Radiation Safety for Level 2 Users of Portable Density and Moisture Gauges



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Read This First

Welcome to the self paced training module.

Please follow these guidelines for a successful outcome

- The course notes provided as part of this training module contain a significant amount of information for the trainee. It is recommended that you view the presentation first and refer to the course notes for more detailed information.
- Of particular importance are Chapters 4, 5 and 6 that outline the safe working procedures, transport and emergency procedures.
- At the end of your course notes, there is a written exam.
- The minimum pass mark for this course is 85%
- On completion of the course module and examination, please return a scanned copy of the examination only to training@mckeng.com.au
- A digitally signed course certificate will be provided via email if the minimum pass mark is attained.
- Ensure to include your Order# on your examination sheets
- If you require support, please contact 07 5427 0126

Introduction



Radiation Safety Course Objectives

Radiation Safety Awareness with the soil density/moisture gauge sources used.

DOSE minimisation during use & transport

Maintenance of the sealed source apparatus

Do’s and don’ts on use

Roles Of:

- Radiation Safety Officer
- Licensed user



Emergency Procedures

Transport Rules

Legislation

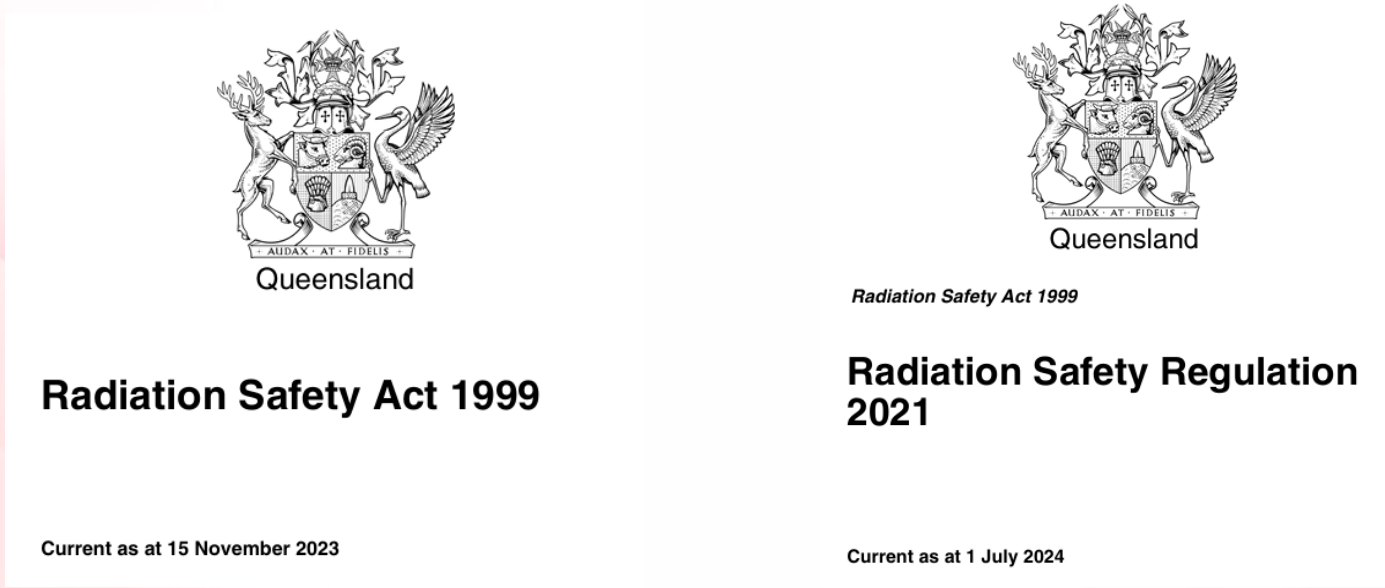




The Australian Radiation Protection and Nuclear Safety Agency is the Australian Government's primary authority on radiation protection and nuclear safety. Its purpose is to protect the Australian people and the environment from the harmful effects of radiation, through understanding risks, best practice regulation, research, policy, services, partnerships and engaging with the community.

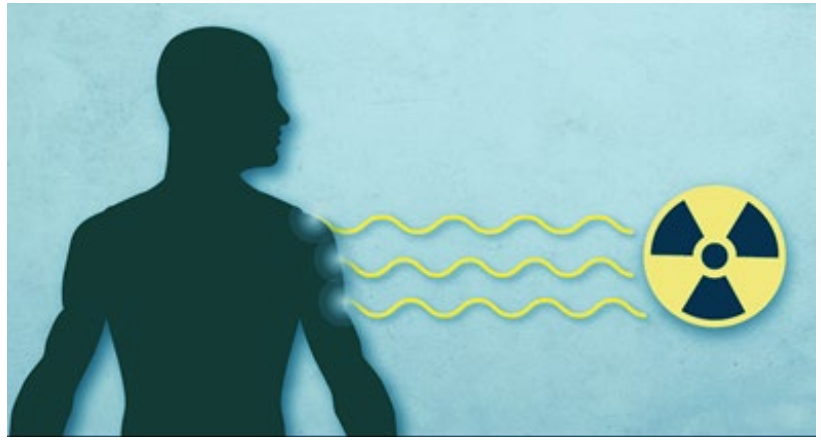
Each State and Territory within Australia bases their Legislation on the ARPANSA Radiation Protection Series set of documents.

State (Qld) Legislation



The Legislative Objective

The objective of the Act is to protect persons and the environment from the health risks associated with exposure to sources of ionising radiation and harmful non-ionising radiation.



Some Obligations of Licensed Users

- Limiting of Radiation Exposure to other persons
- Ensuring health safety & protection of environment
- Compliance with conditions
- Compliance with Codes of Practice

There are penalties for breaches of the legislation as a licenced user.

You are personally responsible and liable under the ACT.

Competencies for Use License

In order to obtain a Use Licence, the regulators require confirmation that you have undertaken an approved course and demonstrated safe practical use of the gauge. Some requirements are:

- Demonstrated safe use
- Performing surveys
- Maintenance (as per manufacturers manual)
- Adherence to Rules for storage and transport
- Incident response

Why Is This Course Needed ?

The Licensed User has obligations under the Radiation Safety Act 1999 that they must be made aware of.

In order to fulfill the obligations as a Licensed user under the Act, the user needs to understand the implications of careless use and or disregard of safe work practices.



Background Radiation

Click the link to view the video presentation



PMDG TRAINING RESOURCES | McKavanagh Engineering Services (mckeng.com.au)

If viewing this presentation in a web browser, right click the link and select “Open in New Tab”

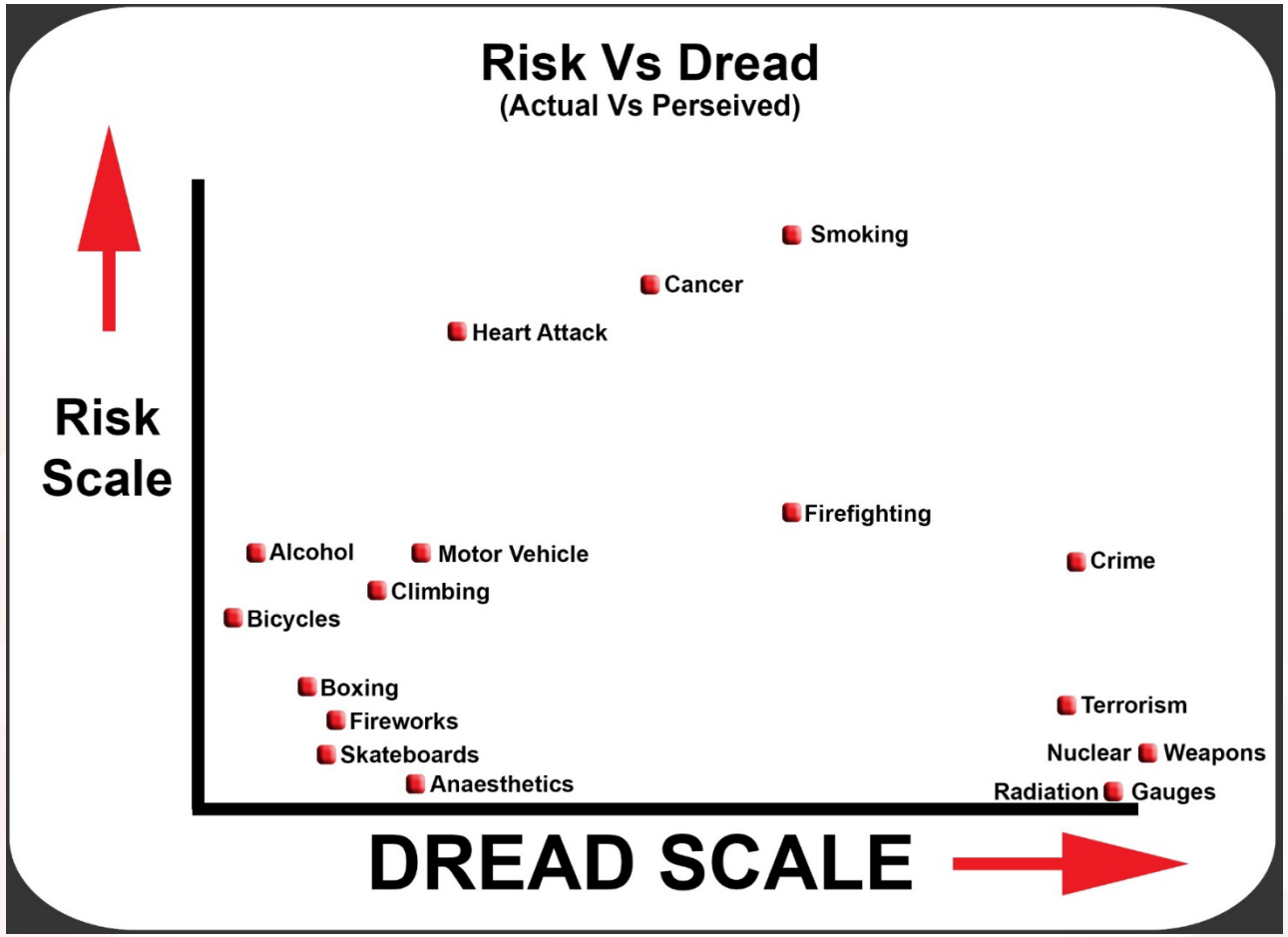
The Danger Of Ionising Radiation?

What was your gut reaction when you first found you were going to be working with ionising (or “atomic” or nuclear radiation)?:

- Fear?
- Concern?
- Not worried?
- Designed by engineers, must be safe!
- Other: (specify)?



What The Australian Public Thinks



Where do the public obtain these facts?



Radiation Incidents

Major Radiation Incidents

Three Mile Island near reactor melt-down March 1979.
A cooling malfunction caused part of the core to melt in the #2 reactor

Chernobyl accident, was a catastrophic nuclear accident that occurred on April 26 1986 and the first disaster to be given the level 7 event classification on the International nuclear Event Scale

The Fukushima disaster is the largest nuclear diaster since the 1986 Chernobyl disaster and the second disaster to be given the Level 7 event classification on the International nuclear Event Scale

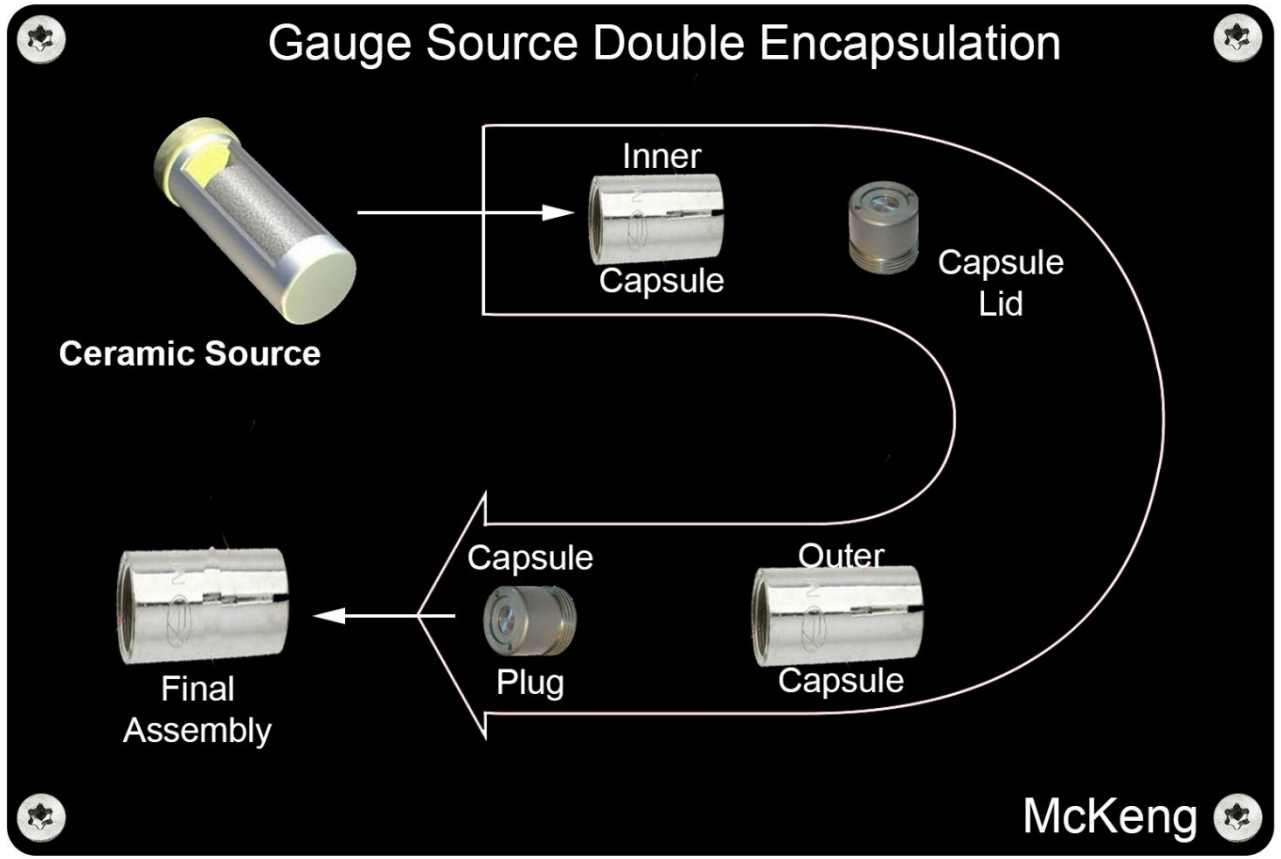




How Industrial Radiation Sources Differ

- Industrial sources are completely sealed. Radioactive material is placed inside a ceramic bead or fused metal which is placed in two stainless steel capsules. Capsules vary in size but are typically 8mm x 10mm in diameter.
- Both the source, and the apparatus that houses the source, must pass a series of tests, eg: the temperature test is 800^0C for 30 minutes. Other tests include puncture, pressure, vibration.
- There is an extensive system of Qld & Federal regulation of the import, use, and disposal of radioactive materials. Your site Radiation Safety Officer is part of this system.

Source Construction Cs-137



Source Construction (cont.)









The Portable Moisture and Density Gauge

Moisture Density Gauge

Direct Transmission

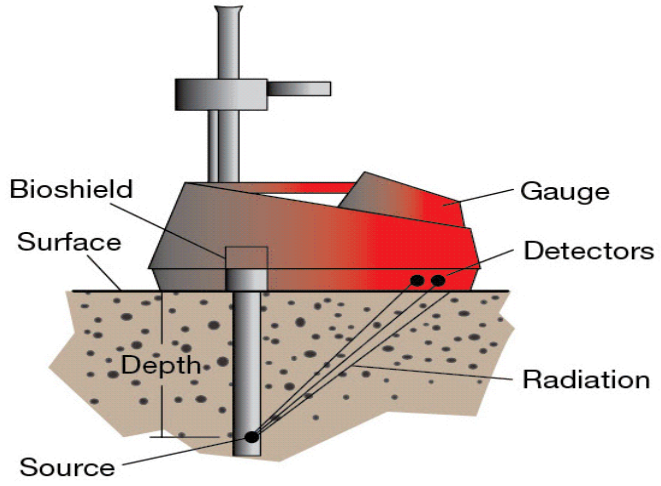




Photo courtesy: APNGA

A moisture density gauge indicates whether a foundation is suitable for constructing a building or roadway.

Why Do We Use Radiation Sources?

1. Sealed sources are used despite:
   - Cost,
   - Regulations, and
   - Opposition from the uninformed etc.
   - If another technique is as reliable, it should be used!
2. Their use in density gauging improves:
   - Quality control, (can sample more points in same time)
   - Efficiency, and hence
   - The time taken to do specific tasks.
3. The radiation source is very stable (decays predictably), and is unaffected by normal environmental variables such as:
   - Heat
   - Moisture & corrosion
   - Vibration
4. Re-calibration is simplified, and reliability is relatively high.

Sources Used In Materials Industries

- On-pipe density gauges: Cs^{137} (as density is main method of separating many materials from waste. Used in many other industries.)
- Industrial radiography using Ir^{192} , Co^{60}, Se^{75}
- Borehole logging on mine sites using Cs^{137}, Am^{241}/Be
- Portable Moisture & Density Gauges : Cs^{137} and Am^{241}/Be
- On-line elemental analysers: Cf^{252} neutron sources

So where does Radiation Come From?



The Radiation sources that are used in Soil Density and Moisture gauges are man made radioactive materials.

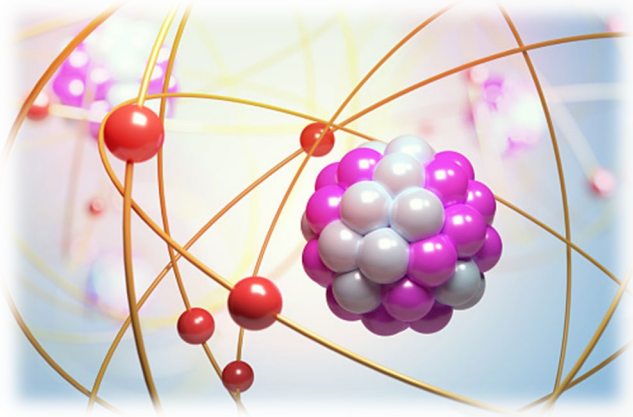


They have the same properties as naturally occurring radioactive material ie: they emit their excess energy in the form of particles and waves.

Atoms and Radioactivity

Atoms are the building blocks of all matter. Everything in the universe is made up from atoms from the largest galaxies to our own bodies.

The centre of the atom is called a nucleus



(that’s where the word nuclear comes from)

The Atom

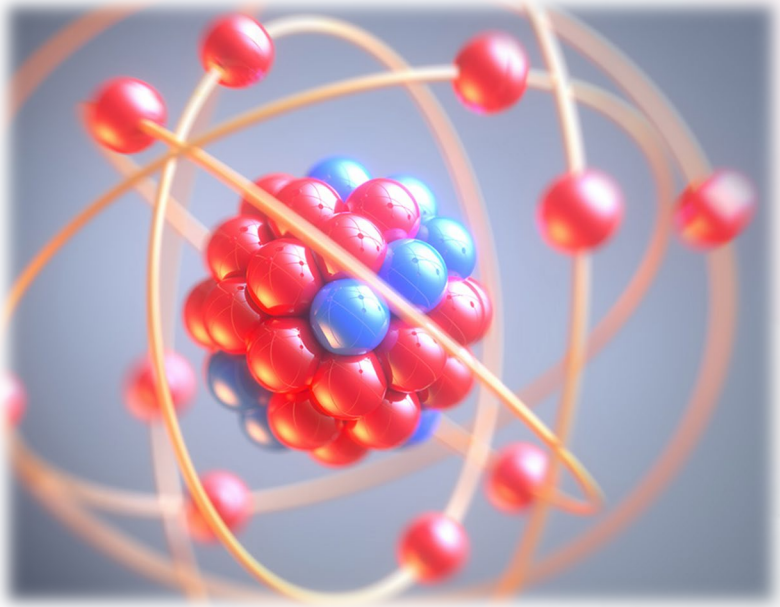
The atom is made up of different types of particles

The nucleus itself contains two types of particles

1) Protons (positive charge)
2) Neutrons (no charge)

Orbiting the nucleus are electrons (negative charge)

Nucleus is held together by the strong nuclear force



Radioactivity

Under certain conditions the particles within the atom can be displaced or excited.

The atom then becomes what we call radioactive. In essence it contains too much energy.

When there is too much energy within the atom it attempts to shed the excess energy, and it does this in the form of both particles and waves.

We call this nuclear decay or disintegration.

Eventually the atom will shed all it’s excess energy and decay or disintegrate to a point where it becomes stable or Non-Radioactive.

The Atom And Radiation Emmisions

There are 5 common types of radiation that originate from the nucleus of at atom

1) Alpha (Particle)
2) Beta (Particle)
3) Neutrons (Particle)
4) Gamma (Energy or Photon)
5) X-Rays (Energy)

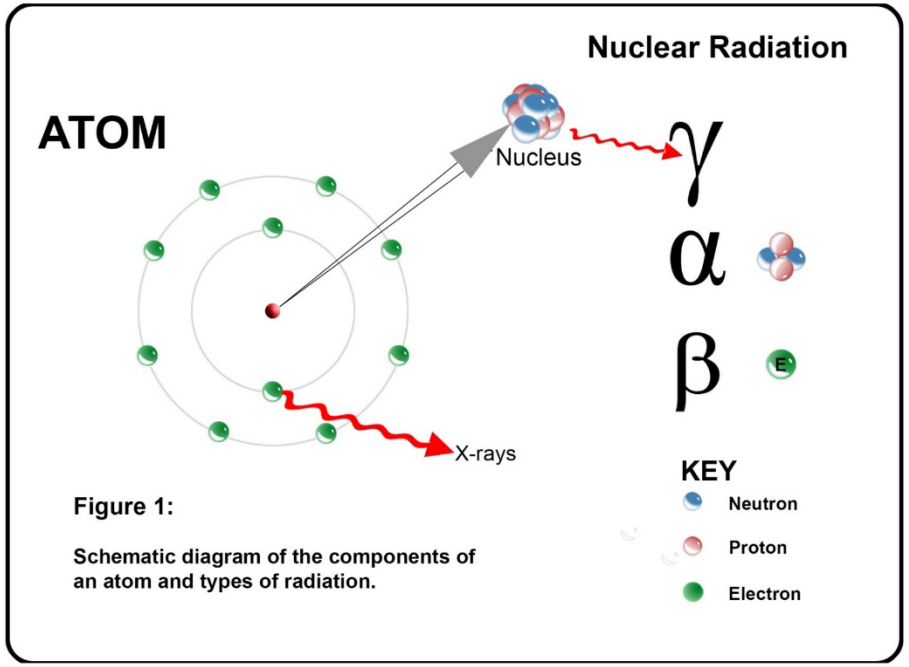
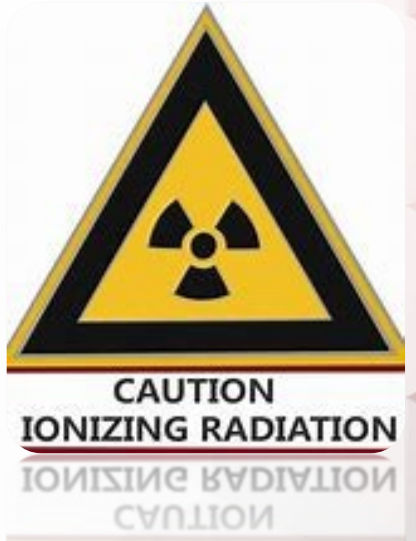


Figure 1:

Schematic diagram of the components of an atom and types of radiation.

Ionising Radiation

- Ionising radiation is defined as radiation that has sufficient energy to remove or eject electrons out of the absorbing material.
- In the ionisation process, an energetic radiation particle collides with one of the electrons in an atom in the material and knocks the electron out of the atomic cloud.
- This process leaves the atom with a nett electrical charge which makes it very reactive.

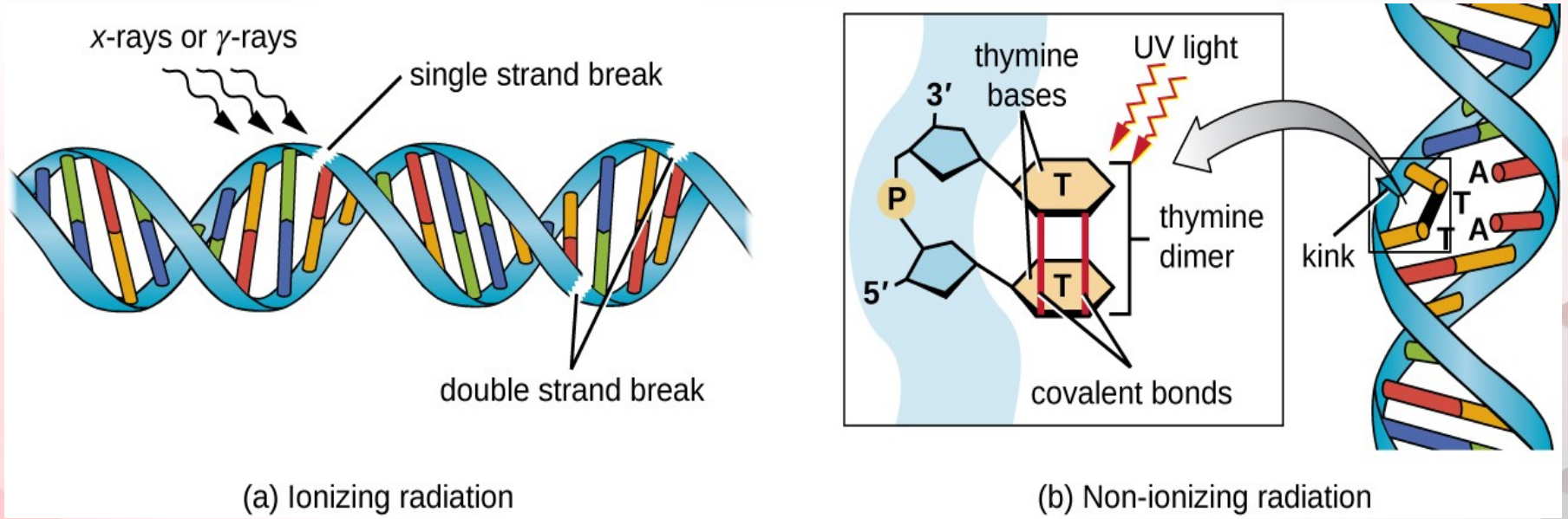


What is Ionising Radiation ?

If the absorbing material is our body, the ionisation effect can cause chemical reactions at a cellular level.

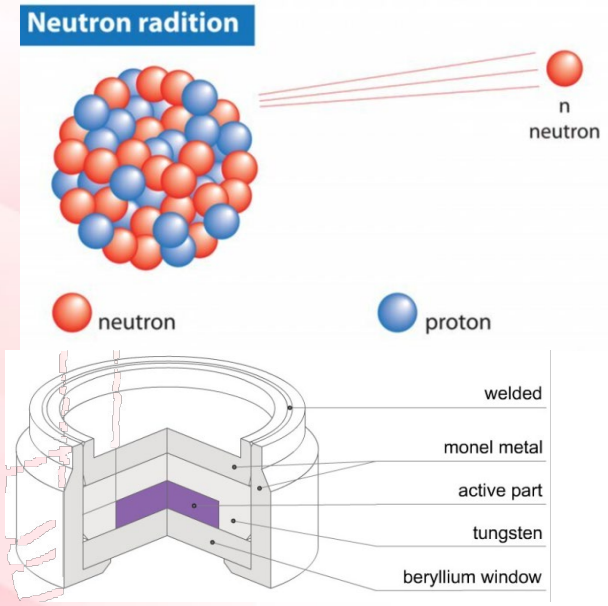
We know that it is the DNA that is the most affected by ionising radiation. If the amount of ionisation is sufficient, the result can be either impairment or in extreme cases, death of the cells.

Radiation Effects on DNA

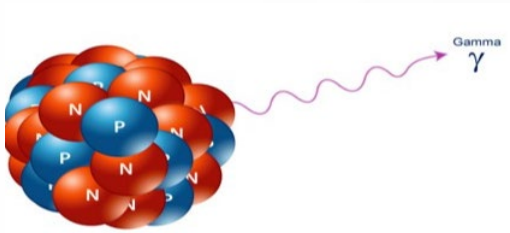


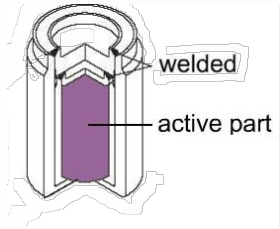
What types of radiation are in a PMDG

Am^{241} is mixed with Beryllium metal to form a neutron source



Cs137 in the form of a sealed ceramic bead emits Gamma radiation.



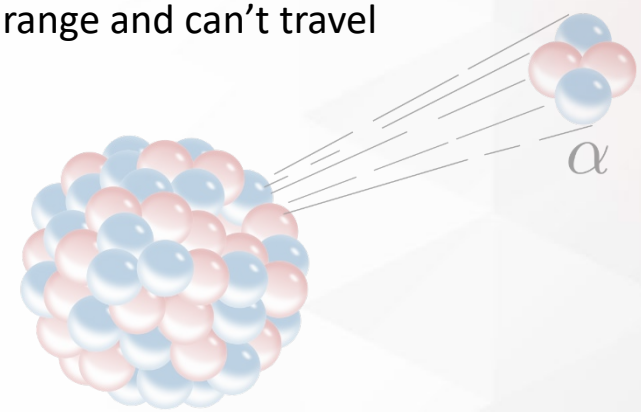


Alpha Particles

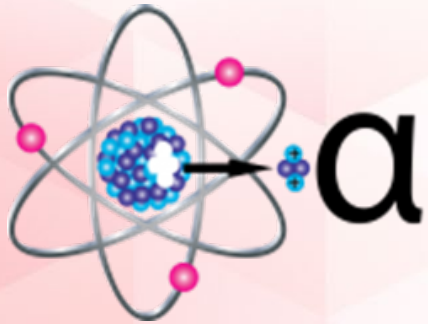
(α) are positively charged and made up of two protons and two neutrons from the atom's nucleus.

Am241 emits alpha particles, followed by X-rays.

Alpha particles travel relatively slowly (about 10,000km per second) due to their large mass, they have a short range and can't travel far from the atom.



Alpha Particles



If alpha-emitters enter the body via pathways such as inhalation or ingestion, the alpha particles can damage sensitive living tissue.

The way these large, heavy particles cause damage makes them more dangerous than other types of radiation. The ionisation events they cause are very close together - they can release all their energy in a few cells. This results in more severe damage to cells and DNA.

Beta Particles



Beta particles (β) are small, fast-moving particles with a negative electrical charge that are emitted from an atom during radioactive decay. These particles are emitted by certain unstable atoms such Cs^{137}.

Beta particles are more penetrating than alpha particles but are less damaging to living tissue and DNA because the ionisation events they produce are more widely spaced. They travel farther in air than alpha particles but can be stopped by a layer of clothing or by a thin layer of a substance such as aluminum. Some beta particles can penetrate the skin and cause damage such as skin burns. However, as with alpha-emitters, beta-emitters are most hazardous when they are inhaled or swallowed.

Neutrons

Neutrons are particles found within the nucleus of all elements with the exception of hydrogen. They extremely penetrating in matter because they have no electrical charge and are not affected by electrical charges in matter.

Many materials exposed to neutrons can to some extent become radioactive or activated. This is not possible with alpha, beta, xrays and gamma radiations. With the relatively small activity sources used in industry, the amount of neutron activation is so small that it is of little concern to us.

Neutrons can travel several centimetres in human tissue.

Neutrons can also be generated using Neutron generators which contain compact linear particle accelerators and that produce neutrons by fusing isotopes of hydrogen together.

X- Rays

Because of their use in medicine, almost everyone has heard of x-rays. X-rays are like gamma rays in that they are photons of pure energy. X-rays and gamma rays have the same basic properties but come from different parts of the atom. X-rays are emitted from processes outside the nucleus, but gamma rays originate inside the nucleus. They also are generally lower in energy and therefore less penetrating than gamma rays. X-rays can be produced naturally (examples Am^{241}/Be, Fe^{55}) or by radiation apparatus using electricity.

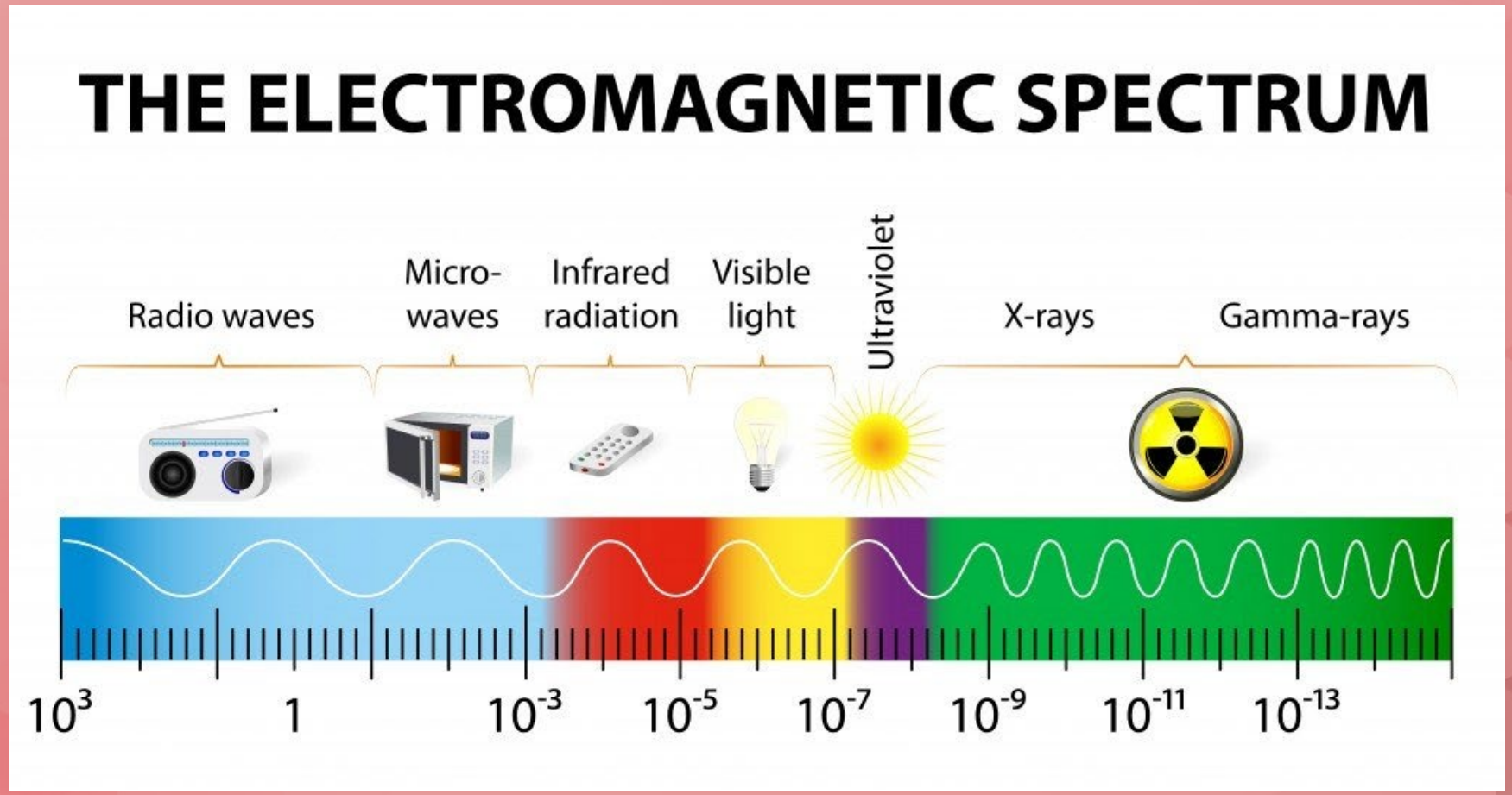
X-Rays and Gamma Rays pose an external hazard and at high intensity can cause severe burns to the skin.

Gamma Rays

Gamma rays (γ) are weightless packets of energy called photons. Unlike alpha and beta particles, which have both energy and mass, gamma rays are pure energy. Gamma rays are like visible light but have much higher energy. Gamma rays are often emitted along with alpha or beta particles during radioactive decay.

Gamma rays are a radiation hazard for the entire body. They can easily penetrate barriers that can stop alpha and beta particles, such as skin and clothing. Gamma rays have so much penetrating power that several inches of a dense material like lead, or even a few feet of concrete may be required to stop them. Gamma rays can pass completely through the human body; as they pass through, they can cause ionisation that damage tissue and DNA.

The Energy Spectrum



REVISION

Radioactive Isotopes are continually undergoing a decay process which means they are giving off EXCESS energy in the form of radioactive particles and waves.

They do this to try to become stable. All radioactive Isotopes will continue the decay or disintegration process until the atom again becomes stable.

Cs^{137} is the radioisotope used in PMDG's (gamma source) for measuring density and emits beta particles and gamma rays.

Am^{241}/Be is the isotope used in PMDG's & Hydroprobes (neutron source) for measuring the moisture and emits alpha particles, X-rays and neutrons.

Alpha & Beta shielding

From the previous slides we learned about the penetrating power of alpha and beta particles. Alpha particles are slow and heavy, beta particles are charged and light.

These particles are easily shielded and therefore it stands to reason that they cannot penetrate the double encapsulation of the source construction.

The source capsule is sufficient to provide shielding from the alpha and beta particles. Good news for users !!

Under normal operating conditions the particles are shielded. It is only if the source capsule is compromised that we need to be concerned about these particles and the hazards they pose.

Source Activity

International System of Units (SI) for activity is the Becquerel, abbreviated Bq and it can be defined as the number of disintegrations occurring within the source nuclei each second. (number of decay events)

The Becquerel prefix symbols, and the factor commonly used for measuring activity of radiation sources are:

GBq (giga 1 000 000 000)

MBq (mega 1 000 000)

kBq (kilo 1 000)

Source Activity

The Cs^{137} source used in PMDG's is ~ 300 MBq, this means that

the source is undergoing 300 million disintegrations each second

The Am^{241}/Be source used in PMDG's is ~ 1.5GBq, this means that the source is undergoing 1.5 billion disintegrations each second

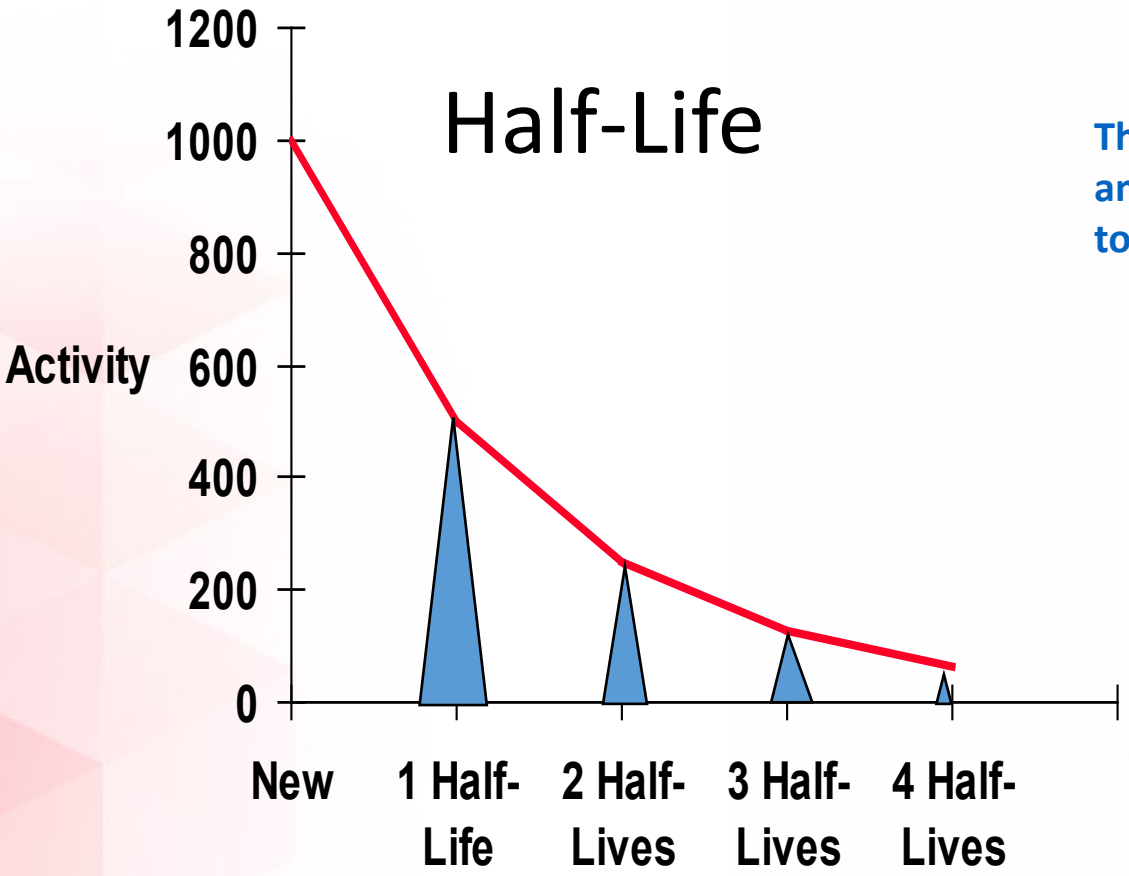


Half Life

The half life of a radioactive source is defined as the time taken for the original activity to decrease to half……

Example: Original activity 100MBq After 1 half life the activity is 50MBq, after 2 half lives the activity will be 25MBq, after 3 half lives the activity will be 12.5MBq and so on…….

Half Life



The time required for the amount of radioactive material to decrease by one-half

Some relevant half-lives:

Cs-137: 30 years

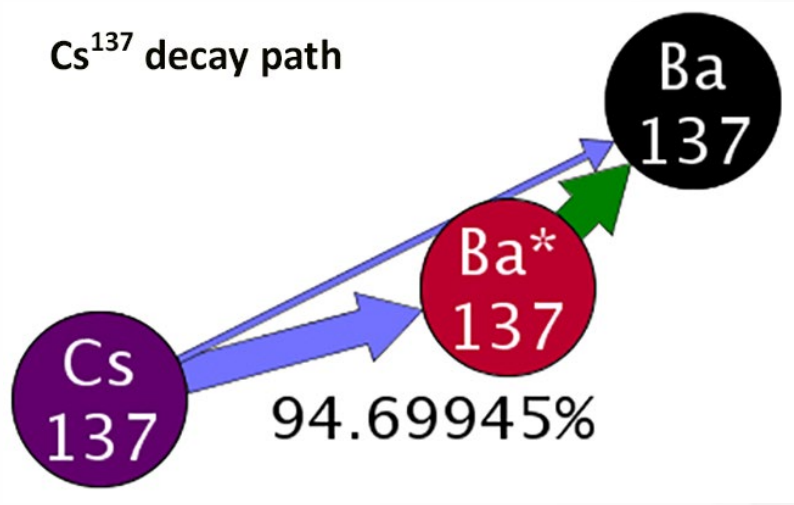
Am-241: 432 years

Cf-252: 2.6 years

Ir-192: 73.8 days

The Decay Process

After 1 half life, half of the atoms will have decayed into stable atoms and become no longer radioactive.



Half-life & Standardisation

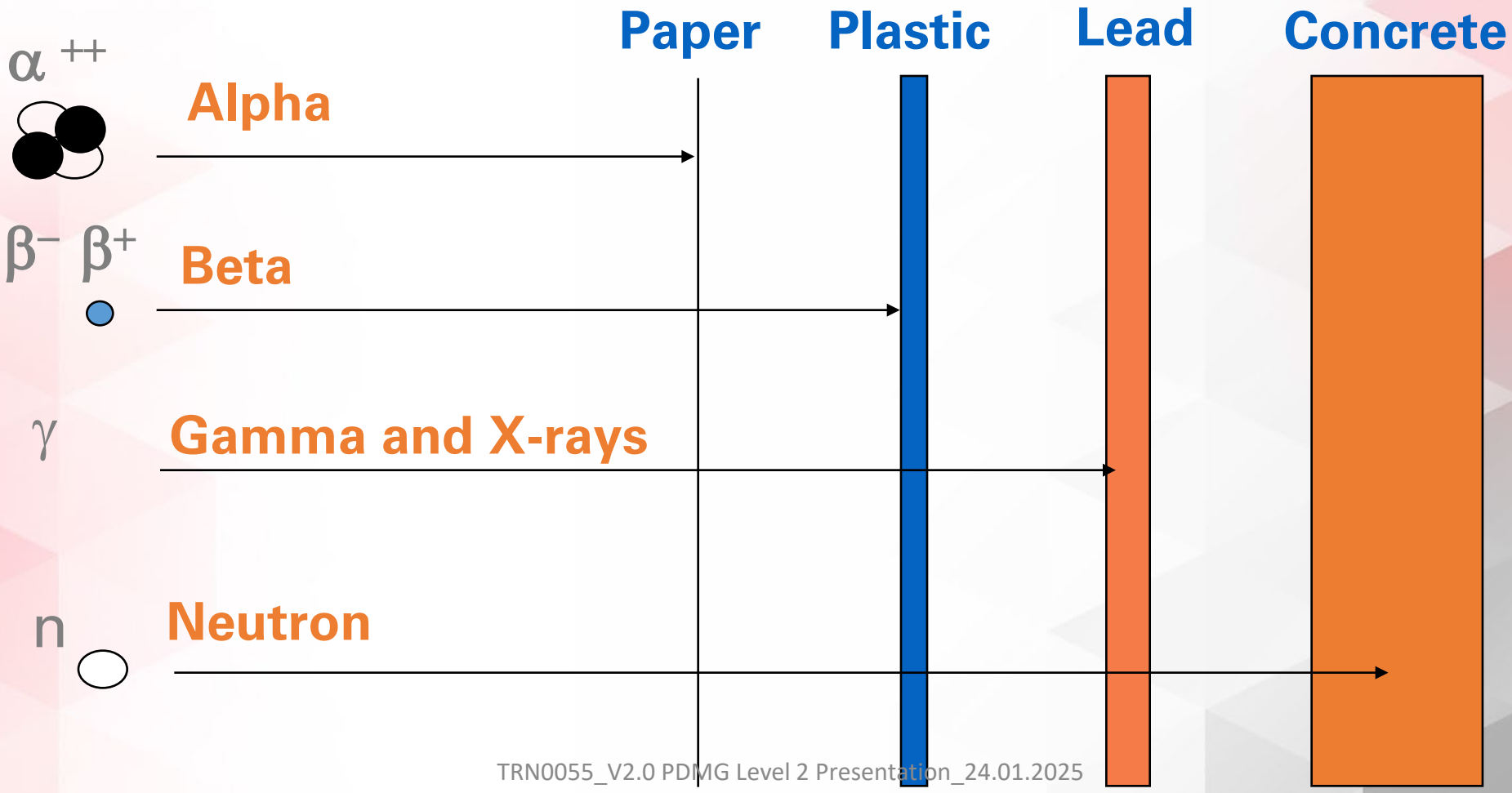
Half-life is an important topic in radiation safety.

For example, 10 half-lives is often used as a guide to how long we must keep source material out of the environment in a repository.

However, it is not a consideration for an PDM gauge user, if you follow the handbook, and perform a standardisation before every day's use.

Gauge is in the SAFE position, on the plastic block, and 5 metres from any large object (e.g. ute). In Standard mode, the gauge is counting both density & moisture counts in a fixed geometry, so if all else is equal, these counts represent decay of the sources.

Shielding


Paper
Plastic
Lead
Concrete
α ++
Alpha
β− β+
Beta
γ
Gamma and X-rays
n
Neutron

Shielding

Shielding for gammas and X-rays consists of having sufficient mass of material in the beam. Materials of high density and high atomic number are usually chosen. The decrease in the shield is exponential, so it is convenient to use HVLs (Half Value Layers) to describe shielding properties.

For Cs-137 gammas, some useful HVLs are:

- Tungsten: 4 mm
- Lead: 6.5 mm
- Steel: 16 mm
- Concrete: 47 mm

For neutrons, shielding is more complex, and involves moderation with Hydrogen rich materials, absorption by specific elements such as Boron, followed by gamma shielding. Concrete is a cost-effective neutron shield.

* CPN give the HVL as 62.5 mm for Am/Be neutrons in water

Radiation Protection

Radioisotopes are inherently dangerous substances, and the general aim of the legislation is to protect persons from the risks associated with exposure to sources of ionising radiation.

The Australian Federal Government controls the entry of radioisotopes into Australia. There is an extensive system of federal and state control measures in place that regulate the possession and use of radioactive substances.

ARPANSA

Radiation Protection

We have to be protected from radiation from PMDG & Hydroprobe sources for two reasons:

1. Because of the external radiation in the form of gammas and neutrons.
2. Because of the risk of contamination, in which case we may ingest source material unknowingly, and be exposed to the alpha and/or beta radiation at short range from within the body.

NB: Despite having had several accidents in Australia in which an PMDG has been completely destroyed, the sources have remained intact due to the strict regulation of their construction, so point 2 is not considered unless the PMDG has been visibly damaged.

Radiation Protection

Under normal conditions, the radiation exposure from the use of PMDG's is low, however, we need to ensure that our exposure to the sources from radiation are kept low and that has to do with the way we use the gauge.

Poor work practices have been shown to increase the user's exposure to radiation sources.

Because little is known about the long term health effects, we should play it safe at all times to ensure we don't exceed the limits as set by the regulators and that our exposure is minimised.

Personal Safety



There are three commonly *stated factors you can* take to reduce your radiation dose. These are:

1. TIME: reduce time spent near the source.

2. DISTANCE: this is the most powerful form of protection. Especially to the trunk of the body, which is most sensitive. (hands are x20 less affected.)

3. SHIELDING: if it is unavoidable to work in a radiation field, it may be possible to reduce the levels to more acceptable by shielding – lead or concrete are cheap enough.

LAST BUT NOT LEAST:

The system of protection and regulation is well organised and effective. Obey your Working Rules as part of your RSPP.

Time Of Exposure



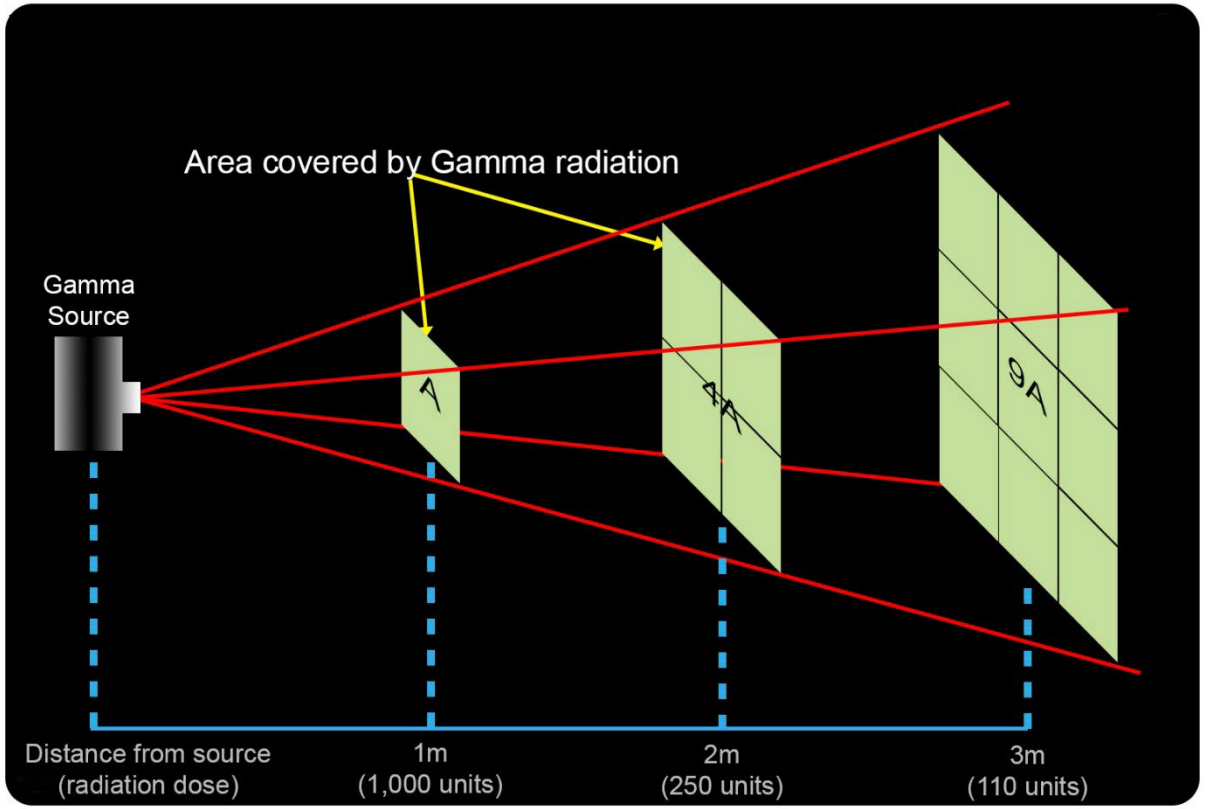
This involves ensuring that personnel are exposed for the minimum possible period throughout the course of their work.

For an exposure limit of 20mSv over a working year of 50 weeks, it equates to 0.4mSv per week.

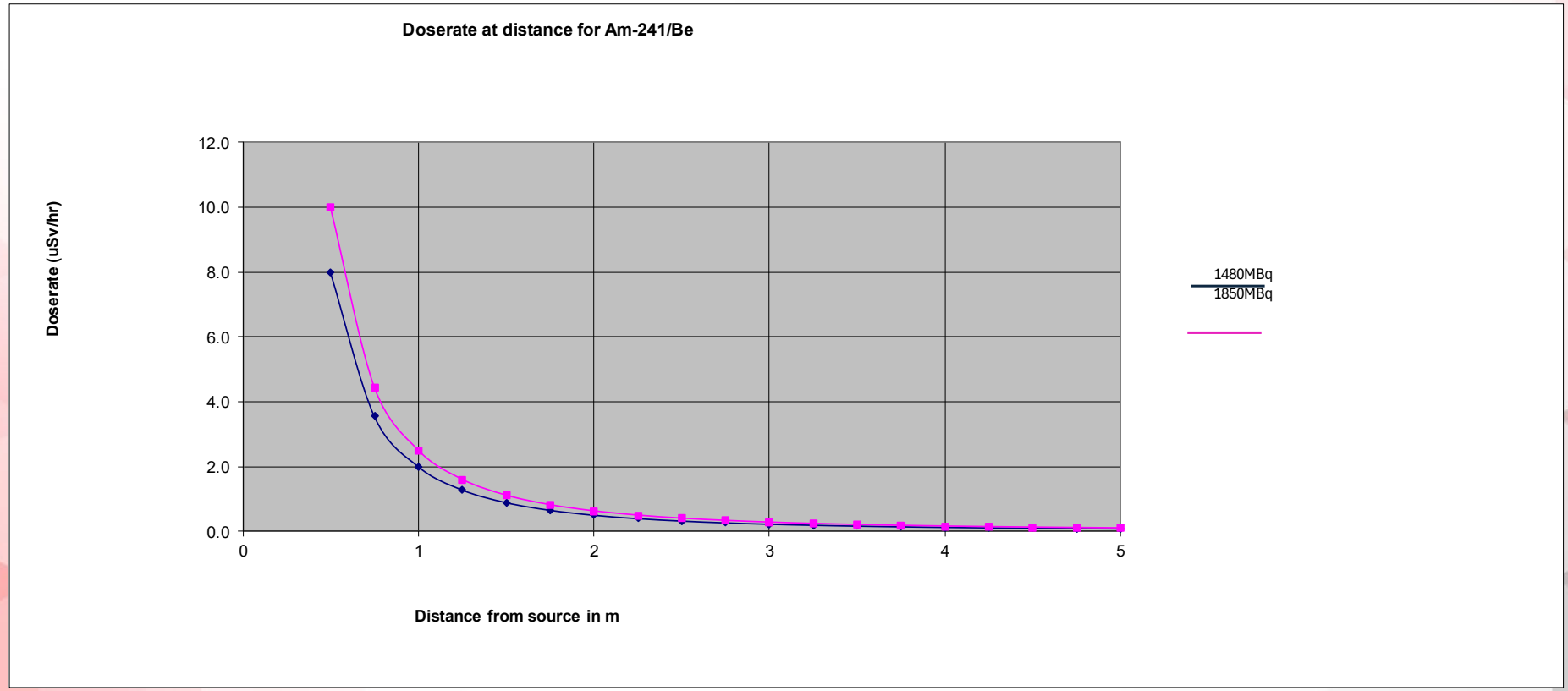
If the dose rate is 26µSv.h^{-1} at 1 meter the working time limit is 15.4 hours per week.

Distance (The Inverse Square Law)

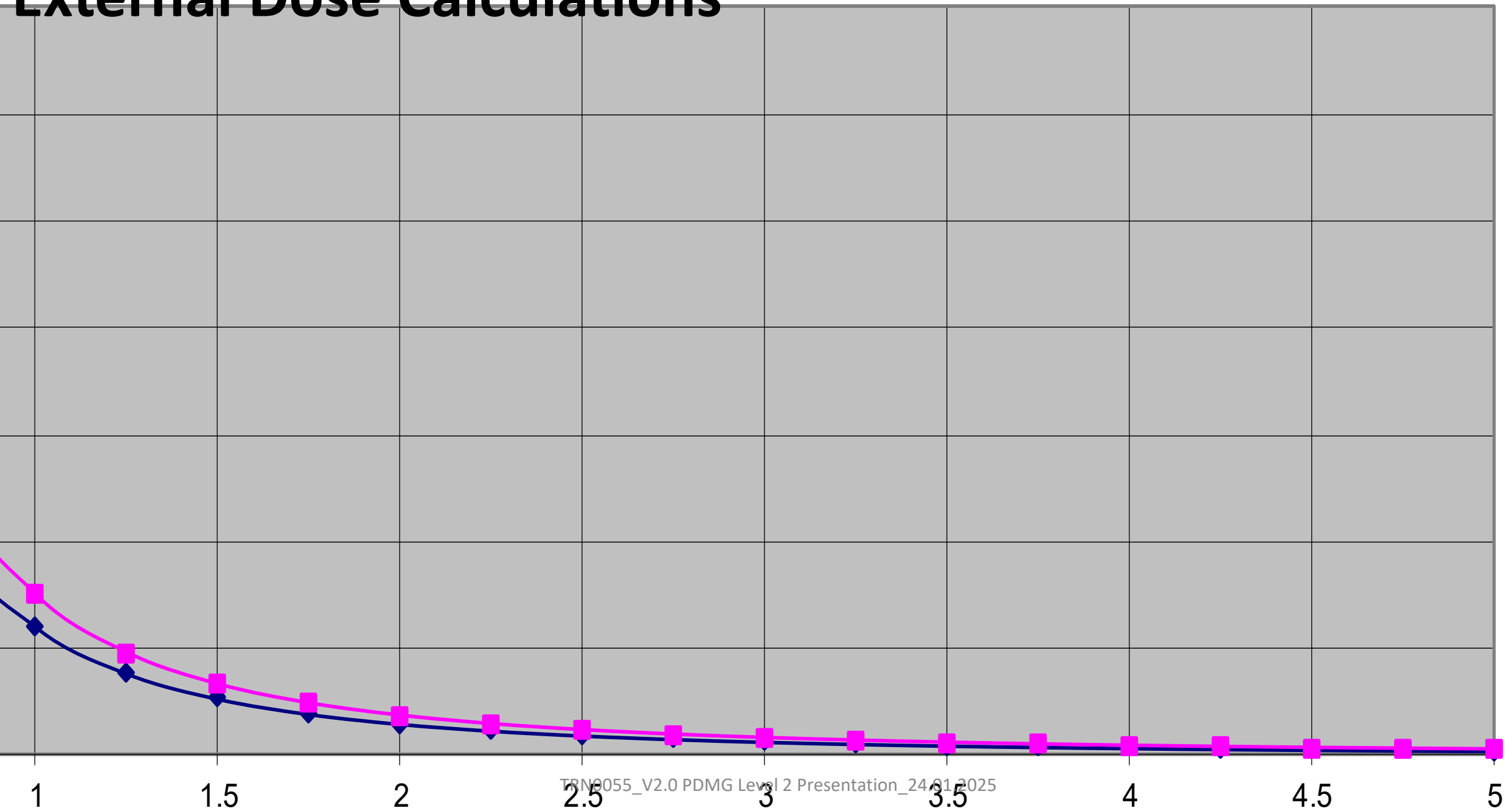
"Radiation is like a campfire"



External Dose Calculations



External Dose Calculations



Radiation Dose Units

A Gray (Gy) is defined as the amount of radiant energy deposited in the body, ie Joules / kg.

The equivalent dose is called the Sievert.

Abbreviated Sv, and often expressed as mSv for annual dose,

and as $uSv.hr^{-1}$ as a dose rate.

These are the units of “exposure” the units that we use to measure the intensity of the radiation emitted from the radiation sources we are exposed to.

The Concept Of “Radiation Dose”

It is similar in concept to a dose of paracetemol (eg Panadol), where we are used to the recommended dose being 2x 500mg tablets every 4 hours, and a lesser amount for children etc.

For ionising radiation, there are two numbers of interest:

1. The unavoidable background dose.
2. The dose limits.

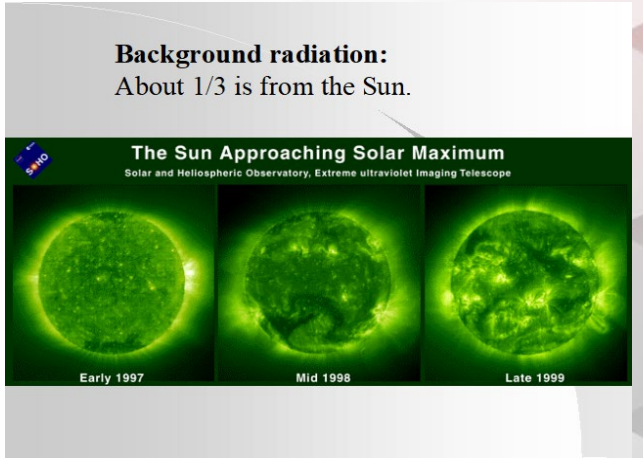
Background Radiation

Where does background radiation come from?

- Soil & rocks: another 1/3
- Internal: K-40, U, Th & their daughters.
- Man-made: medical procedures, “fallout” from atmospheric testing of weapons, Chernobyl, smoke detectors, etc.
- Cosmic radiation, from the Sun and the Universe in general

THE TOTAL IS 1.5 – 2mSv PER YEAR, OR 0.15µSv.h^{-1}

Cosmic radiation is the cause of the increase in background with height above the ground, so for example in an aircraft at 37,000 feet, it can be 5µSv.h^{-1} or more.



Dose Limits - Where do they come from ?



The ICRP is a not-for-profit organization

It is an independent, international organisation with more than two hundred volunteer members from approximately thirty countries on six continents, who represent the world's leading scientists and policy makers in the field of radiological protection.

Dose Limits – Schedule A

Type of limit	Limit (18 years and over)[1]	Limit (more than 16 years but under 18 years)[1,5]
Effective dose	20 mSv per year, averaged over a period of five consecutive years[2]	6 mSv per year
Annual **equivalent dose** to the lens of the eye	20 mSv per year, averaged over a period of five consecutive years[3]	20 mSv per year
Annual **equivalent dose** to the skin[4]	500 mSv per year	150 mSv per year
Annual **equivalent dose** to the hands and feet	500 mSv per year	150 mSv per year

- **Schedule A Dose limits for occupationally exposed persons**
- The occupational dose limits for ionising radiation are as follows:

[1] The limits apply to the sum of the relevant doses from external exposure in the specified period and the 50-year committed dose from intakes in the same period.

[2] With the further provision that the effective dose must not exceed 50 mSv in any single year. When a pregnancy is declared by an occupationally exposed female, the working conditions of that person should be such as to ensure that the additional dose to the embryo/foetus would not exceed about 1 mSv during the remainder of the pregnancy.

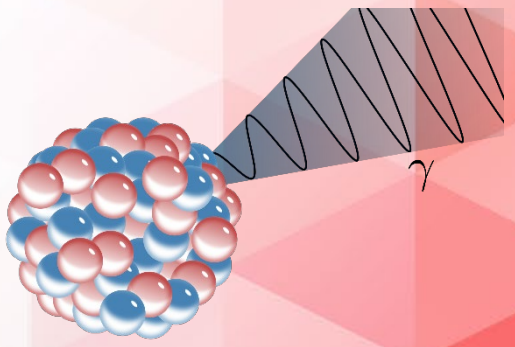
[3] With the further provision that the equivalent dose must not exceed 50 mSv in any single year.

[4] The equivalent dose limit for the skin applies to the dose averaged over 1 cm^2 of the most highly irradiated area of the skin. The dose to the skin also contributes to the effective dose, this contribution being the average dose to the entire skin multiplied by the tissue weighting factor for the skin.

[5] Persons under the age of 16 years must not be subject to occupational exposure. Persons under the age of 18 but more than 16 years must not be subject to occupational exposure unless they are under supervision and only for the purpose of training for employment or for the purpose of studies in which sources are used.

Reference: Code for Radiation Protection in Planned Exposure Situations
Radiation Protection Series C-1 (Rev. 1)
January 2020

Radiation Injuries



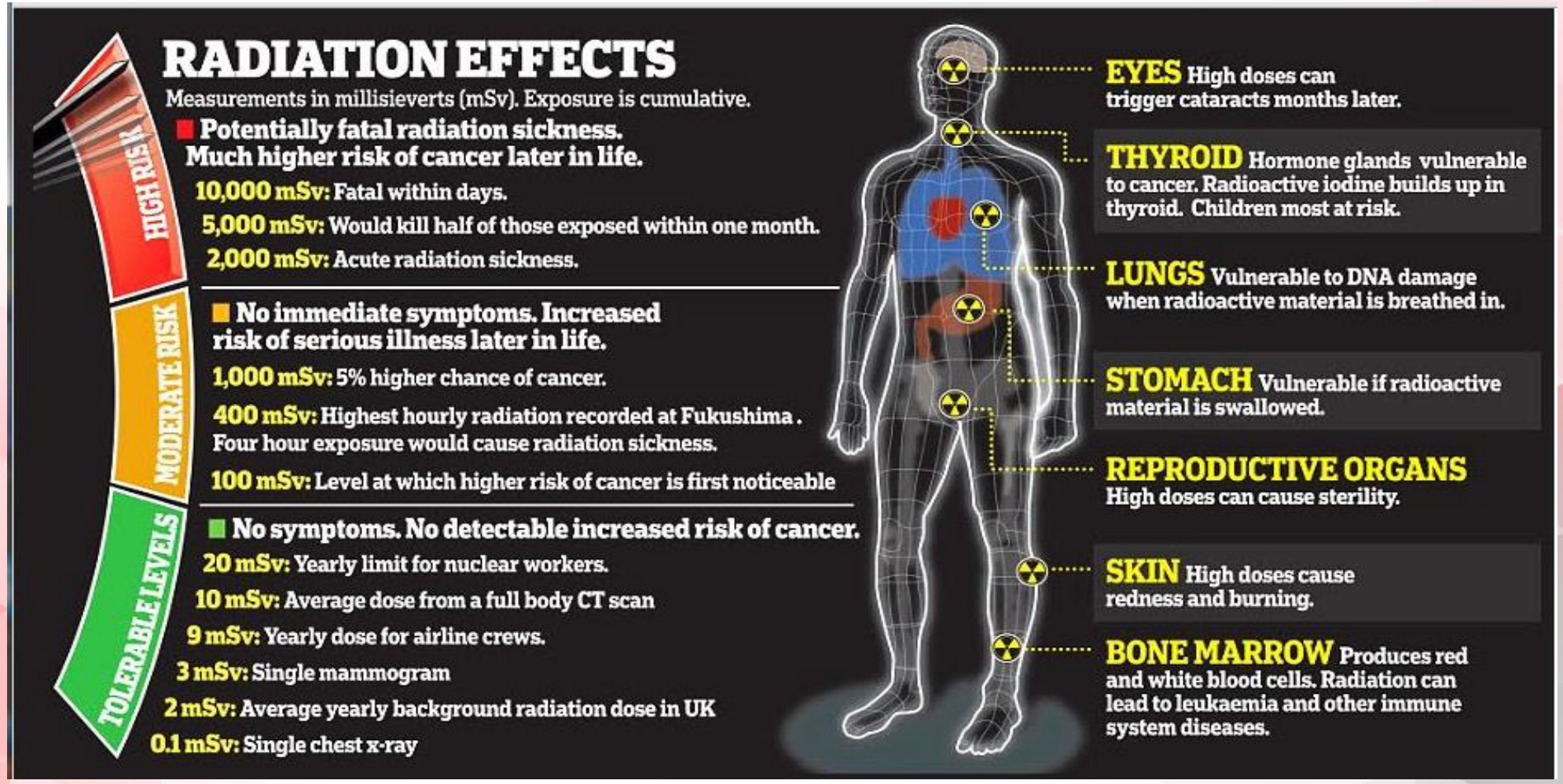
- We are quite used to the damaging effects of the ultraviolet component of solar radiation (sunburn and risk of skin cancer.) We also know from experience that we cannot sense this radiation directly, and that the perception of sunburn starts after the damage has been done.

- It is not surprising then, that ionising radiation has similar effects, as it borders on UV in the spectrum.

- As with sunburn, it is possible to get a fatal radiation dose if one is exposed to a very large amount of ionising radiation in a short time. Although the only persons in Australia receiving large doses are cancer patients undergoing radiotherapy.

- Similarly, the risk of cancer increases with the level of exposure to radiation, and inversely with the age of person exposed. By law, you must be 18 years old to work with radiation, and medical exposures are limited to justified cases only.

Radiation Exposures – Short Term High Dose



Health Effects

For cancer of all types, the risk of a fatal cancer being induced by cumulative doses of Ionising radiation totaling 1000mSv is considered to be 4.5%.

At the radiation worker limit of 20mSv, the risk remains to be proportionally less, and becomes just under 0.1% that a fatal cancer was caused by a radiation dose.

Expressed another way, this is around 1 in 1,000, and is obviously "small but finite" . This is a good reason for the radiation dose limits to be treated as absolutes. (in radiation protection terms, this equates to the ALARA Principle : all doses should be kept "As Low As Reasonably Achievable"

Chronic versus Acute Dose

The risk from small doses accumulate over time, so exactly as for the risk of skin cancer, the risk of a radiation induced cancer increases with your accumulated dose. Currently accepted risk is 4% per Sv of dose received for occupationally exposed persons.

Our response to this “statistical” risk at low accumulated dose is to reduce our doses to the bare minimum, or ALARA: As Low As Reasonably Achievable.

ALARA Principle

A

L

A

R

A

is an acronym for **As Low As Reasonably Achievable**.

A radiation safety principle for minimising radiation doses

It is not only a sound safety principle but is a regulatory requirement for all radiation safety programs.

Dose Rates

The combined gamma dose from the exposed Cs^{137} and Am/Be sources at 1 meter is ~ 25µSv.h^{-1} for Troxler PMDG's and 30µSv.h^{-1} for CPN PMDG's.
The neutron dose from the Am^{241}/Be sources is negligible and equates to ~ 1µSv.h^{-1}

So maximum doserate is ~ 31µSv.h^{-1} if you are using a CPN or 26µSv.h^{-1} for the Troxler.

Dose Rates



For Hydroprobes, the activity of the Am^{241}/Be source is around 50mCi or (1.85GBq)

Dose rate @ 1m is ~ 1.1µSv.h^{-1}

Personal Monitoring Devices





Personal Monitoring Devices

- It is the Possession Licensees obligation to provide personal monitoring devices to persons who could be exposed to an annual dose that exceeds the general public limit of 1mSv.
- As a User, you are obligated to wear your personal monitoring device whenever you are exposed to sources of radiation during the course of your work
- PMD’s are easily damaged by heat and moisture
- PMD’s should be worn on the same area of the body each time it is worn ie: clipped to your belt or in your trouser pocket
- Never allow anyone else to wear your badge
- DO NOT EVER LEAVE YOUR BADGE IN THE TRANSPORT CASE WITH THE GAUGE -------- YES IT HAS HAPPENED !!!!

Personal Monitoring Devices

- The wearing period for Badges is 3 months
- The control badge is issued to measure background radiation, all wearers doses are calculated by subtracting the background dose reported from the control badge.
- Personal monitoring devices must not be tampered with
- Monitoring results are reported to the Health Department
- Radiation Badges must not be worn during medical procedures.

Personal Safety



Some things you should never do:

1. Sit on the transport case.
2. Attempt to sharpen the source rod so it goes into the ground easier.
3. Do any modifications to the gauge, or probe, apart from cleaning etc as per the manual.
4. Lean on the tailgate of the ute for a yarn when the gauge is transported.
5. Use the PMDG for any purpose for which it is not intended.
6. Always fill out the logbook accurately, so your use location & transport route is known.
7. No unauthorised use!

The RSPP

It is a requirement under the Act that a Radiation Safety & Protection Plan is developed (RSPP).

- The Radiation Safety & Protection Plan describes how the radiation practice is carried out.

- A Radiation Safety Officer is appointed by the Licensee and is there to advise the Licensee and employees on radiation safety matters associated with the Radiation Practice. It is the RSO that you must contact in the event of an incident.

- It is your obligation as a user to ensure you read and understand the Radiation Safety & Protection Plan. It describes specific procedures for your workplace such as;
- Safe working rules
- Emergency Procedures
- Transport Procedures
- Storage Procedures

Working Rules



Important!

There is a level of maintenance which YOU, the user, are expected to do.
This is described in the gauge manual.

Note that it (usually!) includes cleaning the shutter block, especially if the gauge is being used in cement base, or sticky clays.

Do not go beyond what you are permitted to do by your Lab Manager.

In particular, you are not permitted to modify anything on the gauge or the transport case – these are both designed to do a specific job.

Source handling requires a specific set of skills, where the possibility of source leakage must always be borne in mind.

And always wear your dosimeter (badge)

Working Rules (Chapter 5)

- Area warning signs must be displayed
- before moving the source from its shielded housing, ensure that all people who are not required to assist with measurements are excluded from the vicinity of the gauge, eg. to a distance of 3 metres;
- keep the number of people assisting with the measurement to the absolute minimum;
- while a portable density/moisture gauge is in use, the site is appropriately supervised; always lock the source(s) in the shielded position whenever measurements are not being made;
- never move the source(s) from the shielded housing except to make a measurement or to carry out routine maintenance (eg. cleaning of source rod);
- only move the source(s) from its housing immediately prior to making a measurement, then immediately return the source(s) to its shielding on the completion of the measurement

Working Rules Continued

- do not waste time while conducting measurements;
- do not stay close to the gauge except when necessary to conduct measurements;
- never conduct measurements unless those workers directly involved with using the gauge are correctly wearing appropriate personal monitoring devices; and
- never place the gauge where vehicles or machinery may damage it.

If there are any issues with the condition of the gauge, ie; damaged labels or physical damage, you must report to your RSO.

Rules for storage of gauges

When in storage, the gauge should be locked in its transport case in an approved Radiation Store. (charging being the exception)
As far as practicable and considering the ALARA principle, portable density/moisture gauges should not be stored near regularly occupied or frequented areas.

Portable density/moisture gauges should not be stored in the same storage area as dangerous goods of the following classes:



1. Explosives
2. 2.1 Flammable gas
3. 3 Flammable liquid
4. 4.1 Flammable solid
5. 4.2 Spontaneously combustible
6. 4.3 Dangerous when wet
7. 5.1 Oxidising agent
8. 5.2 Organic peroxide
9. 8 Corrosive

Consideration should be given to separation of these classes when designing a store from the ‘ground up’ or as is more often the case, when designating an existing store as a storage area for portable density/moisture gauges.

Maintenance



- Cleaning the shutter block: always work from “top” side of gauge.

Maintenance



Cleaning the shutter block:

- The slider plate has been removed & cleaned.
- Shutter block is still in place – source still SAFE.

Maintenance

Cleaning the shutter block:

Block has been removed, source not SAFE as a restricted beam is issuing from the baseplate.



PMDG Safe Work Practices

Click the link to view the video presentation



PMDG TRAINING RESOURCES | McKavanagh Engineering Services (mckeng.com.au)

If viewing this presentation in a web browser, right click the link and select “Open in New Tab”

Emergency Procedures

- Treat the injured, if any for immediate threats.
- Cordon area, 5 metres minimum
- Contact RSO & describe incident.
- Don’t touch gauge unless directed by RSO
- Remain outside of, and control the cordon.
- The RSO will survey the area with a meter, and decide the appropriate actions to render the area safe.



Emergency Procedures – Specific Incidents

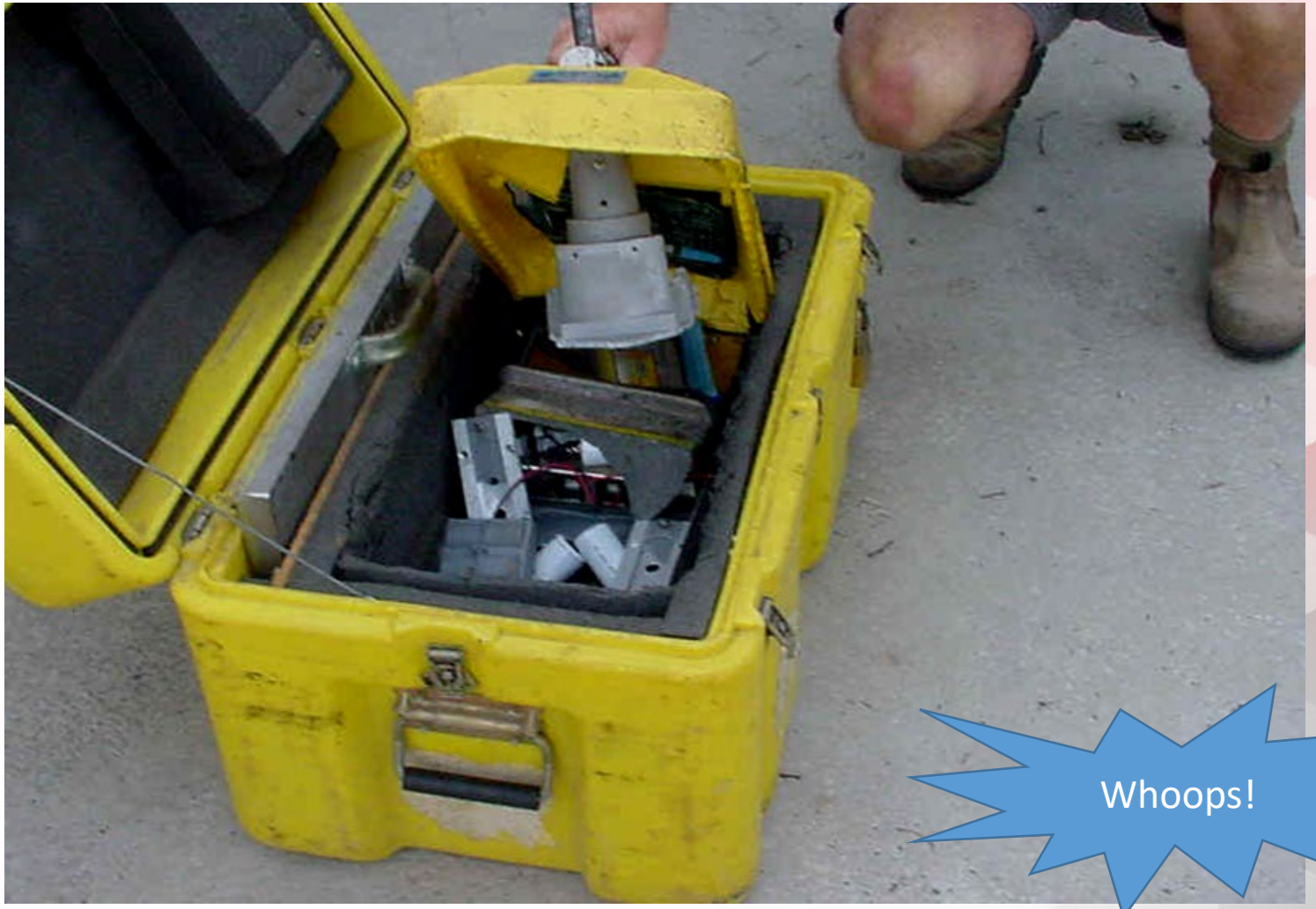
Let’s look at other conceivable incidents

- Gauge is struck by vehicle
- Gauge is dislodged from vehicle during transport
- Fire to storage area whilst gauge is stored
- Unusually high dose rate whilst performing a survey

Refer to your Radiation Safety & Protection Plan for emergency procedures specific to your radiation practice.

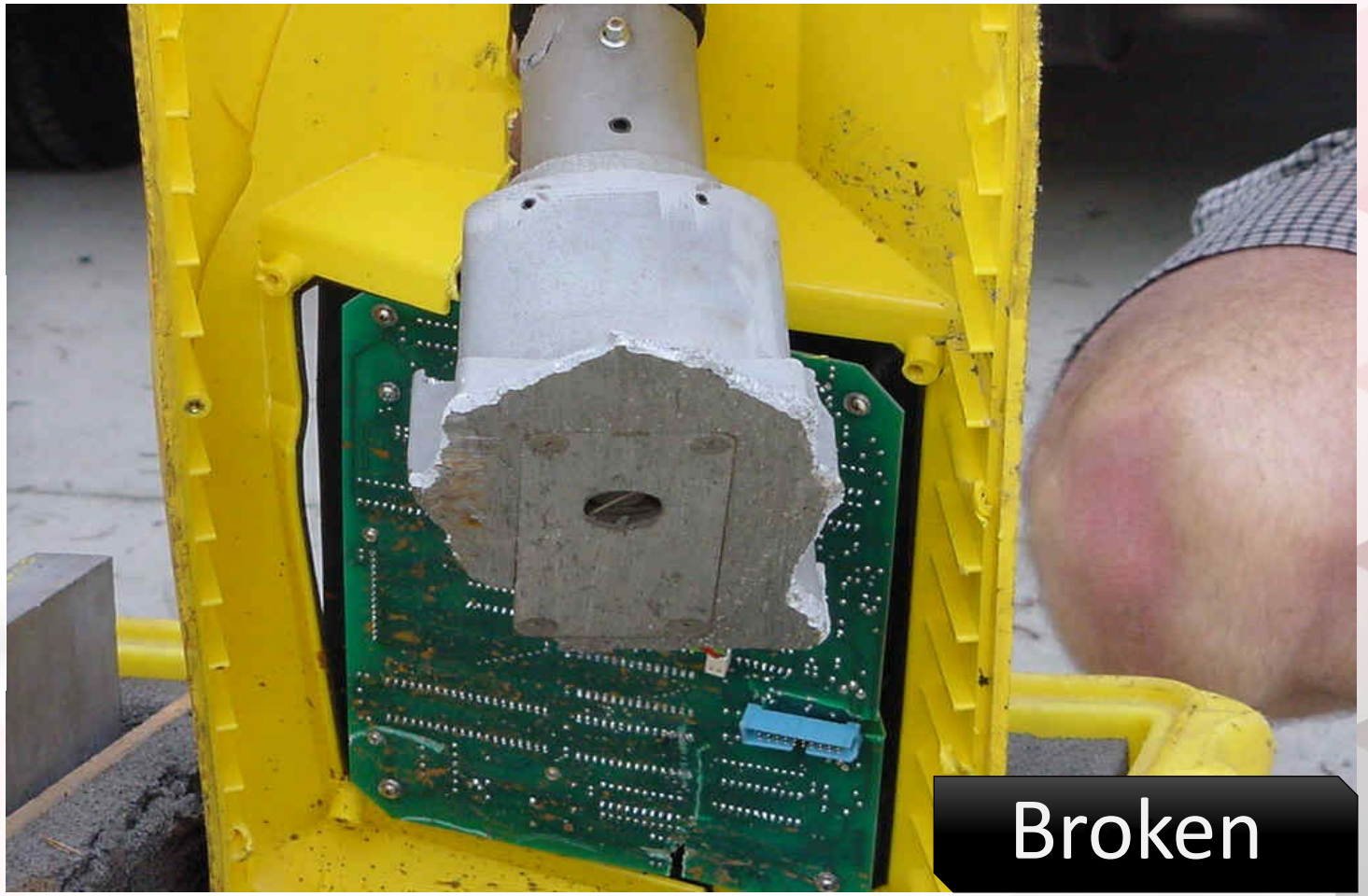


Emergency Procedures – Specific Incidents



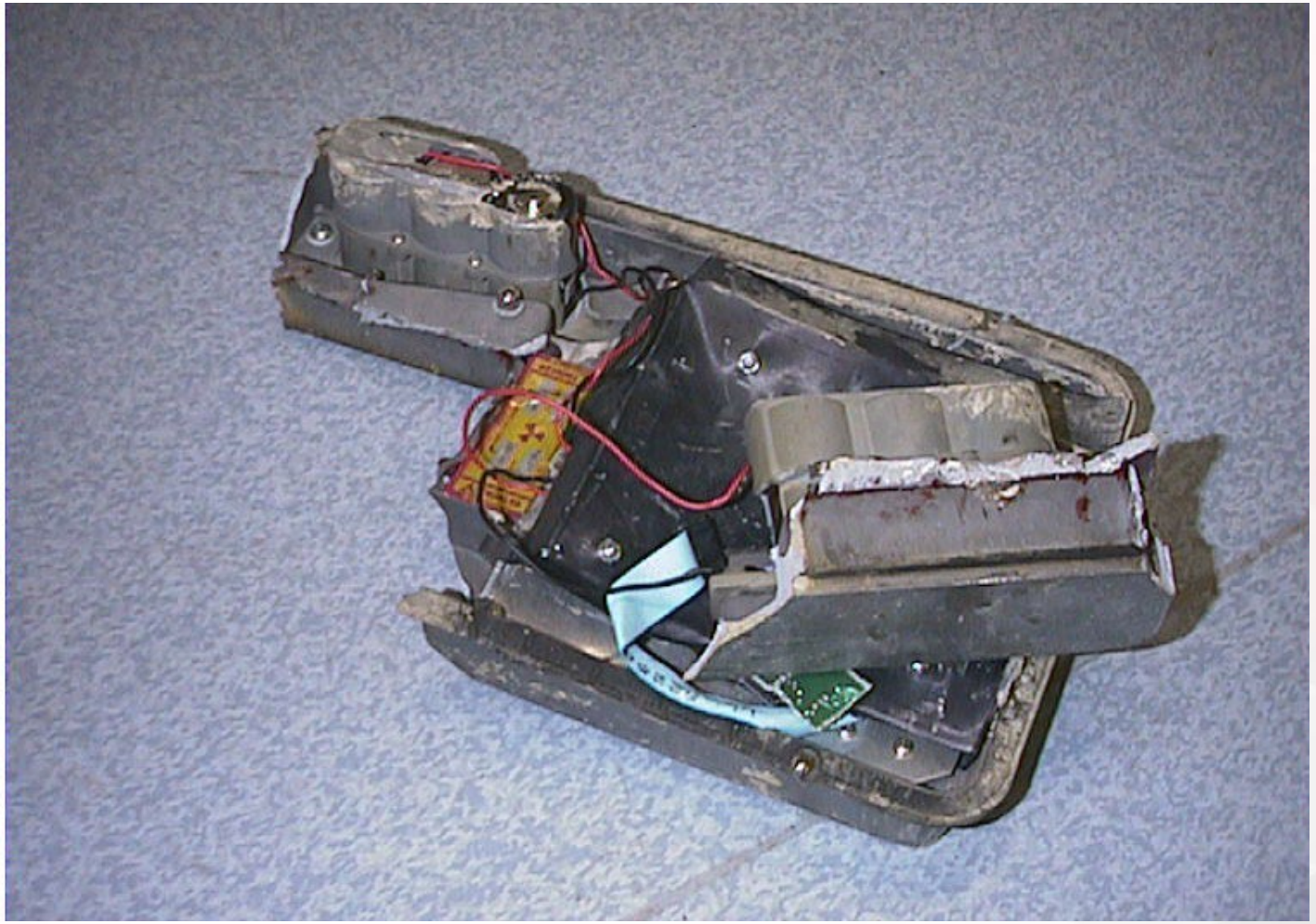
Emergency Procedures – Specific Incidents





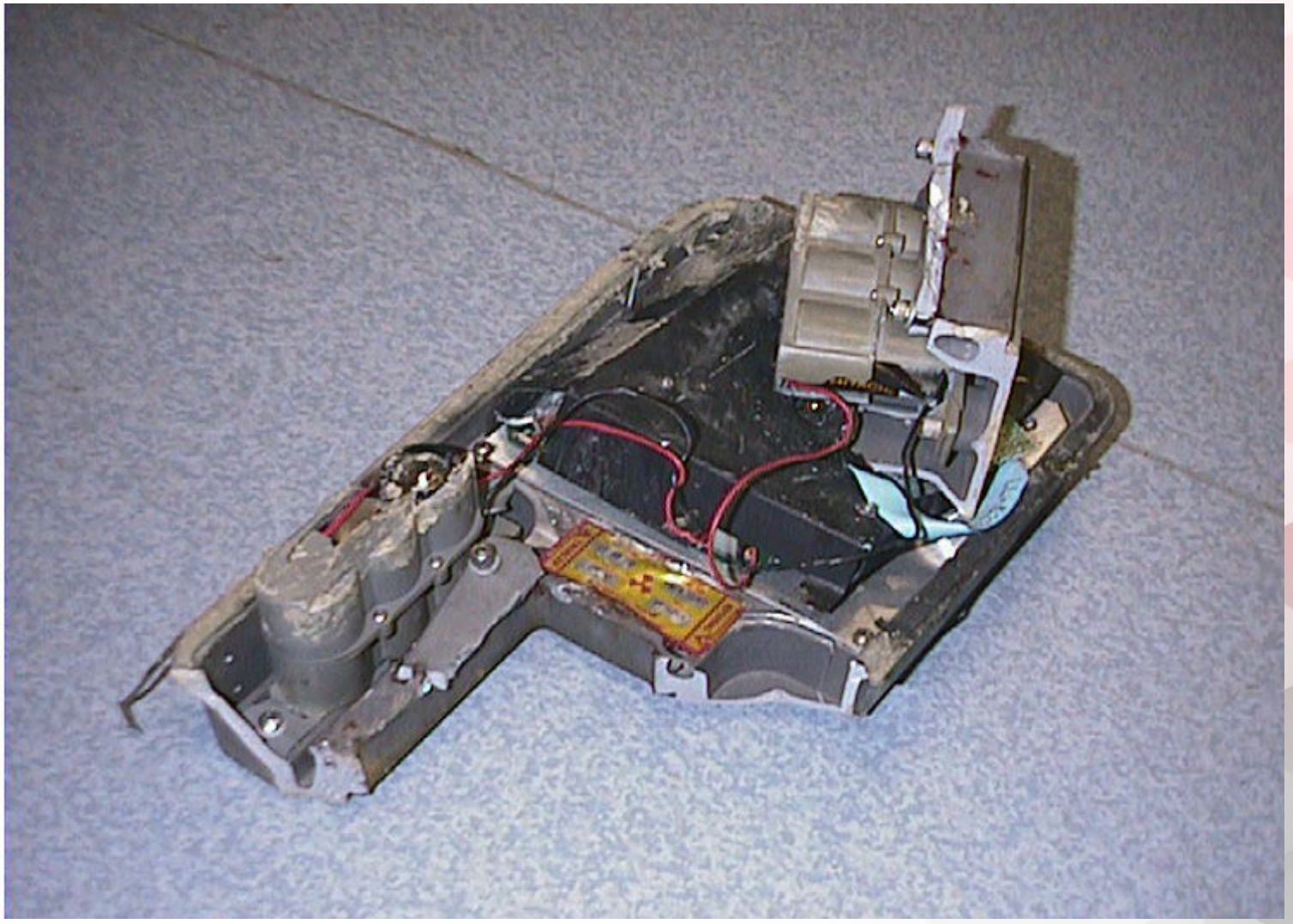
Emergency Procedures – Specific Incidents



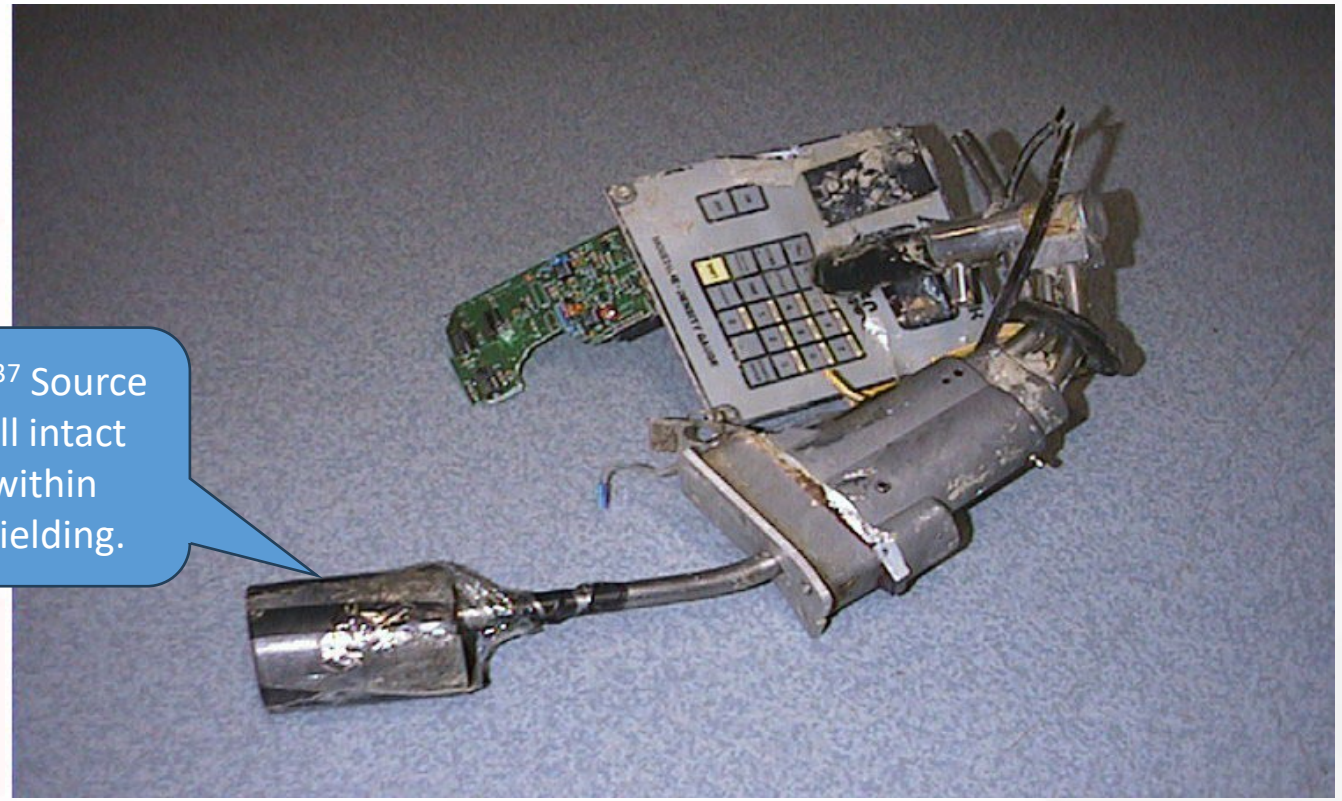


Emergency Procedures – Specific Incidents





Emergency Procedures – Specific Incidents



Emergency Procedures – Specific Incidents

Gauge Left Unattended





Things you need to remember !

- Check the condition of the gauge each time you use it
- Check the condition of the label on the gauge, is it legible ?
- (if not, report to the RSO)
- Look after the gauge and carry out the prescribed maintenance tasks.
- Remember the 3 principles of protection

Time ……. Distance…….Shielding

Radiation Survey Meters

Survey Meters that are capable of detecting neutron radiation are very expensive and fragile. It is highly unlikely that your company will own a neutron survey meter. The most common types of survey meter used are those used to measure a range of energies emitted by gamma rays.

They are generally light weight and measure in units of $\mu Sv.h^{-1}$. The types of meters shown here are used for general surveys. They will not measure the neutron dose, they will only measure photon radiation within a specified energy range. They are used as “indicators” They are never 100% accurate.







Obligations for Transport

PMDG's & Hydroprobes must be transported in the transport case provided & kept locked at all times.

Transport vehicle must be placarded both sides of vehicle & rear

Transport case is to be placed as far away from the driver as practicable

Transport case must be secured within the vehicle;

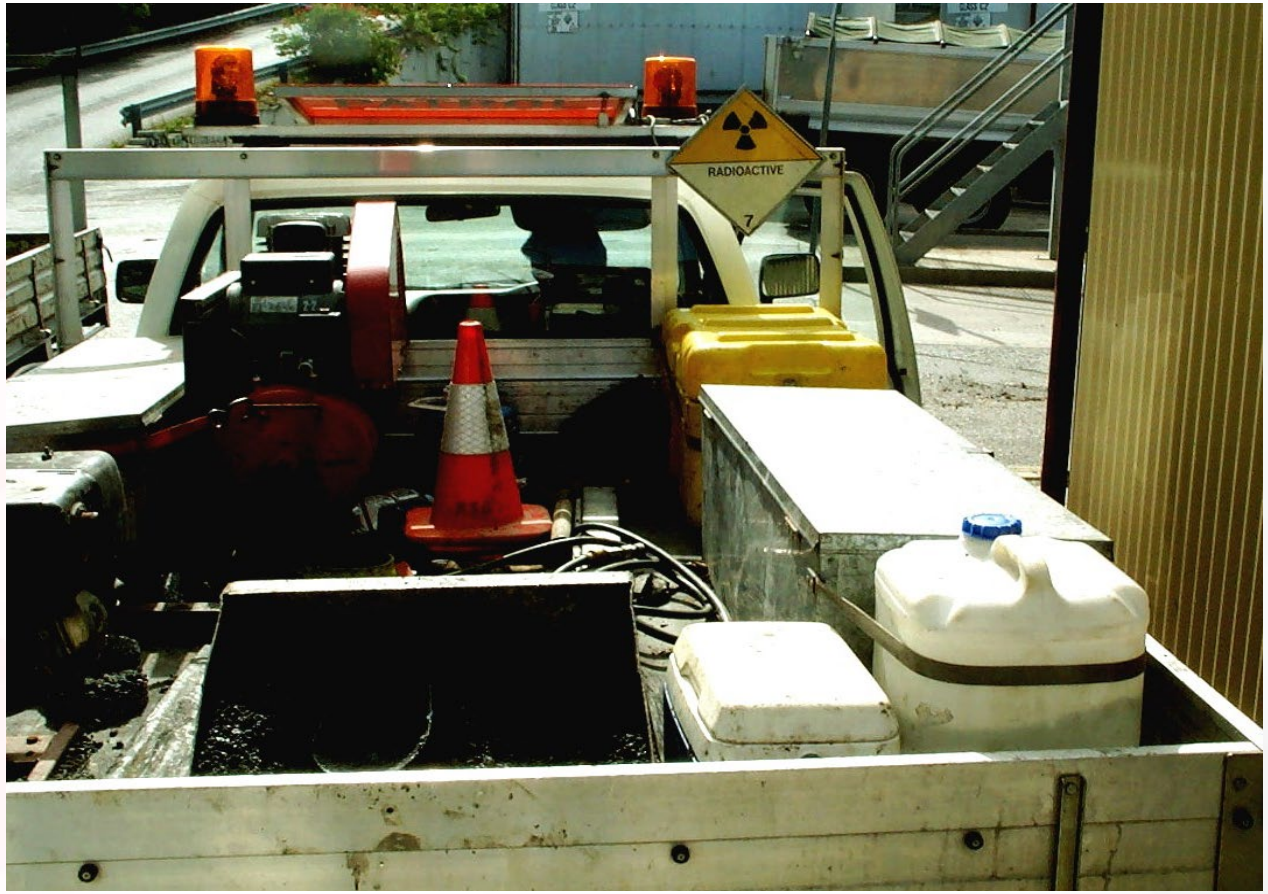
- to prevent unauthorised access and
- to reduce the risk of dislodgement in the event of a vehicle accident

DON'T EVER TRANSPORT IN PASSENGER COMPARTMENT OF THE VEHICLE

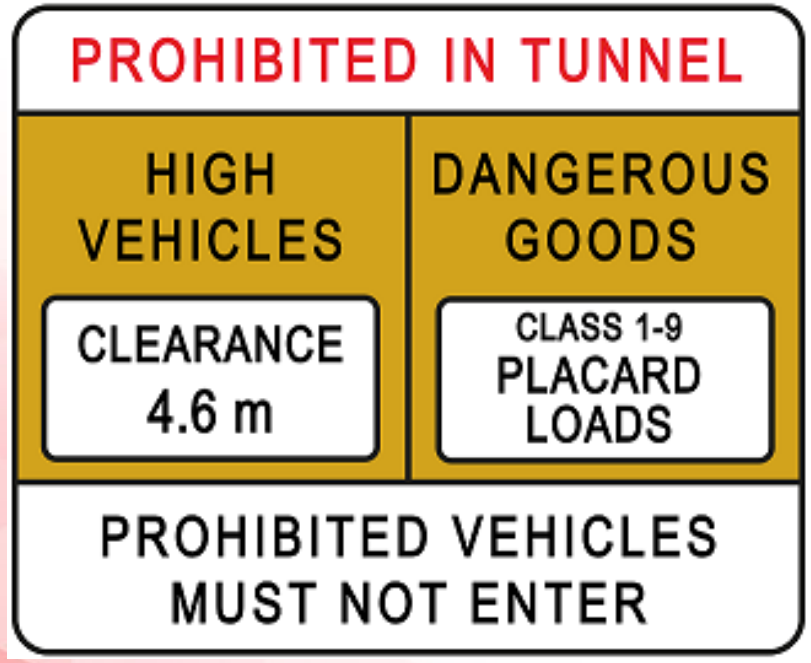


Obligations for Transport

What's going on here?



Obligations for Transport



Obey Local Traffic Rules and signage

- Hefty Fines Apply

It's not worth the risk – if there is a vehicle accident in a tunnel involving vehicles carrying class 7 DG the fines could be substantially more.



Note on Penalties and Penalty Units

There are penalties applicable for breaches of the QLD legislation

Penalties are stipulated as a value in terms of a maximum number of “penalty units”

The maximum number of penalty units for specified breaches ranges from 10 to 2500.

Total value of a penalty = no. penalty units X current legislated value (in A$)

The A$ value of a penalty unit is prescribed in the QLD “Penalties and Sentences Act”.

- Value @ July 1 2024 = $161.30

So, the total value (fine) for a penalty of 10 penalty units as at this date was:

10 x $161.30 = $1613.00

Insignificant?



Example of Penalty Units applicable

Radiation Safety Act 199

Part 2 Licenses (s 12)

A person must not use a radiation source, unless the person is allowed to use it under a use licence.

Maximum penalty—

(a) for a radiation source that is not a portable security enhanced source—400 penalty units; or

(b) for a portable security enhanced source—2500 penalty Units.



Safe Working Rules It’s All Up To You

- REMEMBER: TIME – DISTANCE – SHIELDING
- ALWAYS WEAR YOUR BADGE !
- AS LOW AS REASONABLY ACHIEVABLE
- SECURITY OF THE GAUGE WHILST IN USE IS YOUR RESPONSIBILITY





If you have difficulties with any of the information in this module, please contact us for support.

Ph: 07 5427 0126 or email training@mckeng.com.au