Rio Tinto

ALARA learnings of the lost radioactive source in the West Australian outback

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European ALARA Network April 2025

The Incident(s)

- On the 12th December 2022, it was observed that the gauge's top plate had came off and the shielding material (with the source capsule intact within) had fallen out of the gauge outer housing
- In the process of falling the shutter mechanism lever and the source rod holder bolt had been sheared off with the top plate
- Regulatory authorities were informed and the gauge, shield and source safely moved to a radiation storage area
- An experienced and licenced firm were contracted to reassemble the gauge and package the gauge in an overpack for transport to Perth and this was performed on the 10-11 January 2023
- The gauge was transported from site to the contractors location in Perth over the period 12-15 January 2023
- On the 25th January the contractor informed the Regulatory Authorities and Rio Tinto that the gauge was damaged and the source was missing
- A very large scale media storm resulted

Public/Government/Media Attention

- The incident raised significant media attention with local, national and international press, TV and internet attention for a period of over a week
- Rio Tinto response was focused on openness and assistance (and taking full ownership)
- Government concern at all levels (council, State and Commonwealth)
- Strong government cooperation involving multiple agencies
- Although some public concern no incidents of panic or inappropriate responses

Prime minister slams 'ridiculously low' penalty for mishandling radioactive material

Rio Tinto apologises for losing radioactive capsule in Australia

A radioactive capsule is missing in Australia. It's tiny and potentially deadly

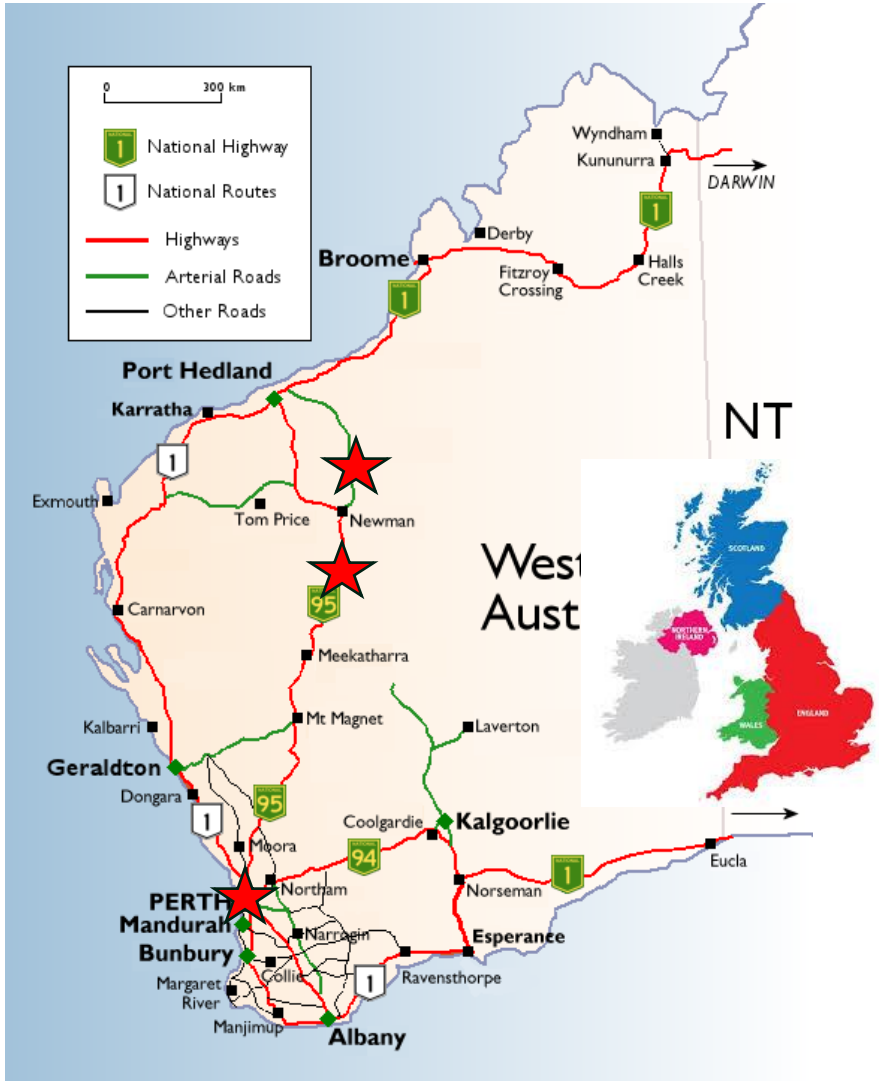
Three months, three missing radioactive items. Here's what you need to know

Radioactive capsule found in Australia could have been deadly with prolonged exposure, expert says

Call for review into disappearance of 'dangerous', tiny radioactive capsule in Western Australia

The Search

- Initial searching of major transport points such as mine site, loading area, transfer yards using a combination of industry and State resources
- Some targeted searching based on public information
- More specialised instrumentation and teams sourced from Commonwealth agencies (ANSTO, ARPANSA and Defence)
- Larger and more sensitive detectors enable the speed of search to be greatly increased with a higher probability of source location

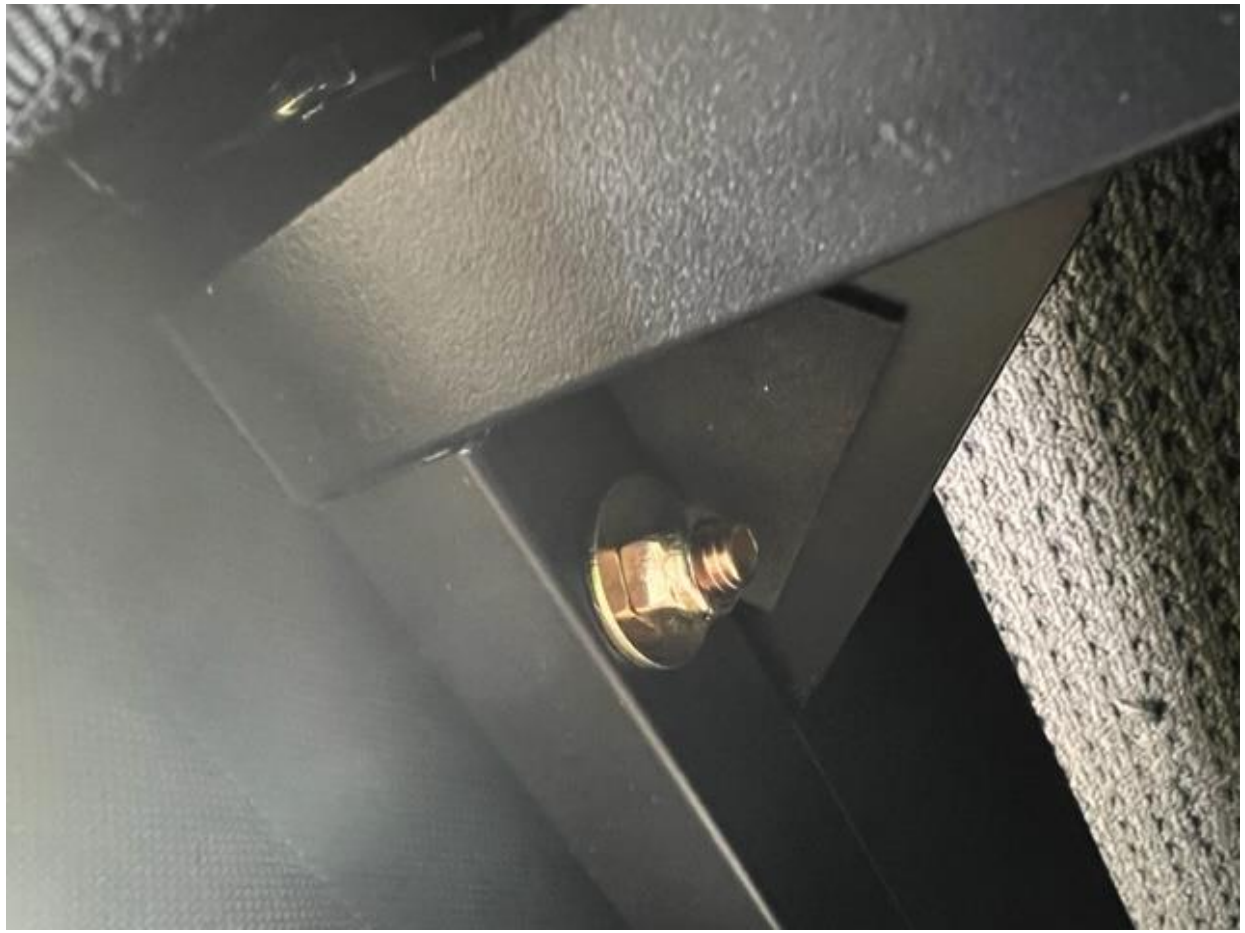


FOUND!!!!

- The lost source capsule was found approximately 2m off the edge of a road in a remote area of the Australian outback
- The gauge had only travelled approximately 160km from the point of origin before the capsule was lost
- The source capsule recovery represented a great result of State and Commonwealth government agencies
- The source capsule remained fully intact with no release of material from the double encapsulation
- Dose estimates confirm no individual received a radiological exposure even a small fraction of the public dose limit or even the levels from annual exposure to natural background radiation

Vibration!!!!!!

- Vibration is a well known potential cause of failure in mechanical components where screws or bolts are used
- Even common items which may be exposed to vibration are protected



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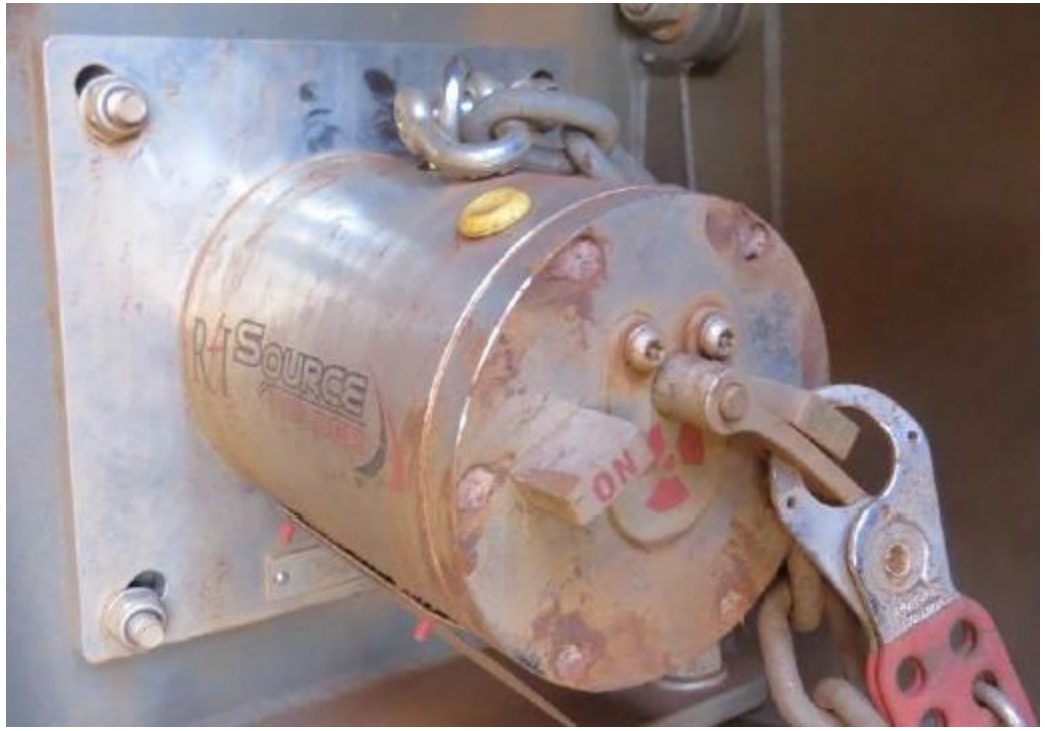
Old vs New – Progress is not always a good thing

- The “new” gauge designed moved from the historic cast construction to an engineered structure with the outer casing consisting of a cylinder attached to a front and back end plate
- The structure is supposedly held together by 12 M5*16mm bolts (6 at the front and six at the back)



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First Incident

- The top plate had totally separated from the rest of the housing. Bolts were NOT sheared off and appeared to have just come undone
- Shield housing still contained the source capsule and was found approximately 2m below

Second Incident

- The gauge basically shook itself into its component pieces in the overpack
- One of the two mounting bolts vibrated loose, enlarged its hole and left this enlarged hole as an overpack penetration, This allowed movement of the gauge within the overpack
- Even the locking bolt at the end of the source rod holder was unscrewed and missing

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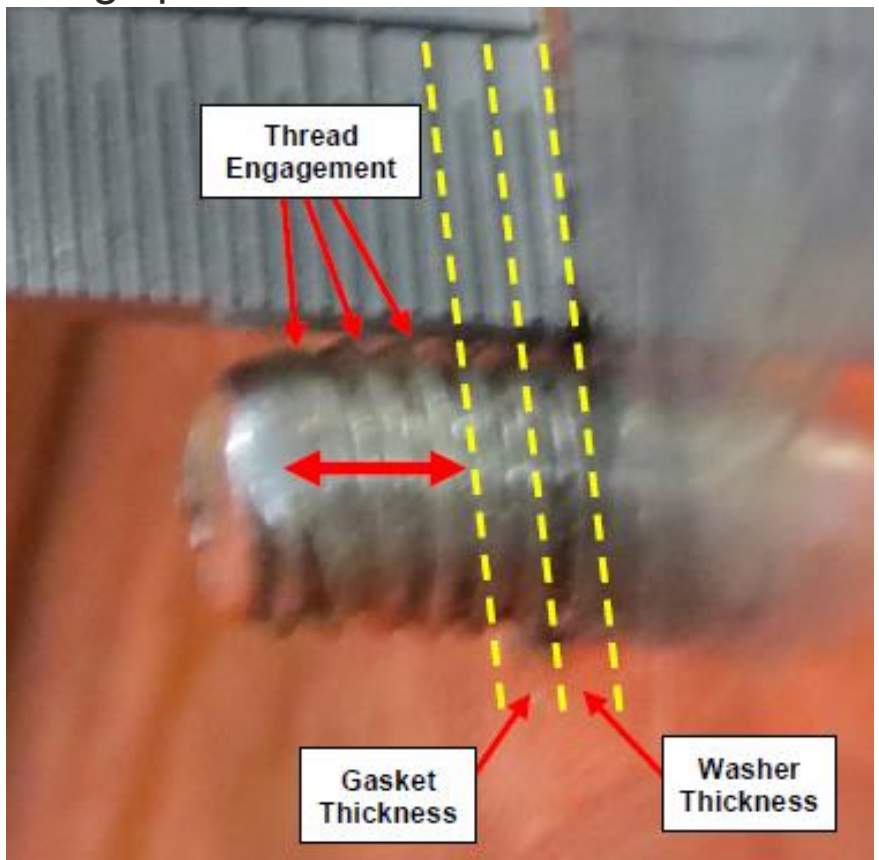
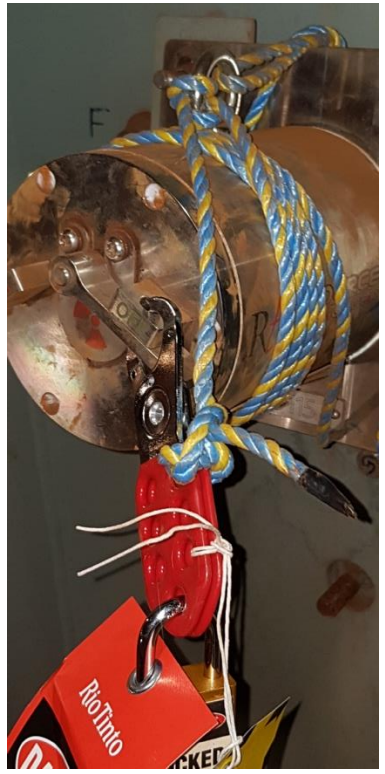
Bolts and attachment

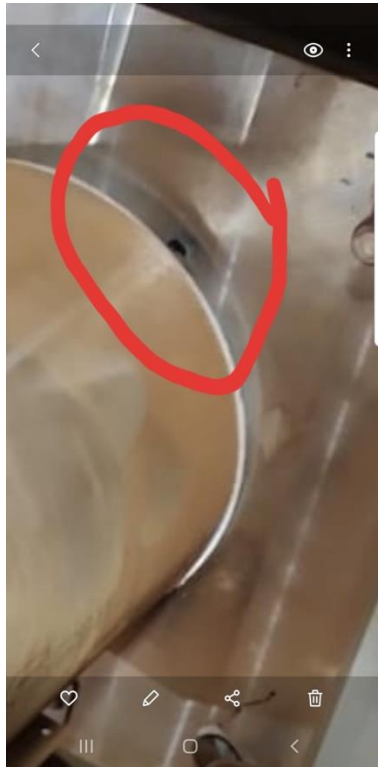
- Only one bolt remained attached for either the top or bottom plate and it was sheared off (a case of last man standing). Other bolts found show damaged threads
- The only design component for vibration was the use of spring washers (no nylon lock nut, Loctite, silicon filler, epoxy resin, etc.)
- Inconsistencies in size of bolt used (two manufacturing specification M5x20mm / M5x16mm and M5x10mm used in repair



Other gauges

- Rio Tinto had 5 gauges of the same design all purchased new (less than a year old) for the new plant and had only been is service less than six months
- All other gauges were inspected and taken out of service
- One gauges was two loose bolts from failing in a similar manner to the destroyed gauge





Gauge Designation and Testing

- The gauge was purchased on the basis that it was tested and approved
- As part of the investigation it was found that the gauge was incorrectly labelled as DG01 the “old gauge design
- The initial approval for the “new” gauge was for a DG02(L) gauge (the L indicates lead shielding)
- However, due to the source activity the gauge used tungsten allow as its shielding DG02(T)
- Due to the difference in density there would have to be a significant difference in weight (~6-8kg) based on density though the specifications do not reflect this
- Vibration testing unlikely to occur in worst case direction (either vertical or horizontal but not where weight of shield is in the plane of vibration)

Packaging

- Rio Tinto contracted a licensed and experienced form to reassemble the gauge and package it for transport
- The gauge was attached to the base of the overpack using two bolts (in a similar way to how new gauges are sent from the manufacturer. Vibration failure of one bolt would lead to significant motion of gauge in overpack
- No additional packaging or precautions were taken despite the gauge being previously damaged with the exception of some additional steel plates at the base (for additional shielding due to shutter being broken
- The overpack was placed at the rear of the rear trailer of a B Double truck

Reporting

- In the event of any incident involving damage to a gauge the regulatory authority must be informed (generally within 24 hours of discovery)
- There was a significant delay (16th – 25th January) between the delivery of the gauge to its destination at the contractors site and when the gauge was determined to be damaged and the source capsule missing
- This delay had the potential to substantially increase the potential public exposure and also increased the public concerns around the lost source capsule

ALARA lessons from the incident

- The lack of any significant dose to the public was due to good luck not good practice
- Potential occupational exposures were minimised due to the positioning of the package at a large distance from the driver (at the rear of a B-double truck so source to driver distance >10m)
- Actual public doses insignificant due to source lost in the middle of the outback
- Doses during search and recovery very low due to appropriate source discovery and recovery controls
- Industrial packages particularly for gauges need to consider vibration and have good QA/QC. *NEW* designs are not necessarily better
- If a industrial package suffers a failure than the original IP certification may need to be re-examined
- High potential dose if source had of fell out in a populated area
- The 10 day delay between package arrival and reporting (13 days from source loss) could have been critical for potential exposure
- If the transport or package is not routine then there should be a process of checking the arrival of the source not just the package (e.g. comparison of pre and post transport TI)

Conclusion

- The loss of a source capsule from an industrial radiation gauge is EXTREMELY unusual and the loss during transport is even more uncommon
- The loss of the source capsule in January 2023 created significant public, media and Government concern
- Due to excellent cooperation between State and Commonwealth agencies the source was found
- Radiological exposure to all individuals was extremely low and well below the public dose limit and the source encapsulation was intact ensuring no distribution of radioactivity to the environment
- Vibration was a major contributor to the failure of the gauge and allowed the source capsule to escape from the overpack during transport. Poor design and quality control did not give sufficient resistance to vibration
- There are deeper learnings for the regulations for radioactive transport and gauge design and manufacture
- Time delay between loss and reporting could have been critical for ALARA
- Rio Tinto has been investigated by the appropriate regulatory authority and deemed to have performed appropriately throughout the incident (no Breaches)