

FAQ Title More Realistic Contained Fire Duration Limits

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Purpose of FAQ:

This FAQ assigns a realistic duration to contained fires (i.e., fires contained to the ignition source, and that do not involve secondary combustibles). Further, this FAQ reduce the Non-Suppression Probability (NSP) floor from 1E-3 to 1E-5.

Relevant NRC document(s):

NUREG/CR-6850
NUREG/CR-6850 Supplement 1 (FAQ 08-0050)
NUREG 2169
NUREG 1792
EPRI 1021081

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

NUREG/CR-6850 Supplement 1, "Fire Probabilistic Risk Assessment Methods Enhancements," Chapter 14, page 14-10, Table 14-1

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NUREG-2169, "Nuclear Power Plant Fire Ignition Frequency and Non-Suppression Probability Estimation Using the Updated Fire Events Database" Section 5.2, pg 5-4, paragraph 1

Circumstances requiring interpretation or new guidance:

The guidance in NUREG/CR-6850 Supplement 1, Table 14-1 and NUREG-2169, Section 5.2 states that the minimum value for manual Non-Suppression-Probability (NSP) is 1E-03, regardless of how much time is available to target damage. However, no basis was provided for this limiting value. This floor artificially limits the insights provided by the empirical data used to develop the NSP curves.

Additionally, the fire durations applied to various fire scenarios are overly conservative when compared to realistic fire durations for contained fire scenarios (i.e., no secondary combustible ignition).

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

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

A two-part resolution is proposed, depending on whether the fire scenario involves secondary combustibles. For fire scenarios that ignite secondary combustibles, the minimum non-suppression probability would be changed from 1E-03 to 1E-05, based on the application of the same non-suppression curve for a longer duration. For fire scenarios that do not ignite any secondary combustibles, the fire duration is limited to the 98th percentile confidence point associated with the NSP curve. In other words, the 98th percentile fire duration can be back-calculated from the manual NSP, these durations are provided below, in Table 1. This does not apply to high energy arcing faults. High energy arcing faults are modeled as igniting secondary combustibles (NUREG/CR-6850 Section M.4.2).

The NSP data contained in NUREG-2169 indicates that long duration fires are primarily due to the ignition of secondary combustibles. There is a wide range of data indicating that long duration fires do not occur without the ignition of secondary combustibles. The suppression curves already allow the possibilities of fire durations well beyond what has been experienced.

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For example, the fire events data shows that the longest duration control room fire is 10 minutes. However, the NUREG-2169 manual non-suppression probability (NSP) curves allow small heat release rate fires in the control room to last 60 minutes and requires that the NSP be limited to 1E-03. For a fire in the control room, the NSP value of 1E-03 is reached with a fire lasting 21.3 minutes. These scenarios can contribute to risk, but are not credible. Manual suppression is performed by fire brigade crews, typically with personnel from operations and a team lead capable of calling additional resources, as required.

The revised longest duration for contained fires (i.e. no secondary combustibles ignited) would result in revising the fire duration and NSP values in NUREG-2169, Table 5-3 to those in Table 1, below.

Table 1: Updated Maximum Fire Duration Based on NUREG-2169 Suppression Rates

NUREG 2169				
<u>Suppression Curve</u>	<u>Number of Events</u>	<u>Revised Total Duration (mins)</u>	<u>Revised Mean Suppression Rate (1/min)</u>	<u>98% Confidence Fire Duration is Less than</u>
T/G fires	30	1167	0.026	152
Control room	12	37	0.324	12
PWR containment	3	40	0.075	52
Containment (LPSD)	31	299	0.104	38
Outdoor transformers	24	928	0.026	151
Flammable gas	8	234	0.034	114
Oil fires	50	562	0.089	44
Cable fires	4	29	0.138	28
Electrical fires	177	1815	0.098	40
Welding fires	52	484	0.107	36
Transient fires	43	386	0.111	35
All fires	442	6583	0.067	58

If the actual combustible load is known, then it may be appropriate to use a much shorter duration than these maximum durations listed. As these limits are based on fire brigade control of a fire scenarios, the shortest limiting duration should be applied be it based on combustible load, other empirical information, or brigade response.

Sample Abandonment Reduction Example with a Contained Fire

Control Room Abandonment Improvement (w NUREG 2178 Credited)									
<u>Bin, i</u>	<u>HRR (kW)</u>	<u>SF</u>	<u>Time To Abandonment</u>	<u>Duration limited</u>	<u>SF*NSP w duration limit</u>	<u>Contribution w Duration Limit</u>	<u>NSP with Floor</u>	<u>SF*NSP with Floor</u>	<u>Contribution with Floor</u>
1	34	0.161	33	0	0.00E+00	0.00%	1.00E-03	1.61E-04	16.0%
2	130	0.554	25	0	0.00E+00	0.00%	1.00E-03	5.54E-04	55.3%
3	221	0.205	22	0	0.00E+00	0.00%	1.00E-03	2.05E-04	20.5%
4	310	0.059	19.1	0	0.00E+00	0.00%	1.00E-03	5.92E-05	5.9%
5	400	1.61E-02	17.25	0	0.00E+00	0.00%	1.00E-03	1.61E-05	1.6%
6	490	4.03E-03	15.67	0	0.00E+00	0.00%	1.00E-03	4.03E-06	0.4%
7	579	9.72E-04	13.8	0	0.00E+00	0.00%	1.00E-03	9.72E-07	0.1%
8	669	2.35E-04	12.59	0	0.00E+00	0.00%	1.00E-03	2.35E-07	0.0%
9	759	5.47E-05	11.82	0.0217	1.19E-06	72.98%	0.0217	1.19E-06	0.12%
10	848	1.25E-05	11.3	0.0257	3.21E-07	19.73%	0.0257	3.21E-07	0.03%
11	938	2.90E-06	10.76	0.0306	8.88E-08	5.46E-02	0.0306	8.88E-08	8.86E-05
12	1,028	6.53E-07	10.46	0.0337	2.20E-08	1.35E-02	0.0337	2.20E-08	2.20E-05
13	1,118	1.46E-07	10.01	0.0390	5.71E-09	3.51E-03	0.0390	5.71E-09	5.70E-06
14	1,208	3.25E-08	9.68	0.0434	1.41E-09	8.69E-04	0.0434	1.41E-09	1.41E-06
15	1,462	9.24E-09	8.64	0.0608	5.62E-10	3.45E-04	0.0608	5.62E-10	5.61E-07
				Pr(ab)	1.63E-06		Pr(ab)	1.00E-03	

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

Replace the guidance in NUREG/CR-6850 Supplement 1, Table 14-1 and NUREG-2169, Section 5.2 stating that the minimum value for manual Non-Suppression-Probability (NSP) is 1E-03 with 1E-05.

Limit the duration of contained fires to the 98% confidence NSP duration. This should be noted in NUREG-2169 Table 5.2 when updated. If the actual combustible load is known, then it may be appropriate to use a much shorter duration than these maximum durations listed. As these limits are based on fire brigade control of a fire scenarios, the limiting duration should be applied be it based on combustible load or brigade response.