HSE Formula Sheet

The calculations that come up on the job and in ASP and CSP study, on two pages.

HSE HUB by NeuraSafe
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INJURY AND ILLNESS RATES (US OSHA BASIS)

Total recordable incident rate

TRIR = recordable cases x 200,000 / hours worked

200,000 h = 100 full-time workers x 40 h x 50 weeks; recordable per 29 CFR 1904

DART rate

DART = cases with days away, restriction or transfer x 200,000 / hours worked

Counts cases, not days (OSHA 300 Log columns H + I)

Lost time injury frequency (IOGP, Gulf, Australia style)

LTIFR = lost time injuries x 1,000,000 / hours worked

Check the base: 200,000 (OSHA), 1,000,000 (IOGP), 100,000 (UK AFR)

Severity rate

Severity = lost workdays x 200,000 / hours worked

Days away + restricted days (OSHA 300 cols K + L), capped at 180 per case

Experience modification rate (NCCI)

EMR = (Ap + W x Ae + (1 - W) x Ee + B) / (E + B)

A actual, E expected losses; p primary, e excess; W weight, B ballast. Below 1.0 is a credit

NOISE

OSHA permissible time at level L

T = 8 / 2^((L - 90) / 5) hours

90 dBA PEL, 5 dB exchange rate (29 CFR 1910.95 Table G-16a)

Noise dose

D = 100 x (C1/T1 + C2/T2 + ...) %

C = hours at a level, T = permissible hours there; action level counts 80 to 130 dBA

OSHA 8-hour TWA from dose

TWA = 16.61 x log10(D / 100) + 90 dBA

PEL 90 dBA (100% dose); action level 85 dBA (50% dose). 1910.95 App. A

NIOSH REL permissible time

T = 8 / 2^((L - 85) / 3) hours

REL 85 dBA 8-hour TWA, 3 dB exchange rate (NIOSH 98-126)

Adding sound levels

L total = 10 x log10(10^(L1/10) + 10^(L2/10) + ...)

Two equal sources add about 3 dB

Distance from a point source (free field)

L2 = L1 - 20 x log10(d2 / d1)

About 6 dB less per doubling of distance (3 dB for a line source)

Hearing protector derating (OSHA guidance)

Protected level = TWA (dBA) - (NRR - 7) / 2

OSHA Technical Manual 50% factor; dBC data: TWA - NRR/2; plugs + muffs: +5 dB

CHEMICAL EXPOSURE AND ATMOSPHERES

8-hour time-weighted average

TWA = (C1 x T1 + C2 x T2 + ...) / 8

29 CFR 1910.1000(d)(1); unsampled time counts as zero only if there was no exposure

Mixtures with additive effects

Em = C1/L1 + C2/L2 + ... must not exceed 1

C = measured level, L = its limit. 29 CFR 1910.1000(d)(2)(i)

ppm to mg/m3 (25 C, 1 atm)

mg/m3 = ppm x molecular weight / 24.45

ppm = mg/m3 x 24.45 / molecular weight

LEL of a gas mixture (Le Chatelier)

LEL mix = 100 / (P1/LEL1 + P2/LEL2 + ...)

P = volume % of each gas in the fuel only (P values sum to 100)

Permit-space hazardous atmosphere (29 CFR 1910.146)

Oxygen below 19.5% or above 23.5%; flammable above 10% of LFL

Also combustible dust at its LFL, a toxic above its PEL, or any IDLH condition

VENTILATION

Airflow

Q = V x A

cfm = fpm x ft2, or m3/s = m/s x m2

Air changes per hour

ACH = Q (cfm) x 60 / V (ft3), or Q (m3/h) / V (m3)

Velocity from velocity pressure

V = 4005 x sqrt(VP)

V in fpm, VP in inches of water, standard air (ACGIH Industrial Ventilation)

Dilution ventilation for a solvent

Q = 403 x 10^6 x SG x ER x K / (MW x C)

cfm; ER pints/min evaporated, C target ppm, K mixing factor 1 to 10 (ACGIH)

HEAT STRESS

WBGT outdoors with sun

WBGT = 0.7 NWB + 0.2 GT + 0.1 DB

NWB natural wet bulb, GT globe, DB dry bulb

WBGT indoors or no sun

WBGT = 0.7 NWB + 0.3 GT

Add clothing adjustment, then compare with ACGIH TLV/action limit for workload

WORKING AT HEIGHT AND RIGGING

Fall clearance below the anchor (energy-absorbing lanyard, anchor at D-ring)

Lanyard length + deceleration distance + harness stretch + D-ring to feet + safety margin

OSHA: free fall 6 ft max, deceleration 3.5 ft max, arrest force 1,800 lb (1926.502(d)(16))

Sling leg tension

Tension per leg = (Load / number of legs) / sin(angle from horizontal)

Factor 1/sin: 60 deg 1.155, 45 deg 1.414, 30 deg 2.0. Multi-leg: plan on 2 legs

ERGONOMICS: REVISED NIOSH LIFTING EQUATION (US UNITS)

Recommended weight limit

RWL = LC x HM x VM x DM x AM x FM x CM

LC = 51 lb (23 kg)

Multipliers

HM = 10/H, VM = 1 - 0.0075 x |V - 30|, DM = 0.82 + 1.8/D, AM = 1 - 0.0032 x A

Inches, degrees: H 10 to 25, V 0 to 70, D 10 to 70, A 0 to 135; FM and CM from tables

Lifting index

LI = load / RWL

Above 1.0: increased risk for some workers; above 3.0: many workers, redesign

PHYSICS, RELIABILITY AND MONEY

Inverse square law

I2 = I1 x (d1 / d2)^2

Point source of radiation, light or sound intensity

Radioactive decay

A = A0 x (1/2)^(t / half-life)

Shielding works the same way: I = I0 x (1/2)^(thickness / HVL)

Ohm's law and power

V = I x R; P = V x I = I^2 x R

Combined gas law

P1 x V1 / T1 = P2 x V2 / T2

Absolute pressure and absolute temperature (K)

Kinetic energy and impact speed

KE = 1/2 x m x v^2; v = sqrt(2 x g x h)

g = 9.81 m/s2 (32.2 ft/s2); a dropped object's speed after falling h

System reliability

Series: R = R1 x R2 x ...; Parallel: R = 1 - (1 - R1)(1 - R2)...

R = probability each component works

Simple payback

Payback (years) = initial cost / annual savings

Present value

PV = F / (1 + i)^n

i = interest rate per period, n = periods

General guidance for study and planning. Always use the current standard, the manufacturer's data and a competent person for decisions on site. HSE HUB is an unofficial study tool and is not affiliated with BCSP. ASP and CSP are BCSP trademarks.

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