there is a 100% probability of failure of the plant staff to take appropriate corrective actions. This assumes that there will be a fire for every incipient condition requiring traditional plant fire suppression response. Yet, the majority of these incipient conditions will be identified and prevented from achieving ignition (flaming) in the vast majority of instances due to the substantial lead time that would be available prior to the onset of fire growth phases. Timeframes are at least tens of minutes, and more expectedly hours to days, for these types of incipient conditions to develop into significant fires. These conditions would be more like corrective maintenances than fire fighting incidents. From a fire prevention perspective, the response would be essentially 100% effective and would not pose a fire ignition and growth threat. It is certainly a gross over conservatism to assume 0% effectiveness.	Not Incorporated	The comment does not address the foundation of the staff's position. In order to prevent a fire from occurring, the responder must remove power from the component. In many cases, this is not something that can be done very quickly. Based on the unknown duration of the incipient stage, and the limited number of qualified people available to identify and locate the appropriate switch/breaker/fuse to remove power, the staff will continue to emphasize suppression with incipient detection in cabinets. If additional credit is desired, industry could perform research sufficient to provide failure data that demonstrates "tens of minutes, and more expectedly hours to days."

Source	Comment	Resolution	NRR Comments
Industry Comment # 7	Expectation of Justification for Deviation: In addition to the conservative qualifications noted above, the draft FAQ states that, "deviations from the information provided in this position should be justified and prior to credit in NRC regulatory activities should be submitted to the NRC for review and approval." This is inconsistent with the existing regulatory approach for addressing technical adequacy of PRA. NRC should be specifying only the requirements that need to be met in order to take credit for incipient detection and how much credit (i.e., the probability of failure). These requirements already exist in ASME/ANS RA-Sa-2009, which is endorsed under RG 1.200. The RG 1.200 certification process should be the means by which the credit given in the FPRA is validated.	Not Incorporated	Meeting the supporting requirements is indeed a necessary condition for demonstrating that the PRA is of sufficient technical adequacy to support the application. In addition, the staff does, and will continue to, assess the validity of assumptions associated with sources of model uncertainty. In the draft FAQ, the staff has developed a position which it recognizes as somewhat conservative. However, how much additional credit can be taken for incipient detection is uncertain due to lack of knowledge about how and under what conditions the system will work. The staff's expectations are therefore fully consistent with RG 1.200.
Xtralis Comment # 1	Only "*low voltage (less than or equal to 250V)*" – we understand the perception that higher voltages may be expected to produce faster growth fires, however, there is no evidence presented that such systems have a zero probability of incipient fire. Indeed, the existence of an example of IFDS providing early warning of impending fire at a nuclear plant (see Appendix C to EPRI TR 1016735) from a 480 VAC pump motor is surely evidence that there is some finite probability. We recommend that a factor be developed from discussions with equipment OEMs who do destructive reliability and failure analysis.	Not Incorporated	While the staff agrees that higher voltages <u>may</u> exhibit incipient behavior, the industry position as stated does not adequately address the potential for high energy failure modes which do not exhibit incipient behaviors. The staff would welcome additional analysis and data that could be used to establish split fractions for higher voltage equipment (480V and higher).

Source	Comment	Resolution	NRR Comments
Xtralis Comment # 2	Only "*cabinets*" – there appears to be no justification presented to limit the credit to only cabinets. It is agreed that protection of all cabinets in a room provides the very best opportunity for very early warning fire detection within those cabinets, but some risks are not present within 'cabinets' and the safety of the facility would benefit from detection in their vicinity (through sampling in and around their components) and in the room in which they are placed. The application of IFDS to the room also provides an opportunity for redundancy of detection systems. IFDS that operate via a 'cumulative sampling' system like all the aspirating systems discussed, provide a very good indication of the presence of smoke from a small fire risk that has been diluted in a large open space. This is their forte. We recommend that the credits be extended to include non-cabinet equipment protection and general area protection.	Not Incorporated	The staff agrees that VEWFDS may be used to effectively monitor areas and/or rooms. As stated in the staff comments to previous issues, the interim staff position provides "one acceptable approach" based on the staff's review of the proposed VEWFDS approach. In the staff's view, the proposed industry approach does not provide adequate justification for the numerical credit being claimed for area-wide use of VEWFDS. There are several issues that must be addressed before substantial credit may be claimed for area-wide applications: • Percentage of ignition sources that will/will not exhibit an incipient degradation mechanism (mechanical components, high voltage components, bus ducts, etc.) • HEP/HRA to address effectiveness and timing of operator response to incipient alarms for area wide applications
Xtralis Comment # 3	Only "*control cabinets*" – there appears to be no justification for the types of cabinets eligible for credits being limited to control cabinets per se. There are many other types of cabinets that present incipient fire risks and they should be included.	Incorporated	The interim paper has been modified to refer to "electrical cabinets" vice "control cabinets."

Source	Comment	Resolution	NRR Comments
Xtralis Comment # 4	Only those that "do not contain fast acting components (such as electrical/electronic circuit boards that contain electrolytic capacitors, chart recorder drives, cooling fan motors, mechanical timers driven by electric motors, etc.)". The presence of potentially fast fire growth components on a subsystem does not at all dictate that the progression of a fire risk involving the subsystem will necessarily be fast growth. An over-taxed oil-filled transformer can have a long incipient fire phase even though it also has the potential to cause severe explosions. A kerosine lantern has the potential of fast growth if broken, but it is safely used to provide a slow steady heat. This limitation is most severely limiting and overly conservative given that most of the subsystems within a cabinet (or indeed ANY electronic system) will contain electrolytic capacitors and cooling fan motors and other electro-mechanical devices. Again, the existence of an example of IFDS providing early warning of impending fire at a nuclear plant (see Appendix C to EPRI TR 1016735) from a 120 VAC fan is surely evidence that there is some finite probability from electro-mechanical systems. Xtralis has many examples of incipient fires being detected in electro-mechanical systems and in systems that might have the propensity to be fast growth after the incipient growth stage has been exceeded. The mere presence of an allegedly 'fast acting' componet in a larger system that is very likely to exhibit a long incipient phase needs to be removed. This arbitrary limitation should be removed and replaced with a fair estimate from equipment and subsystem	Not incorporated. Paper will be revised to remove the conflict in the wording.	The position paper presently states that in order to set $\alpha = 0$, there can be no fast acting components in the cabinet. If there are, the paper tells the licensee to "…and adjusted as necessary based on the results of the inspection if there are components that would be fast acting." The paper now includes a discussion of an example where a cabinet that has 25 non fast acting components and 2 fast acting components, the licensee would ratio 2/25 to set the value of $\alpha = 0.074$.

	OEMs.		

Source	Comment	Resolution	NRR Comments
Xtralis Comment # 5	The Interim Position notes that "*The system should pass the full vendor's acceptance test and associated sensitivity testing prior to being placed in service.*" Some IFDS systems manufacturers require an extended period of commissioning (e.g. 90 days) to ensure that the environment is 'suitable' for a low obscuration alarm level setting. In some cases this is required to meet manufacturer and UL requirements. Accordingly, we recommend that the Interim Position text be changed to include "*any extended period of commissioning*".	Incorporated	
Xtralis Comment # 6	The Interim Position notes that "*…the systems shall be … (calibrated at least annually or more frequently if required by the manufacturer)*." Re-calibration is only required in the case of system sensitivity drift due to things such as contamination of optics – typically resulting in reported background particulate increases or loss of sensor gain. Some systems do suffer from this problem, but not all. Since the introduction of IFDS systems using protected optics allowing fixed ('absolute') sensitivities, no in-field detector calibration has been required by the manufacturers of such systems. This position has been supported by the approvals of such systems and proven after years of use in hostile environments with particulate levels well beyond those expected in a nuclear facility. The 'requirement' should be replaced with a manufacturer's recommendation. Accordingly, we recommend that the Interim Position text be changed to "*calibrated as required by the manufacturer*".	Incorporated	

Source	Comment	Resolution	NRR Comments
Xtralis Comment # 7	The Interim Position also astutely requires that "*Calibrations, such as re-baselining the alert and alarm levels that reduce the sensitivity of the system should be evaluated to assure that the early detection function of the system is not compromised. Reductions in sensitivity should be considered in the fire PRA as a reduction in the system's effectiveness*." Though the intention is excellent, a description of what evidence of continued performance would amount to a satisfactory assurance should be provided. Surely any manufacturers of systems that require in-field calibration (manual or automated) should be required to provide a quantitative analysis of how such calibration does not adversely affect the probability of alarming on slow growth incipient fires. It should be made clear that any algorithmic change in the alarm level settings (in conventional and traceable units of obscuration such as %obscuration/ft) fits within the definition of 'calibration' so as to include any "drift compensation" or "relative sensitivity" methods. Accordingly, we recommend that the Interim Position text be changed to read "In-field calibrations (automated or manual), such as re-baselining the alert and alarm levels, drift compensation, relative scaling methods or any other methods that could reduce the sensitivity of the system to slowly developing incipient fires should provide quantitative evidence that such calibrations do not compromise the early detection function of the system. Any reductions in sensitivity should be considered in the fire PRA as a reduction in the system's effectiveness.".	Not Incorporated	The intent of this section of the Interim Position is that changes in sensitivity in order to avoid spurious alarms should be addressed in the Fire PRA. The comment appears to be directed towards specific methodologies on the part of specific vendors. The staff believes that the intent is easily understood without the need for "quantitative analysis." It should be within the capability of the PRA practitioners to adjust the assumed values in the risk analysis to account for a reduction in sensitivity.

Source	Comment	Resolution	NRR Comment
Xtralis Comment # 8	The Interim Position notes that "*Success of this event implies that plant personnel have **identified the cabinet** which contains the source of the alert and have staged appropriately trained personnel*." It also states that "*This number assumes that the operator response procedure directs **the area** to be investigated upon an alert from the incipient detection system."* {my emphasis}. The Interim Position makes an assumption that it is plant personnel who have to conduct an investigation in an 'area' and identify 'the cabinet' which is the source of the alert. In fact, many IFDS allow automated discovery of the source of an incipient fire risk discretely to within a single cabinet or enclosed space. Such 'addressable' IFDS provide plant personnel the precise location of the risk at the cabinet level to speed the response. The information can be presented graphically at the facility's emergency response centre and maintenance centres and locally near each room. Monitoring software can also present (in an HTML browser for example) the emergency response procedures for each cabinet, for each level of alarm as the event escalates. The availability of precise location information from fixed addressable IFDS should be acknowledged as reducing the risks of an unsuccessful operator response (γ) and may even avoid the necessity to use HRA. *Accordingly, we recommend that the Interim Position text be changed to add the words "or cabinet" after the words "the area".*	Incorporated	

Source	Comment	Resolution	NRR Comment
Xtralis Comment # 9	At Page 6, the Interim Position states that *"Effective methods must be established for locating the source of the incipient detection (portable VEWFDS, thermography, etc.) and the associated equipment must be dedicated for use, maintained in an operable condition and available on site at all times."* It is important to understand the degree to which different systems can help identify and speed the investigation and rectification of any identified incipient events in different circumstances. We would classify four scenarios: 1. room with one potential risk source - detection provides indication of risk present in room or within risk source, no further manual investigation of source is required. 2. room with multiple potential risk sources - detection only provides indication of risk present somewhere within the room, further manual investigation of source is required. 3. room with multiple potential risk sources - detection provides specific indication of risk present within a subset of the likely risk sources, further manual investigation of source is required. 4. room with multiple potential risk sources - detection provides indication of risk present within a specific risk source, no further manual investigation of source is required. Having an automation of the discovery process improves the speed and availability of the human response and the training required etc. The availability of portable systems that use batteries (which may not be monitored for health or have other failure mechanisms) and that may not otherwise be connected as part of a 24x7 monitored system raise other risks. We are also cognisant of	Incorporated	The staff agrees that VEWFDS that are addressable to an individual cabinet reduce the time needed to locate incipient degradation. More risk credit should be allowed if an addressable system (or the installation is designed to only have one cabinet per monitor) is used. The Interim Position has been changed to reduce the risk by a factor of 2 (failure rate is 50% of previous value) to account for the fact that the specific cabinet has been located and efforts to open multiple cabinets to locate the source will not be required.

	the time taken to do thermographic analysis and the challenges of gaining visible access within the requirements of the facility safety procedures. Therefore the use of IFDS systems that provide an indication of the location of the risk to within a single cabinet should be preferred and gain additional credit in the risk analysis. Accordingly, we recommend that the Interim Position text be changed to *"IFDS that provides automated location of the source of the incipient fire risk should receive a greater level of credit in the event tree quantification commensurate with the improved reliability of fire risk location and reduced risk of unsuccessful operator response. In all cases effective methods must be established for locating the source of the incipient detection (addressable IFDS, portable VEWFDS, thermography, etc.) and the associated equipment must be dedicated for use, maintained in an operable condition and available on site at all times."*		

Source	Comment	Resolution	NRR Comments
Xtralis Comment # 10	At Page 6, the Interim Position states that *"To simplify the analysis, δ, the factor for the probability of failure to remove power from the device once it has been located, is set to 1."* We fundamentally disagree with this simplification. This appears to be an error of logic. Please explain the rationale. We would argue that the probability of removal of power from the device once located would be close to 1. This is especially true if the fire system design provided discrete IFDS detection addressable to a single cabinet which would allow for improved reliability in isolation and shutdown of the cabinet at risk. To make the simplification as stated in the Interim Position is to assume that all events lead to 'fire' and necessitate 'suppression'. Perhaps these definitions need to clarified. On the basis of a common construction of the language, we recommend that the Interim Position text be changed to "*To simplify the analysis, δ, the factor for the probability of failure to remove power from the device once it has been located, is set to 1E-02. This considers the likelihood of successful shutdown using the many automated and manual options for power removal." Also delete the text "This approach is taking credit for the fire watch only, as a surrogate for prevention." The simplification to the event tree shown on Page 7 require incorporation of the above changes*	Partially Incorporated. Added a paragraph explaining how a licensee could claim additional credit for prevention of fires. The new paragraph explains how a licensee could pre-locate the isolation devices, conveniently display information on the location of the isolation devices, provide training to responders in how to locate and properly use the isolation devices, and provide periodic drills to demonstrate the ability	The basis for the statement in the Interim Position is that for many control cabinets in a nuclear power plant, the electrical isolation devices needed to remove power are not readily identified. Although there may be some cabinets that are easily isolated, this is not the case for most. The time needed to locate the isolation device (switch, fuse, breaker, disconnect switch, etc.) can range from a few minutes to several hours. In many cases, someone knowledgeable in electrical circuits, drawings and wiring practices will be needed to locate the device. This is not to say that a licensee couldn't "pre-locate" the isolation devices for all ignition sources within each cabinet in an effort to speed up the process. If such an effort was taken, additional credit for preventing fires could be allowed. To achieve maximum credit, this would need to include predetermining the isolation devices, conveniently displaying that information for use in response to VEWFDS alert, responder training so that they could rapidly locate and operate the isolation device, and drills to periodically demonstrate this ability.

Source	Comment	Resolution	NRR Comments
Xtralis Comment # 11	The credits to be given (as described in Appendix P) should also include detection and suppression independent of the technology type used. The narrow language of "normal spot detectors" is inappropriate. Aspirating-type IFDS uses the 'cumulative sampling' method and so has been proven to be ideal for detection of threats of fire where smoke is likely to have spread and been diluted in large open spaces. IFDS should indeed be encouraged in these areas as it provides improved detection performance and some additional redundancy on the IFDS protecting the cabinets. Accordingly, we recommend that the Interim Position text be changed to *"Credit should be given for automatic detection and suppression (including IFDS protecting the open room areas (preferred) and automatic suppression in the area) as well as delayed manual detection, manual actuation of fixed suppression and manual suppression via the fire brigade.'*	Not Incorporated	While the staff agrees that VEWFDS may be effective when used to monitor large areas, the process identified in the EPRI report provides insufficient justification for the numerical credit being given. What has not been sufficiently addressed is the probability of success in finding the source of the incipient degradation prior to that source turning into a flaming source. In order to consider VEWFDS use in area wide applications, a detailed, quantitative method should be presented that can reliably predict the probability of success. At this stage, such a method has not been presented.