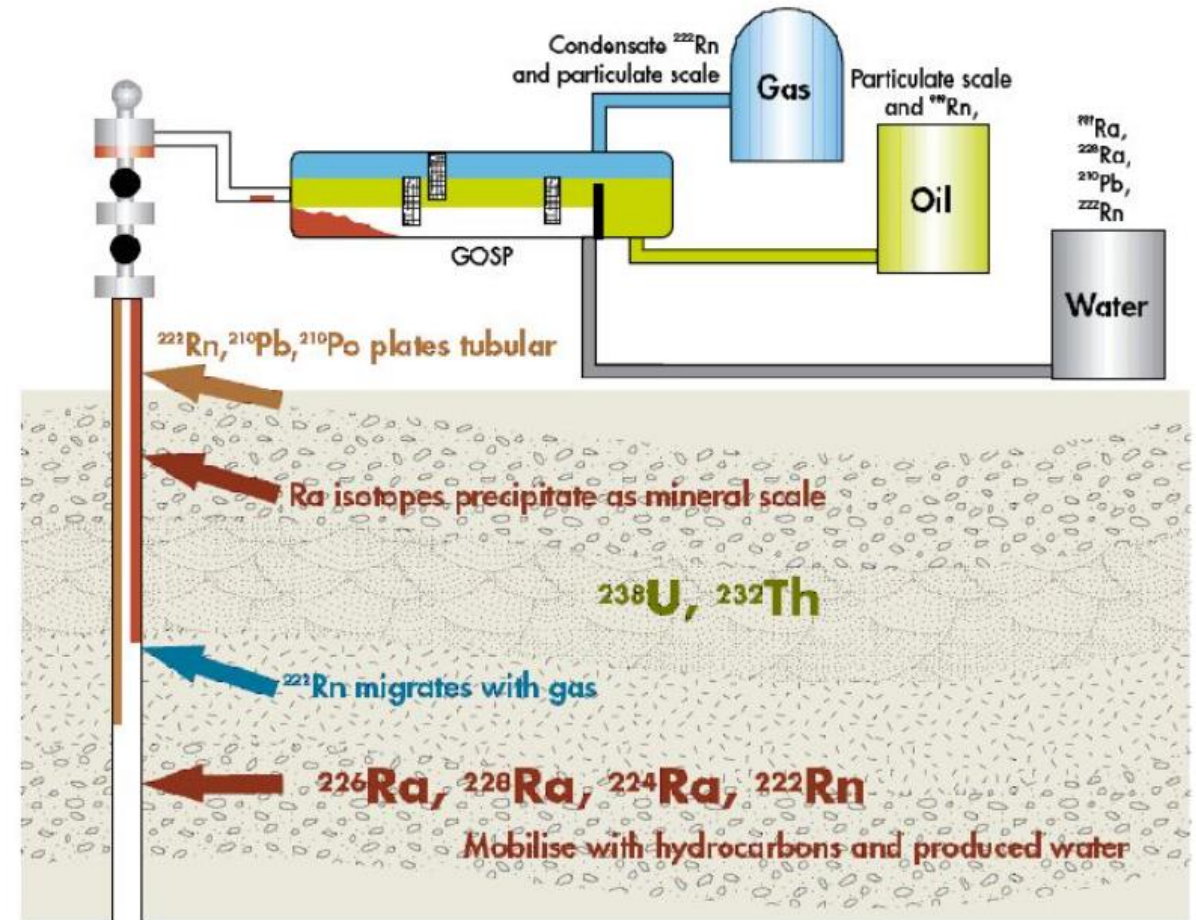


Naturally Occurring Radioactive Material (NORM)

Naturally Occurring Radioactive Material (NORM)

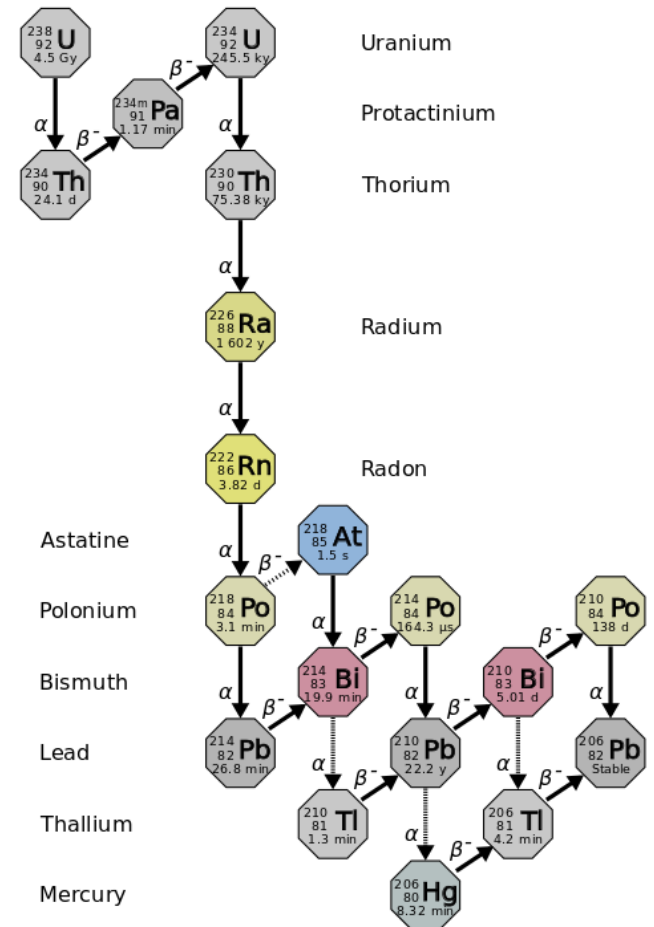
The presence of NORM in gas transmission and distribution systems is growing with the diversification of sources of gas.

- NORM originates from naturally occurring Radon gas, present in variable – but low - concentrations in natural gas
 - Levels of NORM in natural gas can vary widely, according to the geology of where it was sourced
- NORM can accumulate over time in scale, dust or sludge in pipelines and on equipment
 - Also known as “Technologically Enhanced Naturally Occurring Radioactive Material” (TENORM)
- The radioactive particles may migrate from site to site with product and materials



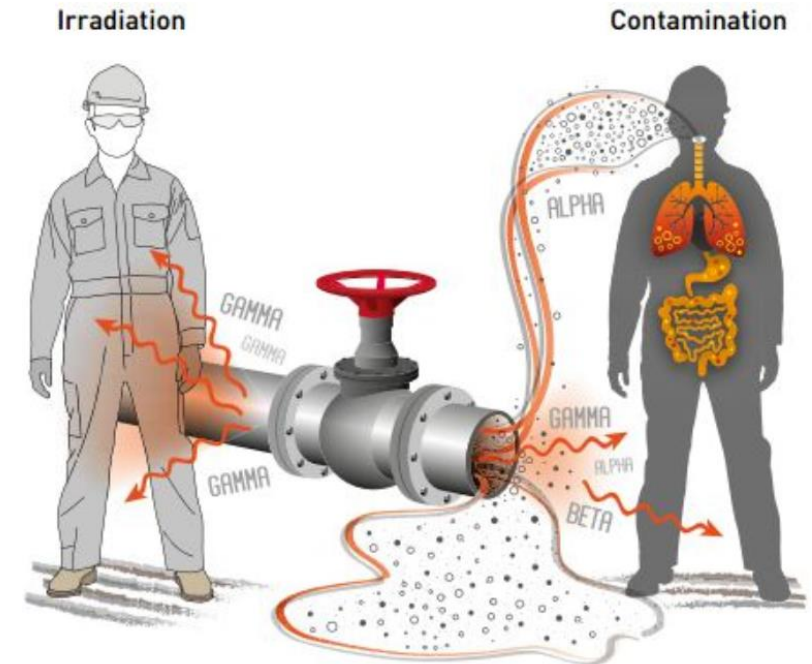
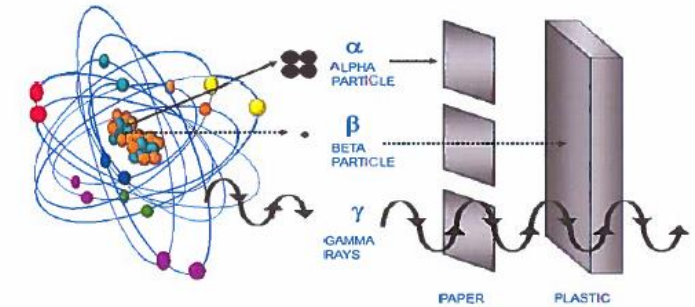
NORM and the “Decay Chain”

- NORM arises from the decay of Uranium 238, arising as a result of the gas production process releasing isotopes from the earth
 - Decay takes place via a series of isotopes known as the “natural decay chain”, the terminal isotope being stable lead
- Each isotope has a different half-life
 - Uranium 238 is 4.5 billion years
 - Polonium 214 is 164 microseconds
- Lead 210 and Polonium 210 are the isotopes potentially present within LNG assets (being decay products of Radon)
 - Lead 210 has a half-life of 22 years
 - Polonium 210 has a half-life of 138 days
- Although NORM will usually be found in dust and sludge, Lead 210 can form very thin (mono-molecular) deposits



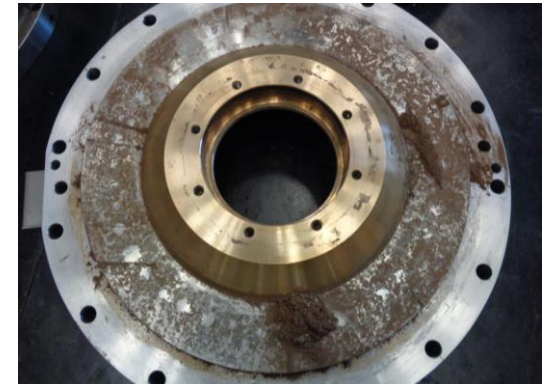
NORM as Ionising Radiation

- The isotopes present in NORM dust produce Alpha, Beta (and Gamma) radiation – known as ionising radiation
 - More energy than non-ionising radiation
 - Can cause damage to cells and DNA
- However, each radiation type has different characteristics:
 - Alpha particles can be stopped by paper, but are hazardous to a person's health if inhaled or ingested
 - Beta particles are stopped by metal or plastic and are hazardous if inhaled or ingested
 - Gamma rays must be shielded by lead and considered an external hazard to living tissue
- However, Gamma radiation from Lead 210 is low energy and not something considered to be a risk from NORM dust
 - To protect against the internal dose from NORM we must prevent ingestion and inhalation – prevent the spread of contamination



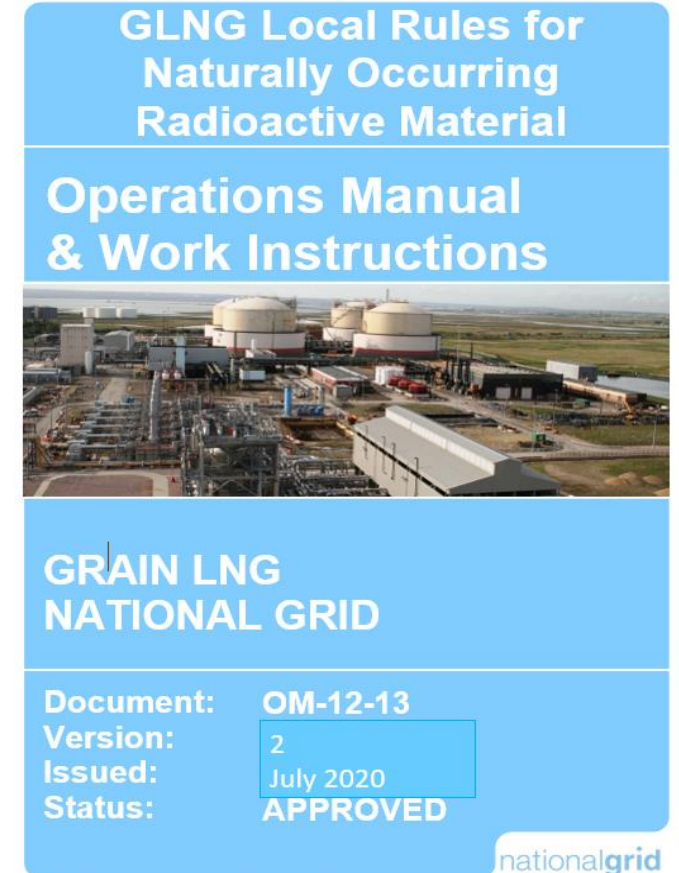
NORM at Grain LNG - History

- Historically, NORM was not considered a significant issue for Grain LNG
 - Protocol employed partially based on a National Grid Gas Transmission document
 - Dispensations as Grain LNG not an “accumulation site” and deemed low risk due to feedstock
- However, experiences shared in the LNG industry circa 2019 highlighted potential changes
 - Internal inspection of some assets at other terminals identified a black powder dust contamination
 - Information shared at an LNG forum
- This information initiated an investigation at Grain LNG
 - Dust from filters analysed and found to have NORM present
 - Expertise from wider National Grid called upon to provide guidance

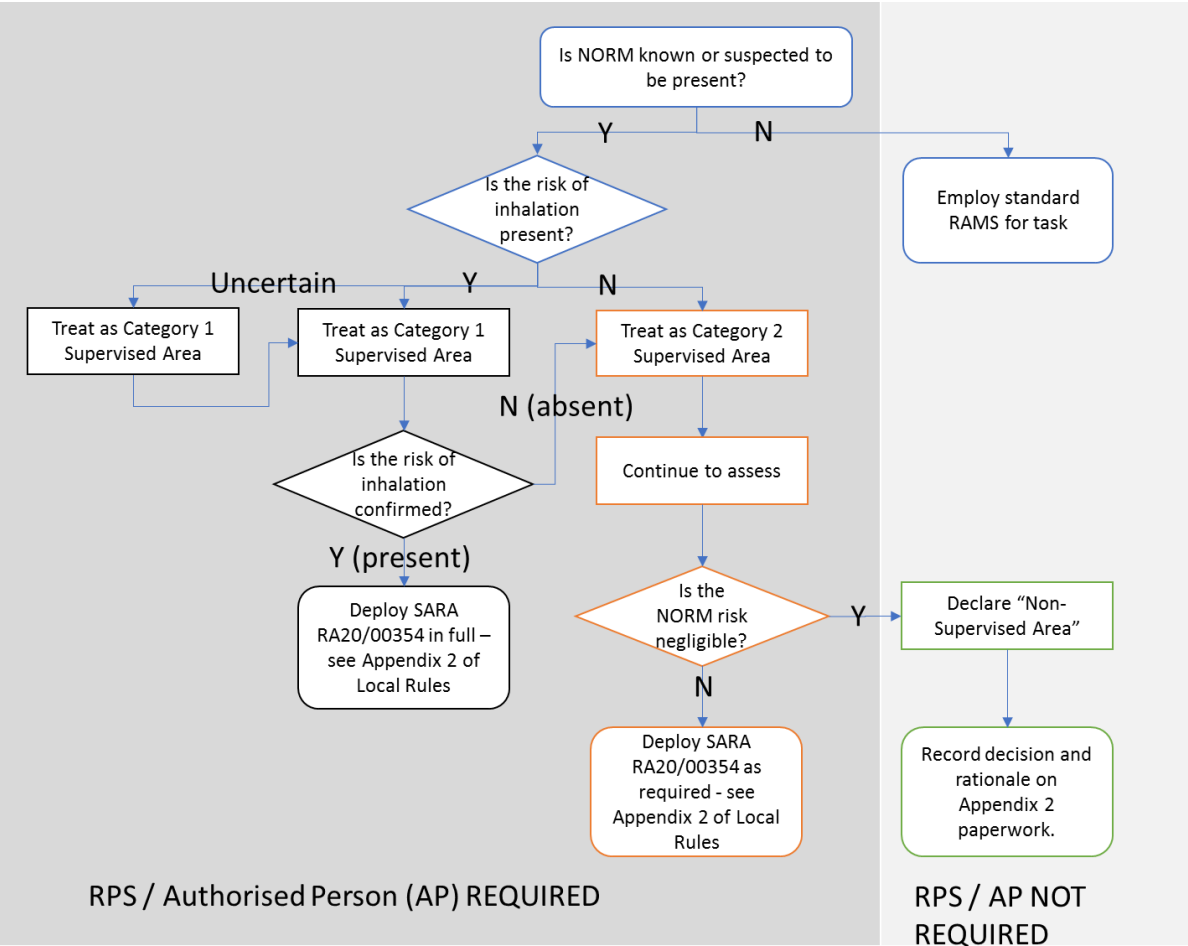


NORM at Grain LNG – Local Rules

- Grain LNG developed “Local Rules for NORM”
 - Defines roles and responsibilities
 - Introduced Radiation Protection Supervisors
 - Defines control measures
 - Specifically, around intrusive work and PPE
 - Defines “supervised and non-supervised areas” for areas of intrusive work
 - Supervised areas – where NORM is known or suspected to be present
 - Non-supervised areas – where NORM is known not to be present, or is deemed by an RPS to be of low risk
 - Splits supervised areas into two types
 - Cat 1: NORM may become airborne
 - Cat 2: NORM exposure only through contact
 - Controls defined for each
 - Sets out record keeping, management of waste etc
- Grain LNG reviewed the legislative requirements
 - Notified the Health and Safety Executive in accordance with the Ionising Industry Regulations
 - Applied for an Environmental Permit as an accumulator site



NORM at Grain LNG - Tools



NORM at Grain LNG – Supervised Areas



Category 1

- Dust (potentially airborne)
- Attendant Radiation Protection Supervisor
- Exclusion zone
- Containment of area
- Monitoring (pre and post)
- PPE including RPE
- Waste disposal

Category 2

- No dust
- Radiation Protection Supervisor to assess risk
- Monitoring (pre)
- Limited PPE to protect against contact



NORM at Grain LNG - Significance

Current background exposure:

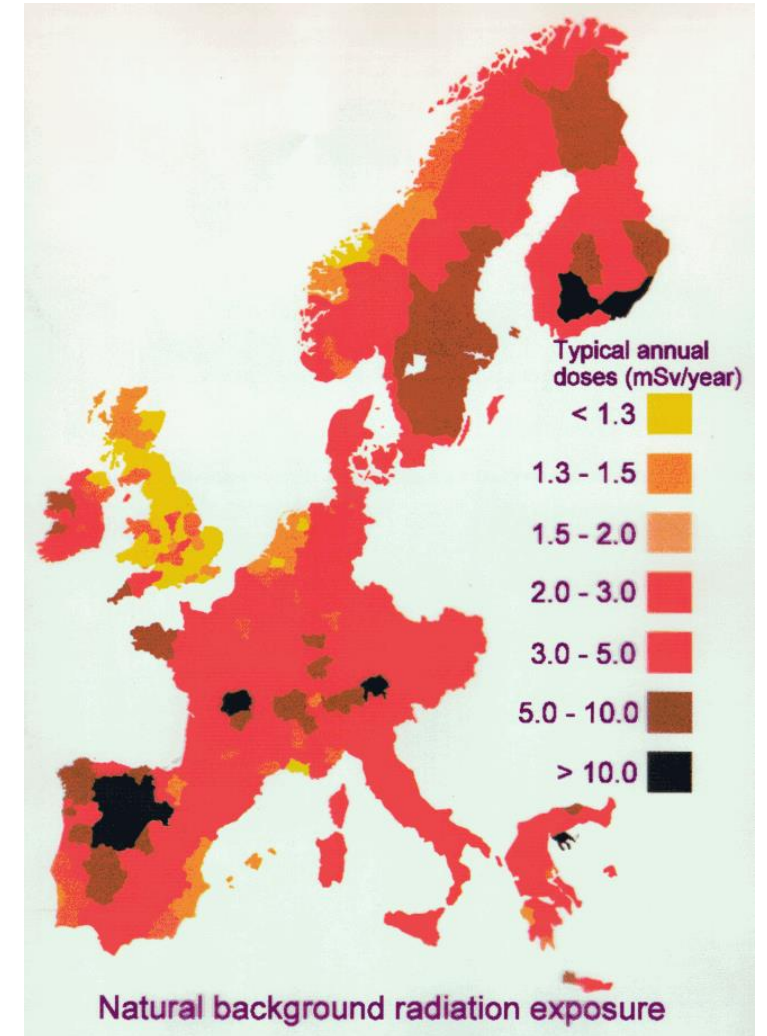
- Cosmic Radiation = 0.25mSv
- Radioactivity in food = 0.3mSv
- Gamma rays from ground / buildings = 0.35mSv
- Radon = 1.3 mSv (average)
- TOTAL = 2.2 mSv

Although:

- Average annual dose from radon exposure in Cornwall is 7.8mSv
- 100g of Brazil nuts = 0.01mSv
- Return flight to Australia = 0.25mSv

Inhalation of the dust found in GLNG assets would have to take place for over 75hrs p.a. before exceeding 1mSv* annual exposure.

**Ionising Radiation Regulations 2017*



Please get in touch if you have any questions.

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