Suppression

ELMFIRE includes experimental initial attack and extended attack suppression models. These models, both disabled by default, can be configured from the `&SUPPRESSION` namelist group.

Initial Attack

The approach used here to quantify initial attack probability of containment is based on the analysis of `Hirsch et al. <https://academic.oup.com/forestscience/article/44/4/539/4627517`_ who leveraged expert judgment to quantify initial attack effectiveness as a function of fire size and head fire fireline intensity, *i.e.* intensity at the main advancing fire front, at the time of initial attack commencement. The authors developed an expression for probability of containment (*POC*) as a function of fire size (*A*) and fireline intensity (*I*) which is given in the equation below:

$$POC = \frac{E}{1+E} lnE = 4.6835 - 0.7043A - 0.00041I - 0.000052AI$$

In the equation above, A is in hectares and I is in kW/m. Since trends in probability of containment are not immediately apparent upon inspection of the equation, probability of containment calculated from the equation is tabulated in the following table as a function of fire size and head fire fireline intensity at the time of initial attack. Although the qualitative trends in the table are logical, *i.e.* containment probability increases with smaller fires, lower intensity, or both, the `Hirsch et al. <https://academic.oup.com/forestscience/article/44/4/539/4627517`_ study was based on expert opinion from Canadian firefighters so differences in suppression tactics between Canadian and U.S. agencies are not reflected in the table.

Fire size (hectares)	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
10	77%	64%	49%	34%	22%	13%	8%	4%	2%	1%
9	82%	71%	58%	43%	29%	19%	11%	6%	4%	2%
8	86%	78%	66%	52%	38%	26%	16%	10%	6%	3%
7	89%	83%	73%	61%	48%	34%	23%	15%	9%	5%
6	92%	87%	80%	70%	57%	44%	31%	21%	14%	8%
5	94%	90%	85%	77%	66%	54%	41%	30%	20%	13%
4	95%	93%	89%	83%	74%	64%	52%	40%	29%	20%
3	97%	95%	92%	87%	81%	73%	63%	51%	39%	29%
2	97%	96%	94%	91%	86%	80%	72%	62%	51%	40%
1	98%	97%	96%	94%	90%	86%	80%	72%	63%	52%
	Fireline Intensity (kW/m)									

In order to use the equation, the time of initial attack commencement relative to the time of fire ignition (t_{ign}) must be established for each ignition location. This can be viewed as the sum of fire detection time (t_d), report time (t_r), and travel time (t_t):

$$t_{initialattack} - t_{ign} = t_d + t_r + t_t$$

Initial attack suppression modeling, disabled by default, can be enabled by setting `ENABLE_INITIAL_ATTACK=.TRUE.`. The time of initial attack commencement, in seconds, must also be specified using the `INITIAL_ATTACK_TIME` keyword.

Extended Attack

Change in containment (ΔC) during time interval Δt (in days) is:

$$\frac{\Delta C}{\Delta t} \approx \chi(1 - \frac{logA_d}{logA_{d0}})f(SDI_{\Delta t})$$

where Chi is suppression effectiveness coefficient (-), A_d is areal growth on a daily basis (acres/day), and A_{d0} is areal growth on a daily basis at which containment change becomes negative (acres/day).

The function $f(SDI_{\Delta t})$ is calculated from the mean suppression difficulty index during interval $\Delta t(\bar{SDI}_{\Delta t})$ as:

$$f(SDI_{\Delta t}) = \{\exp(-B\bar{SDI}_{\Delta t}), \quad \text{for } \frac{\Delta C}{\Delta t} \geq 00\exp(B\bar{SDI}_{\Delta t}), \quad \text{for } \frac{\Delta C}{\Delta t} < 0$$

where B is the calibration constant, i is the pixel index, n is the number of pixels during time interval Δt, and SDI_i is the Suppression Difficulty Index of pixel i.

The extended attack model can ben enabled by setting `ENABLE_EXTENDED_ATTACK=.TRUE.`. Additional parameters that can be used to fine tune the extended attack model are:

```
B_SDI                      = 1.0
DT_EXTENDED_ATTACK         = 3600.
AREA_NO_CONTAINMENT_CHANGE = 10000.0
MAX_CONTAINMENT_PER_DAY    = 100.0
SDI_FACTOR                 = 1.0
USE_SDI                    = .FALSE.
USE_SDI_LOG_FUNCTION       = .FALSE.
```