Explosion and Fire Probits: Overpressure and Thermal Dose

Probability of lung-haemorrhage death, eardrum rupture, structural damage and glass breakage from a peak overpressure, and of burn death from thermal dose.

Method: Crowl and Louvar; Chemical Process Safety: Fundamentals with Applications; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Peak overpressure	21.400	kPa
Thermal radiation intensity	12.500	kW/m²
Exposure time to the radiation	30.000	s

Calculated results

Parameter	Value	Unit
Deaths from lung haemorrhage	0	%
Eardrum rupture	8.7599	%
Structural damage	62.390	%
Glass breakage	100.000	%
Burn deaths from flash or pool fire	0.50588	%
Burn probit	2.4282	

Notes for this case

- Probit equations from Eisenberg et al. as listed by Crowl and Louvar; they describe average populations and open-air exposure. People can escape radiation, which shortens the effective exposure.
- A screening estimate for training and early design, not a hazard or risk study.

Formula and method

$$Y = k_1 + k_2 \ln V, \quad P = 50\left[1 + \frac{Y-5}{|Y-5|}\operatorname{erf}\frac{|Y-5|}{\sqrt{2}}\right]$$

$$V = p^o \ (\text{lung}: \ -77.1, 6.91;\ \text{eardrum}: \ -15.6, 1.93;\ \text{structure}: \ -23.8, 2.92;\ \text{glass}: \ -18.1, 2.79), \quad V_{burn} = \frac{t_e I^{4/3}}{10^4} \ (-14.9, 2.56)$$

Variables

p^o	Peak overpressure	Pa
I	Thermal radiation intensity	W/m²
t_e	Exposure time to the radiation	s
P_{lung}	Deaths from lung haemorrhage	-
P_{ear}	Eardrum rupture	-
P_{struct}	Structural damage	-
P_{glass}	Glass breakage	-
P_{burn}	Burn deaths from flash or pool fire	-
Y_{burn}	Burn probit	-

Method and standards

Probit model with Eisenberg's constants (p in Pa, I in W/m², t in s).

Assumptions and limits

- Average population; no shelter.

References

- Crowl and Louvar
- Chemical Process Safety: Fundamentals with Applications
- 2nd ed. (Prentice Hall, 2002)
- ch. 2
- Table 2-5 and eq. 2-6 (Eisenberg probits)

Report details

Report reference	FCC-JWKZ-JNY2 (the same inputs always give the same reference)
Generated	17 November 2026, 19:44 UTC
Calculator	Explosion and Fire Probits: Overpressure and Thermal Dose
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/chemical/process-safety/explosion-burn-probit

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.