NRC INSPECTION MANUAL

APOB

INSPECTION MANUAL CHAPTER 0609 APPENDIX F ATTACHMENT 7

GUIDANCE FOR FIRE NON-SUPPRESSION PROBABILITY ANALYSIS

Effective Date: January 1, 2025

0609F.7-01 PURPOSE

This attachment provides guidance for performing the non-suppression probability (NSP) analysis in Step 2.7 of the Fire Protection Significance Determination Process (SDP), IMC 0609 Appendix F. Guidance is provided for determining the time to detection and time to suppression for both automatic and manual methods and for determining the overall NSP for a fire scenario. Manual NSP curves for various ignition sources and fire areas are provided at the end of this attachment.

0609F.7-02 GUIDANCE FOR STEP 2.7.2 - FIRE DETECTION ANALYSIS

The dominant means of fire detection may vary somewhat depending on the type of fire postulated (e.g., hot work fires with a fire watch present), fire location within the room (e.g., proximity to fire detectors). Hence, the fire detection analysis is nominally conducted on a scenario specific basis. However, in practice, the same analysis result will apply to multiple fire scenarios. The following general rules will be applied in the fire detection analysis:

- Prompt fire detection is assumed for two cases, and in these cases the time to detection is set to zero. The two cases are:
  - Postulated hot work fires so long as a hot work fire watch is posted and there is no finding of degradation against the licensee's hot work permitting and fire watch programs, or
  - Fires postulated in a fire area with a continuous fire watch posted so long as there are no findings against the fire watch and the point of fire origin (the fire ignition source) can be directly observed by the fire watch.

- For other general fire scenarios, it will be assumed that automatic fire detection systems will be the first line of defense in fire detection. That is, if a fixed fire detection system is in place, the response time of that system will determine the fire detection time for all scenarios. This time is estimated from the tables in set F in Attachment 8 as follows:
  - For fixed and transient ignition sources, except dry transformers, determine the minimum heat release rate (HRR) for detector actuation as a function of ceiling height above the source, H, and radial distance between the source and the detector, R, from Figure F.01 or F.02 of Attachment 8 to the Fire Protection SDP. For the ignition source under consideration, use Figures F.03 through F.28 to determine the shortest time for the ignition source HRR (which depends on the type of the ignition source and the severity factor) to reach or exceed the minimum HRR for detector actuation, $t_{min\ HRR}$. If the minimum HRR for detector actuation exceeds the peak HRR of the ignition source, the detector is assumed not to actuate. Otherwise, the detection time is equal to the sum of $t_{min\ HRR}$ and the total lag and response time for the applicable H and R from Figure F.29 or F.30.
  - For dry transformers, determine the minimum HRR for detector actuation as a function of ceiling height above the source, H, and radial distance between the source and the detector, R, from Figure F.01 or F.02. If the minimum HRR for detector actuation exceeds the peak HRR of the ignition source (30, 70 or 130 kW for Class A, Class B and Class C dry transformers, respectively), the detector is assumed not to actuate. Otherwise, the detection time is equal to the total lag and response time for the applicable H and R from Figure F.29 or F.30.

- For high energy arching faults (HEAFs) in switchgear, load centers and bus ducts, the amount of smoke is expected to activate any smoke detector in the area when the HEAF occurs (i.e., t=0).
- For liquid fuel spill fires, first determine the HRR of the fire from Tables A5.5 or A5.6 in Attachment 5 to the Fire Protection SDP for confined and unconfined fires, respectively. If this HRR is equal to or higher than the minimum HRR for detector actuation from Figure F.01 or F.02, the detection time is equal to the total lag and response time for the applicable H and R from Figure F.29 or F.30. If the HRR of the fire is lower than the minimum HRR for detector actuation, the detector is assumed not to actuate.
- For fires that result in the ignition of secondary combustibles, use the tables and plots in Attachment 8, set C in accordance with the guidance in Attachment 3 for fire damage state (FDS) 2 scenarios, to determine the combined HRR profile for various ignition source/cable tray configurations.

- For areas covered by a fixed fire suppression system, but not an independent fixed detection system, the activation of the suppression system should universally result in a fire alarm signal. Hence, for these cases the time to fire suppression system actuation will be taken as the fire detection time. This time will be adjusted to reflect findings against the suppression system as appropriate.
- Barring any other means of detection, manual detection (detection by plant personnel) will be considered. Manual detection will apply in fire areas that lack fixed detection, in cases where a detection system is found to be highly degraded, or in cases where the detection signal is tied to actuation of a fixed suppression system and that system is found to be highly degraded. The manual detection time is estimated based on an evaluation of factors such as room occupancy, frequency of routine entry into a room, fire watch rotation periods when applicable, general room accessibility, and fire severity.

02.01 Detection by a Continuous Fire Watch

In fire areas with a continuous fire watch posted, prompt detection of fires will be generally assumed. For a continuous fire watch (fire watch is maintained constantly within the physical room) the time to detection by the fire watch would be close to or at the time of ignition. No delay in detection is assumed, therefore:

$t_{detection} = t_{ignition} = 0$

Discretion is available to assess the effectiveness of a fire watch in the context of specific fire hazards. For example, in some fire areas a continuous fire watch posted in a particular location cannot observe the entire fire area. In this case, the fire area may be treated as continuously occupied for “hidden” fire ignition source scenarios and a nominal delay time may be assigned in fire detection for these scenarios.

If the continuous fire watch is responsible for fire detection in multiple rooms at the same time, the time to detection should be treated the same as for roving fire watches with the time of recurrence equal to the frequency with which the affected fire area is toured.

02.02 Cross-zone Detection

In some circumstances, the analysis of a cross-zone fire detection strategy is needed. In a cross-zone strategy, a minimum of two detectors, one on each of two separate detection circuits, must actuate to generate the desired signal. This is most common when the actuation of an automatic fire suppression system is tied to a fire detection signal. Common applications include: pre-action or dry-pipe fire sprinklers, water deluge systems, water curtains, and gaseous suppression systems. Generally, only one signal is required to generate an alarm, but two signals are required to activate a suppression system. In this case, analysis of the cross-zone strategy is not necessary to determine the time to detection but would be used to determine the time to suppression system activation.

Identify which detectors are assigned to each of the fire detection circuits and locate the nearest detector in each of the circuits. Of these two, the detection time is generally dominated by the detector closest to the fire ignition source (radial distance from fire center to detector location) and the suppression system activation time is dominated by the detector farthest from the ignition source. Exceptions include:

- Cases where one of the detectors is located in a different beam pocket from the fire ignition source,
- Cases where one detector has a slower time response than another (e.g., a heat detector will generally respond more slowly than a smoke detector).

Identify the detector that is the limiting factor in the time response and base the actuation analysis on the time response of that detector.

02.03 Detection by a Roving Fire Watch

Fire watches may be implemented by licensees either as a compensatory measure, or as a part of routine plant operation. All fire watches, at a minimum, provide a fire detection function. Hence, if a fire area is covered by a roving fire watch, and is not covered by an operational fixed fire detection system, then the fire watch recurrence frequency is used to estimate the time to fire detection. When crediting a fire watch with detection, the detection time is assumed to be one-half the recurrence time. The following examples illustrate this approach:

- For a roving fire watch on a 15 minute recurrence schedule (roving patrol) the time to detection by the fire watch is assumed to be ½ the duration of the roving patrol

  $t_{detection}$ = 7.5 minutes

- For an hourly fire watch:

  $t_{detection}$ = 30 minutes

The detection time by general plant personnel should also be checked consistent with the discussion immediately below. The lowest detection time dominates the process and is taken as the final estimate.

02.04 Detection by General Plant Personnel

In the absence of a fixed fire detection system (or a fire detection signal tied to actuation of a fixed fire suppression system), or given a highly degraded fixed detection system, detection of the fire will be assumed to occur by plant personnel. In many fire probabilistic risk assessments (PRAs), the default time for detection by plant personnel in normally accessible areas is assumed to be 15 minutes for simplicity since multiple fire areas are being evaluated. When a single fire area is being evaluated, the analyst should establish the extent to which personnel enter or occupy the compartment, and use that information to determine the manual fire detection time. When evaluating multiple fire areas, the default timing may be used if the analyst determines it is appropriate. If the fire area is continuously manned by plant personnel (but not by a fire watch) the fire detection time should be assumed to be 5 minutes. Assuming 5 minutes for detection of fire in the main control room (MCR) may be conservative and may be reduced, if appropriate, in Phase 3.

0609F.7-03 GUIDANCE FOR STEP 2.7.3 - FIXED FIRE SUPPRESSION SYSTEMS

General rules to be applied in the fixed suppression system analysis include the following:

- The activation of a non-degraded, fully functional fixed fire suppression system that is deemed by the analyst to be effective for the fire ignition source scenario (e.g., properly positioned to apply suppressant to the ignition source) will be assumed to disrupt the development of the fire scenario. That is, if such a system activates, it will be assumed the fire growth will be arrested and no further fire damage will occur.
- Judgments are expected to be made as to whether or not the suppression system, degraded or not, will be effective against the specific fire threat being postulated (i.e., is the system installed and configured such that a fire involving each specific fire ignition source will be controlled given actuation of the suppression system?). If it is judged that the system will not be effective (e.g., the system provides partial coverage, and a specific fire ignition source is outside the coverage zone, or the fire source is such that the fire suppression system would likely be overwhelmed), then the system will not be credited on a scenario specific basis (e.g., it might be credited in some scenarios and not in others).
- The assessment of any fixed fire suppression system includes application of nominal system reliability factors (random failure probabilities of different fixed fire suppression systems are given in Table A7.1, from NUREG/CR-6850). In those cases where the fire suppression system fails on demand, fire suppression is totally dependent on manual firefighting provisions (see Step 2.7.4). Recovery of the failed fire suppression system will not be considered in the SDP Phase 2 analysis.

Table A7.1 – Random Failure Probability (RFP) for Various Fixed Fire Suppression Systems	
Type of Fixed Fire Suppression System	RFP
Automatic Carbon Dioxide (CO_2) Systems	0.04
Automatic Halon and Halon Replacement Systems	0.05
Automatic Wet Pipe Sprinkler Systems	0.02
Automatic Deluge or Pre-action Sprinkler Systems	0.05

- If the inspection finding is against a fixed fire suppression system, the finding may result in allowing only partial or no credit to the system. The degradation may be reflected as a reduction in overall reliability or a delay in activation time. If the finding is associated with improper spacing of discharge heads, the actuation timing analysis should reflect the as-found spacing conditions. If the degradation involves less than 25% of the heads being nonfunctional, analyze discharge timing assuming that the head nearest the fire source will not function. In this case, assume that the second closest fire discharge nozzle will function and use the location of this second closest discharge nozzle in estimating response time.

- The activation time of wet pipe sprinkler systems can be determined for different fixed and transient ignition sources as a function of ceiling height above the source, H, and radial distance between the source and the detector, R, and the severity factor from Figures F.31 through F.61 in Attachment 8. The activation time of wet pipe sprinkler systems can be determined as a function of the HRR of a steady fire, and ceiling height H and radial distance R from Figures F.62 through F.67.
- If the fixed fire suppression system is automatically actuated, the time to actuation will be based on the detection time determined from Figures F.01 through F.30 in Attachment 8 as described in the previous section, 0609F.7-02.
- If the fixed fire suppression system is manually actuated, the time to actuation will be based on the estimated fire brigade response time, plus a nominal period of 2 minutes to assess the fire situation and activate the system.
- Fixed gaseous suppression systems may have discharge delay timers. The activation time for such systems will be the estimated time to a valid activation demand signal (based on engineering correlations) plus the discharge delay time.
- Gaseous fire suppression systems that are degraded due to an inability to maintain adequate concentration will be credited with providing some time delay in the progress of the fire (based on the demonstrated suppressant soak time that is available). However, manual fire response will be needed to complete fire suppression. See discussion below.
- Credit will be given to gaseous suppression systems that provide multiple discharge capacity (this typically requires manual actions to initiate a repeated discharge).
- There are a number of time delays that may apply to gaseous, deluge, pre-action sprinklers, or dry-pipe water systems. These delays must be accounted for. The time to actual discharge is the sum of the time to actuation of the demand signal plus any applicable discharge timing delays. The actuation time is determined in Step 2.7.2. The delays to be considered are:

    - For gaseous suppression systems there may be a built-in timer that delays discharge to allow for personnel evacuation. The analyst should determine this time (typically on the order of 30 seconds to 2 minutes).
    - There may be a delay for cross zoned detection system, i.e., the automatic suppression system will not begin actuation sequence until after the second detector is actuated. If cross-zoning is used, the detection time analysis should be reviewed to ensure that the cross-zone detection criteria are met. The time to generation of the actuation signal will be dominated by the slower detector (typically the detector farther from the fire ignition source).
    - Also, there may be a time lag for suppressant to get to the hazard (for example, low pressure CO_2 may have to travel an extended distance) or for pipes to fill with water prior to discharge (dry or pre-action systems). If the delay is not known, use 1 minute. If it is known, the delay should typically be between 30 and 60 seconds.

0609F.7-04 GUIDANCE FOR STEP 2.7.4 - PLANT PERSONNEL AND THE MANUAL FIRE BRIGADE

Fire suppression by manual firefighting is assessed based on historical evidence provided by fire event data. In Step 2.7.4, one of the pre-calculated fire duration curves must be selected to be applied to each scenario. The curves are presented at the end of this attachment as Figures A7.1 thru A7.13. The same curve may be used for multiple scenarios, if appropriate, or different curves may be chosen for each scenario.

Additional analyses of the raw fire event data is neither expected nor required as a part of the Phase 2 SDP analysis; rather, one of the pre-calculated curves should be applied to each fire scenario being analyzed based on the fire type and/or location.

In no case should an attempt be made to generate a new fire duration curve to suit a particular analysis. The various pre-calculated curves for specific conditions should cover the vast majority of fire scenarios. If none of these specific condition curves provide a reasonable match to the conditions of the fire scenario, the "all events" curve should be applied. The "all events" curve represents a composite analysis of all of the events that went into each of the other individual fire duration curves.

Note that some of the curves apply to fires in a particular location (e.g., the MCR or containment). However, most are applicable to a particular fire ignition source scenario. The cases that are covered by these pre-calculated curves are:

1. Turbine Generator (T/G) Fires
2. HEAFs
3. Outdoor Transformer Fires
4. Flammable Gas Fires
5. Oil Fires
6. Electrical Fires
7. Transient Fires
8. PWR Containment At-Power (AP) Fires
9. Containment Low Power/Shutdown (LPSD) Fires
10. Welding Fires
11. MCR Fires
12. Cable Fires
13. All Events

The mean non-suppression probability curves for each of these fire types are presented at the end of this attachment (based on curves from NUREG-2262 for HEAFs, NUREG 2178, Vol. 2 for MCR fires and NUREG-2169 for the other curves). Table A7.2 presents the same information in a tabulated format. The tabulated values of NSP_{manual} should address most situations. As an alternative, the NSP_{manual} value can be calculated using the following formula:

$$NSP_{manual} = \exp[-\lambda \times t] \qquad [7\text{-}1]$$

where:

λ = mean rate constant (1/min) for the given fire type
$t = T_{damage} - T_{detection}$

‘t’ is the time available to suppress the fire that remains after subtracting the detection and response time from the original duration until irreparable component damage occurs, relative to time zero (i.e., when the fire starts), in minutes. The values for ‘λ’ for each of the 13 fire type/location categories are provided in the last row of the NSP_{manual} table (Table A7.2).

Table A7.2 – Non-suppression Probability Values for Manual Fire Fighting Based on Fire Duration (Time to Damage after Detection) and Fire Type Category

T_{damage} - $T_{detection}$ ** (min)	Mean manual non-suppression probability curve values - NSP_{manual}												
	T/G Fires	HEAFs	Outdoor Transformers	Flammable Gas	Oil Fires	Electrical Fires	Transient Fires	PWR Containment (AP)	Containment (LPSD)	Welding	MCR	Cable Fires	All Events
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	0.879	0.878	0.879	0.843	0.641	0.614	0.572	0.687	0.595	0.584	0.146	0.502	0.715
10	0.773	0.771	0.772	0.710	0.411	0.377	0.328	0.472	0.355	0.341	0.021	0.252	0.511
15	0.680	0.677	0.678	0.599	0.263	0.232	0.188	0.325	0.211	0.200	0.003	0.126	0.365
20	0.598	0.595	0.596	0.505	0.169	0.142	0.108	0.223	0.126	0.117	*	0.063	0.261
25	0.526	0.522	0.524	0.425	0.108	0.087	0.062	0.153	0.075	0.068	*	0.032	0.187
30	0.462	0.458	0.460	0.359	0.069	0.054	0.035	0.105	0.045	0.040	*	0.016	0.133
35	0.407	0.403	0.404	0.302	0.044	0.033	0.020	0.072	0.027	0.023	*	0.008	0.095
40	0.358	0.353	0.355	0.255	0.028	0.020	0.012	0.050	0.016	0.014	*	0.004	0.068
45	0.314	0.310	0.312	0.215	0.018	0.012	0.007	0.034	0.009	0.008	*	0.002	0.049
50	0.277	0.273	0.274	0.181	0.012	0.008	0.004	0.024	0.006	0.005	*	0.001	0.035
55	0.243	0.239	0.241	0.153	0.007	0.005	0.002	0.016	0.003	0.003	*	*	0.025
60	0.214	0.210	0.212	0.129	0.005	0.003	0.001	0.011	0.002	0.002	*	*	0.018
65	0.188	0.185	0.186	0.108	0.003	0.002	*	0.008	0.001	0.001	*	*	0.013
70	0.165	0.162	0.164	0.091	0.002	0.001	*	0.005	*	*	*	*	0.009
75	0.145	0.142	0.144	0.077	0.001	*	*	0.004	*	*	*	*	0.007
80	0.128	0.125	0.126	0.065	*	*	*	0.002	*	*	*	*	0.005
85	0.112	0.110	0.111	0.055	*	*	*	0.002	*	*	*	*	0.003
90	0.099	0.096	0.098	0.046	*	*	*	0.001	*	*	*	*	0.002
95	0.087	0.085	0.086	0.039	*	*	*	*	*	*	*	*	0.002
100	0.076	0.074	0.075	0.033	*	*	*	*	*	*	*	*	0.001
* Value is less than 0.001. Screen using NSP_{manual} = 0.001 or use formula to calculate actual value.													
Mean Rate Constant (1/min)	0.026	0.026	0.026	0.034	0.089	0.098	0.111	0.075	0.104	0.107	0.385	0.138	0.067

** This must include the time for manual response

0609F.7-05 GUIDANCE FOR STEP 2.7.5 - PROBABILITY OF NON-SUPPRESSION

The purpose of Step 2.7.5 is to estimate the overall probability of fire suppression failure. Failure in this context means that suppression was not achieved before the FDS of interest is reached. If the FDS is reached before suppression, then in the SDP context, fire suppression has failed to prevent fire-induced damage consistent with the postulated FDS scenario.

05.01 Fixed Fire Suppression Systems

Both the estimates of fire damage time and the time to fixed suppression system suppressant discharge contain considerable uncertainty. Hence, the probability that the fire suppression system suppresses the fire prior to critical damage is not based on a simple comparison of the time to damage versus time to suppressant discharge. Rather, a probability of non-suppression is assigned based on the “margin” between time to damage and time to suppressant discharge.

The time margin/likelihood relationship is described in the table below. The first column presents the difference in minutes between the time to damage and the time to suppressant discharge. If the two times are close, or damage occurs before suppressant discharge, a high likelihood of damage will be assumed (NSP approaches 1.0). If the time to suppression is shorter than the time to damage, the NSP value decreases reflecting a higher likelihood of suppression success. As the time difference reaches 10 minutes, NSP approaches zero. Note that in quantification, the likelihood that the fire suppression system fails on demand is explicitly treated.

Table A7.3 – Non-suppression Probability for Fixed Fire Suppression Systems Based on the Absolute Difference Between Damage Time and Suppression Time

Time Delta: (t_{damage} - $t_{suppress}$)	NSP_{fixed}
Negative time up to 1 minute	1.0
> 1 minute to 2 minutes	0.95
> 2 minutes to 4 minutes	0.80
> 4 minutes to 6 minutes	0.5
> 6 minutes to 8 minutes	0.25
> 8 minutes to 10 minutes	0.1
> 10 minutes	0.0

05.02 Treatment for Degraded Gaseous Fire Extinguishment Systems - Inadequate Soak Time

One specific type of degradation that may be identified for gaseous fire extinguishment systems involves the inability of the system to maintain the design concentration of fire suppressant for a sufficient time to assure the complete extinguishment of a deep-seated fire. The required suppressant concentration and maintenance time are established by the system design criteria. This degradation is commonly referred to as an “inadequate soak time.” This can be an issue for Halon and CO_2 fire extinguishment systems, as well as for other gaseous suppression systems (e.g., Halon replacements).

For the inadequate soak time degradation case, special consideration is required to estimate the NSP. So long as the system can deliver an initial concentration that meets the design criteria, then some credit is given to the system for disrupting the fire growth and spread process. For this case, the following assumptions are made:

- Fires involving cables or other electrical and electronic components will be deep-seated.
- If a gaseous suppression system cannot maintain adequate concentration for a sufficient time to assure fire extinguishment (per design specifications), manual firefighting must respond and must achieve final fire suppression.
- The fire will be held in check during the time that the fire suppressant concentration is maintained at design level.
- Assuming that the system actuation is timely (i.e., adequate margin between discharge time and the estimated fire damage time) the systems effectiveness will be reflected as a corresponding delay in the estimated time to fire damage. As a result, the manual fire brigade is given additional time to effectively respond to the fire.
- Upon dissipation of suppressant, the fire will re-flash and the fire growth and damage process will pick up where it left off.

The quantification process for this case is as follows:

- Select the appropriate manual suppression fire duration curve corresponding to the fire ignition source.
- Estimate the time to fire detection in the usual manner. In addition to any other fire detection capability, assume that a valid actuation signal for the gaseous suppression system will trigger a fire alarm.
- Using the fire damage time calculated in Step 2.7.1 (t_{damage}), and the estimated time to fire detection ($t_{detection}$) from Step 2.7.2, calculate the value of NSP_{manual} from the selected fire duration curve in the usual manner (i.e., using t_{damage} - $t_{detection}$ as the time available for manual suppression).
- Estimate discharge/actuation time ($t_{suppress}$) for the gaseous fire extinguishment system in usual manner. Recall that actuation will either be automatic or manual, and that the pre-discharge alarm/warning time must be included.
- Calculate the time margin (“time delta”) between the actuation time and fire damage time in the normal manner:

$$\text{Time Delta} = (t_{damage} - t_{suppress}) \quad [7\text{-}2]$$

- Use the general NSP_{fixed} probability table based on “Time Delta” to assess the likelihood that the suppression system actuation is timely in comparison to the estimated fire damage time.
- If the NSP_{fixed} value assigned is 1.0, then the gaseous system will not be credited. In this case use the value of NSP_{manual} as calculated previously as $NSP_{scenario}$ and the analysis is complete.
- If the NSP_{fixed} value is less than 1.0, then the gaseous system will be credited. Continue this analysis to estimate $NSP_{scenario}$.

- Calculate a modified fire damage time as follows:

$$t_{damage\_new} = t_{damage} + t_{maintain\_gas} \quad [7\text{-}3]$$

where $t_{maintain\_gas}$ is the length of time that the desired gaseous suppressant design concentration can be maintained.

- Using t_{damage_new} (i.e., in place of t_{damage}) and $t_{detection}$, estimate NSP_{gas_manual} based on the selected manual fire suppression fire duration curve. That is, calculate $[t_{damage\_new} - t_{detection}]$ as the modified time available for manual suppression, and estimate NSP_{gas_manual} in the manner normally applied to NSP_{manual}.

- Estimate $NSP_{scenario}$ by combining NSP_{fixed}, NSP_{manual}, and NSP_{gas_manual} using the following equation:

$$\begin{aligned} NSP_{scenario} = {} & [0.05 + 0.95 \times NSP_{fixed}] \times NSP_{manual} \\ & + [0.95 \times (1 - NSP_{fixed}) \times NSP_{gas\_manual}] \end{aligned} \quad [7\text{-}4]$$

The calculation of $NSP_{scenario}$ combines three cases. In the first two cases the fire suppression system either does not work (the 5% unreliability/unavailability factor) or its discharge is not timely (NSP_{fixed}), and the fire brigade fails to suppress the fire. This is reflected in the first term on the right-hand side of the equation. In the third case, the fire suppression system does not fail randomly (the 95% reliability/availability factor), discharge of the fire suppression system is timely (1 - NSP_{fixed}), and the fire brigade responds and fails to suppress the fire following dissipation of the fire suppression concentration (NSP_{manual}).

- Verify that ($NSP_{scenario} \leq NSP_{manual}$). As in other cases, the manual brigade response given the original fire damage time is the minimum credit given to fire suppression for any scenario. If ($NSP_{scenario} > NSP_{manual}$), then reset ($NSP_{scenario} = NSP_{manual}$).

05.03 Manual Fire Suppression

The following process is repeated for each fire scenario:

- Subtract the fire detection time (which must include the time for manual response) from the fire damage time.
- Using the appropriate fire duration curve, read across the x-axis to the time difference from the above step.
- Transfer up to the corresponding point of the fire duration curve and read across to the left to estimate the NSP_{manual}.

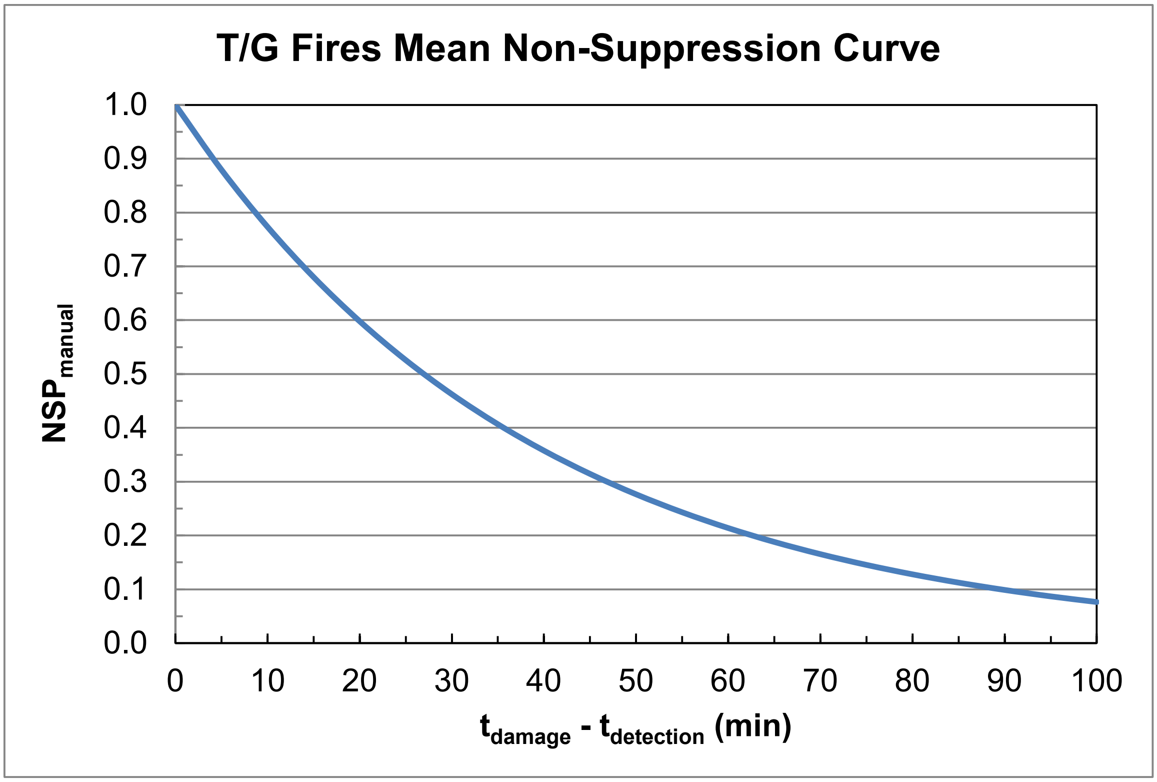

Figure A7.1 T/G Fires Mean Non-Suppression Curve

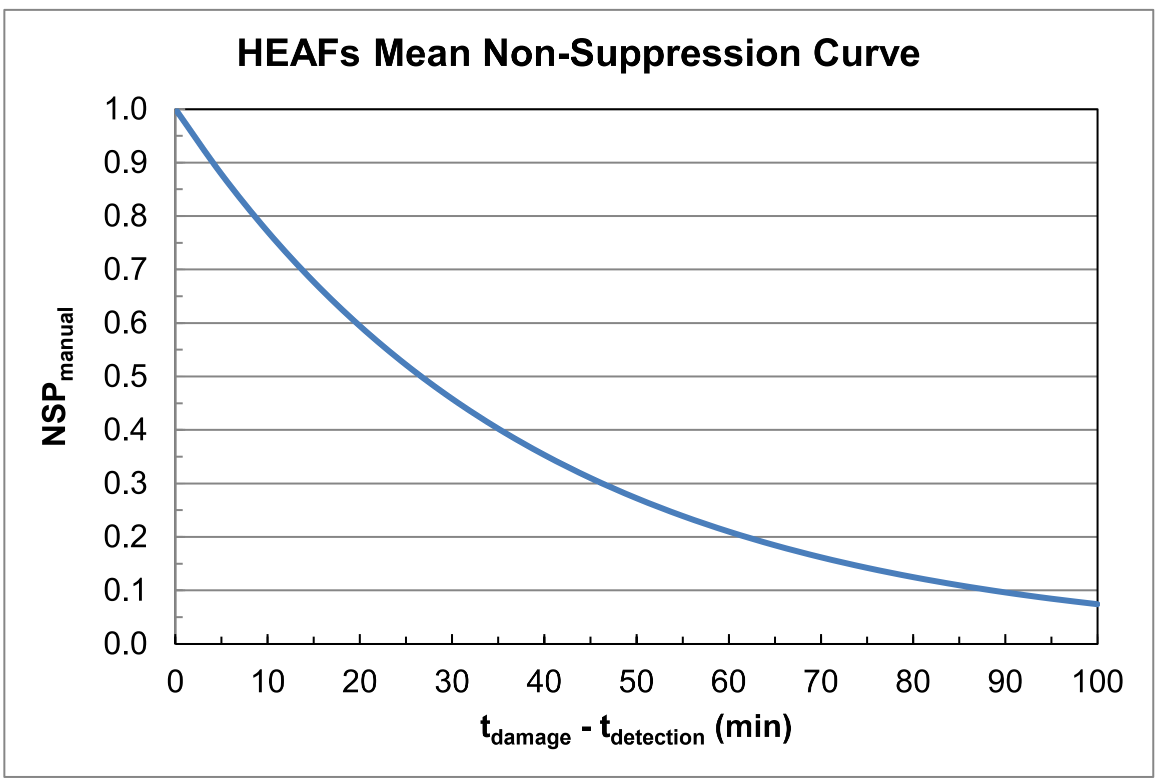

Figure A7.2 HEAFs Mean Non-Suppression Curve

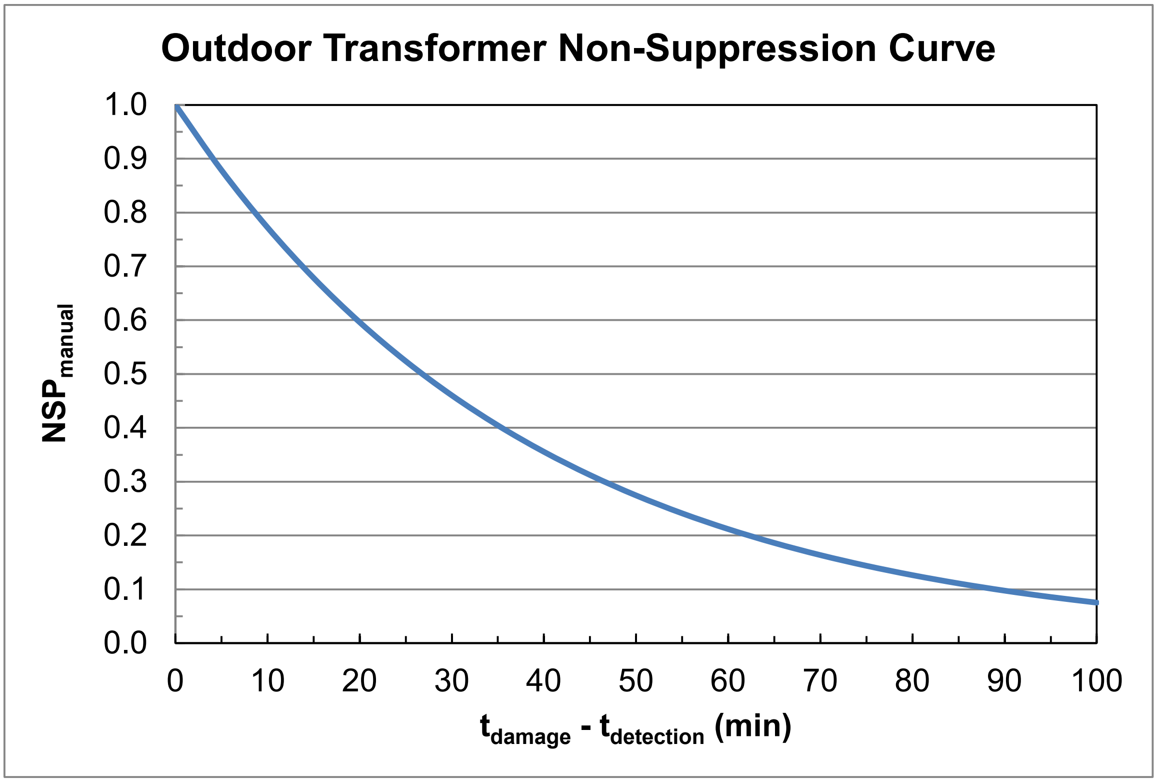

Figure A7.3 Outdoor Transformer Mean Non-Suppression Curve

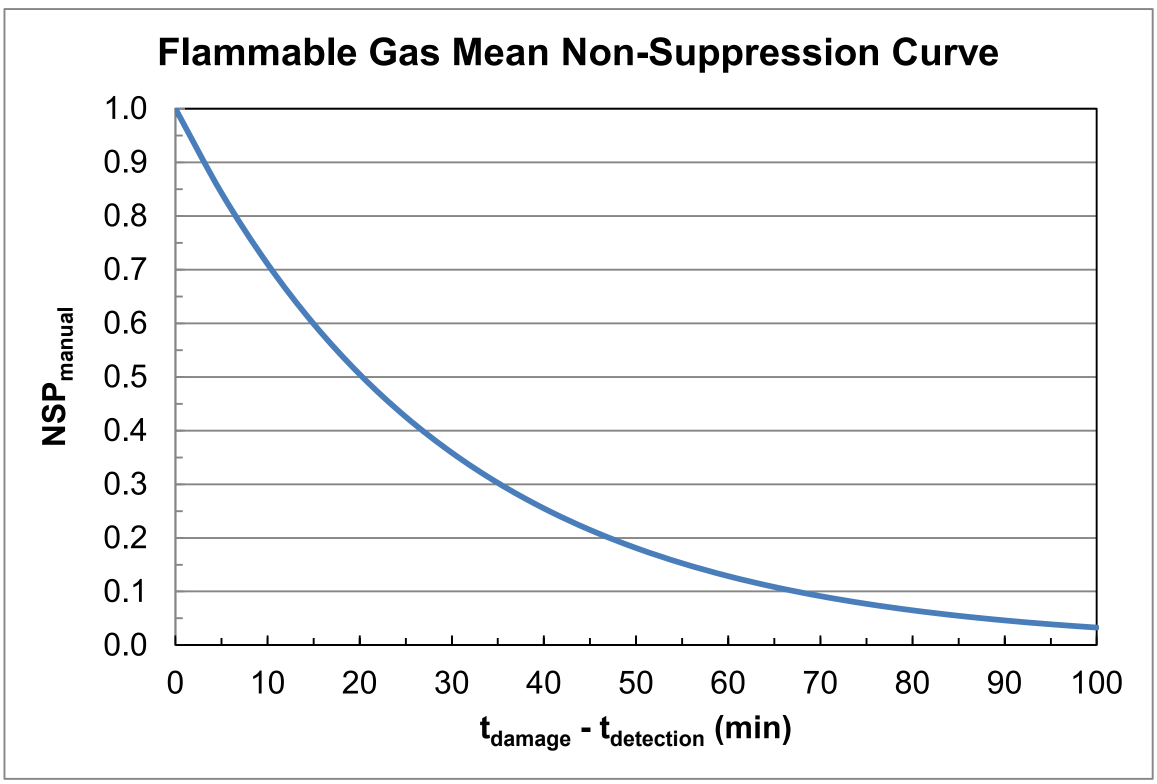

Figure A7.4 Flammable Gas Mean Non-Suppression Curve

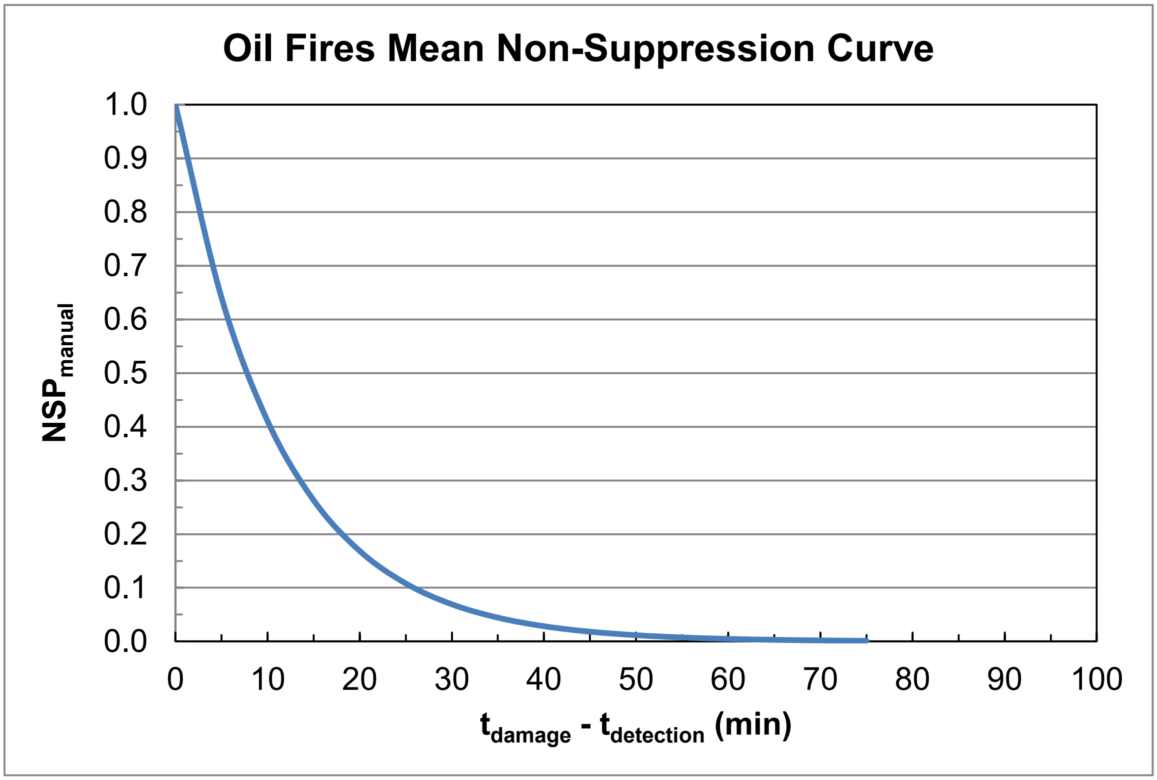

Figure A7.5 Oil Fires Mean Non-Suppression Curve

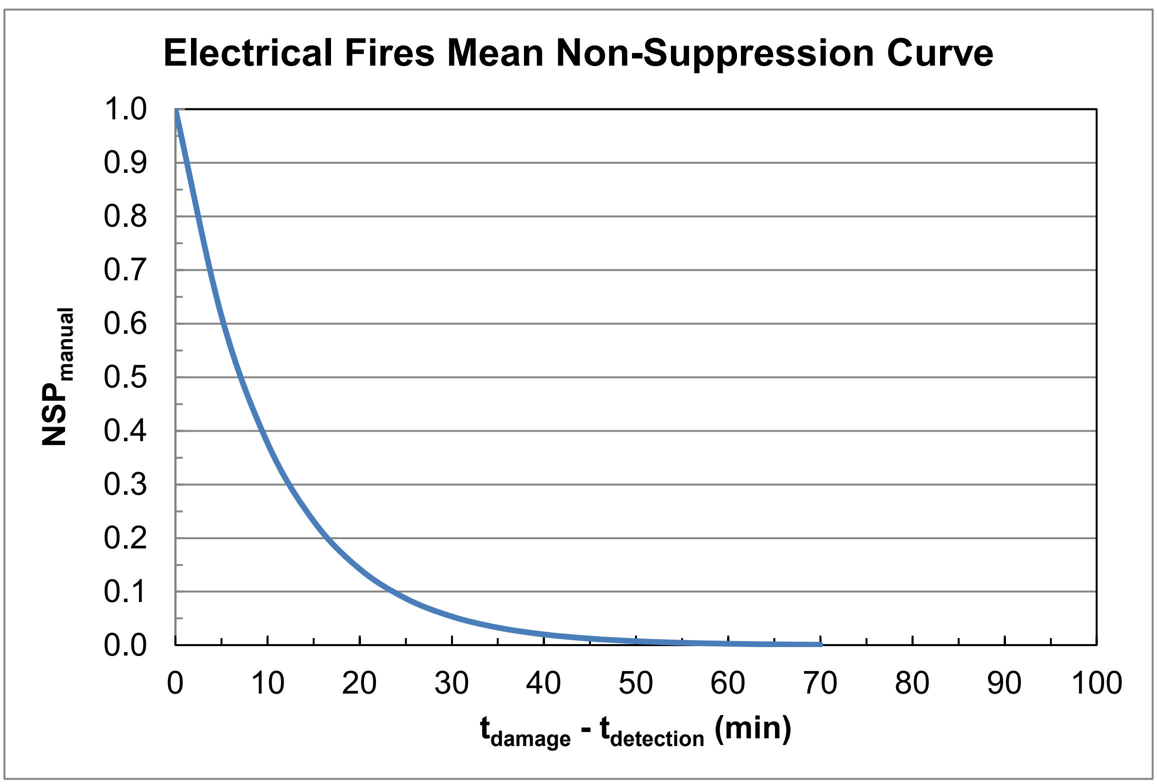

Figure A7.6 Electrical Fires Mean Non-Suppression Curve

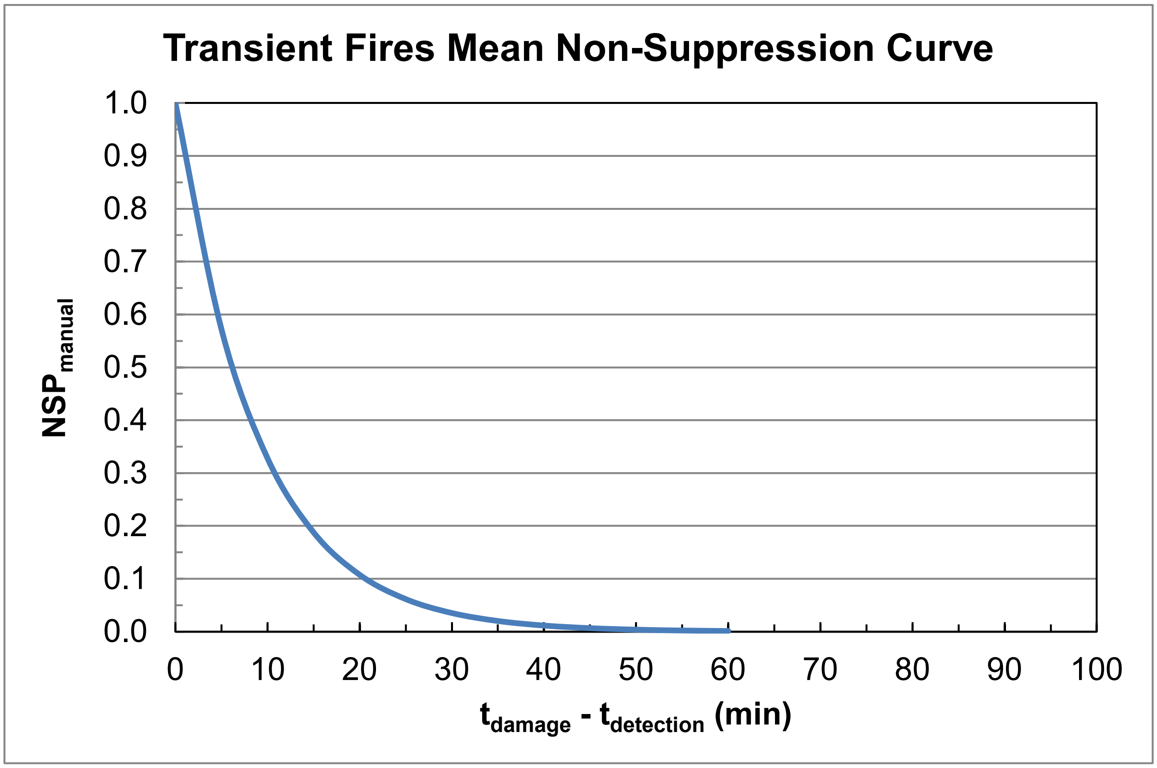

Figure A7.7 Transient Fires Mean Non-Suppression Curve

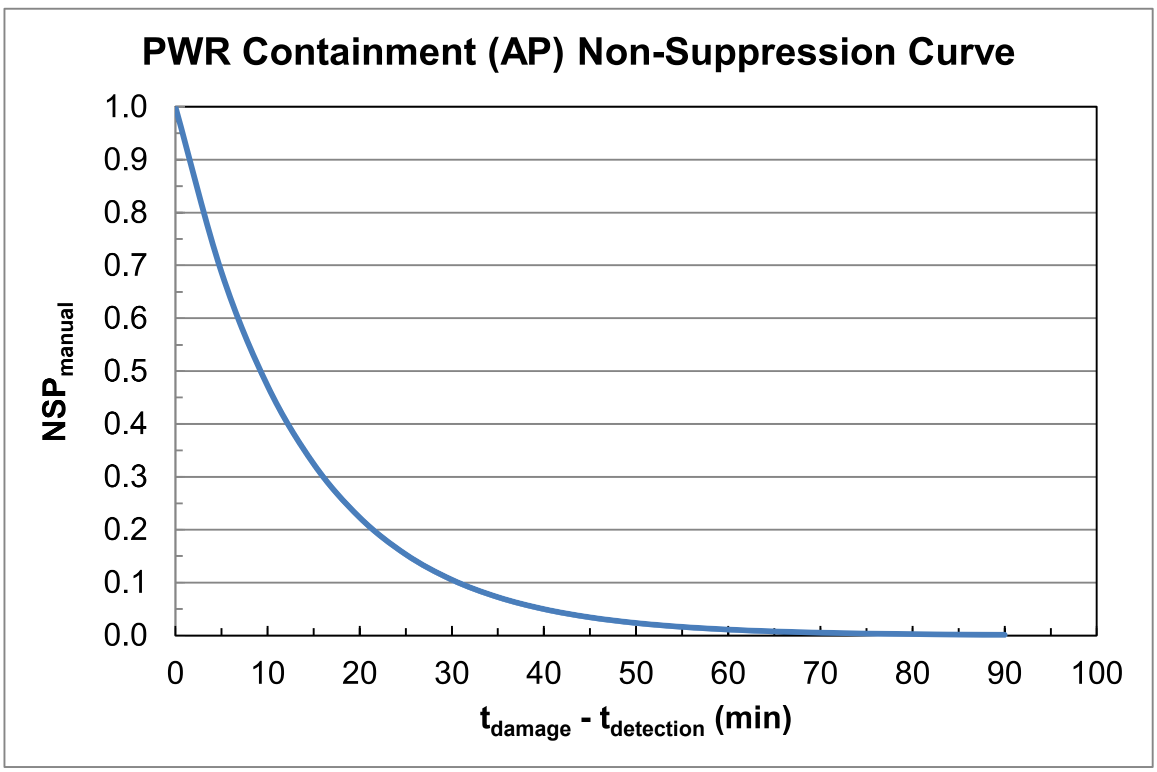

Figure A7.8 PWR Containment (AP) Non-Suppression Curve

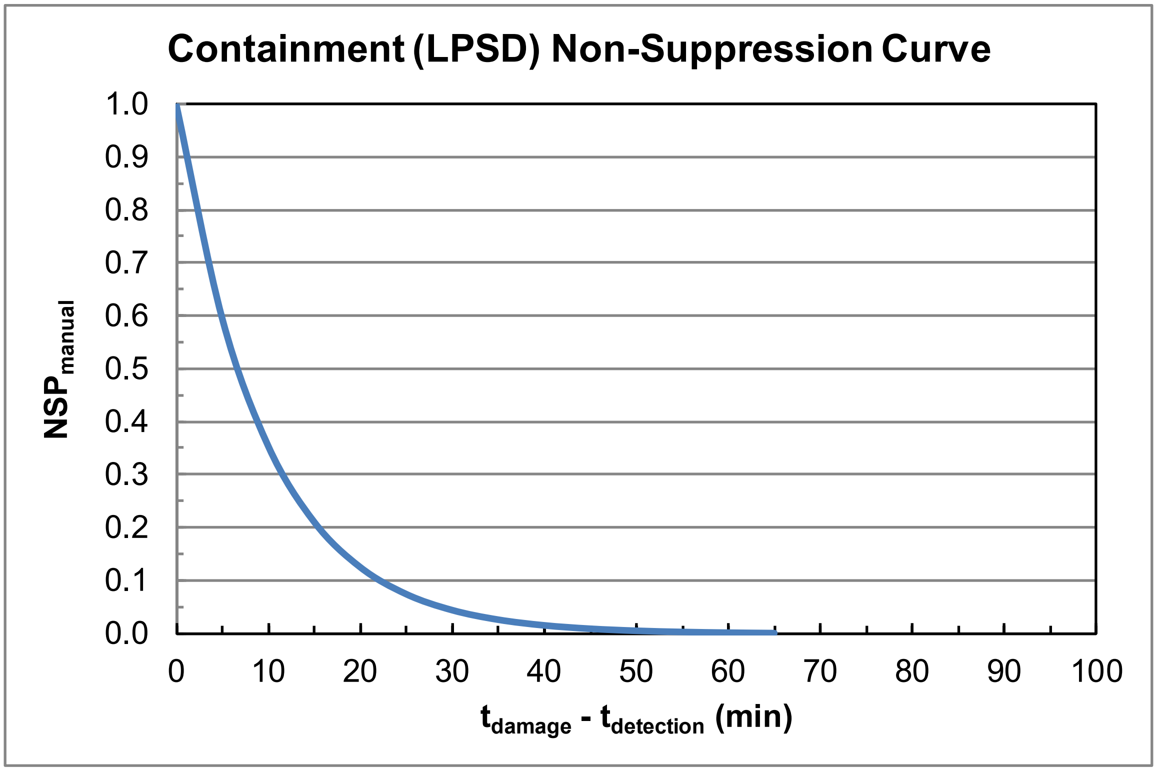

Figure A7.9 Containment (LPSD) Non-Suppression Curve

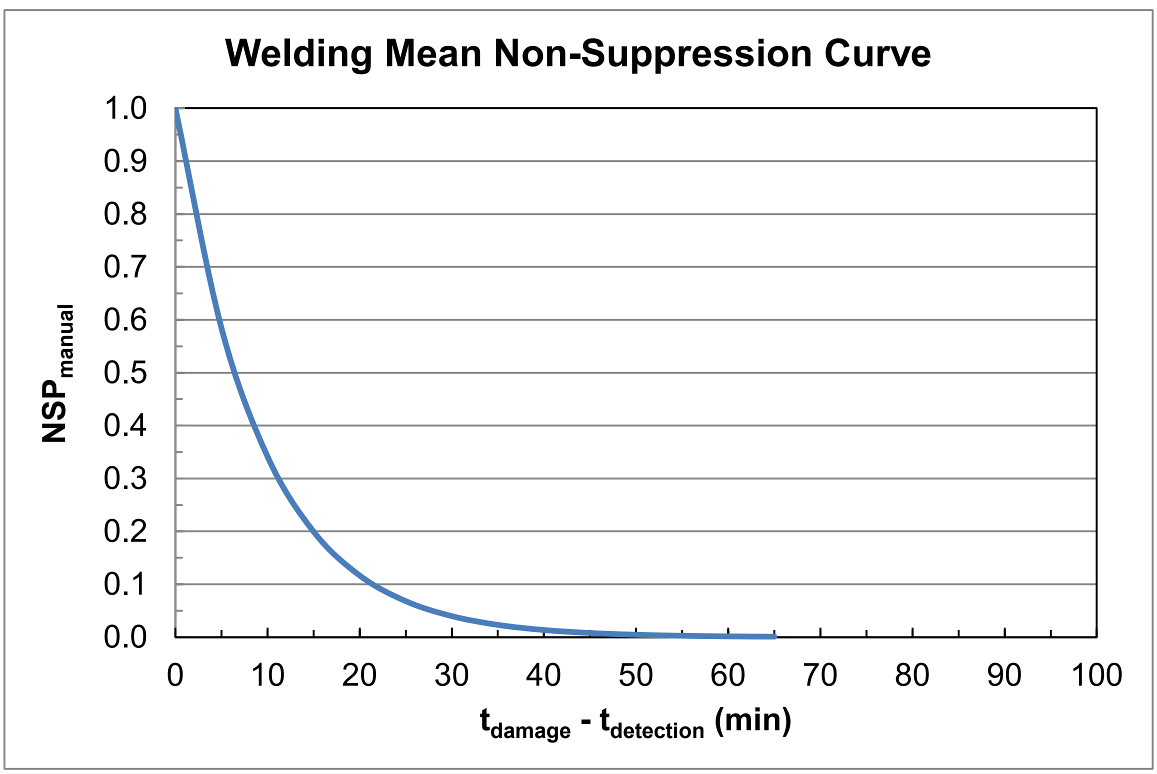

Figure A7.10 Welding Mean Non-Suppression Curve

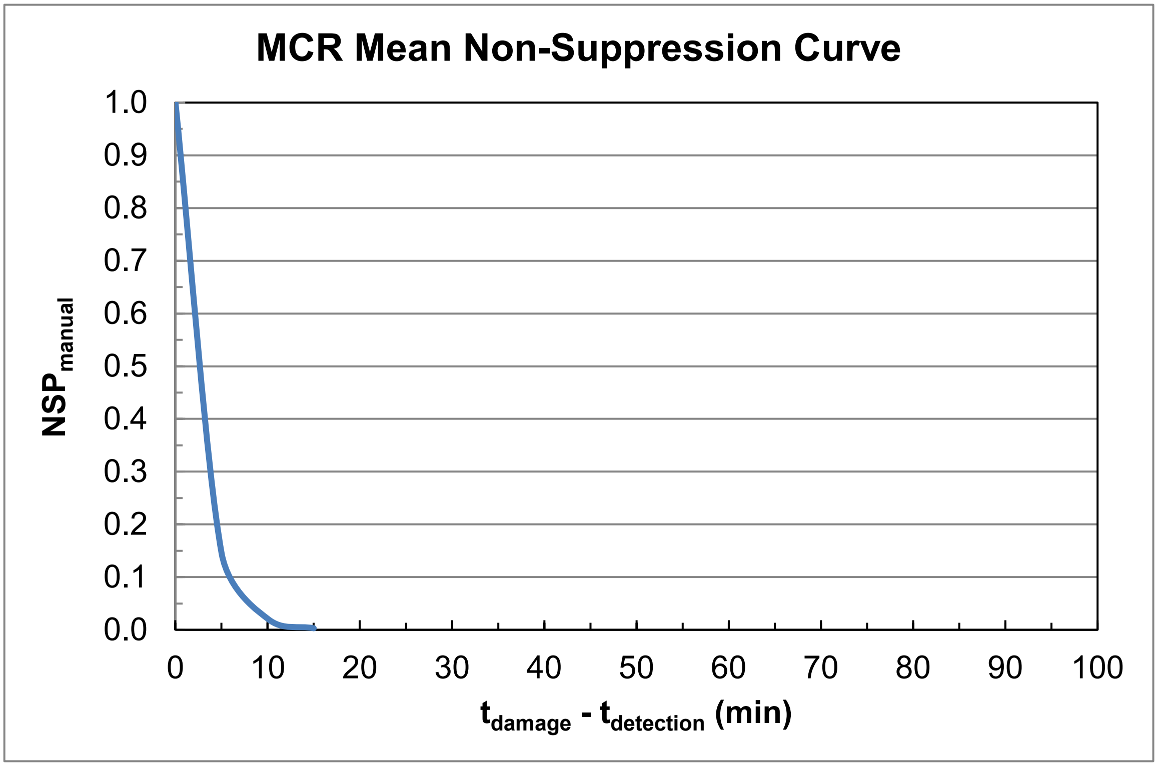

Figure A7.11 MCR Mean Non-Suppression Curve

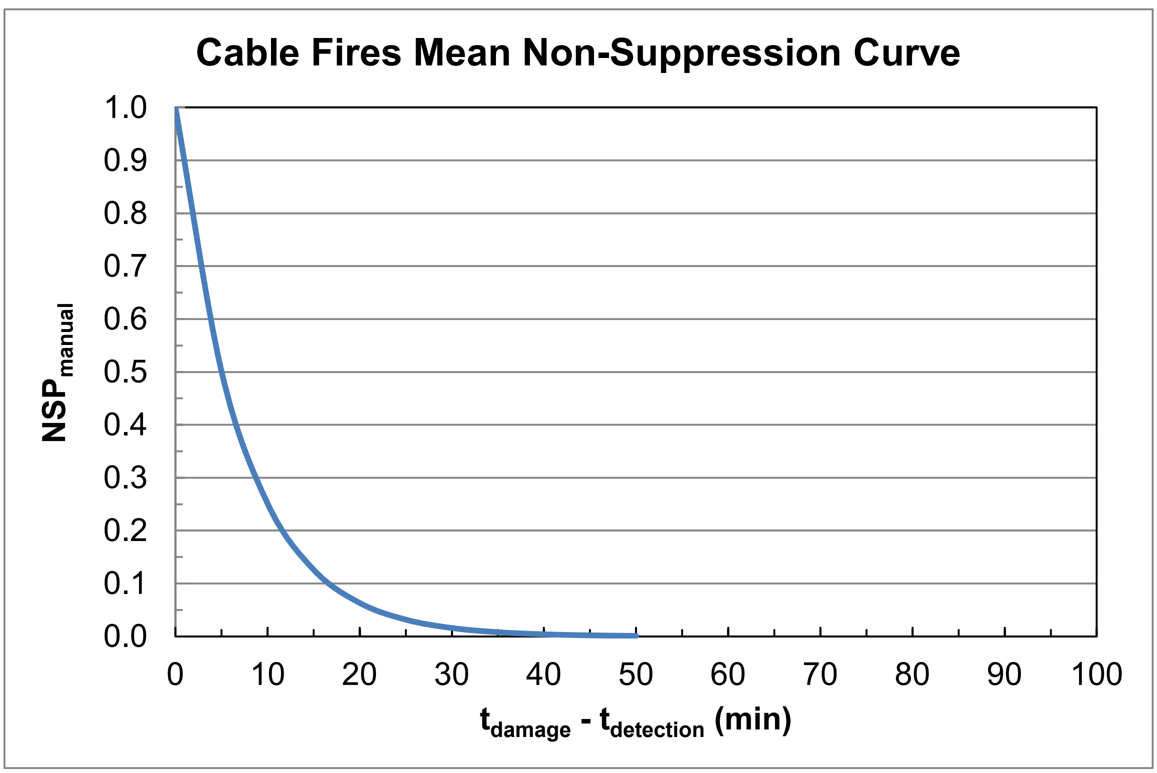

Figure A7.12 Cable Fires Mean Non-Suppression Curve

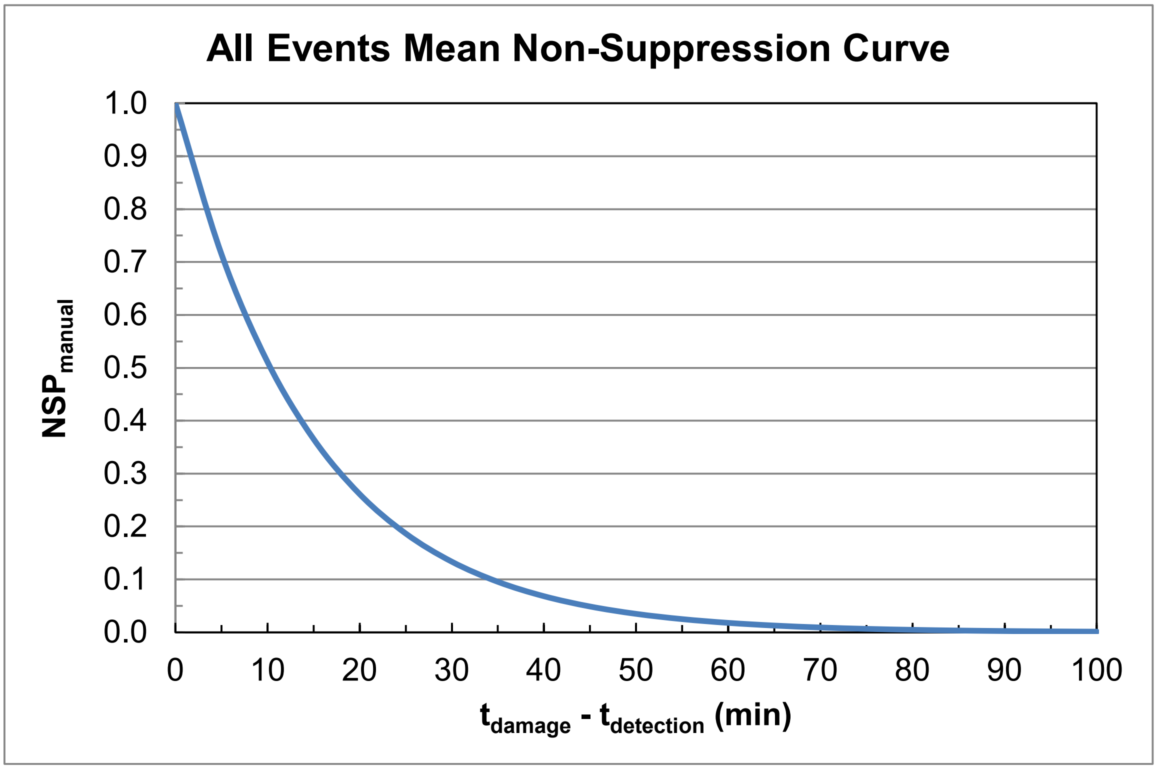

Figure A7.13 All Events Mean Non-Suppression Curve

END

Attachment 1: Revision History for IMC 0609, Appendix F Attachment 7

Commitment Tracking Number	Accession Number Issue Date Change Notice	Description of Change	Description of Training Required and Completion Date	Comment Resolution and Closed Feedback Form Accession Number (Pre-Decisional, Non-Public)
	ML041700310 05/28/2004 CN 04-016	IMC 0609, App F, Att 7 “Guidance for Fire Growth and Damage Time Analysis,” is added to provide guidance for conducting fire growth and damage time analysis.	None	N/A
	ML050700212 02/28/2005 CN 05-007	IMC 0609, App F, Att 7 “Guidance for Fire Growth and Damage Time Analysis,” is revised to expand Tables A7.1 and A7.2 to provide a better breakout of time to failure using temperature ranges; add additional applicable correlations from NUREG-1805; expand the FDS2 guidance on damaging hot gas layer conditions for unprotected and protected cables.		
	ML17089A425 DRAFT CN 17-XXX	IMC 0609, App F, Att 7 “Guidance for Fire Growth and Damage Time Analysis,” is deleted and replaced with the information that was previously in 0609 App F Att 8 “Guidance for Fire Non-Suppression Probability Analysis.” Guidance for fire growth and damage time analysis is no longer necessary because pre-solved tables and plots are now being used in Phase 2 to replace the use of the Fire Dynamics Tools Spreadsheets. The non-suppression probability guidance is revised for consistency with the guidance in NUREG/CR-6850 and superseding guidance in NUREG-2169. CA Note sent 7/18/17 for information only, ML17191A681. Issued 10/11/17 as a draft publicly available document to allow for public comments.	November 2017	ML17093A187

Commitment Tracking Number	Accession Number Issue Date Change Notice	Description of Change	Description of Training Required and Completion Date	Comment Resolution and Closed Feedback Form Accession Number (Pre-Decisional, Non-Public)
	ML18087A412 05/02/18 CN 18-010	Revised to incorporate public comments to add figure numbers to non-suppression curves, add references to other attachments, and clarify fire detection timing by plant personnel. Re-issued with new accession number in order to issue as an official revision after receipt of public comments.	Gap training covering changes to the procedure completed November 2017	ML17093A187
	ML24150A357 09/05/24 CN 24-024	This revision includes updating IMC 0609 Appendix F, its associated attachments, and the basis document to incorporate updated guidance for modeling transient fires per NUREG-2233, high energy arching faults per NUREG-2262, and electrical enclosure, electric motor, dry transformer and main control room fires per NUREG-2178 Volume 2. This attachment was revised to incorporate guidance for dry transformers and to update the non-suppression probabilities/curves for high energy arching faults and the main control room using the guidance in NUREG-2262 and NUREG-2178, Vol. 2, respectively.		ML24155A262