

PPSA 2023

The science and technical application of radioisotopes for safe, accurate & reliable pig tracking

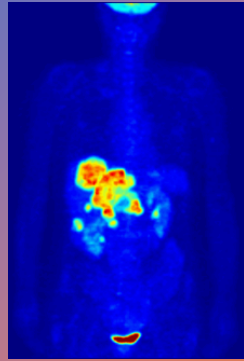
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Nuclear-Radiation-Isotopes - Common perceptions ?



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Radiation is present in our daily lives

Typical values for medical applications:

X-Ray of Limbs (0.06mSv)

CT scan (2.1mSv)

Barium Meal (3mSv)

Red Blood Cells (5mSv)

Typical values for travel:

At 20000m - 13 μ Sv/h

At 12000m - 5 μ Sv/h

At 0m - 0.03 μ Sv/h

Cosmic radiation accumulation for a 6-hour flight - 30 μ Sv

Airport scanners for luggage checks

Annual effective dose (UK=2.2mSv, Norway=4.0mSv) from naturally occurring sources such as:

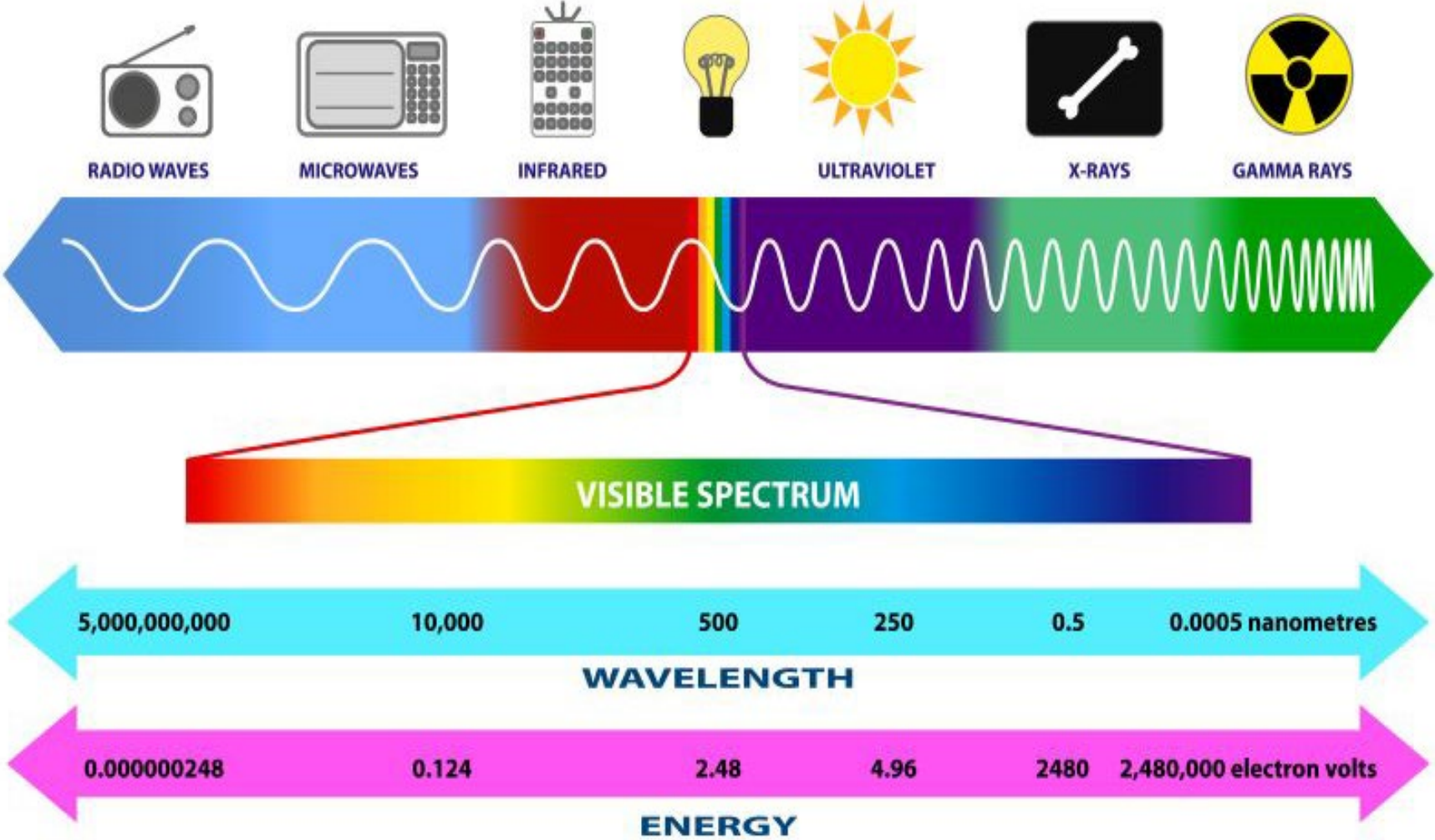
Ingested radionuclides

Emissions and Discharges

Radon Decay

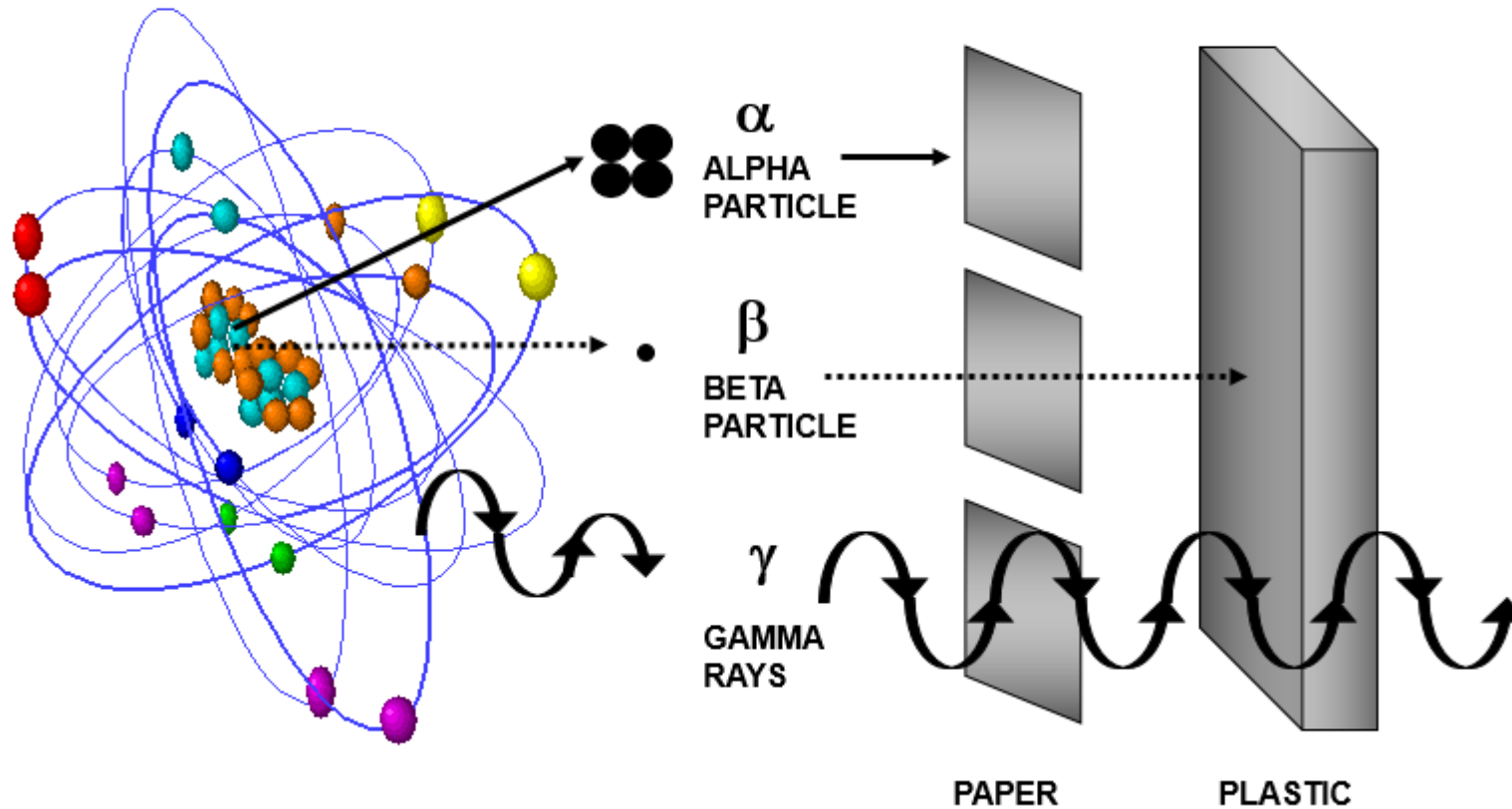


ELECTROMAGNETIC SPECTRUM



Electromagnetic radiation is a form of energy that propagates as both electrical and magnetic waves traveling in packets of energy called photons. There is a spectrum of electromagnetic radiation with variable wavelengths and frequency, which in turn imparts different characteristics.

High Energy EM Radiation



Gamma rays – emitted from the nucleus of unstable atomic particle.

Most mined elements are benign & require reactor intervention to create the unstable isotope.

Certain isotopes will emit Alpha & Beta particles. Have charge & mass and will interact with any matter.

Typical Industrial Radioisotopes

Typical industrial Radio isotopes that are manufactured from a base element or by product of nuclear reaction. i.e. Cs is element Caesium, 137 is the atomic mass number. Tantalum (Ta-182) and Cobalt (Co-60) are common isotopes used for pig tracking.

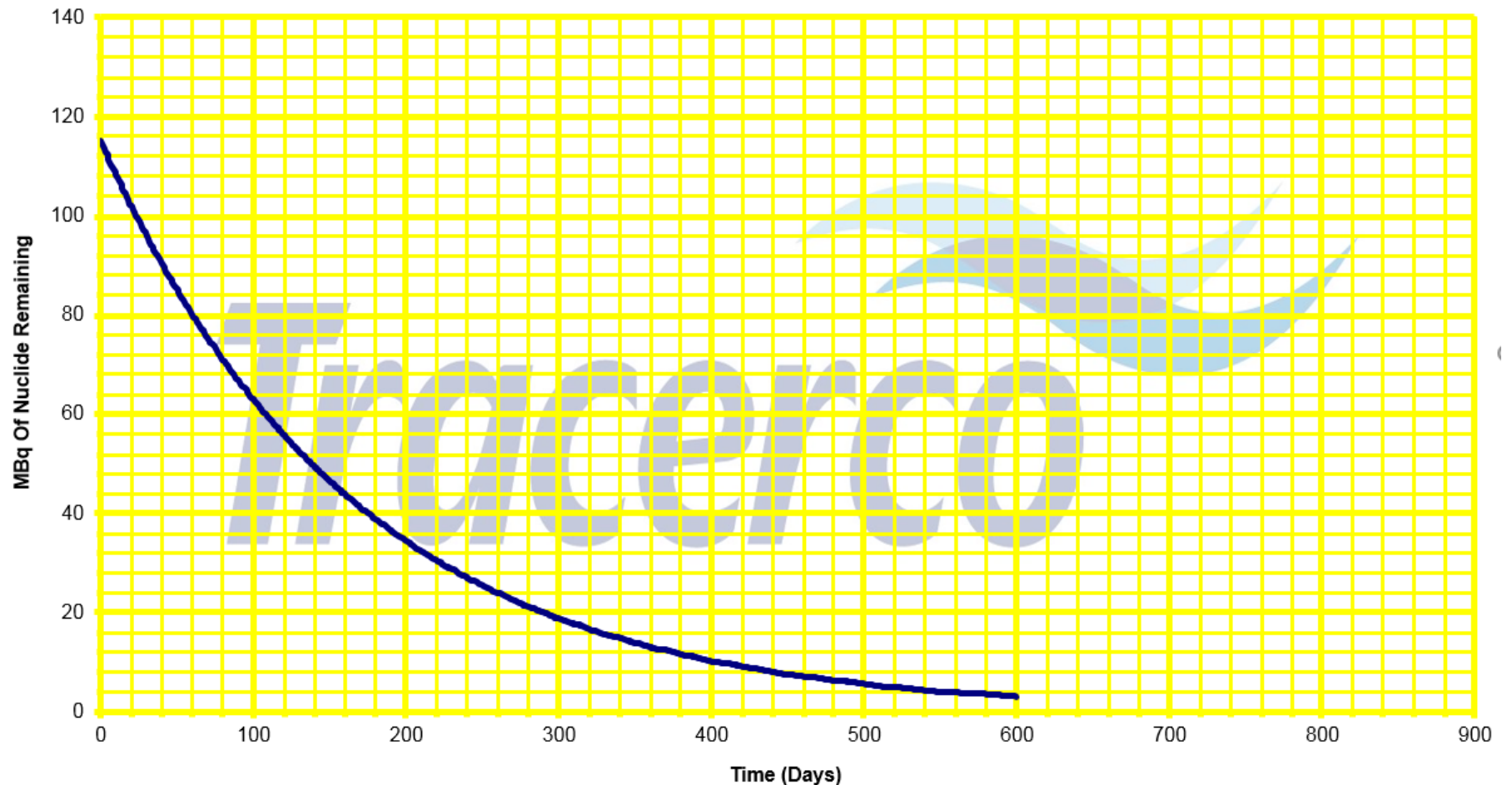
<i>ISOTOPE</i>	<i>RADIATION</i>	<i>HALF LIFE</i>
<i>Cs-137</i>	β, γ	30 Years
<i>Co-60</i>	β, γ	5 Years
<i>Ir-192</i>	β, γ	80 Days
<i>Ta-182</i>	β, γ	115 Days
<i>H-3</i>	β	12 Years
<i>Ra-226</i>	α, β, γ	1600 Years

Radiation Decay Chart

The most common measure of radioisotope activity is the SI unit Becquerel (Bq). A becquerel is one decay per second (dps). The Curie (Ci) is the traditional unit of radioactivity and is the unit most commonly used in the United States. One curie is 37 billion Bq.

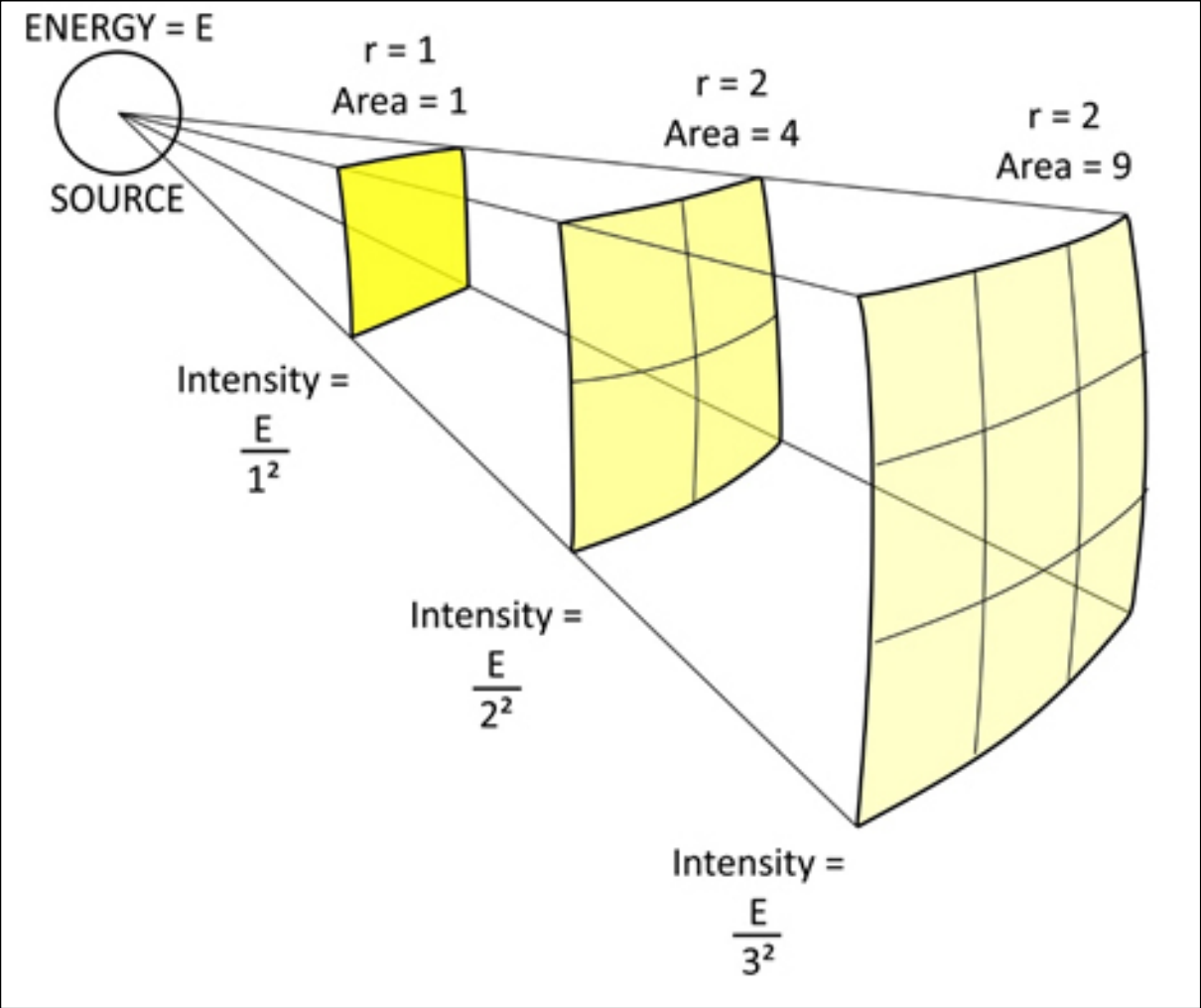
Decay Chart for Tantalum 182

115 MBq - Half Life 115 Days



Half Value Thickness

Shielding and distance are two important parameters used to ensure radiological safety and minimise unnecessary exposure. The strength of the gamma source drops significantly with distance. Double the distance reduces the energy intensity to a quarter. By careful design and material selection, shielding will cut off emissions completely.



Pipeline Pig Tracking - Source Size Calculator

Tantalum-182

Source Size Used (MBq)	11
Thickness S.Steel (mm)	17.5
Thickness Conc (mm)	0

T _{0.5} stainless steel (mm)	23
T _{0.5} concrete (mm)	91.5
T _{0.5} water (mm)	183
1MBq @ 1 metre	0.184 μSv/hr
Source dose rate in air @ 1m	2.0 μSv/hr

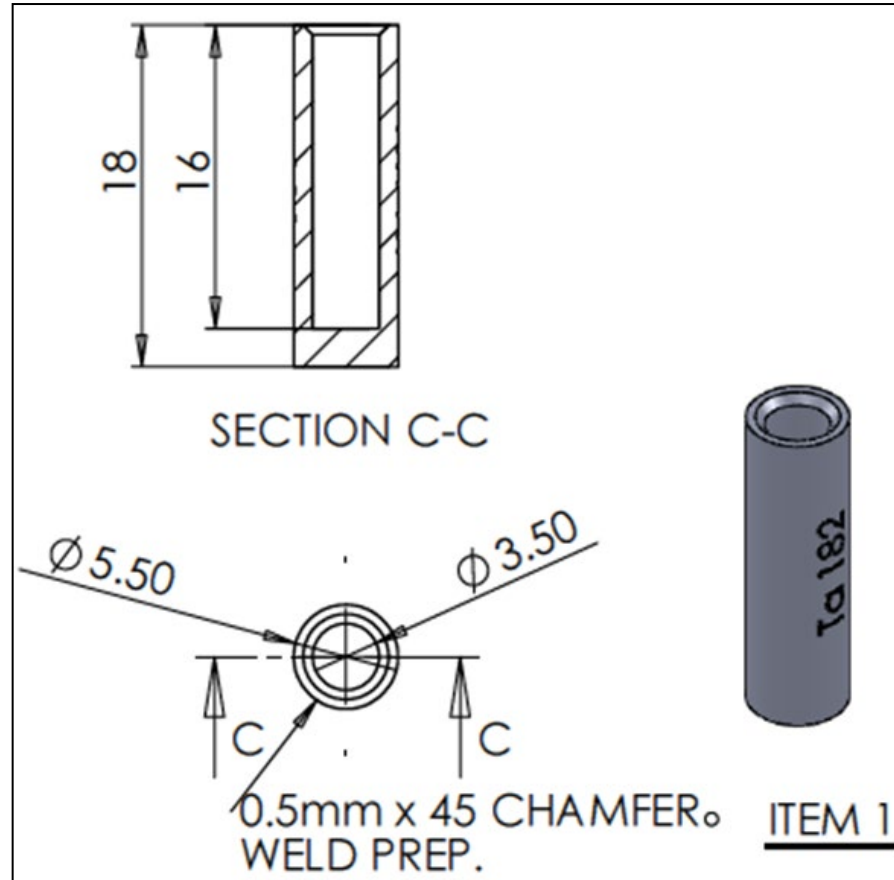
Internal Pipe Diameter (mm) **288.9** 11.37 inches

Desired Surface Dose Rate at Recovery	5	μSv/hr
No. of Days to Recovery	365	
Ideal Source Size at Recovery	1.2	MBq
Ideal Source Size at t=0	10.9	MBq

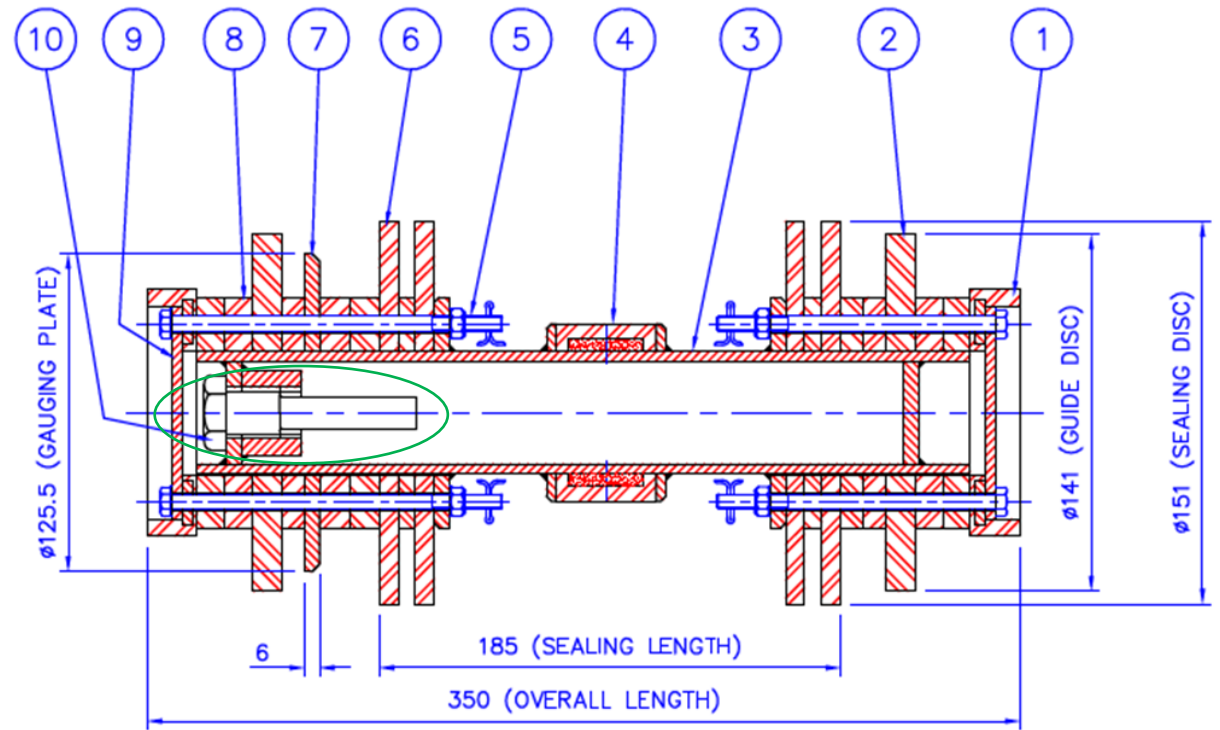
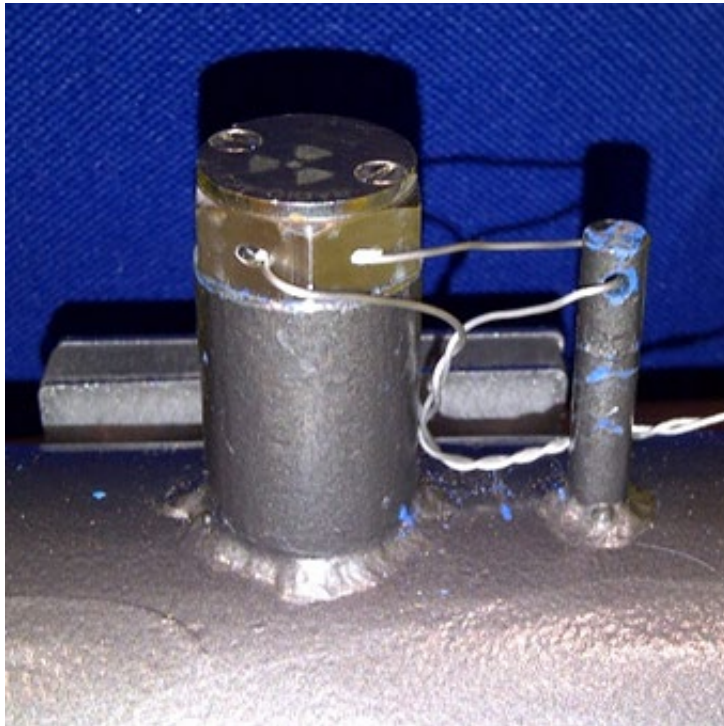
Source Hardware & Physical Dimensions

Tracerco sealed sources are solid metal and encased in an aluminium capsule which is then fitted inside a stainless steel holder which is securely attached to the pig using a 1/2" BSPP thread with Loctite applied and, finally, a locking wire prevents the holder from unscrewing during deployment.

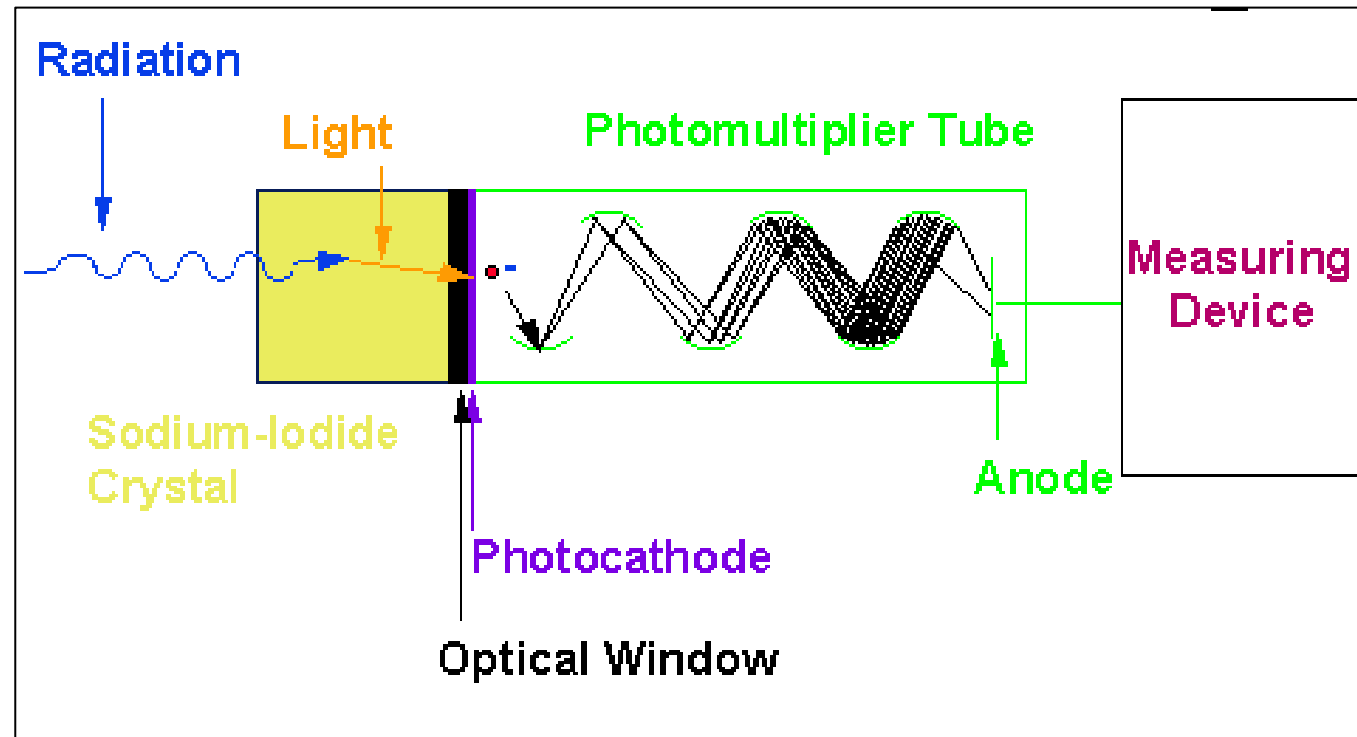
The spool pieces will each be certified as a Type 'A' transit container ensuring there can be no access to the sources once the containers are closed and certified for transport.



Typical Attachment to The Pig



Tracking of Radioisotopes

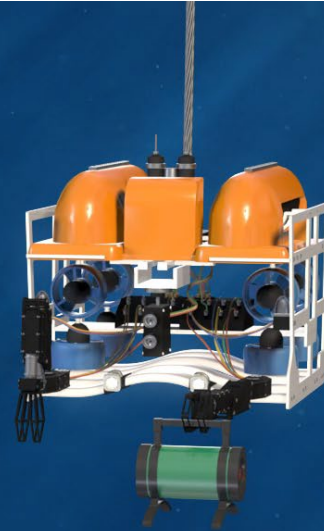


Basic principle of gamma emission using scintillation materials

GammaTrac & SafeTrac



The GammaTrac™ is a multi-functional pig detection unit that allows for non-intrusive detection of multiple pigs and time stamping of pig passage.



Licences & Shipping

Dangerous Goods Declaration and Certificate of Packing
In compliance with the Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulation 1997 SI 2367

Tracerco

Tracerco, Pavilion 11, Coxwold Way, Belasis Hall Technology Park, Billingham, Cleveland TS23 4EA Certificate No: / Page 1 of 1

Shipper: Tracerco Pavilion 11, Coxwold Way Belasis Hall Technology Park Cleveland TS23 4EA				2 - To the Master of MV in accordance with Part II, Reg. 10(2-6) & 12(1) of the above legislation, you are hereby advised of the following classified dangerous goods are being loaded aboard onto vessel.				5 - Destination:			
Consignee: Panalpina Woodside Road Bridge of Don Aberdeen AB23 8EF Onward to: BP Magnus Platform				3 - Shipper's Reference Number (Optional):				6 - Place of Departure:			
				4 - 24-Hour Contact Number +44 (0)1642 375500				7 - Voyage Ref:			
								8 - Departure Date:			

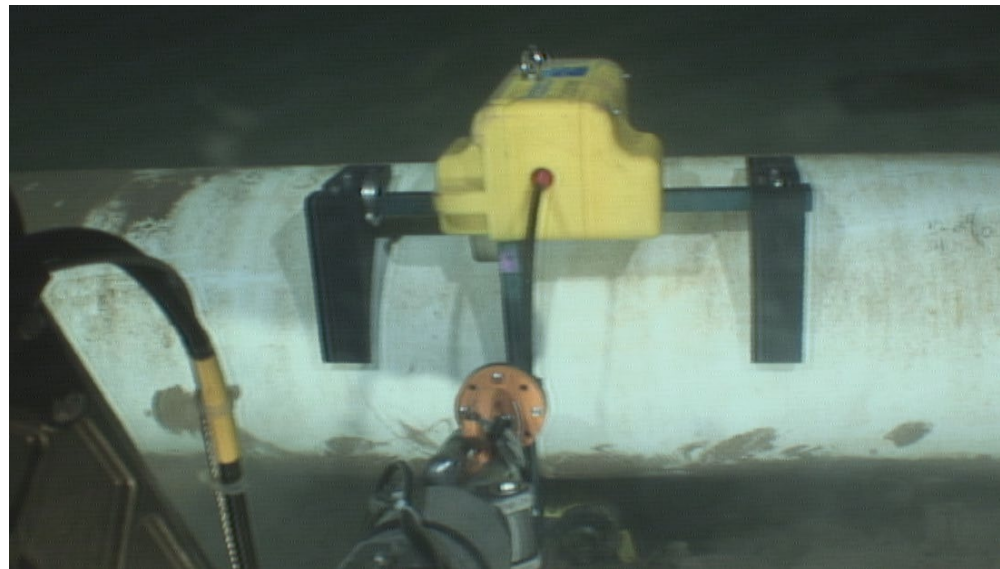
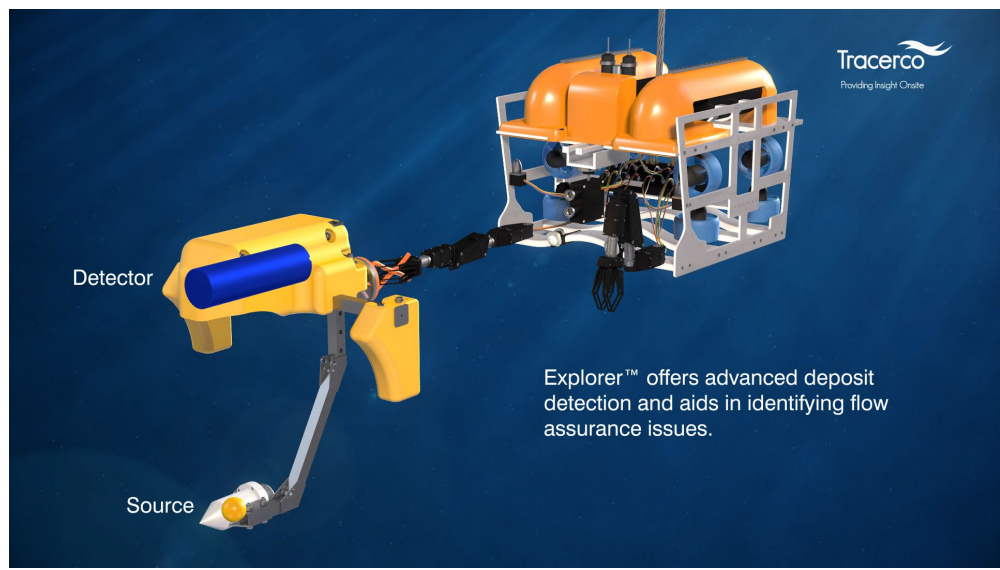
UN NUMBER	PROPER SHIPPING NAME	CLASS OR DIVISION	SUB-RISK	PACKING GROUP	SCHEDULE FOR CLASS 7	RADIONUCLIDE	PHYSICAL CHEMICAL OR SPECIAL FORM	MAXIMUM ACTIVITY (Bq)	CATEGORY OF PACKAGE	TRANSPORT INDEX	IDENTIFICATION MARK FOR COMPETENT AUTHORITY CERTIFICATE	EMS CODE
UN2915	Radioactive Material, Type A Package	7	-	-	9	Ta-182	Solid Metal	20MBq	II-Yellow	0.1		F-I, S-S
9	10	11	12	13	14	15	16	17	18	19	20	21

<p>Declaration: I hereby declare that the contents of this consignment are fully and accurately described above by the Proper Shipping Name and are classified, marked, labeled, or placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations</p> <p>Name and Status of Declarant: M Banks, Subsea Project Manager</p> <p>Date: 24/02/2014 Signature:</p> <p>22 Supplementary requirements (none if left blank)</p>	<p>Container / Vehicle Packing Certificate: It is declared that the packing of the goods into the container/vehicle has been carried out in accordance with the provisions shown overleaf.</p> <p>Name of Company: Signature: Date:</p> <p>23</p>
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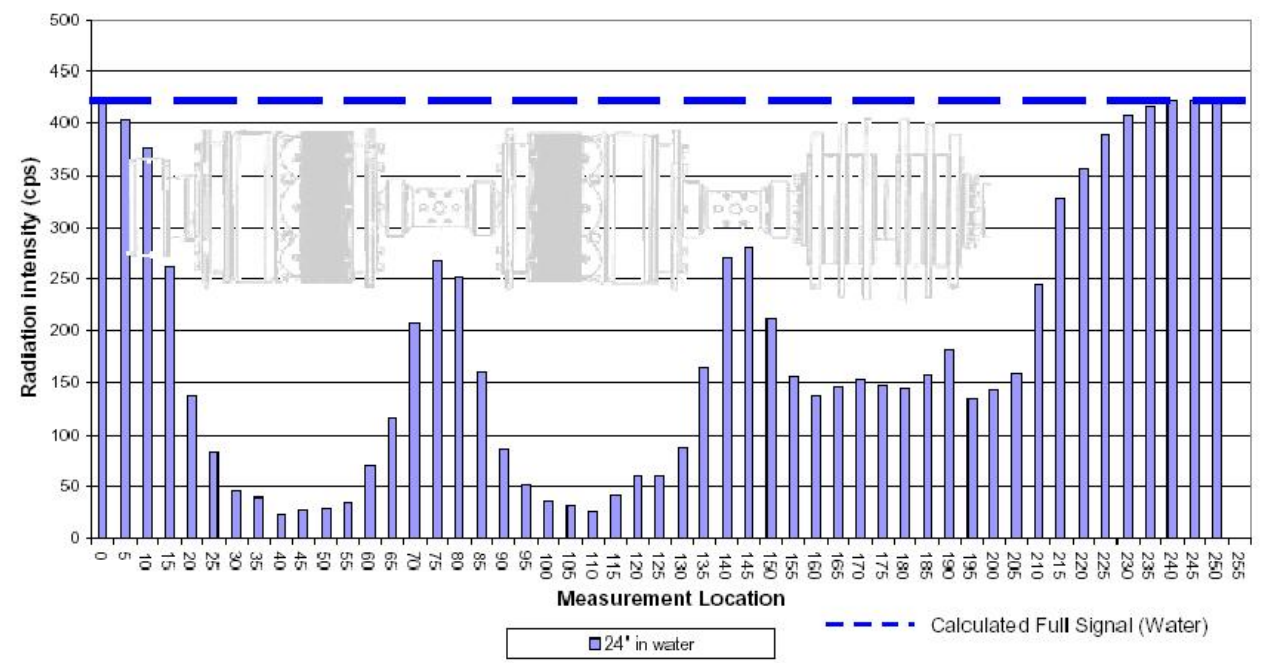
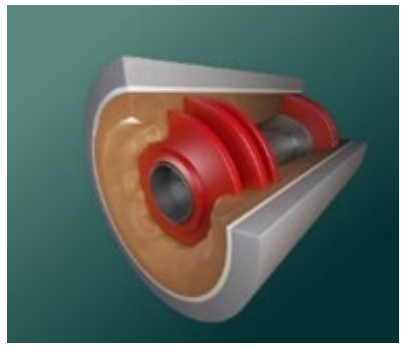


Shielded Type A & Shipping Drum

Lost Pig Location using external radioisotope



- Stuck pig with suspected wax plug.
- Estimate of pig location by pumped volume inaccurate +/- Km
- Pressure pulse ToF measurement placed location to +/- 100m
- Explorer gamma density tool +/- cm

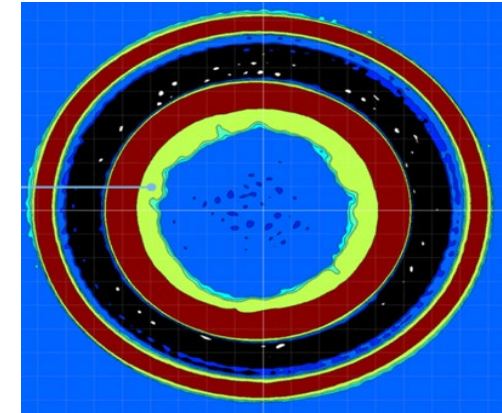
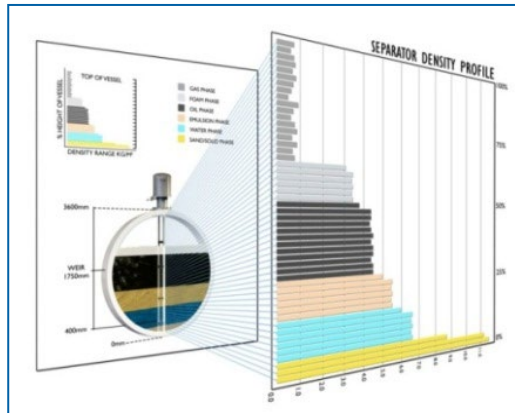
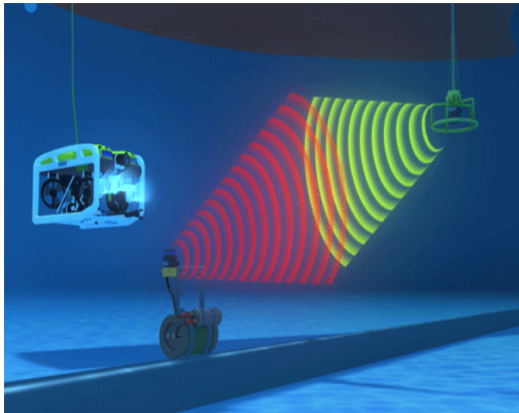


Pig tracking using radioisotopes

- Radioisotopes outlasts equivalent battery systems by a significant margin – effectively doesn't turn off.
- Effect in pipeline systems that cause interference to other electro/magnetic systems i.e. PiP, Electrical Heat tracing etc
- Accurate positioning +/- 5cm.
- Very small footprint, minimal additional payload.
- No interference with other instrumentation systems.
- Retrofit to wide range of pigs.
- Trackers rated to 3000msw - long battery life up to 3000hrs.
- Excellent safety & environmental record.

SME Radioisotope Technology

Established over 60 years ago, Tracerco are an independent world leading technology company providing unique and specialised detection and measurement solutions.



Experts at seeing inside vessels and pipelines to verify real time process conditions and integrity - Online and non-intrusive :
Insight Through Innovation

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