* Audiometric testing :-

- monitors an employee hearing over time.
- Program Elements :-
  - Baseline Audiogram (every 6 Month).
  - annual Audiograms (annual).
  - training
  - F/U procedures.

• Notes :-

- Base-line Must be Conducted within 6 months of first exposure greater than 85 dBA.
- Exception made for Companies utilize mobile test van.
- extend the requirements for 1 year.
- Audiograms shall be proceeded by 14 hours without exposure to noise.
- Testing must be done by :-
  - Audiologist
  - otolarynogolist
  - technition certified by CAOHC, Council for Accredition in occ. Hearing Conservat
- Audiometric test must be pure tone
  500, 1K, 2K, 3K, 4K, 6K, 8K
- Audio meters must meet ANSI 53-6-1969

---

* S.T.S : Standard Threshold Shift *

- The Change in hearing threshold related to base-line Audiogram of an avg. of 10 dBA or more.
- to be recorded in OSHA 300 Log as recordible Inj.
- use Age Correction Calc.
  OSHA 29 CFR 1910.95 Apendix F.

• Hearing Protection eq : - ① Ear plug : NRR 5-10 dB ↓,
② ear muff : NRR 10-35 dB ↓.
③ Canal Cap : Cover entrance of ear Canal.

OSHA 29 CFR 1910.95 appendix B

* training program :-
- exposed employee within 30 days of exposure and repeated annually.
- This traing must include, as minimum:-
  - effects of noise on hearing ✓
  - purpose of Hearing protectors ✓
  - " " Audiometric testing ✓

* Record Keeping :-
- what to record :-
  - name, Job classification of employee
  - Date of Audiograms.
  - Examiner name.
  - Date of Last acoustic Calibration.
  - employee recent noise exp. assessment.

* Document Retinement :-
- noise exp. measurements (every 2 years)
- Audiometric test (duration of employment)

* Hearing Loss *

- types:
  - Conductive loss of loudness outer, Middle ear
  - Sensorineural excessive exp. Irreversible inner ear.
  - Mixed Conductive and Senso.
  - CNS central nervous sys. not related to noise exp
  - psycological emotional trauma

- Major Causes:
  - obstruction or disease.
  - Acoustic trauma
  - pre-sbycusis / sociousis
  - Noise Induced.

* Noise Calculations *

* Entities of Noise:-

Sound pressure L_p	sound power L_w , PWL
$L_p = 20\left(\log \frac{P_{final}}{P_{o\ initial}}\right)$ (sound pressure)	$L_w = 10\left(\log \frac{Pwr_{final}}{pwr_{o\ initial}}\right)$ (Sound power)
• relate to human experience	• related to only the source
• depend on Source and env.	• depend on only the source
• Situation dependent.	• situation Independent.
• difficult to Compare apple to App	• lets you Compare Apple to Apple
• Can be measured by Microphone	• must be Calculated.
• ref. level 0.00002 N/m²	• Ref. Level 10-12 W. watts.

* Note:-
- doubling pressure increase pressure by 6 dB.
- " " " intensity by 3 dB.

∴ Sound pressure : Sound power : Sound Intensity :-

pressure - $L_p = 20\left(\log \frac{P}{P_o}\right) = 20\log\left(\frac{P}{2\times10^{-5}}\right) = 20\log P + 93.98.$

power - $L_w = 10\left(\log \frac{Pwr}{Pwr_o}\right) = 10\log\left(\frac{Pwr}{10^{-12}}\right) = 10\log pwr + 120.$

Intensity - $L_I = 10\left(\log \frac{I}{I_o}\right) = 10\log\left(\frac{I}{10^{-12}}\right) = 10\log I + 120.$

- Sound Intensity:- $dB_1 = dB_o + 20\log\left(\frac{d_o}{d_1}\right).$

• 6dB rule:- If distance doubled, Int. decreased by 6 dB.

* Adding dB *

- $L_{total} = 10 \log \left(10^{\frac{L_1}{10}} + 10^{\frac{L_2}{10}} + \cdots\right)$
- rule of thumbs to make it easy:- (only two dB)

dB difference	sum	example
0 or 1 difference	3 dB higher than Higher	80+80 = 83 100+101 = 104
2-4 difference	2 dB higher than higher	87+85 = 89 75+77 = 79
5-9 difference	1 dB higher than higher	32+36 = 37 80+86 = 87
10 or more ↑	Same as higher	80+95 = 95

* If more than 2 dB :-
  - use the above law.

  or - Do this steps:- ① Do the two lowest first.
  ② result add to next higher.
  ③ Continue Repeat till finish.

* example:- Add 5 Machines :-
  ① 79 dB ② 85 dB ③ 87 dB ④ 95 dB ⑤ 93 dB

- solution:-

$$L_{total} = 10 \log \left(10^{8.5} + 10^{7.9} + 10^{8.7} + 10^{9.5} + 10^{9.3}\right) = 9$$

or,

① adding lowest two : 79+85 = 86
② 86 + next higher is 87 = 86+87 = 90
③ 90+93 = 95
④ 95+95 = 98 ≅ 97.6 بالتقريب

* Noise PEL and TLV *

OSHA PEL		NIOSH TLV
90 dBA for 8h	Duration of exposure	85 dBA for 8 hours
Doubling Rate = 5 dB		doubling Rate = 3 dB

- Each time Sound level increase by doubling, The exposure time limit decrease by 50%.
- for distance:- rule of (6)
  If distance doubled, Intensity decreased by 6dB.

Duration	sound level OSHA (5dB)	sound level NIOSH (3dB)
16	85	85
8	90	88
4	95	91
2	100	94
1.5	105	97
$T_{max} = \frac{8}{2^{\left(\frac{L - Stand.}{DR}\right)}}$	$T_{max} = \frac{8}{2^{\left(\frac{L-90}{5}\right)}}$	$T_{max} = \frac{8}{2^{\left(\frac{L-85}{3}\right)}}$

* Dose Calc., over or under exposed:-

$$Dose = \left(\frac{C_1}{T_{max_1}} + \frac{C_2}{T_{max_2}} \dots \right) \times 100$$

T_{max} في حالة معرفة الوقت المستغرق من الجدول أو القانون

C: amount of time exposed to T_{max}.

T_{max}: Max. time of exposure for Sound level.

→ Exposure = Lp − (NRR − 7)/2. (earplug كفاءة السماعة)
* noise reduction Calc:- NRR
If ear muff NRR = 27 ∴ Substract (7), then devide the result /(2) is the correct NRR

* Noise Notes * Daniel *

* what is Sound:- Vibration received by human ear, redirected firs mechanically then Biochemically to Brain. it propagates as audiable wave of pressure through transmission medium (gas liquid, Solid), can't be transmitted in vaccum.

* Noise:- unwanted sound, doesn't carry information, it is the most frequent complaint of workers today.
* HSE prof. task is to quantify exposure by magnitude and duration, provide appropriate admin, engineering, PPE.

* Speed of Sound:- high for dense materials.
air @ 332 m/s , wood @ 3962 m/s
water @ 1433 m/s , steel @ 5960 m/s

* types of sound waves?
• Transverse / ripples:- move horizontally sound in water. and molecules move vertically, Energy Both ways

• Longitudinal / Compressions:- move vertically sound in air. and molecules move horizontally, Energy in parrallel.

* avg. Sound pressure fluctuation >> is Zero.

* Tinnitus:- ringing / whistling / hissing in ears.
→ take place in sensory auditory cells, in Cochlea of inner ear, when insect crawl inside ear canal, pour mineral or olive oil, Baby oil, will suffocate, quite the insect until remove.

* Sound impedance :- impedance matching, sound is amplified before reaching middle ear, inner ear.

* anatomy of an EAR ??
  1. outer ear: Pinna, ear canal direct sound to eardrum.
  2. middle ear: ear drum, 3 ossicles, eustachian tube that drain fluids to throat, help in stabilizing ear pressure.
  3. inner ear: cochlea, converts vibrations to electrical impulses transmitted to brain by auditory nerve.

vestibular sys- ← 2

* 3 Bones Conduct Sound in middle ear?
  Eustacian tube, ossicles, (M I S) (malleus, incus, stapes) (H A S) hammer, anvil, stirrup

* Eustachian tube function:-
  Connects middle ear cavity with mouth, equalize pressure in middle ear with atmo. pressure, opens during swallowing, and yawning.

* cochlea function:- Corti, has hair like cells, detect sound, tine hair cells vibrate, transmit electrical impulses to brain through nerves.

* Sound Intensity level ?

$$I = \frac{\text{power @ source}}{\text{Area (sphere)}} = \frac{W}{4\pi r^2}$$

* Classes of noise:-
  * Continuous: Broad Band, 1 sec max, Slow response dBA.
  * Impact: peaks, once/sec, fast response in dBA.
  * Intermittent: mix of quiet, noisy period, slow response.

* what cause damage to inner ear?
  - Continous noise exposure,
* what cause damage to middle ear?
  - Impact noise, sudden explosive blast (fire arm)
  - Blows to head, fast barometric press. changes.

* Calibration against, NIST, annual,
  and should be calibrated before, after each use.

* Hierarchy of Control *

most effective substitution of noise eg with quiet one.
- Engineering Control to be used befor Admin or PPE.
∴ noise control procedures:-
  ① control @ the source - modified, redesign, relocated.
  ② along the path. enclosures, absorption, barriers.
  ③ at the reciever. enclosed, relocated, absorping material

* note:- Source control is least expensive.
usually 1/10 of the cost of path. control.

* SLMs: Sound level Meters. types:-

- Type 0: Labs, tolerence +/- 0.7dB, 100-4000 Hz.
- Type 1: labs, field, precision, tolerence ±1dB, 50-4k Hz.
- Type 2: General purpose SLMs, ± 1.5o, 100-1250 Hz.
- Type S: Special, limited no of functions, special applications

* Ventilation *

* why?
- Maintain adequate oxygen supply.
- Control Hazardous Conc. of Chemicals.
- Remove odors.
- Control temp. and Humidity.
- Remove Contaminant at the Source.

* types of ventilation :-

[1] General / Natural ventilation :-
for temp., Humidity and odor Control (AIC)

[2] Dilution ventilation :-
- mixed fresh air + Contaminated air.
- Reduce Concentration
- used in health and fire protection.
- Contaminants of Moderate toxicity only.
- Large number of Sources.
- emission Sources are well distributed.
- HVAC are dilution vent.
- Hood → Duct → air Cleaner → fan → Stack
  (filter) (exhaust)

[3] Local Exhaust ventilation (LEV) :-
- Control Contaminant @ the source before mix with Breathing air occurs.
- Contaminants of highly toxic substances.
- Single source of emissions.
- Drect worker exposure. (Breathing Zone)
- Hood → Duct → Air Cleaning device → fan → Stack.
  (filter) (exhaust)

* Ventilation Concepts *

- Air Movement results from difference in pressure.
- Difference in pressure can be attained by Heating or by Mechanical Means.
- A temp. Gradient contributes to Ventilation.

Dilution * Ventilation Calculations *

- Calc. Volumetric Air flow rate:-

$$Q = V \times A$$

Q: volumetric flow rate, cfm; V: velocity, fpm; A: cross-section area (SF)

- Calc. Total, Static, Velocity pressures:-

$$T_P = S_P + V_P$$

- water gauge in.wg : inch H_2O
- T_P: total wg; S_P: Static wg; V_P: velocity wg

- Calc. velocity from Velocity pressure:-

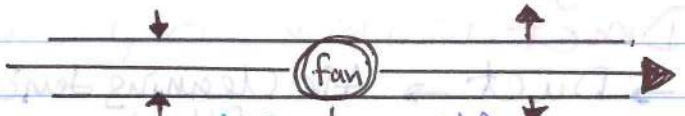
$$V = 4005\sqrt{V_P}$$

V: velocity, fpm; V_P: velocity pressure wg

- Calc. Static pressure of fan:-

$$S_P = S_{P_{out}} - S_{P_{in}} - V_{P_{in}}$$

V_P is always +ve



In	Out
V_P +ve	V_P +ve
S_P -ve	S_P +ve
T_P -ve	T_P +ve

* Calc. Room Air Changes :-

$$N = \frac{60\,Q}{V_r}$$

N: Changes — Q: flow rate Cfm — V_r: volume of room ft^3 or Cft

* Calc. conc. of Contaminant w/ Dilution :-

$$C = \frac{G}{Q_1}\left(1 - e^{\frac{Nt}{60}}\right) \times 10^6$$

* Centrifugical fans :-

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$$ ← fan speed

$$\frac{H_1}{H_2} = \left(\frac{N_1}{N_2}\right)^2$$

$$\frac{HP_1}{HP_2} = \left(\frac{N_1}{N_2}\right)^3$$

Q = flow Rate
H = Head development
Hp = Horse-power
N = fan (Impeller) Speed Rpm

* LEV * Hoods

Hood-types :-

- Canopy hood system. لتوقي — الهاوت أخف من الهوا يجمع
- Downdraft System. الهاوت أثقل من الهوا يجمع لتحت
- Recieving system. Recieve - Contain - empty welding - grinding
- Closed system. enClosing - Contain - Separate Laboratories
- Capturing System. Capture يفرق عن closed أنه يجمع وليس يستقبل.

Hood

* LEV openings *

- flanged
- non-flanged.

* LEV fans *

- Centrifugical
- Axial

* Air Cleaning Devices * filters

function:-

- remove Contaminant from air system.
- protect the Community.
- protect the fan.
- Recover materials.
- enable circulation.

* Ventilation Measurement eq. *

- Pilot tubes.
- Rotating van anemometer.
- Thermal anemometer.

* LEV Calculations *

- Calc. Coefficient entry loss.

Coe. entry loss $C_e = \sqrt{\frac{VP}{SP_n}}$ VP: velocity pressure. SP_n: static pre. of hood

- Calc. Hood entry loss.

hood entry loss $h_e = \frac{(1 - C_e^2)\,VP}{C_e^2}$ VP: velocity pressure. C_e: coe. entry loss

- Calc. Static pressure of The hood.

absolute value $|SP_n| = VP + h_e$ VP: velocity, h_e: hood entry loss.

* Ventilation notes *

* types :-

(A) LEV : eng. Control minimize exposure to airborne Contaminants by vacuuming out of Breathing zone. (Centrifugical fans best option)

(2) DV :

ventilates entire workplace, exhaust large amount of contaminated air, bring clean fresh air - used for extremly low toxicity Contaminants. HVAC are dilution vent.

---

* Hood types :-

(1) Canopy :- mounted over liquid baths, hot plates. "light than air" Therisk come from worker place themselves bet. Containment, exhaust.

(2) Down draft :- draw fumes, smoke "heavier than air" down.

(3) Enclosure :- surrond process contaminants generated, draft away.

(4) Recieving :- Catch emissions have momentum from source. (Capture)

---

* recommends duct velocities for LEV ?

- vapor :- 1000 fpm
- dust :- 4000 fpm

"the heavier particle the higher velocity"

---

* Reynold's number (Re) :.

Describes flow turbelence and characteristics of air - normally it is higher than 4000 for piping systems.

(Re)	Flow
< 2300	Laminar
2300 → 4000	Unstable
> 4000	turbulent

---

* pilot tube :- measure flow speed in a duct.

- must be pointed in air stream @ distance ≥ 7 duct diameter downstream from any elbo, and @ ≥ 3 duct diameter upstream of any obstructions.

≥ 7 ↓ down stream
≥ 3 ↑ upstream

* Sampling velocity:-
Remember: under Sampling, isokinetic, oversampling
- Large particles:- over Sampling.
- Small particles:- under Sampling.

---

* STP :- Standard Temp, pressure:-
Temp: 32°F or 0°C.
pressure: 14.7 psi or 1 atm. or 760 mm Hg.

* NTP:- normal temp, pressure:-
Temp:. 68°F or 20°C
pressure:- 14.7 psi, 1 atm, 760 mm Hg

note:- @ ideal gas @STP ⇒ molar volume = 22.4 L
@NTP ⇒ molar volume = 24.04 L.

---

* parkinson's disease like :- poor ventilation during welding for prolonged exposure to manganese.

✱ Engineering Economy ✱

- Why Safety prof. use Eng. economy?
  - money generates money.
  - Training modules cost.
  - Safety eq. cost.

✱ Simple Interest: (فايدة بسيطة) الفوايد والقروض

$$I = P n i$$

I = amount of interest paid
P = Principal (amount borrowed)
n = no of years
i = interest Rate in decimal. APR

✱ Compound Interest: فايدة مركبة

$$F = P\,(1 + i/n)^{nt}$$

F = future value of Loan
P = initial loan amount
i = interest rate
t = no years , n = no times / year

✱ future value of money:- يعني قيمة إيه؟

$$F = P(1+i)^{n}$$

F: future value, P: present value, i: interest rate

✱ Loan Balance:- فاضل كام سنة

$$B = A\,(1 + i/n)^{nt} + P\,\frac{(1 + i/n)^{nt} - 1}{(1 + i/n) - 1}$$

B: balance after n years
A: original Loan amount
n: no of payments / year
P: amount paid
t: no years , i = APR

* Present Value of money (present value).

$$P = F(1+i)^{-n}$$

P: present value, principal
F: future value (savings)
i: ann. interest rate APR.

* Series Compound amount Factor.

$$F = A\left(\frac{(1+i)^n - 1}{i}\right)$$

Annuities
future value of an annual payment.

A: each payment
n-1: no of period

* Sinking-fund factor.

$$A = F\left(\frac{i}{[(1+i)^n - 1]}\right)$$

* Capital Recovery factor.

$$A = P\left(\frac{i(1+i)^n}{(1+i)^n - 1}\right)$$

period of Payment

P: present

* Series present worth factor.

$$P = A\left(\frac{(1+i)^n - 1}{i(1+i)^n}\right)$$

* Cost benefit analysis (CBA):-

* process used to measure benefits of a decision or taking action minus the costs associated with taking that action
* CBA involves measures financial metric, revenue earned or costs saved
* include intangible benefits and costs or effects from decision such as employee morale, customer satisfa
* forecasts built into the process, if any result not accurate, the result be called into Question.

* total Cost of Risk:-

* framework to think about the overall cost of insurable risks
* Total costs of risk used to evaluate the trade off in costs of various insurance, expenses.

Cost of Capital
insurance premiums
claims Handling
expected retained Claims.

* ROI : Return of investment:- (Benefit or return)

$$ROI = \frac{\text{Current value of invest} - \text{Cost of investment}}{\text{Cost of investment}}.$$

(The higher = the better)

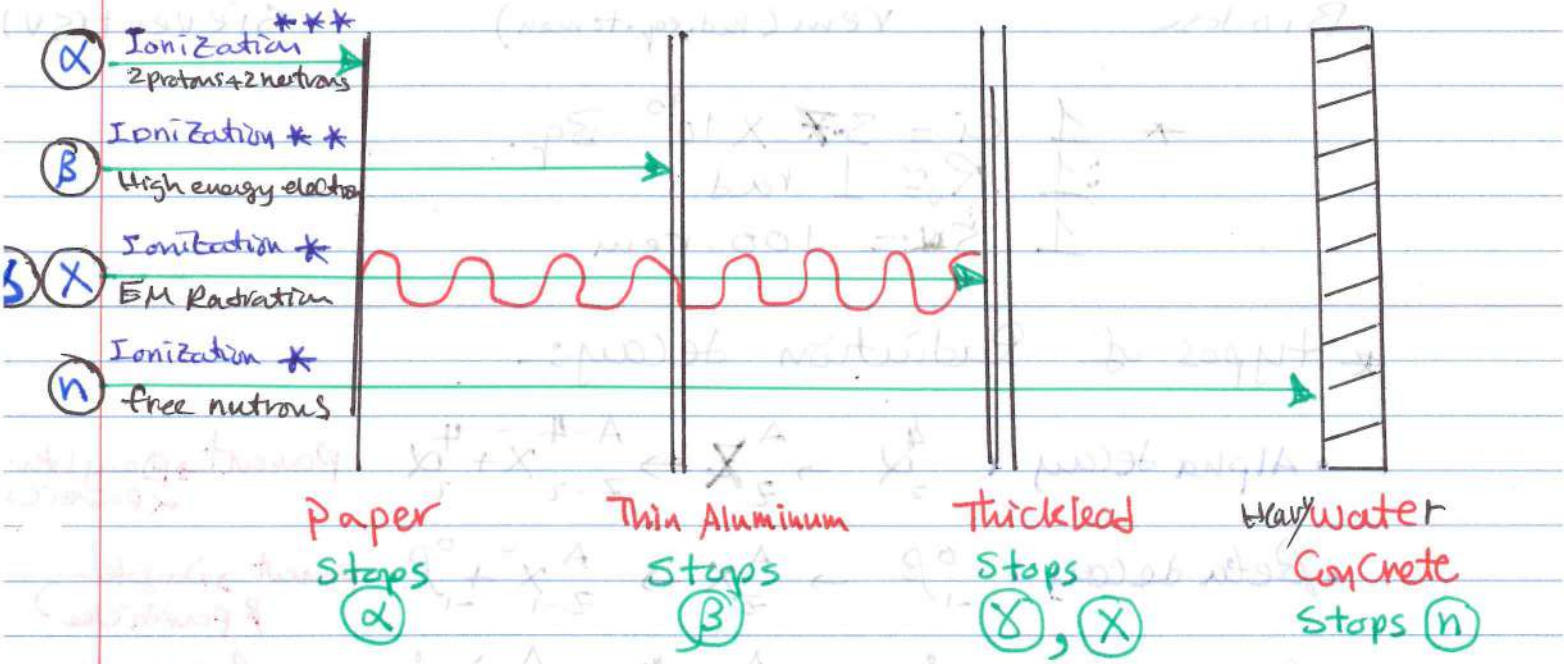
$$= \frac{\text{net earnings}}{\text{Total Assets}}.$$

→ to evaluate efficacy of investment, compare different investments,

A (protons + neutrons) at. mass
Z protons at. no.

Radiation Safety

* types of Radiation :-
  - Ionizing radiation: α, β
  - non Ionizing Radiation: γ, X-Ray, n



* Bio. effect of Ionizing Radiation :-

Burns • acute sonatic effect (ARS) High Dose, little time ✓
[redacted] • Delayed Sonatic effect Low Dose, more time ✓
• Critical organs targeted organs
(DNA) Genetic ← mutation → teratogenic (8-15 weeks in fetus).

* acute Dose (Rad) effect :-

Rad	effect
0-25	No observable effect
25-50	Blood Minor temporary Changes possible nausia, vomit, Reduce WBC
50-150	inc sev. of above + diarria, malaise
150-300	✓ ✓ ✓ ✓ + Hemorrhging, LD_{50} @ 450 rad
300-500	✓ ✓ ✓ ✓ + Sym appear sooner
>500	LD_{100} @ 600 rad

* Ionizing radiation Units *

usage	old units	new units
activity	Curie (Ci)	Becquerel (Bq)
Exposure	Roentgen (R)	Roentgen (R)
Dose	Rad	rad
Biodose	rem (rad. eq. roman)	Sievert (Sv)

* 1 Ci = 3.7×10^{10} Bq.
1 R ≈ 1 rad
1 Sv = 100 rem

---

* types of Radiation decay:-

- Alpha decay: ${}^{4}_{2}\alpha \rightarrow {}^{A}_{Z}X \rightarrow {}^{A-4}_{Z-2}X + {}^{4}_{2}\alpha$ — Parent → Daughter + α particle
- Beta decay: ${}^{0}_{-1}\beta \rightarrow {}^{A}_{Z}X \rightarrow {}^{A}_{Z-1}X^{-} + {}^{0}_{-1}\beta$ — Parent → Daughter + β particle
- Gamma decay: ${}^{0}_{0}\gamma \rightarrow {}^{A}_{Z}X^{*} \rightarrow {}^{A}_{Z}X + {}^{0}_{0}\gamma$ — Relaxation
  excited nuclear state → Daughter → gamma

---

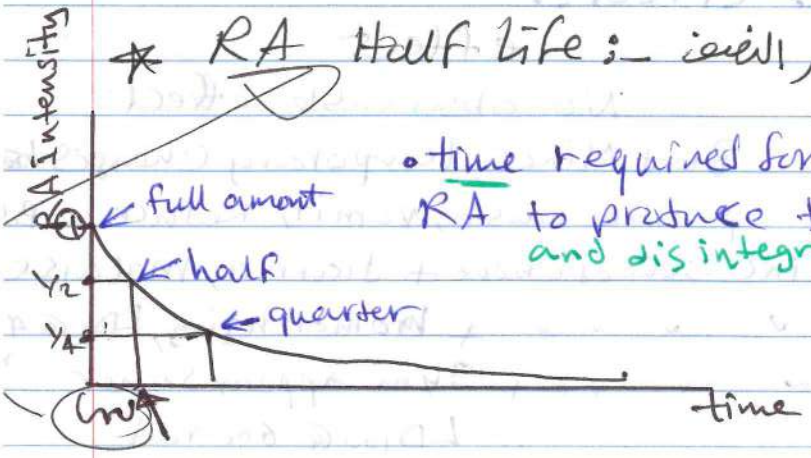
* Calculating Radioactive Decay:-

$$N_t = N_0 e^{-\gamma(t)}$$

N_0 = initial
N_t = remaining quantity
γ = disintegration const.
$\gamma = \frac{0.693}{T_{1/2}}$
$T_{1/2}$ = half-life
λ = decay const.

* RA Half Life:-

- time required for amount of RA to produce to half and disintegrate



ALARA

* Radiation Control Methods *

[1] time: T ∝ Dose effect

$$Dose = D \times T$$

dose rate ↗ (D) ; ↖ time of exposure (T)

[2] Distance: D ∝ 1/Dose effect

$$I_2 = I_1 \left(\frac{d_1}{d_2} \right)^2$$

- I_2: int. @ distance (2)
- I_1: int. @ distance (1)
- d_1, d_2: distances (location)

* gamma Rad. Source Strength

$$S = 6CE$$

S: R/h/1ft ; C: curie ; E: energy

[3] Shielding:- Material and Thickness

* Half-Value Layer (HVL):-

تقلل 50% من الأشعة

Material (α, β)

$$HVL = \frac{0.693}{\mu}$$

, μ = Linear abs. coefficient for material.

Thickness (γ, X)

Approx. effect of a Shield

$$I = I_0 e^{-\mu x}$$

- x = Shield thickness
- μ = lin. abs. coef.
- I_0 = original Intensity
- I = int. after shield.

β

$$I = \beta I_0 e^{-\mu x}$$

β gradiation scatter factor.

* OSHA Exposure Standards *
Ionizing Radiation

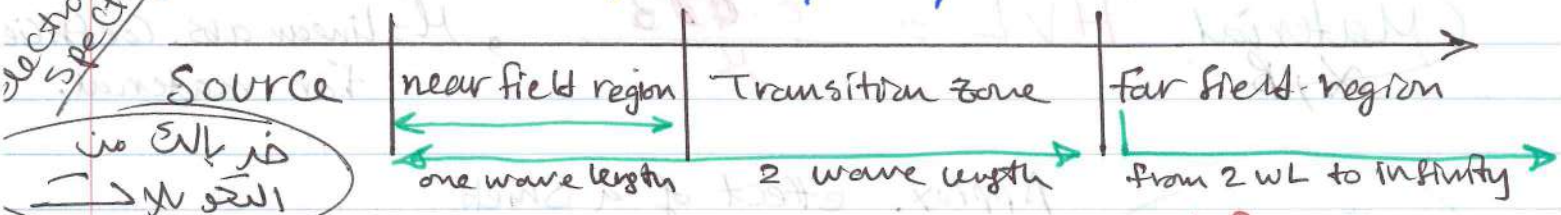
Body part	(rem) max
• trunk, head, Blood organs, eyes	1 ¼ rem / quarter
• Hands, Forehands, feet, ankles	same 18 3/4 rem / quarter
• Skin of whole Body	7 ½ rem / quarter
• whole Body (pregnant women)	5 rem / year

note :. $D = 5(N - 18)$
D = Dose, 5 = limit, N = age

(ICNIRP) F. Comm. non.ion.Rad.prot * Non Ionizing radiation *

melanoma
- UV = Sun, black light, welds arc, UV Lasers
- IR = furnaces, welds, Heat Lamps, IR Lasers.
  - IR-C
  - IR-B
  - IR-A Most Dangerous

electromag. spectrum
- MW : microwave, oven, TV, Some Radars



in EM is spherical

antenna
- N.F.R # $W = 16P/\pi D^2 = 4P/A$
- F.F.R # $W = \frac{GP}{4\pi r^2} = AP/\lambda^2 r^2$

- W = Intensity Power
- P = antenna power
- A = Area
- D = Diameter
- A = Area
- λ = wave length
- r = distance from antenna

✱ LASERS ✱

L	A	S	E	R
Light	Amplification by	Stimulated	Emission	Reduction

✱ Hazard Level table:- Check yates.

OLd	NEW	Haz. Level
1	1	safe (laser printer)
	1C	safe when only used on target
	1M	not used to view, only optical instr.
2	2	Visible laser, Safe for acc. exposure < 0.25 sec
	2M	~ Same + avoid staring. laser pointers
3A, 3B*	3R	Not safe, Low Risk, no direct exp. - Caution sign.
3B++	3B CD, DVD	Hazardous, viewing of diffuse reflection may be safe; prevent eye exp.
4	4	Hazardous, Fire risk, prevent eye, skin exposure

✱ Laser Control:-
- shield to reflect radiation,
- ~ ~ absorb ~ .
- Restrict access to source,
- Increase Distance From Source,
- Limit time of exposure.
- Utilize less Hazardous radiation

---

* Effective Irradiance:-

$$E_{eff} = \sum E_\lambda \, S_\lambda \, \Delta\lambda$$

E_λ : spectral irr. S_λ : relative spectral $\Delta\lambda$: band width.

---

* Speed of light:- Wavelength Calculations

$$C = \lambda F = \frac{\lambda}{T} \quad \text{as } F = 1/T$$

- λ = wave length
  T = time.

---

* factor influence degree of eye injury?
* energy, color of laser
* Divergence of laser light.
* Scattering media (dust) in the beam path.
* Pigmentation of eye
* pupil size.
* focus of laser beam on retina and eye lense

* americium Am^{241}, used in ionization Chamber of smoke detector as during fire smoke particles disturb the electrical current produced by small amount of Am^{241} and trigger the alarm.

* notes (Radiation)

* Industries with high record of oC. dermatitis :-
Syn. resin, leather tanning, oil Ref., Cement, automobiles

* substances used in industry have highest incidence of contact dermatitis ?
Detergents, solvents, degreasers, descalers., sensitizers.

* • lower Carbon ~ Hyd. Z elements, decay by emission β particles
• higher Hydrogen Z elements, ~ ~ ~ α ~ .
Z = atomic number.

* α particles :- two neutrons + two protons (a Charged Helium)
They positive. (short range ≅ 5cm).

β particles: Negatively Charged electrons
+ positive ~ ~~protons~~ positron.

* fission, fusion :-
Sun • fusion: multible nuclei combine, produce bigger nucleus.
At. bomb • fission: in nuclei with high at no splitting into (2) smaller.

* film bandage :- monitor personal exp. to radiation.
γ, X, β high energy =
itis covered by different mat. (masked), That radiation must penetrate to reach photographic film. Then after developing the film → radiation darkness, exp. level detected.

* portable X Ray fluorescent analyzer (XRF).
Components :- (1) Sealed R-A Source produce x Ray (shielded)
(2) shutter allow x Ray release, when trigger pulled.
(3) fluorescence detector measure light emitted by lead.
(4) Micro processor display test result on screen.

* universal color for Radiation hazard is
" Magenta on Yellow background "

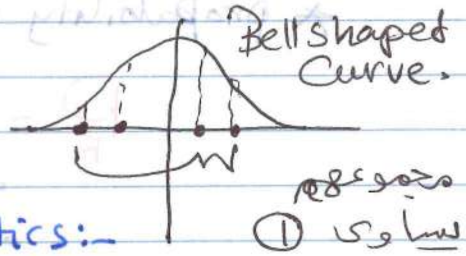
* Statistiss for Safety prof. *

* Mean (avg.) μ or $\bar{x}$ = $\frac{x_1 + x_2 + \cdots + x_n}{n}$

* Mode = most occured most often number.
* Median : middle value after arrangement.
    - odd nombers = middle value
    - even numbers = 2 middle values ⊕ / 2.

* Standard Deviation: $S = \sqrt{\frac{\Sigma (X)^2}{N-1}}$, $X = \Sigma (x_i - \mu)^2$

* Normal distribution:-
  mean = Median = Mode

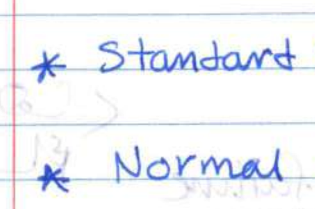


* Chi-square: χ^2 (SIS) Statistics:-
  compared observed vs. Theoritical ones.

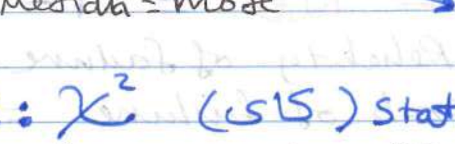
* Z-score:-
  Distance from mean / Standard deviation.

steps: ① Calc mean
② Calc st. deviation
③ Calc. Z-score
④ نعوضنا بجدول ب (Z) للحصول على القيمة الحقيقية

$$Z = \frac{x^2 - \mu}{\sigma}$$

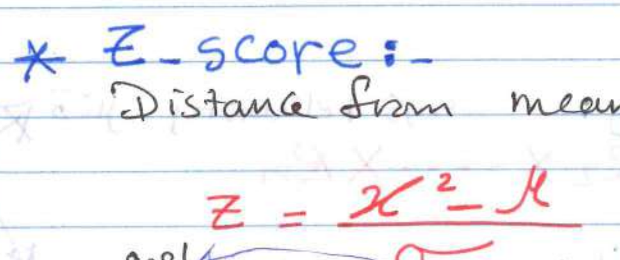


* If Z = 0.41
∴ Correct value = 0.6591



⑤ ① − 0.6591 = 0.34 = 34%
∴ 1 = كل المساحة الجدول
∴ Zscore = 1 − theoritical = %

* St. deviation note:- 68% of area under curve within ± one σ:-
95% ~ ~ ~ ~ ~ ± 2σ.
99% ~ ~ ~ ~ ± 3σ



* ملحوظة Spearman Coefficient
١- لازم ترتيب الـ variables
٢- تحليلهم من الأعلى للأقل.
٣- تنزل بالـ للأعلى
F.r = —

* Thermal Stressors *

* Sources of Heat Stress:-
  - Radiation
  - Convection
  - Conduction
  - Metabolic (internal body temp.)

* Human Body Reaction to heat and Cold:-

"Cold"

Body temp falls.
Blood vessles constrict.
Heat conserved, sweat not secreted
Shivering generates heat
which warms body
Heat is retained
return to normal temp.

"Heat"

- Body temp rises.
- Blood vessles dilate resulting in heat loss to the env. Sweat glands secrete fluids.
- as fluid evaporate, heat lost from body.
- heat lost to env., return to normal

* If body can't return to normal body temp. This leads to Heat, Cold related illnesses.

* Safety Related to issues of Heat:-

- sweat and Slippery Palms.
- Dizziness
- fogging of Safety glasses, goggles.
- over look safety procedures.
- decreased alterness.
- fatigue.
- Emotional state.

* Heat related issues of Heat *

- Heat rash.
- Heat Cramps.
- Heat Syncope.
- Dehydration.
- Heat exhaustion.
- Heat Stroke.

Lowest Risk

Risk increased.

Highest Risk

① Heat Rash

auses

- Hot, humid environment.
- Sweat is not easly removed.
- Skin remain wet
- poor hygiene, prolonged Sweating

ymptoms

- skin eruption
- IChing, Red skin.
- Reduction Sweating

ontrols

- Keep skin clean
- periodically allowing skin to dry
- Change into dry clothing
- Reduce heat exposure.
- tropical ointment.

② Heat Cramps

Causes

- Sweat profusly in heat
- same heat rash causes.

symptoms

- painful muscles
- In capacitating pain in muscles.

Controls

- Drink large amount of water
- add salt to diet
- replace Body salts once loose.

③ Heat syncope

auses

- pooling of blood in legs and skin prolonged
- static posture of body and exp.

;ymptoms

- Blured visicn.
- faint (short duration)
- Dizziness, headaches.

ontrols

- flex legs muscles several times
- Stand or sit slowley.
- Sit or lie down in cool place
- slowley drink water, Clear Juice, sport drinks

④ Dehydration

Causes

- water out > water in
- excess fluid loss
- Alcohol consumption
- Some medication

Symptoms

- fatigue
- weakness
- Dry mouth
- loss of work Capabilities
- Increase response time

Controls

- moniter uring Color Codes and hydrate as per required.

⑤ Heat exhausion:-

- **Causes:**
  - loss of large amounts of fluids, Salts.
  - extreme fatigue or loss of Consciousness.
  - May advance to Heat Stroke.
  - no physical fitness - no acclimation
- **Symptoms:**
  - fatigue / weakness / Blurred vision.
  - Dizziness / High pulse rate.
  - profuse sweat / low blood pressure.
  - Pale face / Clamy skin / Collapse / Headache.
  - Nausia, vomiting / Slightly increase in body temp.
- **Controls:**
  - Drink water
  - take normal Salt.
  - rest breaks in cool area.
  - acclimatization.
- **emergency:**
  - lie down flat on Back and rise legs.
  - Cool environment.
  - Drink water, sips.
  - Cool Their Skin
  - loosen Clothing.

---

* **Heat stress training:-** program shall Contain.

- Knowledge of Hazards
- rec. danger signs / symptoms.
- FA awareness procedure.
- Employee responsibilites in avoid Heat Stress.
- use of PPE, Clothing.
- physical fitness., fluid replacement.
- dangers of drugs, alcohols.

(6) Heat Stroke.

- it is a medical emergency.
- Body temp. regulation system fails.
- Sweat Stops.
- Death or Brain damage.
- excessive work load in hot environment.

- **symptoms:**
  - Chills
  - Restlessness
  - Mental Confusion, ephoria, red face.
  - Dry skin, Collapse.
  - Sweat stops, erratic behaviour
  - Shivering, Convulsiation, unconsciousness.
  - Core temp > 40°C or 104°F.
  - Irritation
  - Dis-orientation.

- **Controls:**
  - persons should acclimitize themselves to env.
  - Healty life style, adhere to an appropriate work/Rest cycle.
  - Maintain proper diet.
  - Drink plenty of fluids.
  - Self determing the amount of heat stress exposure.

- **First aid emergency:**
  - Call 911 emergency medical care.
  - Stay with worker till emergency arrive.
  - Shaded / Cool area, remove outer clothing.
  - Cool worker quickly by Cold water / ice Bath.
  - Circulate air around to speed cooling
  - place cold wet cloth on head, neck, armpits. and groins.

* Control Methods *

- Engineering Controls.
- Administrative ~ .
- PPE.

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[1] Engineering Controls:-

- genral ventilation.
- Air treatment or cooling.
- Air Conditioning.
- Convection fans.
- Reduction in air humidity.
- Heat shields. , Insulation.

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[2] Administration Control:.

- acclimatization. (2 weeks)
- Fluid Replacement.
- work / rest cycles.

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* work / rest cycle calc.:-

$$\text{Avg metabolic} = \frac{M_1T_1 + M_2T_2 + M_nT_n}{T_1 + T_2 + \cdots T_n}$$

Kcal / hour

- M = Metabolic rate Kcal / min
- T = Time / min

* note: resut should be multiplied x 60 to convert rate from min to hour.

- Light work up to 200 Kcal / h
- Medium work 200 - 350 Kcal / h
- Heavy work 350 - 500 Kcal / h

* WBGT Calculations *

wet bulb Global temp. Index

$$\text{Avg. WBGT} = \frac{(WBGT_1)T_1 + (WBGT_2)T_2 + \cdots}{T_1 + T_2 + \cdots T_n}$$

- for out door with solar load

$$WBGT = 0.7\,WB + 0.2\,GT + 0.1\,DB$$

(DB: dry bulb)

- for indoor and outdoor without no-Solar Load

$$WBGT = 0.7\,WB + 0.3\,GT$$

Since
WB : Humidity meter (Cotton piece merged in water)
DB : Air temp. thermo. (normal thermometer)
GT : Black Thermo. (radiation temp.)

* Check results in permissible Heat exp. TLV table
CAF * Check Clothing adjusting factor table. OSHA
Heat index Correction.

note:- If double layerd clothing, add (3) on result.
If poly. prob. Coverall, add (0.5) on WBGT.

* Check air temp / Humidity table.

3 PPE:

- reflective Clothing.
- auxillary Cooling systems.
  - Ice vests
  - Circulating-air garments
  - water Cooled garments
  - wetted terry-Cloth.
- protect exposed skin (neck, face, head, arm).
- using sun block / Cream of atleast 15 SPF.
- wetted Scarf.

✱ Cold-related Illness ✱

- non-freezing inj.
  - Chilblains
  - Immersion inj Trench foot
  - Mild, moderate, severe Hypothermia
- freezing injuries.
  - frost bite of varying degree.

✱ non-freezing Injuries:-

Chilblains	Trench Foot
Causes • familial tendency. • peripheral vascular diseases • low body weight, poor nutrition. • Hormonal Changes • Connective tissue diseases. • Bone marrow disorder	**Causes** • prolonged exp. @ 50-70 F° • Shorter exp @ 0° or 32°F
Symptoms • Itching, tender red skin • Shut down blood vessels in Cold Cond. • exposed to Cold/Humid Climate aggigate by exposure to sun.	**Symptoms** • Cold swollen waxy white skin • Deep musculoskeletal sensation is lost
Controls • topical, steroid creams. • Antibiotic ointment, oral antibiotic • Insulated, heated work place. • warm cloth, gloves, thick wool. • avoid medicine that constrict blood vessles. • exercise vigrously before go outside • wear cotton lined waterproof gloves @ wet work. • Apply sun cream to exposed skin in sunny days. • stop smoking.	**Controls:** • Air dry • elevate the feet • exchange wet shoes socks for dry ones.

* Hypothermia *

- reduction of body Core temp. < 98°F or 36.6°C.
- prognessive deterioration in Cerebal, musclosKeltal, and Cardiac functions.
  - mild-Hypothermia:
    - Body temp range 89-95 °F.
    - violent Shivering, disorientatay
  - moderate-Hypothermia:
    - Body temp 78-89°F.
    - Cardiac irregulation, Corenery reflexes.
  - Severe - Hypothermia:
    - occurs @ Core temp. 78°F, lower.
    - Ventricular fibrillation @ < 80°F.
    - The affected person may appear Clinically dead.

~~X~~ freezing Injuries:-

* frost-bite *

- exposure to environmental Conditions below freezing.
- Severity of Injury depend on:
  Temp., wind Chill, duration of exposure.
- superficial frostbite involve only skin, tissue benith
- Deep frostbite affect deep tissue benith.
- Dead white, Hard or brittle.

* frost-bite degrees:-

- first degree: similar to mild Chilblain.
- second ~ : blistering, shedding of outer layer.
- Third ~ : ass. w/ necrosis of skin, ulceration.
- Forth ~ : destruction of connective tissues accompanied by gangrene.

* prevention measures:-
- full acclimation to cold climate (4 weeks)
- observance and adhere to wind chil factor.
- proper protection clothing.
- proper nutrition 20% protin, 45% Carb., 35% fat.
- fluid replacement or intake.
- training and discipline.

• Wind Chill Factor Calc. •

- no of Calories for 1 hour from sq. meter of surface kept @ 91°F.

$$(F^{\circ}) \text{ wind Chill} = 35.74 + 0.6215\,T - 35.75\,(V^{0.16}) + 0.4275\,T\,(V^{0.16})$$

Since, T = F° air temp V = mph wind speed.

* results in minus (-ve).
* Check wind Chill Factor table.

* Treatment of Cold-related inj *

- Remove to warm env.
- loosen restricted clothing.
- Re-warm by blankets, warm env.
- Drink Hot, warm fluids
- frost bite victim seen by licenced med. provider.
- ~ ~ Cases treated by rapid warm in Hot water Bath gradually.
- non-freezing Inj should be warmed above 98°F.
- Smoking, Consumbtion of alcohol, strictly prohibited.