

## NFPA 502 2026 Annex D Smoke Control (Critical Velocity) Editorial Errors

Several editorial errors / discrepancies have been identified between the technical committee output (Second Draft Meeting concluded Annex D on 27<sup>th</sup> September 2024) and the Annex D issued by NFPA in the NFPA 502 2026 edition (April 2025). Below is a list of the erroneous edits.

- (1) Section D.1, one sentence misses “velocity” after “confinement” (see below)

**Text in Annex D as concluded during Second Draft Meeting on 27<sup>th</sup> Sep. 2024:**

*“Methods for estimation the critical/confinement velocity include empirically derived equation-based calculations and three-dimensional (3D) computational fluid dynamics (CFD).”*

**Annex D after incorrect editorial adjustments:**

*“Methods for estimation the **critical velocity and confinement** include empirically derived equation-based calculations and three-dimensional (3D) computational fluid dynamics (CFD).”*

- (2) Section D.2 states that several equations have been developed “*in this annex*” but most of them have not been developed in this annex. The addition of “*in this annex*” is not correct here (see below).

**Text in Annex D as concluded during Second Draft Meeting on 27<sup>th</sup> Sep. 2024:**

*“Several equations have been developed to estimate the critical velocity.”*

**Annex D after incorrect editorial adjustments:**

*“Several equations have been developed **in this annex** to estimate the critical velocity.”*

- (3) The text in the Annex D about the critical velocity calculation (Section D.2.4) has been made incorrect on how the characteristic length for convection should be interpreted for design (see below).

**Text in Annex D as concluded during Second Draft Meeting on 27<sup>th</sup> Sep. 2024:**

*“For design purposes, it is assumed that the fire is on the roadway and therefore the characteristic length for natural convection  $L_n$  is the tunnel height  $H$  .”*

**Annex D after incorrect editorial adjustments:**

*“For design purposes, it is assumed that the fire is on the roadway and therefore the characteristic length for natural **convection is  $L_n$  and the tunnel height is  $H$**  .”*

- (4) The text “*that can be found in*” in section D.2.4 regarding the set of simplified equation should have been deleted and replaced with a semicolon. The current sentence does not appear correct (see below).

**Text in Annex D as concluded during Second Draft Meeting on 27<sup>th</sup> Sep. 2024:**

“Using the proposed design values leads to a simplified set of equations; Equation D.2.4e and Equation D.2.4f.”

**Annex D after incorrect editorial adjustments:**

“Using the proposed design values leads to a simplified set of equations **that can be found in Equation D.2.4e and Equation D.2.4f.**”

- (5) The headings “Set of full equations” before equation [D.2.4a] and “Set of simplified equations” before “Design assumption that led to the simplified set of equations are listed in Table D.2.4(a)” were deleted. Without those headings, the current text appears confusing as no clear distinction between the two set of equations is provided.

- (6) The “x” in the equation D.2.4a is confusing and should not be there.

**Text in Annex D as concluded during Second Draft Meeting on 27<sup>th</sup> Sep. 2024:**

$$U_c = K_F \left( \frac{gL_n^3}{D_h^2} \frac{\Delta T_p}{T_a + \Delta T_p} \right)^{1/2}$$

**Annex D after incorrect editorial adjustments:**

$$U_c = K_F \left( \frac{gL_n^3}{D_h^2} \times \frac{\Delta T_p}{T_a + \Delta T_p} \right)^{1/2}$$

- (7) Equation D.2.4c is wrong. The whole fraction after the “e” needs to be an exponent with a negative sign in front (see below).

**Text in Annex D as concluded during Second Draft Meeting on 27<sup>th</sup> Sep. 2024:**

$$K_L = 1.83 \left( 0.95 + e^{-\frac{\dot{Q}}{2.2 \cdot L_n \cdot I_{fire} \cdot W_{fire}}} \right)^{-1}$$

**Annex D after incorrect editorial adjustments:**

$$K_L = 1.83 \left( 0.95 + e^{\frac{\dot{Q}}{2.2 \cdot L_n \cdot I_{fire} \cdot W_{fire}}} \right)^{-1}$$

- (8) Section D.2.4 below the full set of equations, the sentence is confused as it is not clear what is meant with user. The original agreed text says “*For tunnel designs that rely on FFFS ... it is recommended to use a validated CFD model...*”. Now it says “*For tunnel designs that rely on FFFS ... it is recommended that the user utilizes a validated CFD model...*” It is unclear what a “user” is in that context (see below)?

**Text in Annex D as concluded during Second Draft Meeting on 27<sup>th</sup> Sep. 2024:**

*“For tunnel designs that rely on a fixed firefighting system, such as water mist or a deluge system, it is recommended to use a validated CFD model as described in Section D.3.”*

**Annex D after incorrect editorial adjustments:**

*“For tunnel designs that rely on a fixed firefighting system, such as water mist or a deluge system, it is recommended that the user utilize a validated CFD model as described in Section D.3.”*

- (9) The format of the correlations in the text above equation D.2.4e is highly inconsistent. The parameters  $H$  and  $A$  are sometimes italic and sometimes not. Before and after the symbol “>” and “<” there is sometimes a space, and sometimes there is no space. It has not been made clear that “ $m$ ” is a unit and not a parameter/variable. Same applies to “ $ft$ ”. It is not apparent why the units “ $MW$ ” and “ $Kelvin$ ” do not need conversion to US units while “ $metre$ ” to “ $feet$ ” needed to be converted in the text? The dot on “ $Q$ ” is missing. The original agreed text looks different (see below).

**Text in Annex D as concluded during Second Draft Meeting on 27<sup>th</sup> Sep. 2024:**

*“With the listed design parameters, the simplified form can only be used for a pool fire on the roadway and is valid for  $HRR > 10 MW$ , tunnel height  $H < 9 m$  and a tunnel area  $A > H(2.5 [m] + 0.35 \cdot H)$ . Due to the constant heat capacity assumption, the simplified equation slightly overestimates the critical velocity ( $\sim 3\%$ ) for very high HRR ( $\dot{Q} > 100 MW$ ) that lead to high average temperatures at the fire site gases ( $T_f > 1000 K$ ). The simplified set of equations are:”*

**Annex D after incorrect editorial adjustments:**

*“With the listed design parameters, the simplified form can only be used for a pool fire on the roadway and is valid for  $HRR > 10 MW$ , tunnel height  $H < 9 m$  ( $H < 30 ft$ ), and a tunnel area  $A > H(2.5 m + 0.35 \cdot H)$  [ $A > H(8.2 ft + 0.35 \cdot H)$ ]. Due to the constant heat capacity assumption, the simplified equation slightly overestimates the critical velocity ( $\sim 3$  percent) for very high HRR ( $Q > 100 MW$ ) that lead to high average temperatures at the fire site gases ( $T_f > 1000 K$ ). The simplified set of equations include the following two equations:”*

- (10) The adjustments in Section D.2.5 do not appear to be appropriate/correct after the editorial edits, and made the sentence confused (see below).

**Text in Annex D as concluded during Second Draft Meeting on 27<sup>th</sup> Sep. 2024:**

*"It is recommended to use a CFD model validated against appropriate full-scale data (see Section D.3) to explore appropriate confinement velocity values."*

**Annex D after incorrect editorial adjustments:**

*"It is recommended **that** a CFD model **be used to validate** against appropriate full-scale data (see Section D.3) to explore appropriate confinement velocity values."*

- (11) Table D.2.4(a) is wrong. Fire intensity is " $MW/m^2$ " and so the conversion needs " $ft^2$ " in the denominator instead of just " $ft$ ". The value for radiative fraction in US units is still "0.2" and not "N/A". The specific heat capacity of 1007 J/kgK translates to 0.240518 Btu/lbR and not 240.518 Btu/lbR. The variable " $T_a$ " should be in the same line as the text "*Ambient air temperature*". The note below the table has inconsistent formatting and sometimes has a space around ">" and sometimes not.
- (12) Some of the US units in Table D.2.4(c) are incorrect/inconsistent. It is indicated that gravitational acceleration in " $m/s^2$ " has no units in US, which is incorrect. Mixing " $Btu/hr$ " with " $Btu/sec$ ", " $lb/sec$ ", and " $ft/sec$ " will produce wrong results. All units used in the equations should be based either on " $hr$ " or " $sec$ ". The conversion of the 3.66 m to US units was missed.
- (13) Reference "[10] MTFVTP, *Memorial Tunnel Fire Ventilation Test Program - Comprehensive Test Report*," Bechtel/Parsons Brinckerhoff, Boston, 1995." is not listed in the Annex D.