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| **FAQ Number** | **18-0014** | **FAQ Revision** | **0 (Draft V7)** |
| **FAQ Title** | **The time of Detection is Zero for the start of the Manual Non-Suppression Probability (NSP) Calculations** | | |


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|---|---|---|---|
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**Purpose of FAQ:**

This FAQ provides an interpretation of when to begin crediting the empirically based manual Non-Suppression Probability (NSP) curves for cases where the fire damaged equipment is indicated in the MCR to align with the data used to develop the curves.

**Commented [MB1]:** The staff is not sure of the purpose of this FAQ. NUREG-2230, which is out for public comment, seems to address the issue of electrical cabinets more comprehensively and incorporates detection for cabinets monitored/indicated in the MCR. On the other hand, there has been discussion that this FAQ would be applied to non-cabinet sources ultimately. The staff seeks to avoid the potential for contradictory guidance with the NUREG; thus, any potential revision to this FAQ to address non-cabinet ignition sources would need to be consistent with the NUREG as well.

**Relevant NRC document(s):**

NUREG/CR-6850
NUREG/CR-6850 Supplement 1 (FAQ 08-0050)
NUREG 2169

**Details:**

**NRC document needing interpretation (include document number and title, section, paragraph, and line numbers as applicable):**

See list of relevant NRC documents

**Circumstances requiring interpretation or new guidance:**

The guidance in NUREG/CR-6850 Appendix P implicitly and through example directs that the detection time be subtracted from the overall time until target damage when developing the manual non-suppression probability. Although NUREG/CR-6850 Supplement 1 (FAQ 08-0050) and NUREG 2169 remove the brigade response time from the NUREG/CR-6850 approach for crediting manual suppression, the subtraction term for the detection time remains. As a result, the risk associated with the manual non-suppression probability is artificially high most cases.

**Commented [CR2]:** This is true for most risk significant cases. If the fire is severe enough to progress to core damage, then control room equipment with control rom indication will be impacted

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**Detail contentious points if licensee and NRC have not reached consensus on the facts and circumstances:**

None.

**Potentially relevant existing FAQ numbers:**

FAQ 08-0050, "Manual Non-Suppression Probability"

**Response Section:**

**Proposed resolution of FAQ and the basis for the proposal:**

The manual non-suppression probability (NSP) curves by nature of the data collection process already include the detection time in addition to the brigade response time most risk significant cases. Once a fire event is logged in a Nuclear power plant, it is detected (i.e. the NSP curve begins).

NUREG-2169 used the Updated Fire Events Database (EPRI 1025284) in the development of the NSP curves. Although detection of a fire precedes control or extinguishment, time to detection is not included in the nonsuppression curves since it is not possible to determine the time between ignition and detection from the fire events database. Therefore, the time available to suppress a fire prior to damage should exclude the time needed to detect the fire. In other words, the time available for suppression prior to damage should be decreased by the time from ignition to detection, yielding a smaller time for suppression prior to damage.

To further substantiate this point, early detection allows suppression activities in the early stages of the fire, leading to greater nonsuppression credit, rather than having detection delayed such that the fire has developed more extensively. ~~Whether the fire is detected by a detector, plant equipment failure, or personnel, the T=0 from which the fire is detected is inherently included in the manual response time curves. T=0 is also considered the point of fire growth which is discussed in more detail in this FAQ.~~

Incipient detectors are excluded from the approach in this FAQ since these detectors are not traditional fire detectors and the vast majority of fires are not detected using incipient detectors.

Detection (T=0), in the context of this FAQ, is considered the point at which operations logs that something has happened. This does not mean that it is initially known that a fire has occurred. But, it corresponds to the start of the time used to determine event duration. This is the point at which the NSP curve begins. The fire will be controlled or extinguished within x amount of time from detection at the confidence calculated using the NSP curves.

**Commented [HJ3]:** This FAQ is insufficient since it does not specify the interaction of this approach with the plant response timeline.

**Commented [CR4]:** The timeline is specified in the same context as the existing 6850 timeline. T=0 is defined a the point at which the growth curve of a fire starts.

**Commented [HJ5]:** Suggest this work be delayed until 2230 is issued. Need a parallel path to 2230 for this FAQ. Any extension to other ignition sources should be done with comparable complexity.

**Commented [MB6]:** This statement is not factually accurate and should be removed or substantially clarified. The second sentence is technically accurate in that once a fire is detected/logged/confirmed, the NSP curve begins, however, the time at which a fire is detected/logged/confirmed is fundamentally different than the detection time, which is a calculated value for the purpose of estimating the amount of time elapsed between ignition and detection of a fire.

**Commented [HJ7]:** This is a small part of the RES/EPRI research project. This condition is integrated into the RES program with respect to interruptible fires and growth fires.

**Commented [CR8]:** As with all of our efforts, future work can supersede aspects of an FAQ or the FAQ in total. There is no work in progress which addresses this concern for non-cabinet fires.

**Commented [HJ9]:** See rework of language. The staff is not interested in this FAQ being contradicted by future work. It would be better for future work to be extended to this topic, once 2230 which is out for public comment is issued. 2230 has a more comprehensive mechanism to credit personnel detection of fires earlier in the event tree than the current state of practice.

**Commented [MB10]:** How is the confirmation of the fire taken into account in the fire response timeline and consequently NSP credit? If a fire is not confirmed, then no response occurs. Also, could some procedures stipulate that a fire should be confirmed, and others not?

**Commented [CR11]:** This is accounted for by the empirical nature of the data collection. If the confirmation takes longer, then the response time will be longer.

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Due to the empirical nature of the data collection, any delays in the response due to embedded confirmations or procedural delays would be reflected in the response time of the data.

The case in which the time to detection equals 0 with respect to applying the NSP curves from NUREG-2169 is the following:

When the fire is detected by a plant equipment failure that is indicated directly in the control room, the time to detection ($T_{det}$) is inherently included in the manual response time curves since the time from fire initiation to detection is generally assumed negligible and thus the HRR t-squared growth profile does not begin in the PRA model until detection
This timeline illustrates the sequence of events:

- Time = -y Fire Starts
- Time = 0 Fire is Detected (i.e. operations logged the event)
  Fire Growth Curve Begins (for the specific case above)
- Time = x Fire is controlled or extinguished

In Fire PRA, the NSP curves are used to prevent damage beyond the initial zone-of-influence (ZOI) of the fire source. For high-energy-arcing faults (HEAF) events, the initial ZOI for target damage is applied at T=0.

For example, if the fire source is an electrical cabinet, the fire might be in the incipient stage for an extended period. Detection can occur due to equipment damage manifesting through main control board indication changes. In this case, the timeclock for controlling the fire from expanding beyond the initial ZOI begins when initially logged by operations (i.e. detected).

Thus, this approach will only be applied to fire scenarios where equipment affected by first target/ignition source affected by the fire would cause direct indication in the control room, aside from any fire detector actuation. Using T=0 for detection time is only applicable for the current t-squared growth curve (characterized as ~~fast~~ growth fires in future research [but considered slow growth in traditional fire protection]). If growth curves other than the t-squared growth at T=0 are considered, then using T=0 as the detection time is not appropriate.

**Commented [MB12]:** The growth profile recommended in NUREG/CR-6850 is considered to be slow relative to other fire protection literature.

**Commented [CR13]:** Add your comment

Direct indication is valve position lights, annunciators, gauges, etc. For example, a transient fire damages a tray that contains a component cooling pump heat exchanger control cable. The fire causes the throttling valve to change state. This causes a reactor coolant pump seal high temperature alarm in the control room. T=0 can be used as valve changing state has control room indication.

**If appropriate, provide proposed rewording of guidance for inclusion in the next Revision:**

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The following are proposed revisions to NUREG 2169:

The start of the t-squared growth curves and manual NSP curves is T=0 if the first piece of equipment damaged by the fire would be indicated in the control room. This is equivalent to using the equation with the time to detection, $T_{det,}$ set to zero ($T_{det}$=0).

Thus, if control room indication for the first piece of equipment damaged by the fire is not available, then the $T_{det}$, must be calculated using the fire detection models. The time to detection, $T_{det}$ , for automatic suppression systems must be calculated regardless of whether or not control room indication is available for the first piece of equipment damaged by the fire. Setting $T_{det}$=0 is only applicable to the empirically based manual NSP curves for this particular case.

As this approach is essentially a data change, use of this FAQ would be considered an update (not an upgrade).

**Commented [MB14]:** This is similar to the existing prompt detection credit in NUREG/CR-6850 for in-cabinet detection.

**Commented [CR15]:** As stated earlier, this is not used where incipient detection is credited.

**Commented [HJ16]:** This project needs to be rolled into the RES/EPRI research project to more fully describe the model, including conditions, caveats, relationship to the plant response model, distinction between interruptible and growth fires and their application, etc.

**Commented [CR17]:** The EPRI task will address cabinet NSP modeling in detail. Once, that is issued, then this FAQ will only apply to non-cabinet growth and suppression.

**Commented [HJ18]:** Suggest approach be aligned with 2230, as previous comments indicate.