Radiological Criteria of Site Acceptability

Guideline:

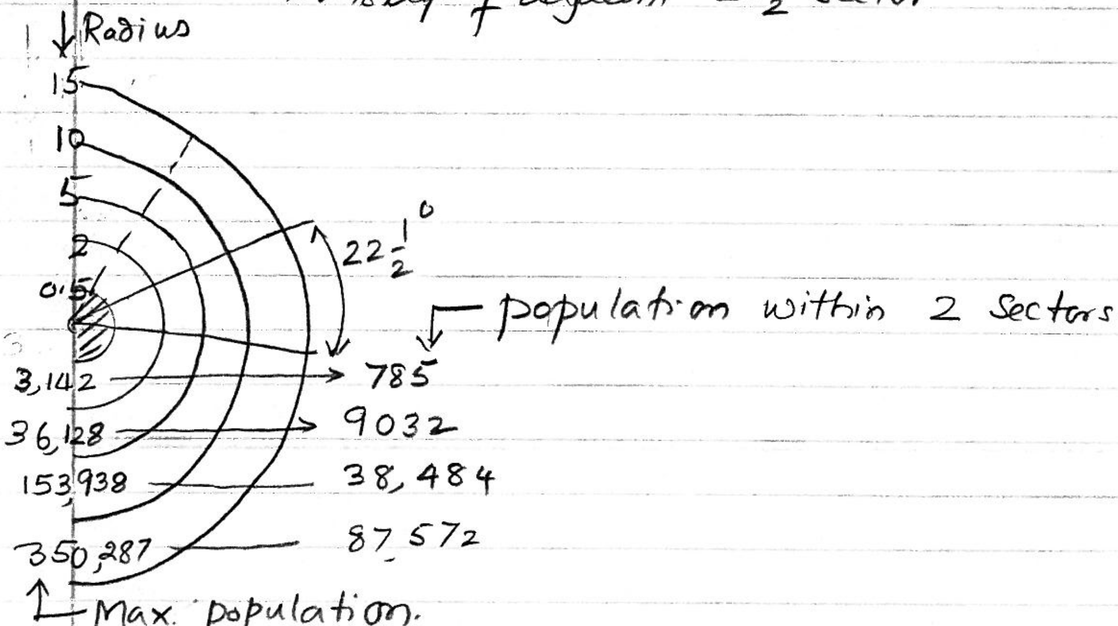
Title 10 of the Code of Federal Regulations Part 100
10CFR Part 100.

Hypothetical accident - radioactive leakage from containment

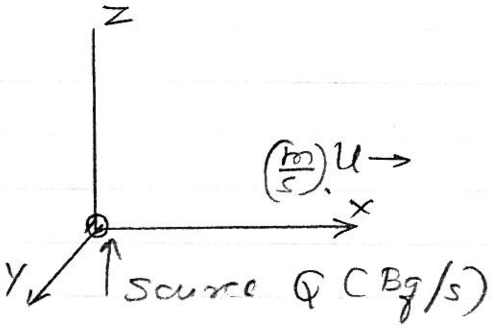
- 1962 - Introduced - Distances from reactor 3 Zones
- 1975 - revised - population density.
- 1979 - Siting Policy Task Force (SPTF). NRC

1) Fixed exclusion distance 0.5 miles.
2) Fixed minimum emergency planning distance (like evacuation). ~10 miles
3) Specific population density and distribution outside the exclusion area.

Radius (Miles)	Areas	
0.5	Exclusion Area Radius (miles)	0.5
0.5 to 2	Density of restricted Area (/mi²)	250
2 to 30	Density of population control Area (/mi²)	500
	Density of adjacent 22½ sector	1000-2000



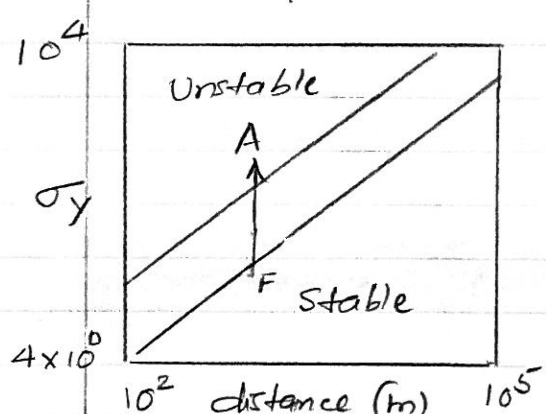
Radiation Dose Calculation

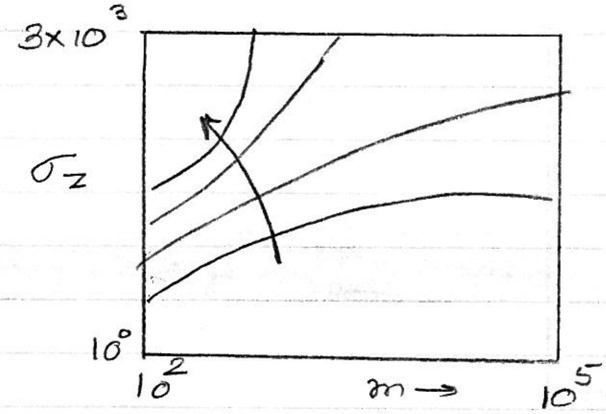


Ground level radiation.

$$\chi(x,y)\ (Bq/m^3) = \frac{Q}{\pi u \sigma_z \sigma_y} \exp\left[-\frac{1}{2}\left(\frac{h^2}{\sigma_z^2}+\frac{y^2}{\sigma_y^2}\right)\right]$$

Gaussian Distribution: — Dispersion.





Atmospheric conditions

Pasquill A – most turbulent

Pasquill F – moderately stable

Q – calculated from equilibrium reactor activity

- In the calculation set $Y = 0$ for first 8-hours

$$\chi(x,y) = \frac{Q}{\pi u \sigma_z \sigma_y} \exp\left(-\frac{h^2}{2\sigma_z^2}\right)$$

After 8 hours – spread is assumed for 22.5° (uniform)

$$= \frac{2.302\,Q}{u \sigma_z} \exp\left(-\frac{h^2}{2\sigma_z^2}\right)$$

For ground $h = 0$

- Assume Pasquill F for first 24 hours. with wind speed of 1 m/s (2.2 mph)

After 24 hours use more realistic conditions

Thyroid Dose:

Dose mainly through air inhalation

If χ_i Bq/m³ - average concentration of I_2 in air

B - breathing rate m³/s.

t - duration of inhalation.

Initial amount taken in lungs. $C(i) = \chi_i B t$ Bq.

$$\chi_i(x) = \frac{Q}{\pi u \sigma_z \sigma_y} \exp\left(-\frac{h^2}{2\sigma_z^2}\right)$$

Q_i Bq/s - escape from the containment

For first 8 hours, $B \sim 3.47\times10^{-4}$ m³/s.

8 - 24 hours $B \sim 1.75\times10^{-4}$ m³/s.

Until plume is passed $B \sim 2.32\times10^{-4}$ m³/s (Normal breathing rate)

Dose commitment D_∞ (in rem)

$$= C_0 \times \underline{4.1\times10^{-5}}$$

$$\frac{D_\infty}{C_0} = 0.85\frac{f E_i T_e}{m} = \frac{0.85\times0.23\times0.23\times6.5\times10^{5}}{0.02}$$

$$= 1.6\times10^{6} \text{ rads/Ci}$$

$$= 1.5\times10^{3} \text{ m rad}/\mu\text{Ci}$$

$$= 4.1\times10^{-5} \text{ rads/Bq.}$$

For other radionuclide - use similar calculations
- or multiply by 1.9 to the iodine dose to obtain total dose

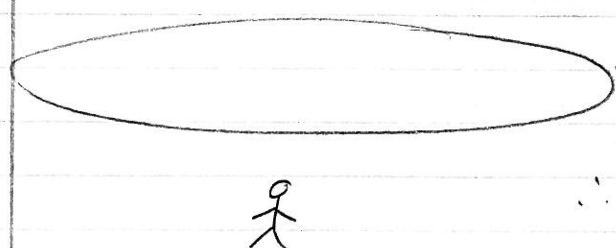
Whole Body Dose

Size of cloud: small cloud dose rate difficult
Large uniform cloud
Concentration for given nuclide χ Bq/m^3
with $\bar{E}_\gamma$ MeV $= 1.6\times10^{-13} E_\gamma$ J/dis

Rate of energy released (absorbed) in air $= 1.6\times10^{-13} \frac{\chi E_\gamma}{\rho}$ J/kg·s

Soft tissue energy absorption $\sim$ 1.1 times the air
$\rho = 1.3$ kg/m^3
10^{-2} J/s = rad.

Absorbed dose rate in body tissue $= 1.2\times10^{-11}\times\bar{E}_\gamma$ rad/s



– solid angle $= 4\pi$
on ground : 2π

$\therefore$ whole body dose $= \frac{1}{2} \cdot 1.2\times10^{-11} \bar{E}_\gamma \chi_i$ rem/s

For total duration t, the dose

$$D_\gamma = \underline{0.6\times10^{-11} \chi\, \bar{E}_\gamma \cdot t} \text{ rem}$$