Today, we will:

- Begin discussion of Chapter 3 – Design Criteria
- Discuss Section 3.1 – Contaminant Exposure Levels
- Discuss Section 3.2 – Fire and Explosions
- Do some example problems
- Do Candy Questions for Candy Friday

Note: Indoor air quality is concerned not only with air pollution, but also with many other issues. In this chapter we discuss:

- contaminant exposure
- fire and explosions
- noise
- heat stress
- odors
- radiation
- general safety issues

Sec. 3.1  Contaminant exposure levels

- OSHA publish PELs
  
  Permissible Exposure Limit (PPM or mg/m³)

- NIOSH publish RELs
  
  Recommended Exposure Level

PEL based on 8-hr work day
REL "" a 10-hr exposure

e.g. benzene → look up MSDS
REL = 0.1 PPM
PEL = 1 PPM

We use PEL unless otherwise stated

ACGIH – American Conference of Governmental & Industrial Hygienists
Publish TLV = Threshold Limit Value (2005)

Note: Air pollution includes many other issues such as particulate matter, ozone, nitrogen oxides, sulfur dioxide, etc.
Note: PEL, REL, and TLV sometimes change with time
(See App. A-1)

Kinds of levels:

**TWA** = time-weighted average

@ OSHA → 8-hr (TWA) 8-hr PEL = \( \frac{1}{8} \int_0^8 c(t) \, dt \)

Most common

**STEL** = short term exposure level or "ST"

\[ STEL = \frac{1}{15} \int_0^{15} c(t) \, dt \text{ in minutes} \]

STEL > TWA

**C** = ceiling → should never be exceeded, even instantaneously

C > STEL > TWA

So... we can have: TLV-TWA PEL-C TLV-STEL PEL-STEL, etc.

Rules for whether a violation may occurred

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See Fig. 3.1
Mixtures of Gases

\[ E_n = \text{Exposure Parameter} = \frac{y_i}{\text{PEL}_i} \]

Criterion: if \( E_n > 1 \), violation
\[ \text{if } E_n \leq 1, \text{ not a violation} \]

Example: Given: gas mixture. benzene 0.4 ppm
\[ \text{8-hr TWA value} \quad \text{acetic acid} 2 \text{ ppm} \]
\[ \text{water} \quad \text{propylene (pro) 30 ppm} \]

Do to: Is this a violation?

Solution:
\[ E_n = \frac{y_{\text{benzene}}}{\text{PEL}_{\text{benzene}}} + \frac{y_{\text{acetic acid}}}{\text{PEL}_{\text{acetic acid}}} + \frac{y_{\text{pro}}}{\text{PEL}_{\text{pro}}} \]
\[ E_n = \frac{0.4 \text{ ppm}}{1 \text{ ppm}} + \frac{2}{10} + \frac{30}{100} = 0.9 \]

[No] not a violation since \( E_n < 1 \)

Sec 3.2 → Instrument to measure pollutant concentration

* skim over this material - interesting but not on exam*
Explosion can occur with both vapor (gas) and particulate (dust).

\[ \text{LEL} = \text{Lower Explosion Limit} = \text{Smallest concentration at which a spark will cause an explosion.} \]

Typically in mg/m\(^3\) or mol fraction (PPm) or \% by volume.

- Most insurance codes require \( Y_0 < 10\% \text{ of LEL} \)

\[ \text{UEL} = \text{Upper Explosion Limit} = \text{Max. conc. above which it won't explode} \]

- LEL = fuel lean limit of flammability
- UEL = fuel rich limit

- UEL > LEL are WAS in the M60S

Compare LEL with PEL:

Typically \( \text{LEL} \gg \text{PEL} \)

By Benzene \[ \text{LEL} = 1.2\% \Rightarrow \frac{\text{LEL}}{\text{PEL}} = \frac{0.012}{0.001} = 12,000 \text{ PPM} \]

\[ \text{PEL} = 1 \text{ PPM} \Rightarrow \text{LEL} \gg \text{PEL} \]