



MOSTI



Working Procedures with TENORM



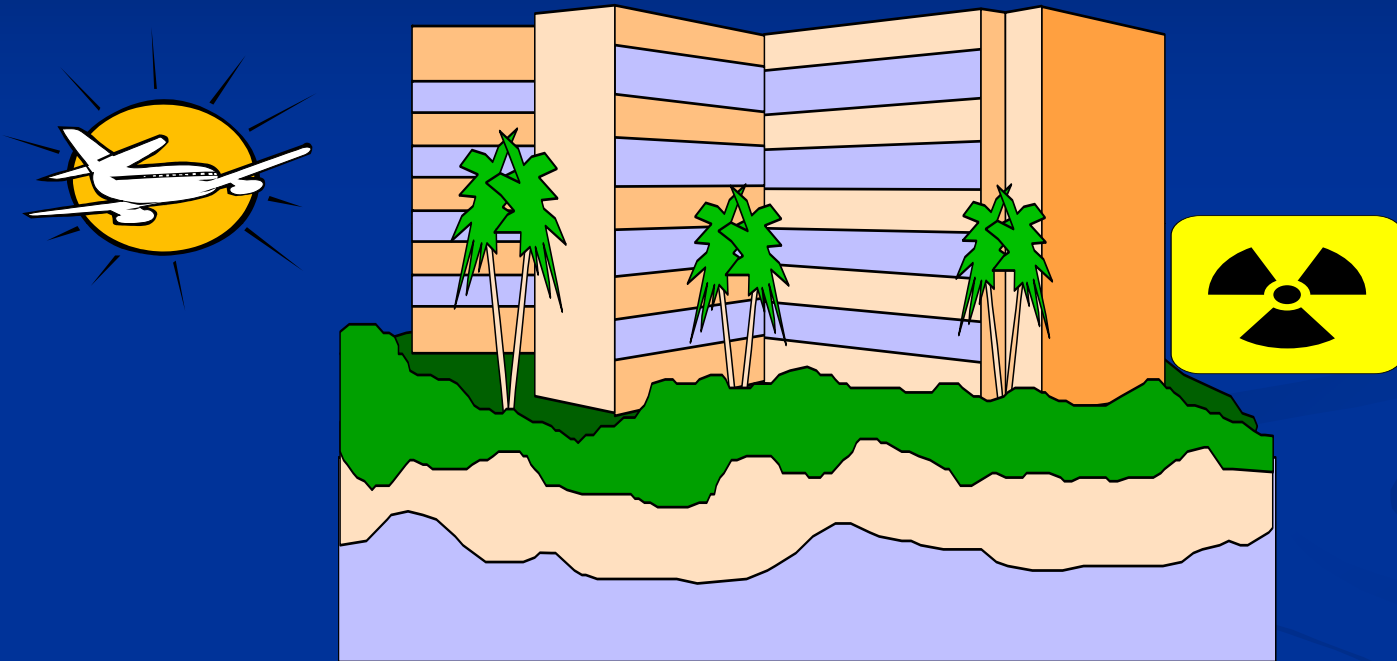
CONTENT

- ✓ NORM/TENORM
- ✓ Classification of Work Areas
- ✓ Working Procedures
- ✓ Storage
- ✓ Transportation
- ✓ Monitoring
- ✓ Workers responsibilities
- ✓ Actions in Abnormal/Emergency Situation
- ✓ Summary

Objective:

- Biological risks:
 - ▣ Somatic effect
 - ▣ genetic effect
- IR need to handle **WITH CARE** no harm to the **user, public** and the **environment** as well as for **future generation** but can enjoy the benefit using IR.

MATERIALS CONTAIN *RADIOACTIVE*



EVERYWHERE IS RADIATION

NORM/TENORM



Definition

- **NORM** - **N**aturally **O**ccurring **R**adioactive **M**aterials
- e.g. rocks; soils; sediment; ores; minerals; coal; bricks & other building materials

- **TENORM** - **T**echnologically **E**nhanced **NORM** through technological processes
- e.g. Oil scales, incineration ash, tin slag

NORM

ship TANKER SLUDGE

$Ra-226 < 0.006 \text{ Bq/g}$

$Ra-228 < 0.004 \text{ Bq/g}$



**TECHNOLOGICAL
PROCESS**



INCINERATION

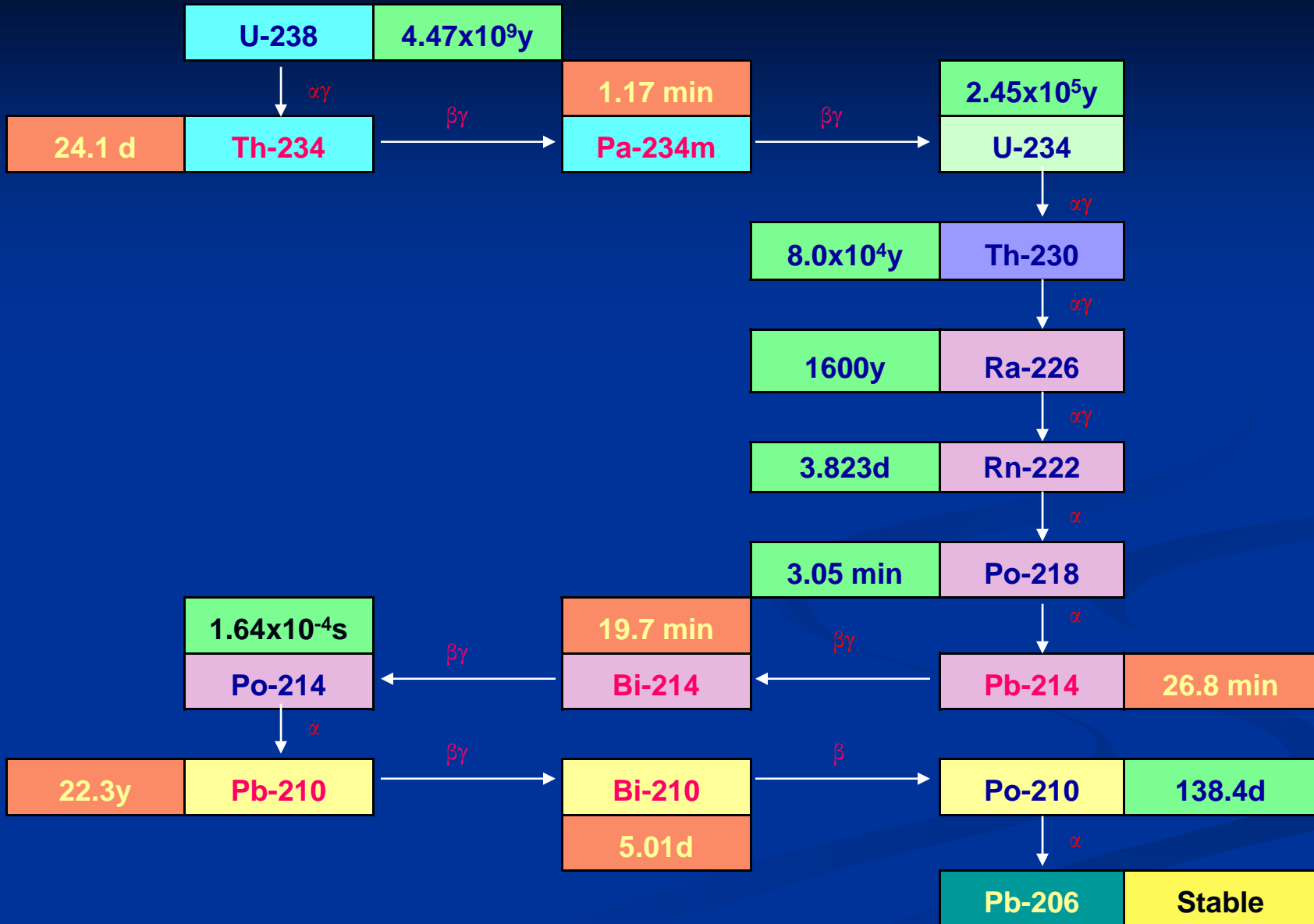
TENORM

SLUDGE ASH

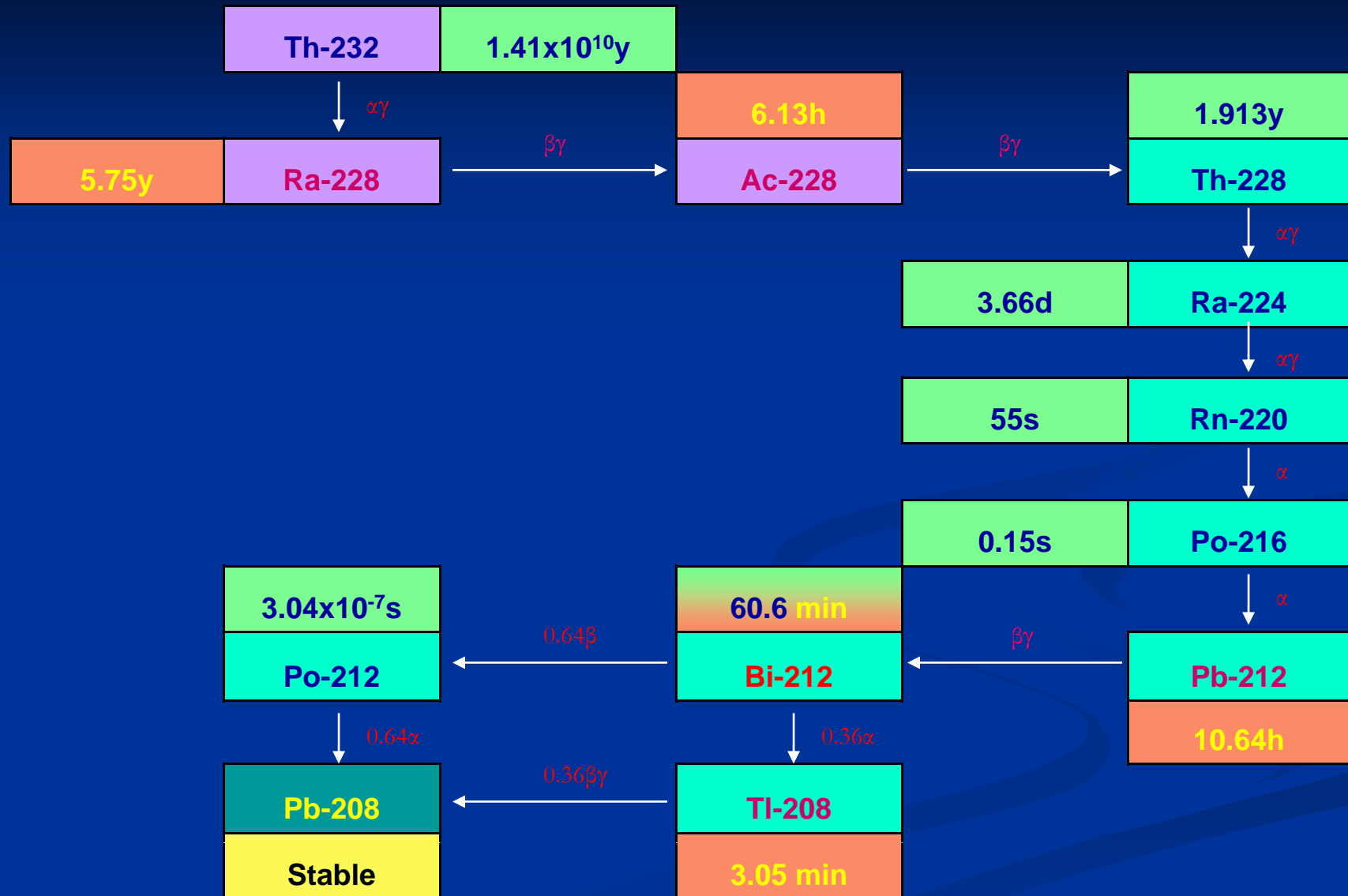
$Ra-226 = 0.12 \text{ Bq/g}$

$Ra-228 = 0.15 \text{ Bq/g}$

Uranium -238 Decay series

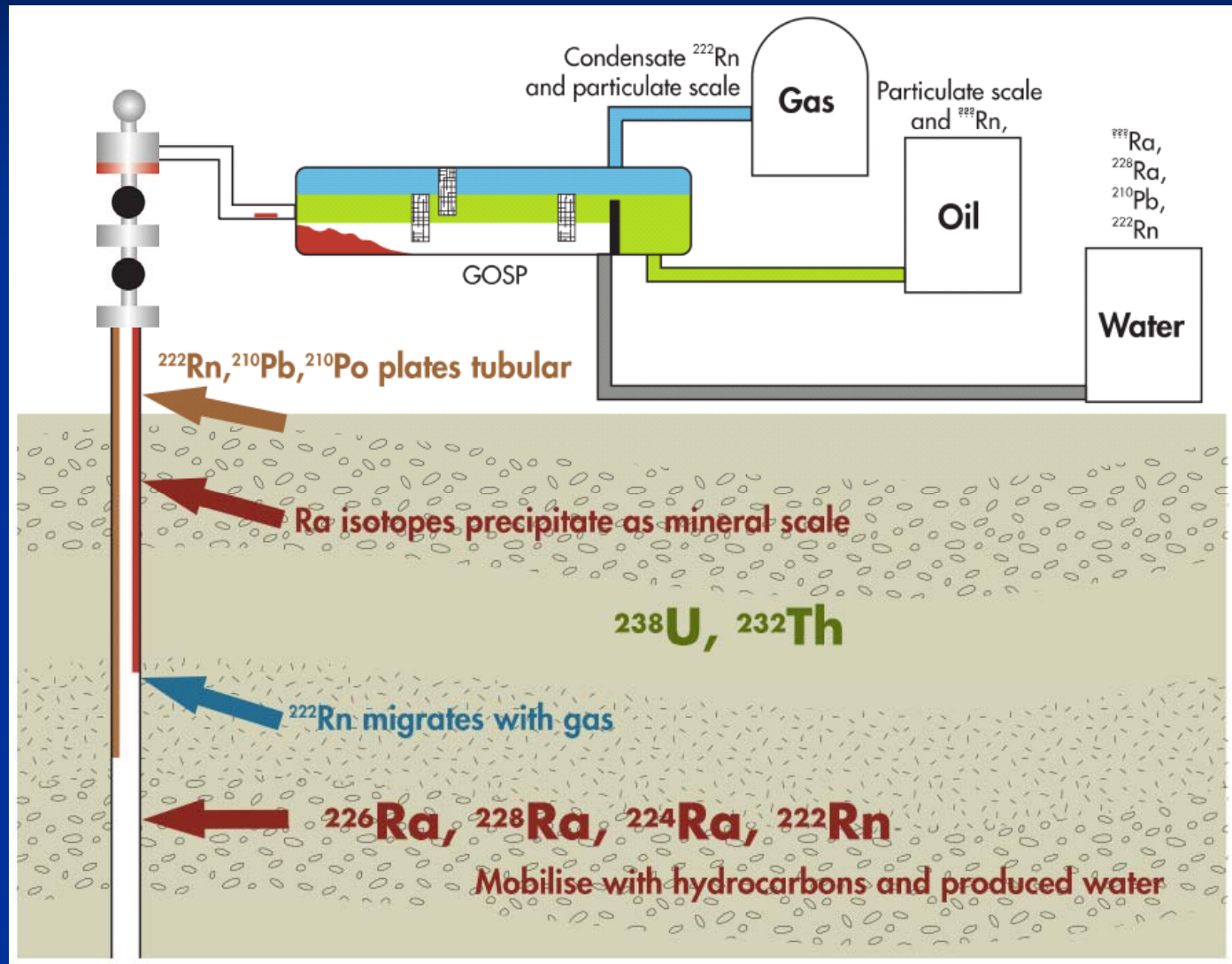


Thorium-232 Decay Series



TENORM IN OIL & GAS INDUSTRY

Scales, sludge and pipelines scrapings, and radon in gas processing facilities.



Radioactivity levels of NORM & TENORM in Malaysia

NORM/TENORM	Ra-226 (Bq/g)	Ra-228 (Bq/g)
MAL normal soils (Peninsular) (Sabah & Sarawak)	0.04 – 0.10 (max 0.24) 0.03	0.07 – 0.13 (max 0.28) 0.03 – 0.04
Amang (tin tailing) Mine sands	0.7 – 1.3 0.04 – 0.11	0.6 – 1.6 0.02 – 0.05
Petroleum Sludge & Scales	0.01 – 430	0.01 – 450
Monazite	8 – 22	64 – 180
Zircon	13	2.2
Xenotime	71	14
Ilmenite	0.7	0.5

TOTAL ACTIVITY CONCENTRATION (TAC) FOR SCALE & SLUDGE

- In the oil and gas industry, as sludge and scales normally contain Ra-226 and Ra-228 as their major parent radionuclides:
- $TAC_{SS} \text{ (Bq/g)} = (6 \times Act_{Ra-226}) + (8 \times Act_{Ra-228})$
- Where Act_{Ra-226} and Act_{Ra-228} are the activity concentrations in Bq/g of Ra-226 and Ra-228 respectively.

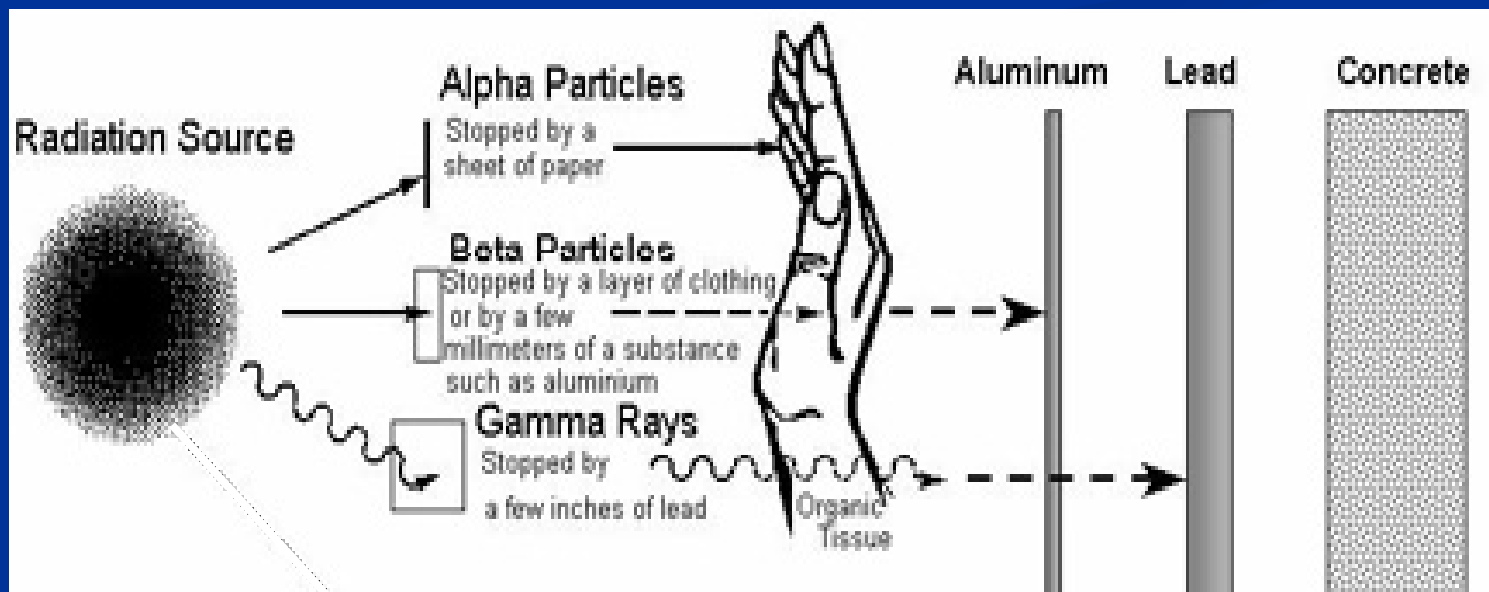
TOTAL ACTIVITY CONCENTRATION (TAC) FOR ORE & MINERAL

- In the case of ores and minerals, where radioactive equilibrium is assumed :
- $TAC_{OM} \text{ (Bq/g)} = (14 \times Act._U) + (10 \times Act._{Th})$
- Where $Act._U$ and $Act._{Th}$ are the activity concentrations in Bq/g of any member of U-238 and Th-232 series respectively.

HEALTH HAZARDS OF TENORM

Hazards of **TENORM** are due to **high energy radiation**:

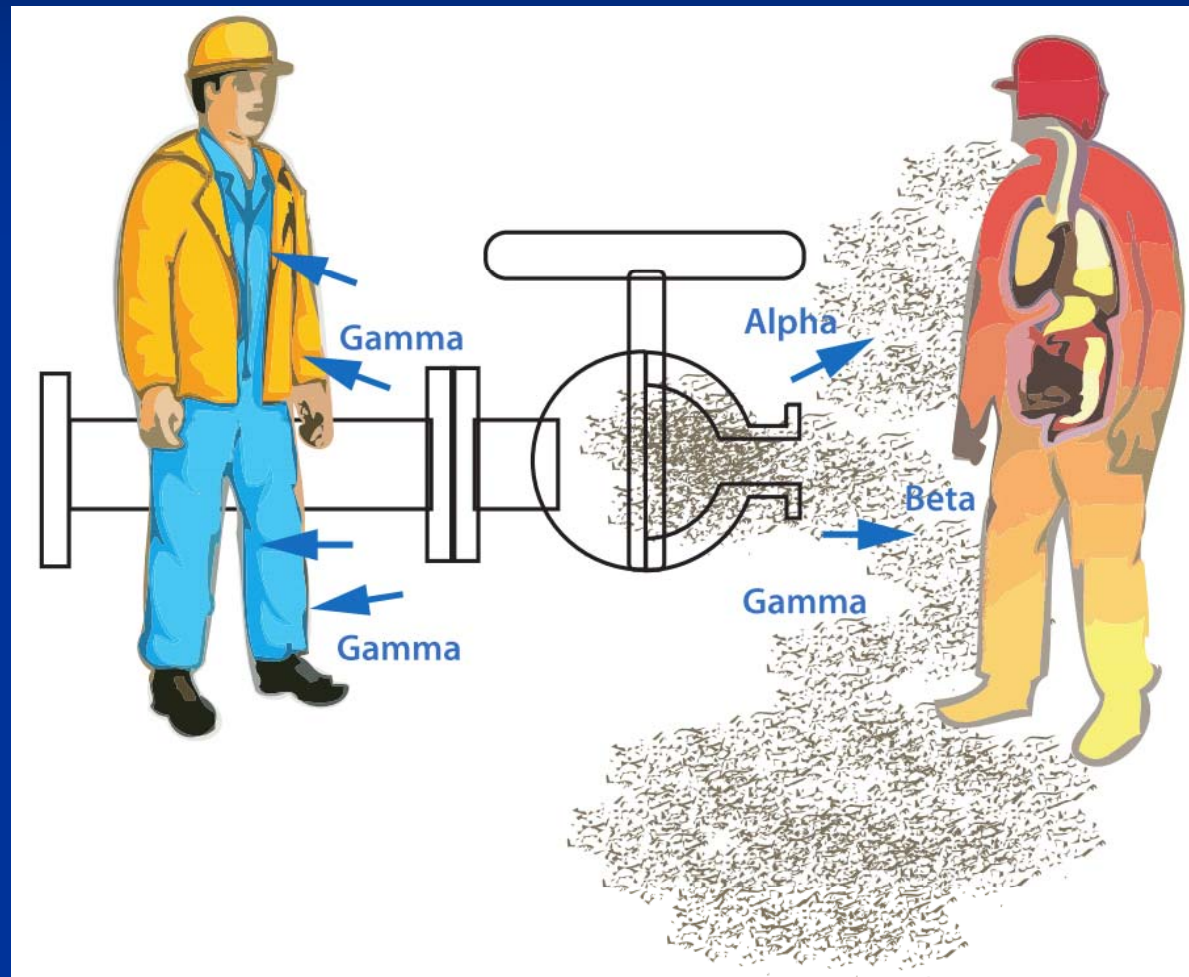
- Alpha (α) – internal exposure
- Beta (β) – internal exposure
- Gamma (γ) – external exposure



HEALTH HAZARDS OF TENORM

Exposure scenarios:
External exposure

Internal exposure (via inhalation,
injection and ingestion)



CLASSIFICATION OF WORKING AREAS

According to the ATOMIC ENERGY LICENSING ACT 1984 ATOMIC ENERGY LICENSING (BASIC SAFETY RADIATION PROTECTION) REGULATIONS 2010

17. (1) The licensee shall classify the working areas into **clean areas, supervised areas and controlled areas**.

(2) The licensee shall, in determining the boundaries of any area, take into account—

(a) *the likelihood and magnitude of potential exposure; and*

(b) *the nature and extent of the required protection and safety procedure.*

(3) Notwithstanding subregulation (2), **an area where the annual dose received by a worker is likely to exceed three-tenth of the dose limit shall be classified as a controlled area.**

(4) The licensee shall **delineate controlled areas by physical means** or, where this not reasonably practicable, by some other suitable means.

CLASSIFICATION OF WORKING AREAS

1. CLEAN AREA

means an area where the annual dose received by a worker is **not likely to exceed** the dose limit for a member of **the public**;

2. SUPERVISED AREA

means an area for which occupational exposure conditions are **kept under review** even though specific protective measures and safety provisions are not normally needed. Likely to exceed **1 mSv/yr** but **unlikely to exceed 3/10 of the Annual Dose Limit**

CLASSIFICATION OF WORKING AREAS

3. CONTROLLED AREA

- means any area in which **specific protection measures and safety provisions are required** for controlling normal exposures or preventing the spread of contamination during normal working conditions, and preventing or limiting the extent of potential exposures
- An Area where the dose received by the worker is likely to **exceed 3/10 ADL (6 mSv y⁻¹)**.
 - This area is subject to **special rules** for the **purposes of protection** against ionizing radiation and to which **access is controlled**.
 - NORM/TENORM working area **should not be classify** as **Clean Area**
- Radiation protection surveillance shall be carried out in a supervised area or controlled area by performing “**area monitoring**” .

CLASSIFICATION OF WORKING AREAS

For NORM/TENORAM (or any unseal source) production/handling area, area classification should also considering other sources of risk beside external radiation

Source Area	External Radiation only	Surface contamination only	Airborne contamination only
Controlled Area	$> 5 \mu\text{Sv/h}$	$> 7 \text{ Bq/cm}^2$	$> 0.01 \text{ Bq/m}^3$
Supervised Area	$2.5 \mu\text{Sv/h} - 7.5 \mu\text{Sv/h}$	$2 - 7 \text{ Bq/cm}^2$	$0.003 - 0.01 \text{ Bq/m}^3$
Clean Area	$< 2.5 \mu\text{Sv/h}$	$< 2 \text{ Bq/cm}^2$	$< 0.003 \text{ Bq/m}^3$



WORKING PROCEDURES

WORKING PROCEDURES

Procedures are developed to **reduce radiation dose** to workers & public

e.g:

- Good housekeeping – reduce surface contamination
- No eating, drinking and smoking at the work place
- Wear face mask
- Wear protective clothing

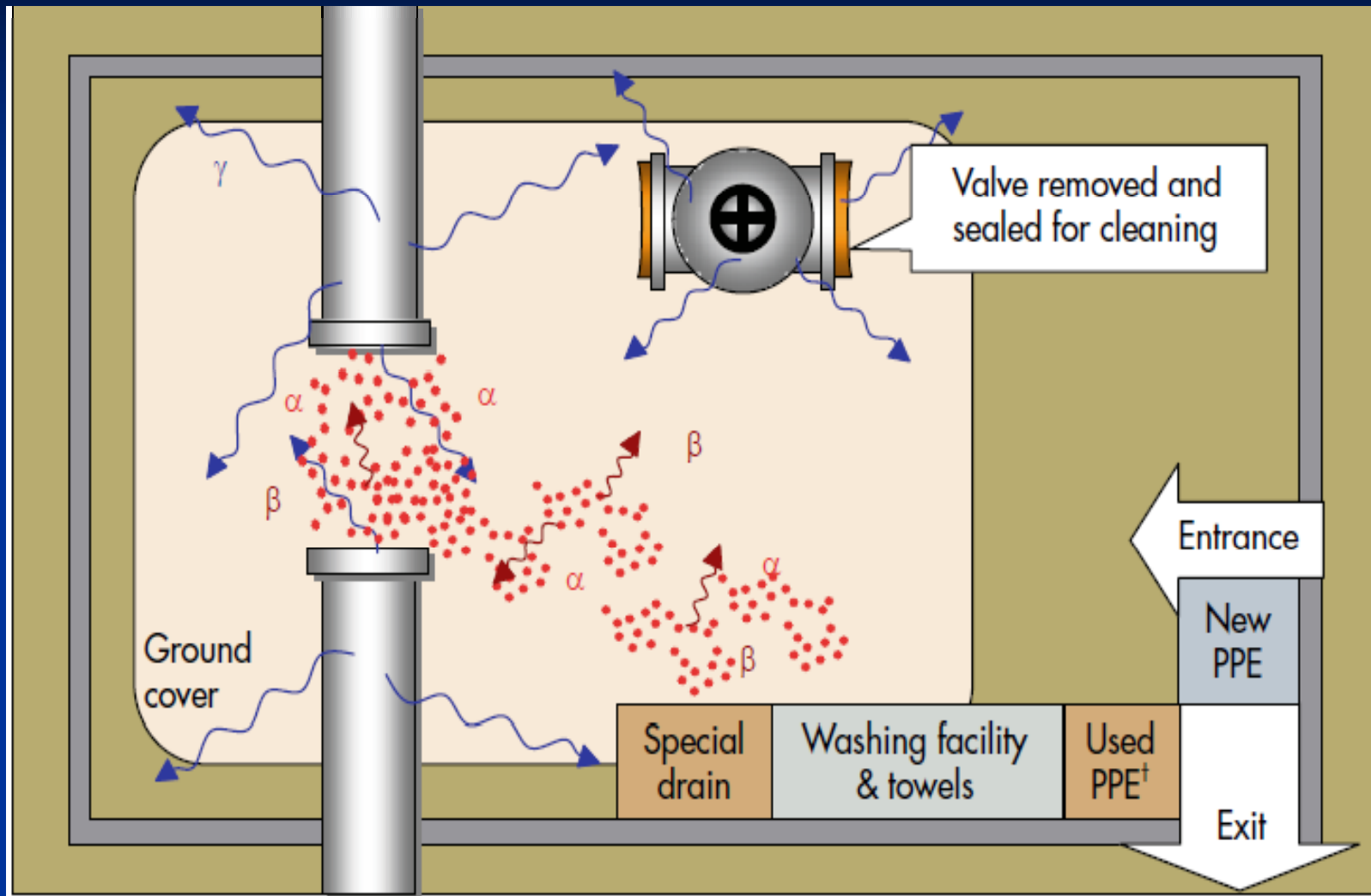
PERSONAL PROTECTIVE EQUIPMENT

EXAMPLE

- Respirator
- Mask
- Laboratory coat
- Coverall/apron
- Safety shoes
- Safety helmets
- Gloves
- Self-contained breathing apparatus (SCBA)



EXAMPLE NORM CONTAMINATION CONTROL FLOW



† PPE: Personnel Protective Equipment

WORKING PROCEDURES

Reduce External Radiations

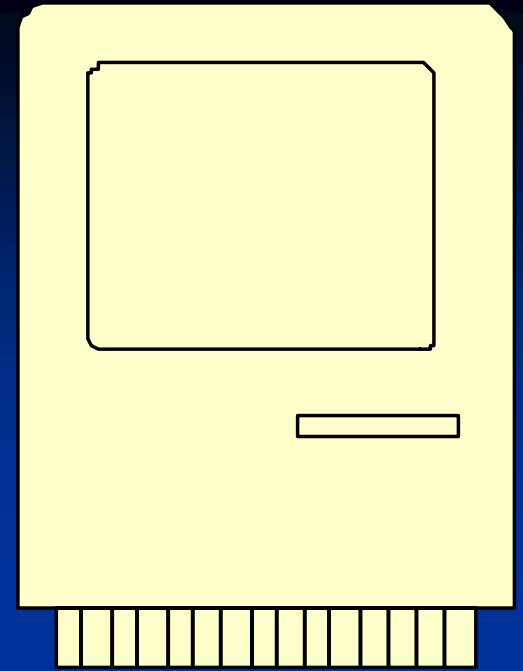
- **SHIELDING**: keep NORM In sealed containers, concrete stores
- **TIME**: avoid unnecessary exposures
- **DISTANCE**: handling from a distance, e.g. use forklift
- **minimise** NORM quantity USED

WORKING PROCEDURES

Reduce exposure to airborne dust & Radon/Thoron progeny

- Processing NORM in closed vessels, wet condition.
- Provide good ventilation – extraction fan, ‘open’ plant design, natural air movement, dilute & disperse

STORAGE OF NORM/TENORM



STORAGE

In NORM/TENORM activities, the **waste storage** require approval from the AELB.

Waste storage:

- **Large volume** – above ground dumps
- Medium & Small sizes – in store, drums, polyester bags

Storage place should be **Isolate, Label, Radiation Sign, Control Access** (Administrative and Technical)

EXAMPLE OF ACCESS CONTROL

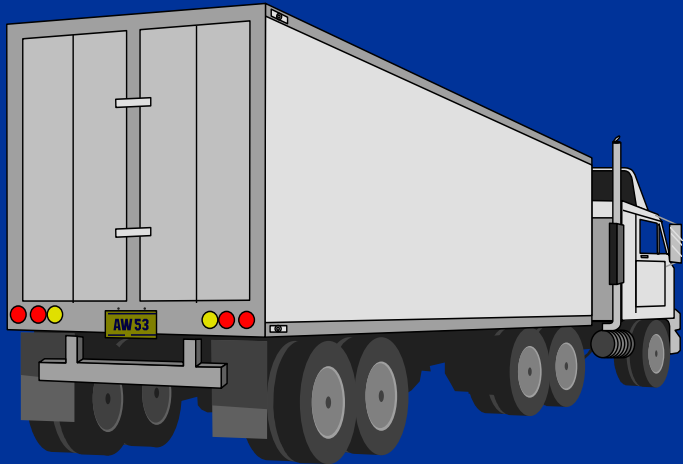
■ Administrative control

- access control procedures;
- alarmed access points (e.g. with radiation detectors);
- key control procedures;
- video cameras or personal surveillance;
- records related to the management of sources

■ Technical control

- fences;
- walls;
- cages;
- transport packaging;
- locks and interlocks for doors (or access points)
- locked, shielded containers

TRANSPORTATION



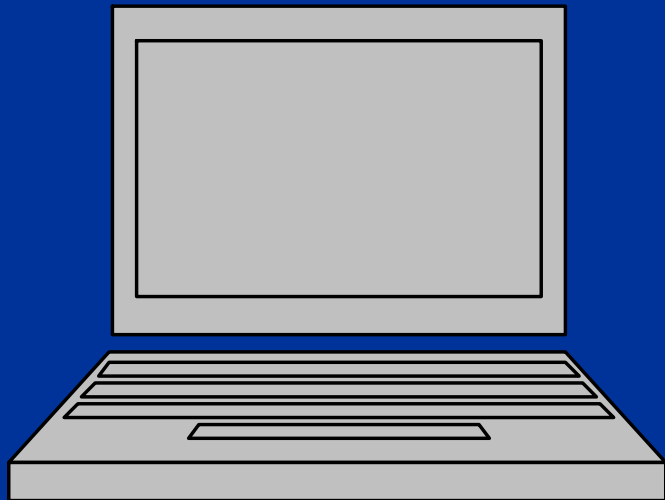
TRANSPORTATION OF NORM/TENORM

- General Procedures
 - within Premise
 - Radiation Protection Regulatory (Transportation) 1989 **not applicable** for **transportation within premise** where NORM/TENORM is produced, used or stored but some guides to be followed
 - **outside Premise**
 - Transportation of NORM by land, sea & air **must comply** Radiation Protection Regulatory (Transportation) 1989

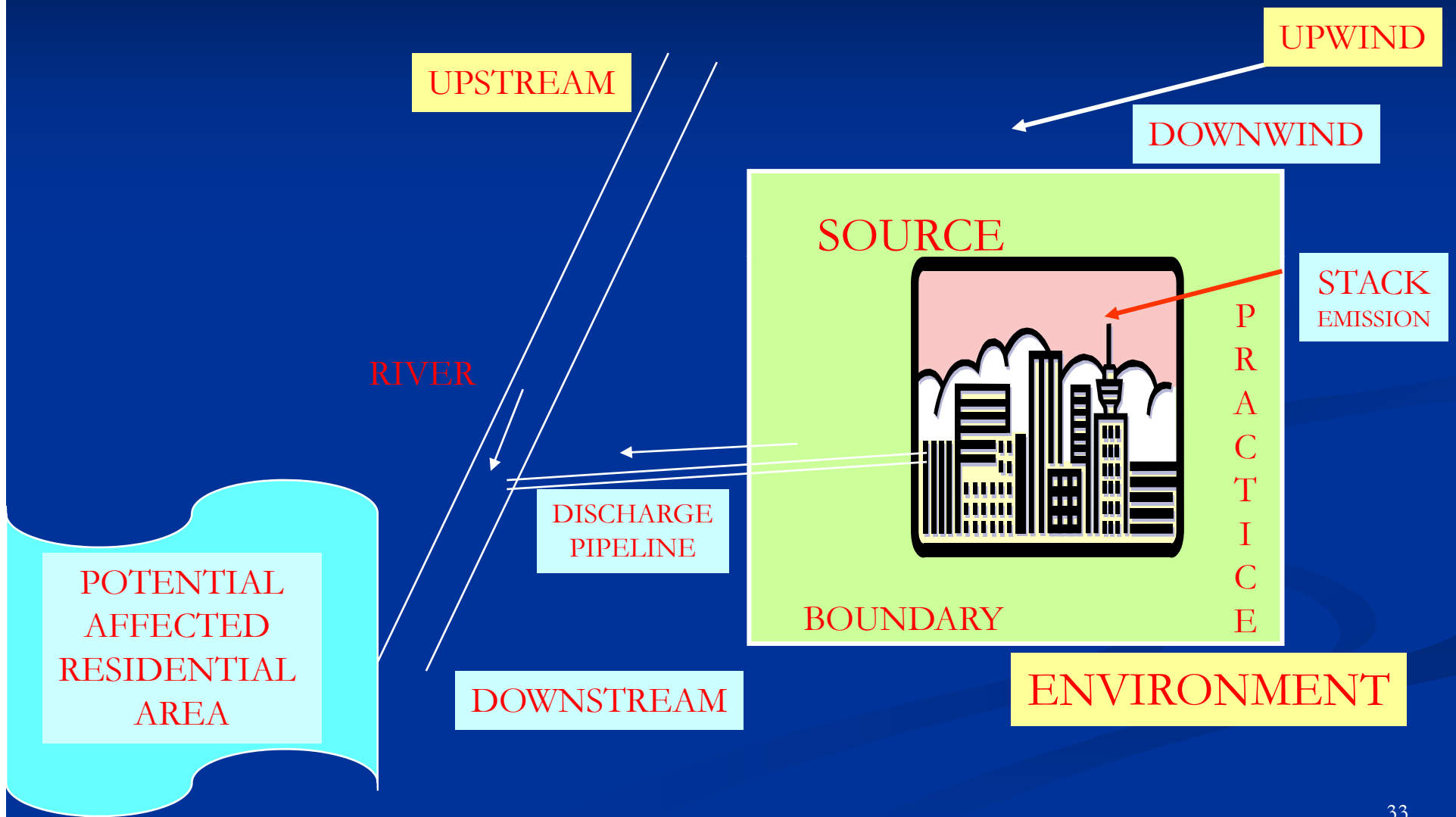
TRANSPORTATION

- NORM/TENORM = **Low Specific Activity** (LSA) Material
i.e. at 3 meter without shielding ≤ 10 mSv/hr
- Use Industrial Package **Type 1** (IP-1)
- Radiation level:
 - the activity in a single package **shall not exceed the limit** for conveyance specified in the Eleventh Schedule of the Radiation Protection Regulatory (Transportation) 1989
- Oil & Gas – contaminated Items: RPO to estimate **sludge & scale** quantity & labeled properly

MONITORING PROGRAM



SOURCE & ENVIRONMENT



ENVIRONMENTAL MONITORING

■ OBJECTIVES

- To ensure **effectiveness** of effluent control program
- To **assess the potential exposure** of the public to radioactive materials & radiation in the environment for protection purposes
- Carry out **trend analysis** of radioactive release
- **Improve public relation**
- To **comply with the license** condition issued by AELB
 - required to be carried out by class A & G licensees
 - or specified in the license conditions

ENVIRONMENTAL MONITORING (Cont.)

- Monitoring area
 - inside & outside (1 km) plant premise
- Monitoring stations
 - **locations & no. of stations**: depending on method of waste and wastewater disposal, weather conditions, the use of surrounding areas (e.g. household, other industries, plantations)
- Frequency
 - During Operational: **BIMONTHLY**, can be reviewed by AELB

ENVIRONMENTAL MONITORING (Cont.)

■ MONITORING PARAMETERS

■ External radiation level, using

- Thermoluminescence Dosimeter (TLD)

- Survey Meter

- Shall $\leq 0.5 \mu\text{Sv/h}$ (=1.0 mSv/yr) base on 24 hr exposure

■ Radon & Thoron daughters

- RDA-200, Alpha Dosimeter



ENVIRONMENTAL MONITORING (Cont.)

■ MONITORING PARAMETERS

- **Surface contamination**, consider contaminate if
 - Alpha emitter $> 0.04 \text{ Bq/cm}^2$
 - Others $> 0.4 \text{ Bq/cm}^2$
- **Airborne contamination**, must be monitor in **dusty working environment**, dust sampled and analyzed for gross alpha and gross beta activity for determination of U-238 and Th-232. It is consider contaminate if dust
 - Uranium $> 0.01 \text{ Bq/m}^3$
 - Thorium $> 0.001 \text{ Bq/m}^3$



ENVIRONMENTAL MONITORING (Cont.)

- MONITORING PARAMETERS (e.g)
 - For **waste treatment of TENORM**, radionuclide that need to be monitor in:
 - Air particulate – conc. of U-238 & Th-232;
 - Effluent – conc. of Ra-226 & Ra-228;
 - Soil – conc. of Ra-226, Ra-228, U-238 & Th-232;
 - Sludge – conc. of Ra-226, Ra-228, U-238 & Th-232;
 - Underground water – conc. of Ra-226 & Ra-228;

- ANALYSIS

- Radium-226, Radium-228 using Gamma Spectrometry System



ENVIRONMENTAL MONITORING (Cont.)

■ REPORT

- Report for environmental radiation and radioactivity levels during **OPERATIONAL** period are compared with the levels during **PRE-OPERATIONAL** period
- To monitor any **ENHANCEMENT** of environmental radiation and radioactivity levels
- Licensee/consultant to submit the report to AELB for evaluation **within 14 days** after receiving results from laboratory

Responsibilities of worker

- (1) Every worker shall **follow all instructions, rules and procedures** issued by the licensee for the control of exposure to ionizing radiation and **shall refrain from practices or actions that could result in unnecessary exposure** to himself or other workers.
- (2) Every worker shall **use**, as instructed by the licensee, **all facilities, devices and protective equipment provided by the licensee or the employer** to limit any possible exposure.
- (3) Every worker shall **use approved personnel monitoring devices** provided by the licensee or the employer **for assessing exposure**.

Responsibilities of worker

- (4) **No worker**, unless duly authorized by the licensee, **shall interfere with, remove, alter or displace any safety device or other equipment furnished for his protection or the protection of others**, or interfere with any method or process adopted for the control of exposure to ionizing radiation.
- (5) Every worker shall take all reasonable precautions **to prevent damage to such equipment furnished** under subregulation (4) and to keep it in a good operating condition.

Responsibilities of worker

- (6) Every worker shall **immediately report all accidental exposures or intakes or any suspected exposure or intake of radioactive material, nuclear material or prescribed substance** to his supervisor or the radiation protection officer or the qualified expert.
- (7) Every worker shall **immediately report any damage to or malfunction of any safety equipment** to his supervisor or the radiation protection officer or the qualified expert.

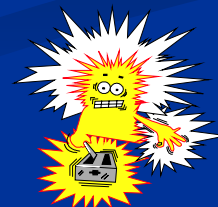
Responsibilities of worker

- (8) Every female worker shall, as soon as she suspects that she is pregnant, seek confirmation of such suspected pregnancy from any approved registered medical practitioner.
- (9) Every female worker who is confirmed to be pregnant by an approved registered medical practitioner shall inform her employer or licensee as soon as practicable, so that appropriate measures may be taken to provide the level of protection as the foetus shall, from the date of the confirmation, be afforded the level of protection so that the dose to the foetus shall not exceed 1 mSv for the remaining period of the pregnancy.



Actions in Abnormal/Emergency Situation

- ✓ If machine involved; Switch **OFF** machine; Stop ventilation; Do not allow anybody to touch any equipment in the working area
- ✓ **Prevent inhalation of NORM/TENORM dust/airborne**
- ✓ **Leave** the area concerned; **Informed RPO**;
- ✓ All involved personnel shall be **isolate** and **examine for contamination (internal + external)**; **medical assistance** where necessary.
- ✓ **RPO-Discontinue work** for staff suspected for over-exposure
- ✓ Send **film badge** to Nuclear Malaysia for evaluation
- ✓ Send personnel for **medical check-up** if exposure **exceeded 100 mSv** such as analysis of **chromosome aberration** (very rare for TENORMs)
- ✓ **RPO investigate** accident & write report



Actions in Abnormal/Emergency Situation

- ✓ AELB must be informed within **24h** of accident
- ✓ Detailed report send to AELB within **30 days**
- ✓ Report should contain:
 - **Details** – licensee, and date, time, place of emergency occurrence
 - **How** it happen?
 - **Description of radiation source** involved, type, quantity, chemical and physical property of RAM (if related)
 - Involved **personnel dose assessment** report
 - **Corrective** and **preventive** action
 - **Action taken** to prevent incident reoccur
 - Others necessary information



Summary

All **SAFETY** procedures must be adhered to all time to ensure **SAFETY** of all concerned





Thank You