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UMEX :- An IAEA Survey of Global Uranium Mining and Processing Occupational Doses

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UMEX – The Idea

- For nuclear industry workers there are a number of databases of occupational doses at both international and national level (IAEA Information System on Occupational Exposure {ISOE})
- Similar systems are in place or being developed for medical exposures and industrial workers
- The Information System for Uranium Mining Exposures (UMEX) was designed to examine global occupational exposures in uranium mining and processing

UMEX – Objectives

- To develop an information system for occupational exposure in uranium mining and milling
- To obtain a global picture of the occupational radiation protection experiences in uranium mining and processing industry worldwide
- To identify leading practices and opportunities and to derive actions to be implemented for assisting in optimising radiation protection
- The UMEX project commenced in 2012

UMEX – The Design - Requirements

- Important requirements and information to collect:
  - capture as many of the uranium workers as possible across a wide number of jurisdictions
  - need to know the type of operation and nature of the work being performed
  - Need to understand the key assumptions used to monitor and calculate exposure and dose
  - Collect dose information based on individual pathways
  - Ideally wish to know the underlying dose distribution
  - Record primary control mechanisms to optimise dose

UMEX – The Design – Current Systems

- Current System of uranium mining doses:
  - Some countries have central dose registers
  - Some mines regulated at local (State, Region, Province)
  - Dose data may be held by multiple bodies (mine, State regulator, national database) across different jurisdictions
  - High variability in how doses are monitored and calculated
  - High variability in how workers are classified

UMEX – The Design
- Limitations and Solutions

- PRIVACY – A critical limitation so only amalgamated information received to prevent with no personal identifiers
- EASE of USE – To enable the widest possible response needed to make the data entry easy and quick (otherwise it would not happen)
- Multiple Dose Databases – Used national regulator to determine which is and use the official dose register
- Variability – Combination of drop down menus, information tabs and free form fields to structure data entry
- Different Dose Methodologies – Capture as much information about monitoring and dose calculation methodologies

UMEX – The Design - The Questionnaire

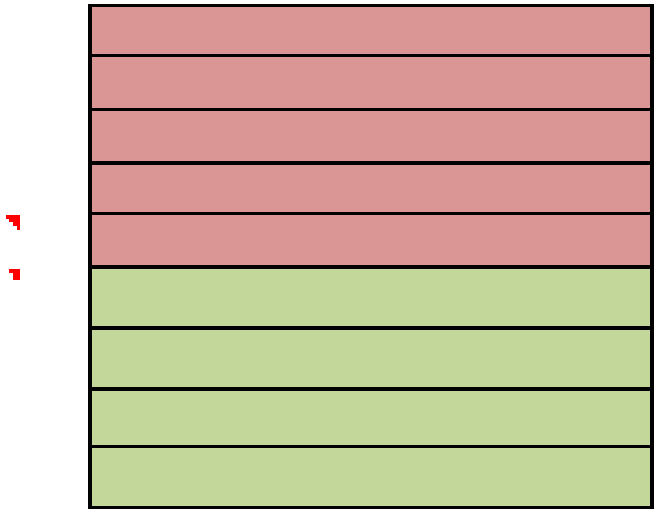
- The final questionnaire developed was EXCEL based (to ease data merging and structure data entry) and covered the following key areas:
  - Background information
  - Operation information
  - Monitoring approach
  - Dose calculation
  - Radiation controls
  - Auxiliary controls
  - Workgroup dose data

UMEX- The Questionnaire - Background Information

- Basic information about the operation to allow communication and further information
- Note that purple is required information and green is optional information

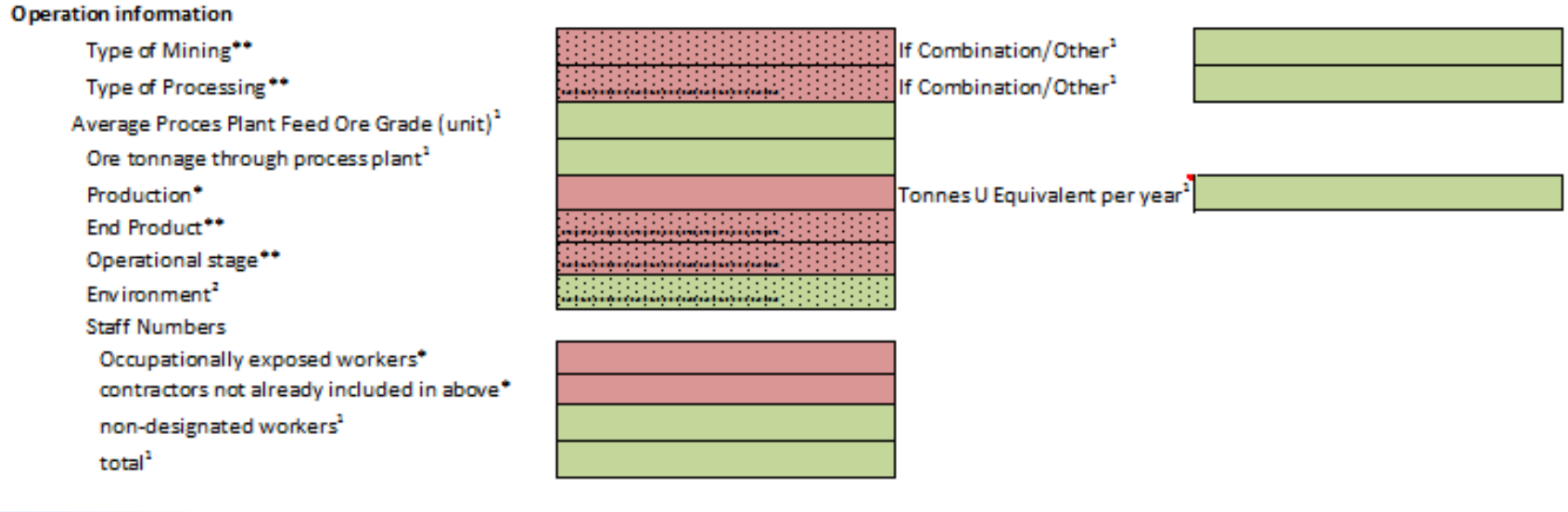
Background Information

Country*
State*
Operation*
Address*
Contact Details*
Person completing[1]
Position[1]
Email contact[1]
Phone contact[1]



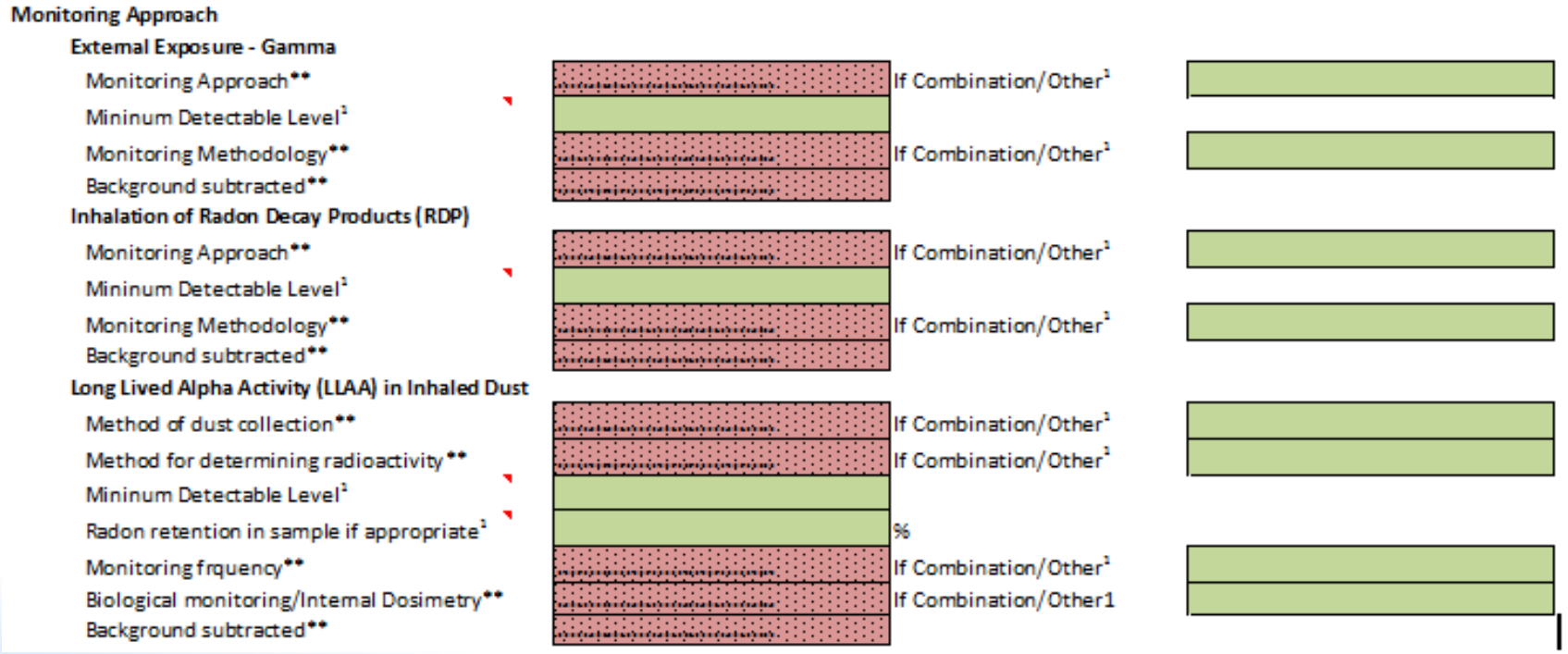
UMEX- The Questionnaire - Operation Information

- The key design aspects of the operation such as open cut or underground and processing methodology, production and staff numbers



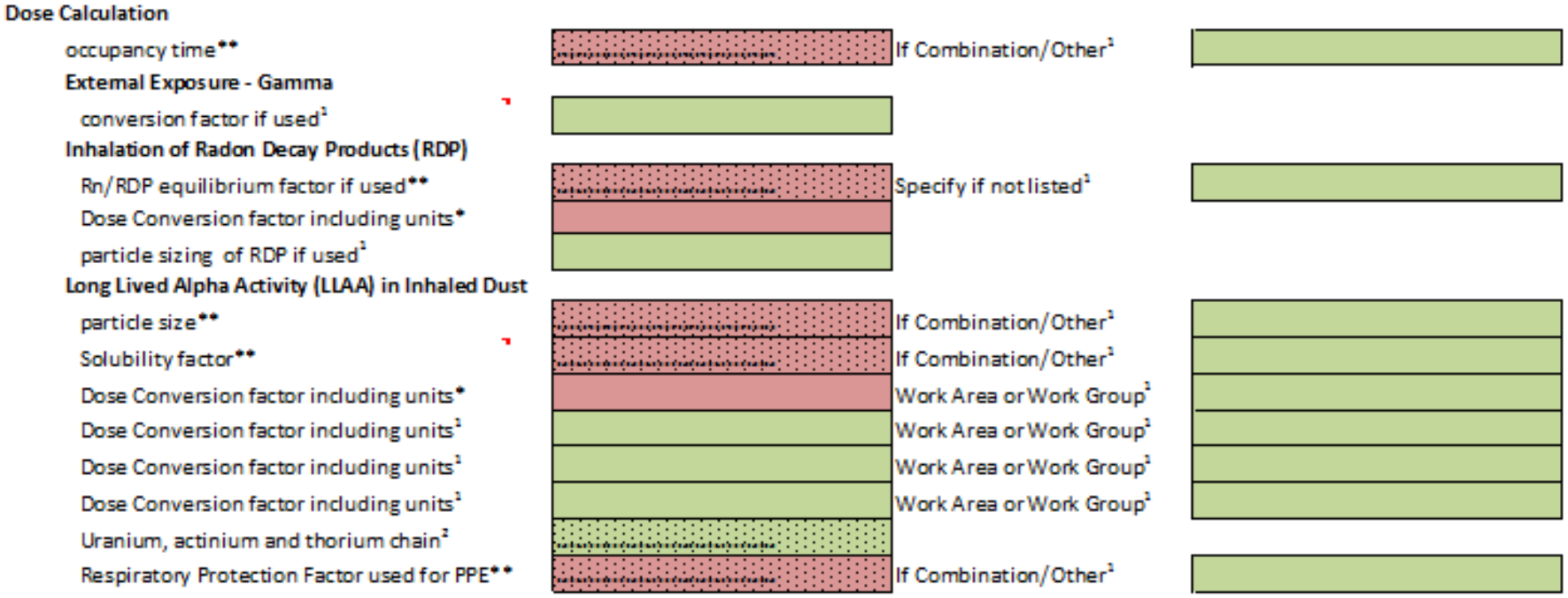
UMEX- The Questionnaire - Monitoring Approach

- Details about the monitoring by exposure pathway and whether background is subtracted



UMEX- The Questionnaire - Dose Calculation

- Details about the key aspects of dose calculation including conversion factors and use of key assumptions such as particle sizing and use of respiratory protection factors



UMEX- The Questionnaire - Radiation Controls

- Radiation controls include a wide range of free form information to try and capture the principal radiation
- Organised by pathway and mining or processing
- Includes any special control with would be in place during an incident
- Drop down menus have a range of common control mechanisms

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Radiation Controls

External Exposure - Gamma

Mining controls (select major controls)**
Details[1]
Details[1]
Details[1]
Details[1]

Processing controls (select major controls)**
Details[1]
Details[1]
Details[1]
Details[1]

Inhalation of Radon Decay Products (RDP)

Mining controls (select major controls)**
Details[1]
Details[1]
Details[1]
Details[1]

Processing controls (select major controls)**
Details[1]
Details[1]
Details[1]
Details[1]

Long Lived Alpha Activity (LLAA) in Inhaled Dust

Mining controls (select major controls)**
Details[1]
Details[1]
Details[1]
Details[1]

Processing controls (select major controls)**
Details[1]
Details[1]
Details[1]
Details[1]

Special Controls in the Event of an Incident

Mining controls (select major controls)**
Details[1]
Details[1]
Details[1]
Details[1]

Processing controls (select major controls)**
Details[1]
Details[1]
Details[1]
Details[1]

UMEX- The Questionnaire - Auxiliary Controls

- General administrative controls for radiation safety

Auxillary Controls

- Radiation induction[1]
- Radiation Training[1]
- Designated vs non-designated[1]
- supervised and controlled areas[1]
- Contamination controls[1]
- QA systems[1]
- Record keeping[1]
- Radiation Staffing[1]
- Restricted release Zones[1]

UMEX- The Questionnaire - Workgroup Dose Data

- Workers divided into workgroups (freeform) under defined work categories and the number of personnel recorded
- For each workgroup average, maximum and conversion factor is given for each pathway and total
- Where possible the standard deviation, assumed distribution and basis for the conversion factor is requested
- The number of personnel in each 0.5mSv/y bracket is also requested to enable a dose histogram to be developed

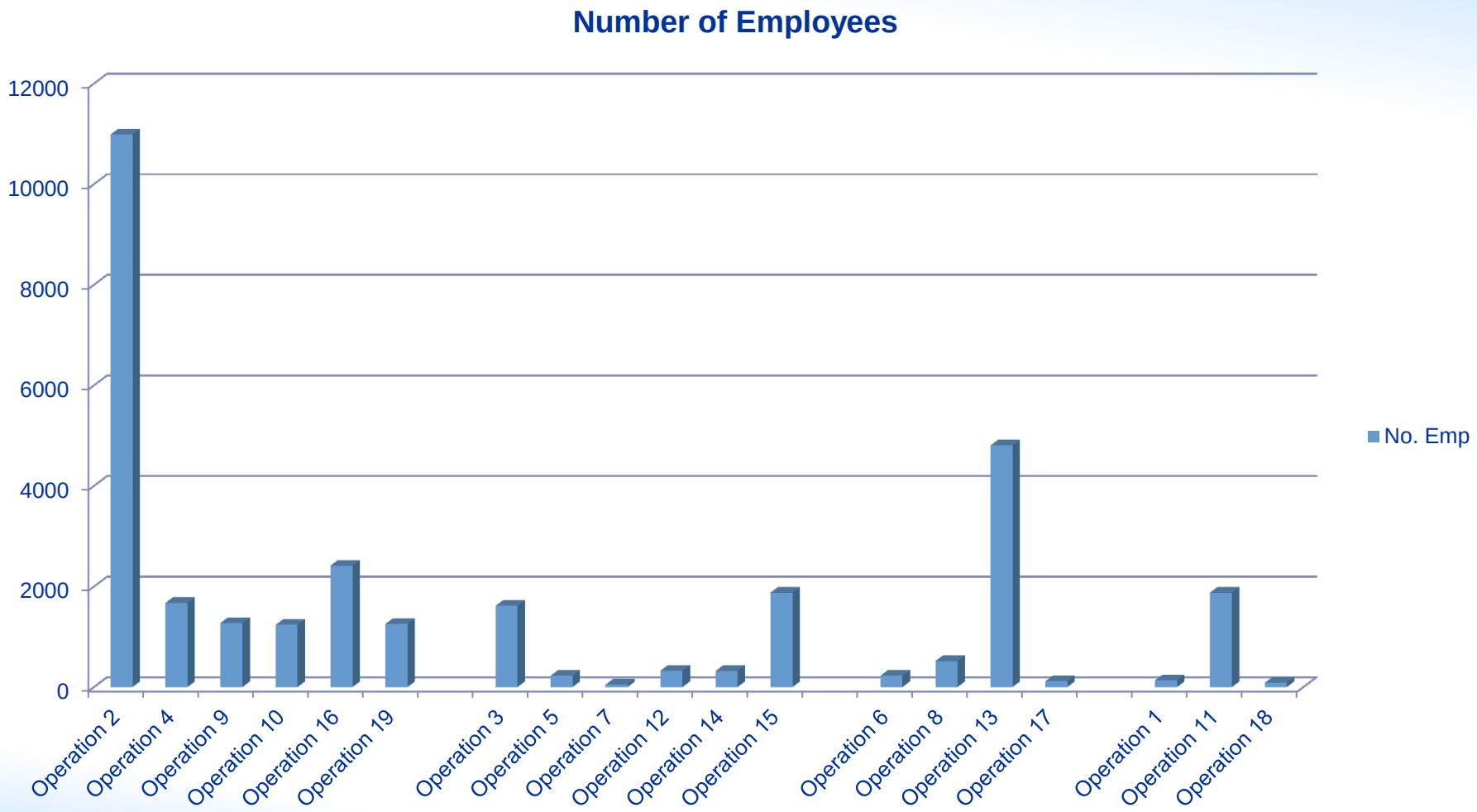
UMEX – The Response

- The survey provided a snapshot of the doses in the 2012 calendar year
- Occupational data from 36 operating facilities were received
- This covered a production of 58 344t of uranium or approximately 85% of global uranium production
- Amalgamated dose data was received from in excess of 30000 workers

UMEX – The Response

- The data received covered open cut mines, underground mines, in situ leach mines, toll processing operations and by-product recovery
- Data on 15 Individual operations using similar mining and processing techniques were amalgamated and reported as a single operation

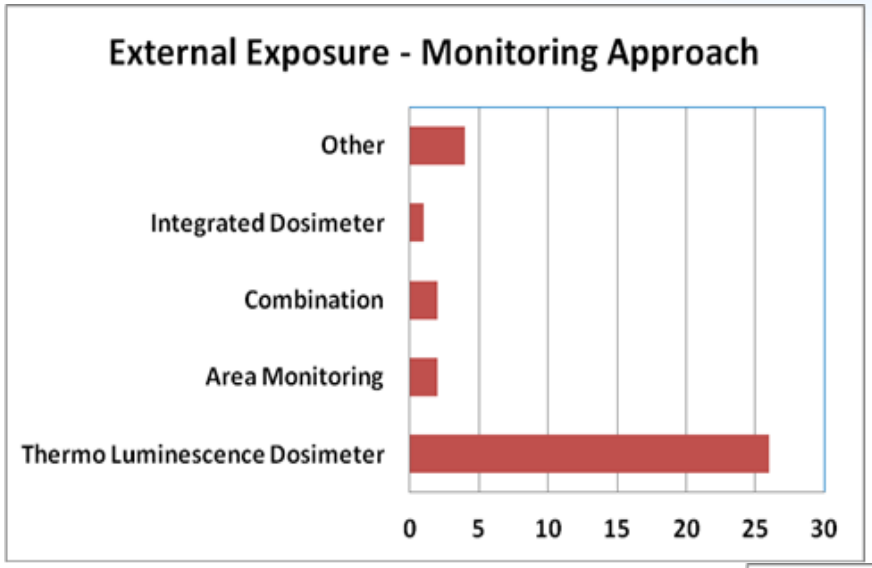
Number of Employees per Operation

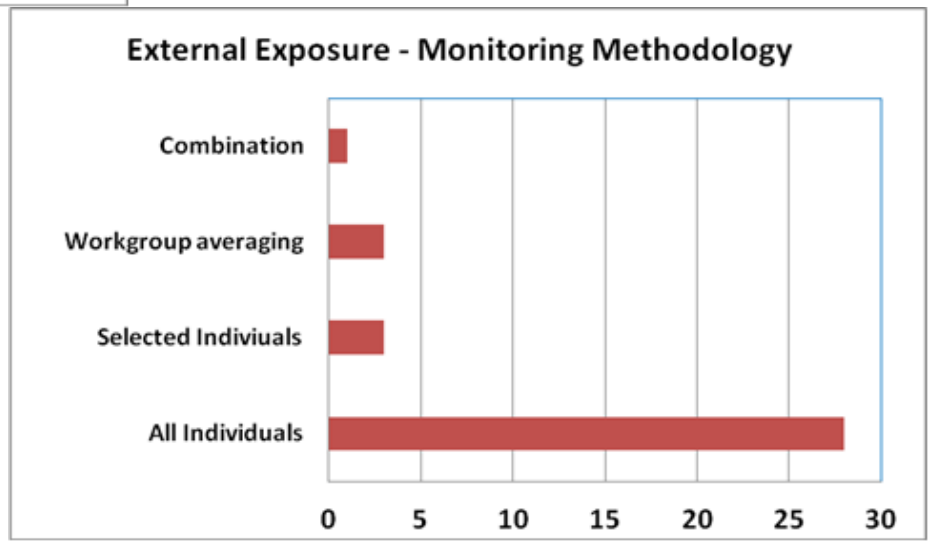


UMEX – The Results

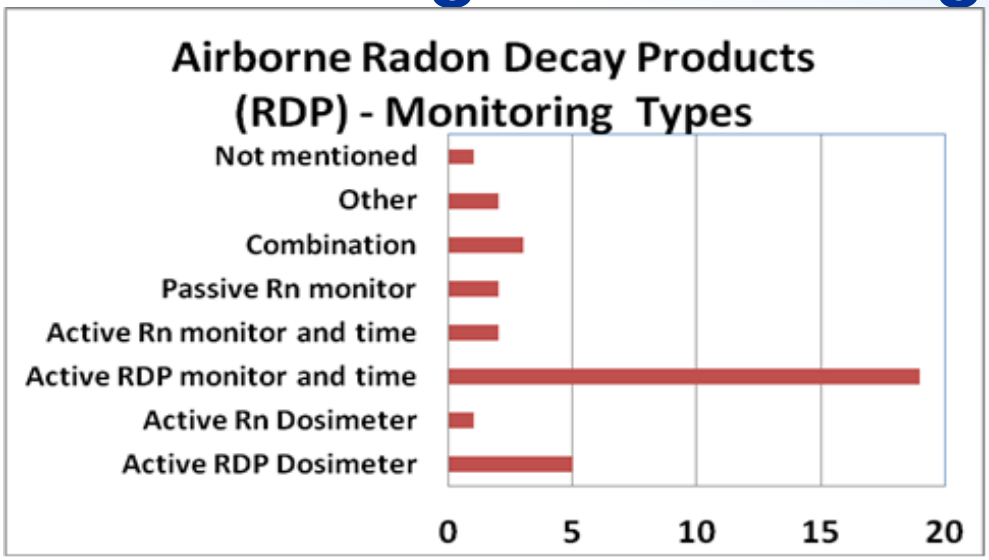
- The Characterise a industry where occupational exposures are well controlled and doses remain within applicable limits
- Average doses were typically less 5mSv/y and the maximum individual dose was 16.5mSv/y
- Majority of doses to personnel below 2mSv/y

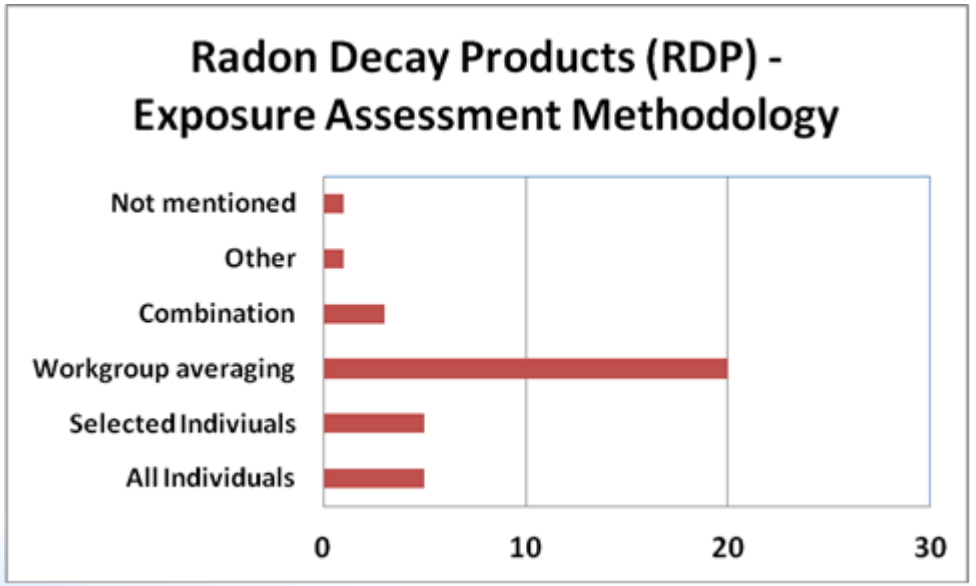
External Exposure Monitoring Methodology



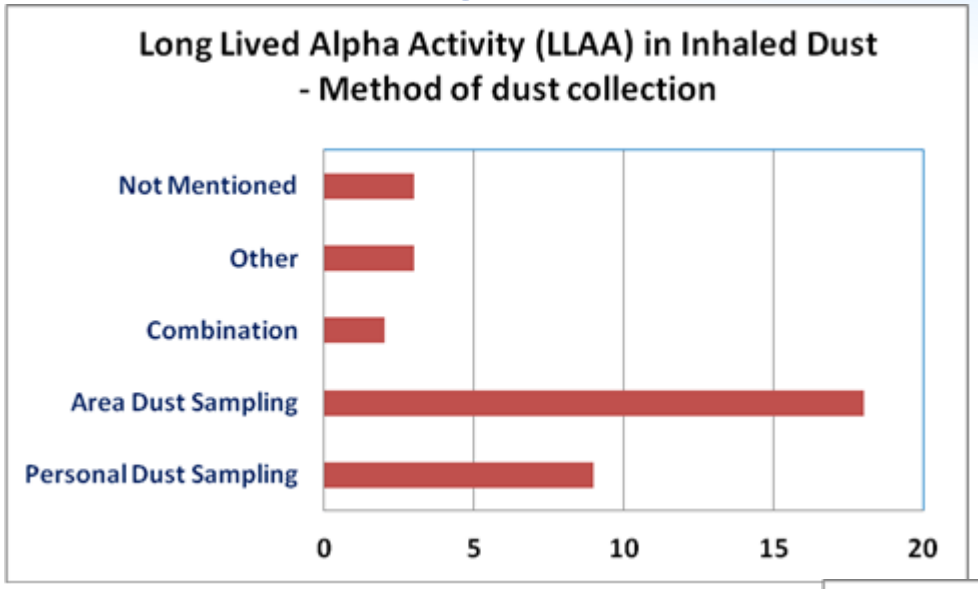


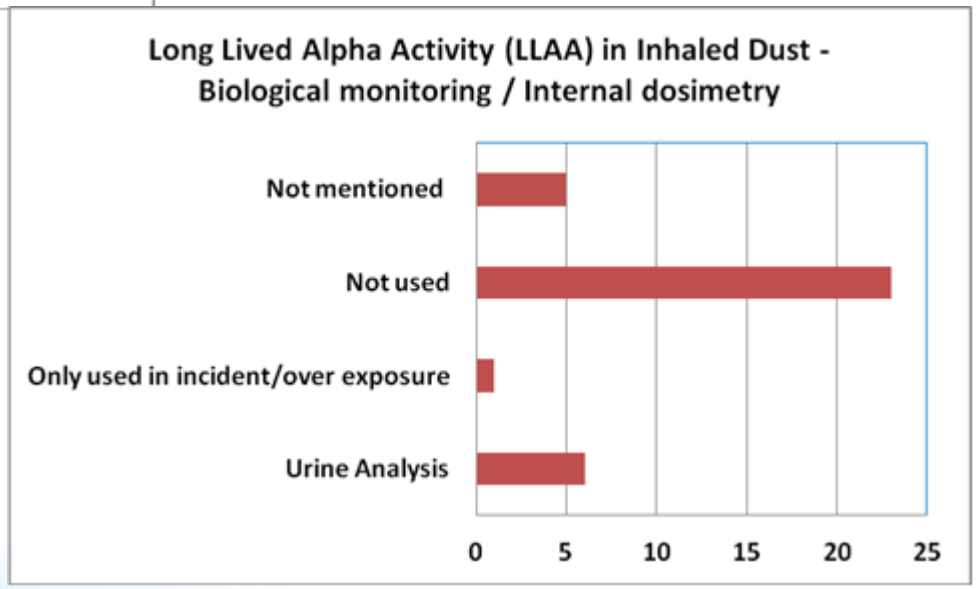
Radon Decay Product Monitoring Methodology



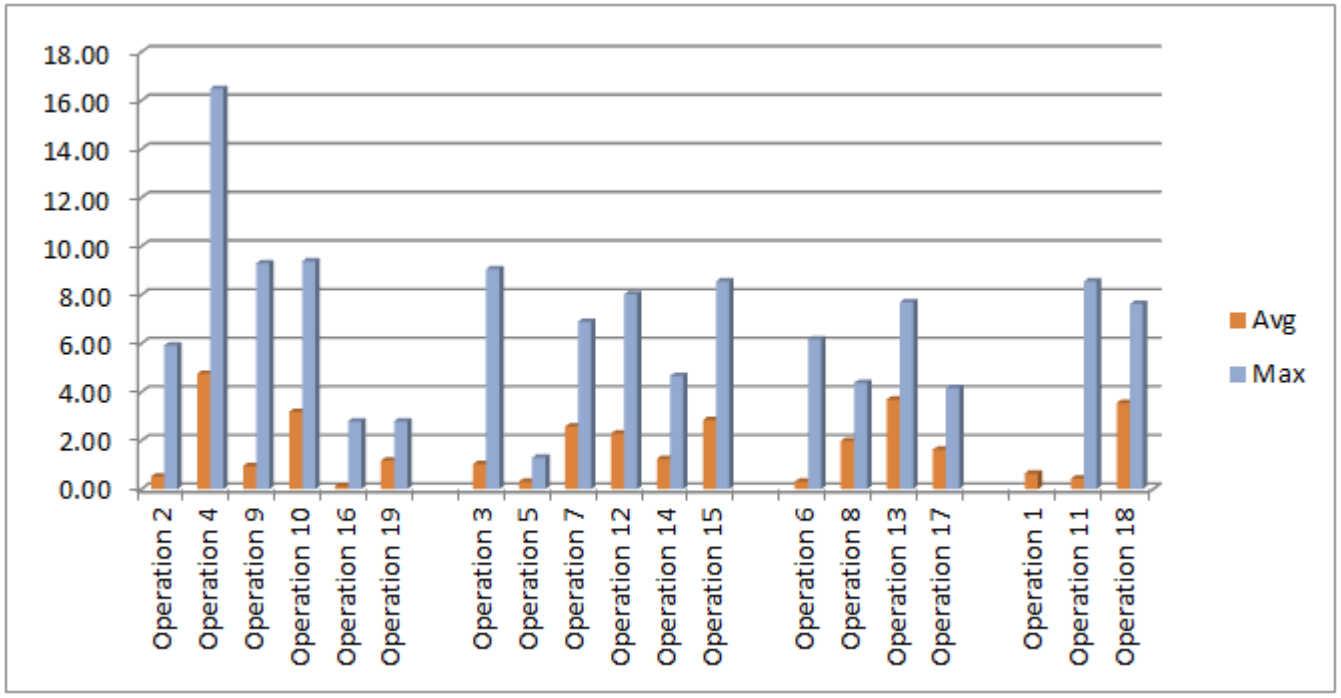


Inhaled Dust Monitoring Methodology

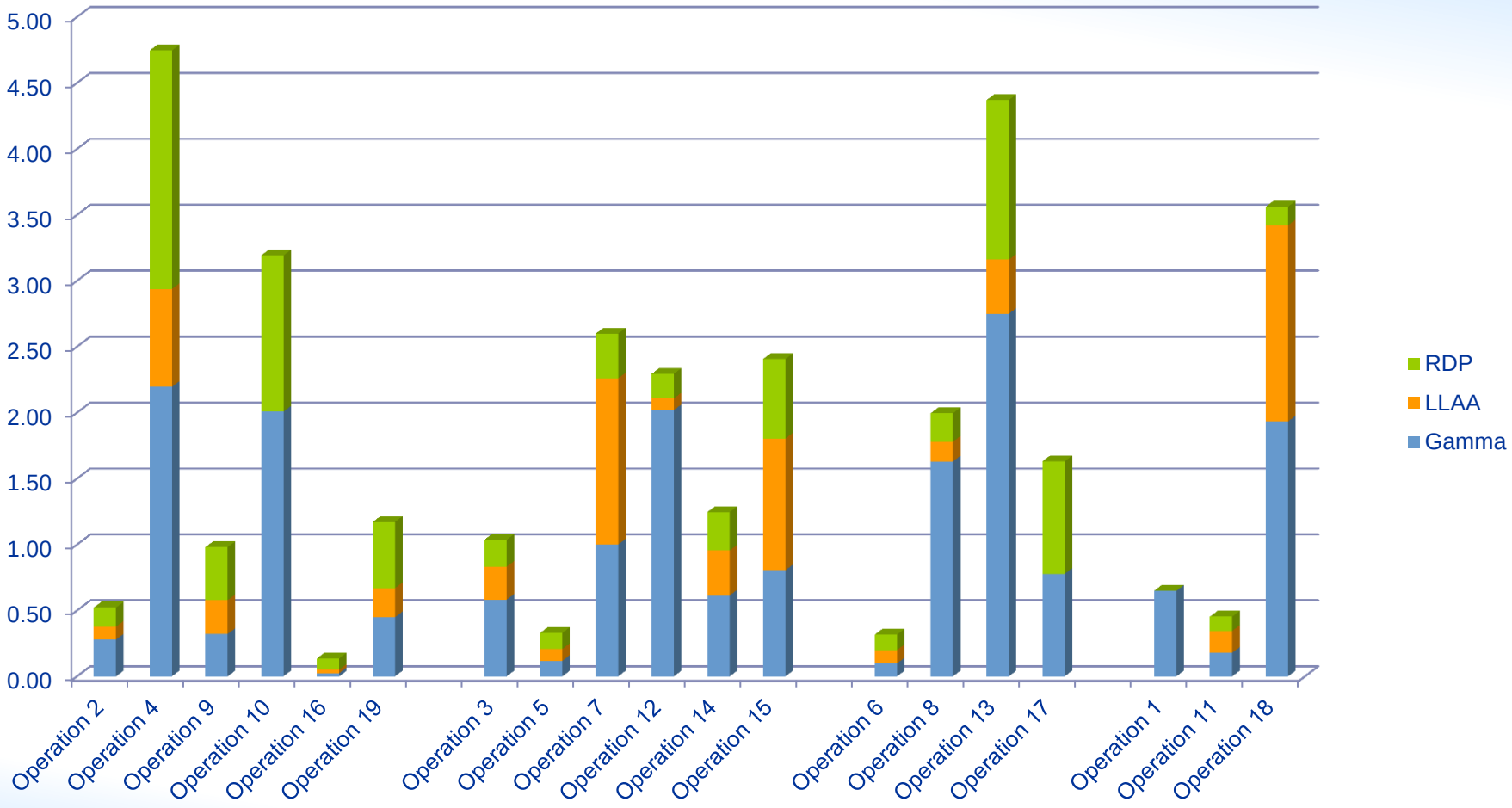




Average and Maximum Doses by Operation



Breakdown of Average Doses by Pathway and Operation



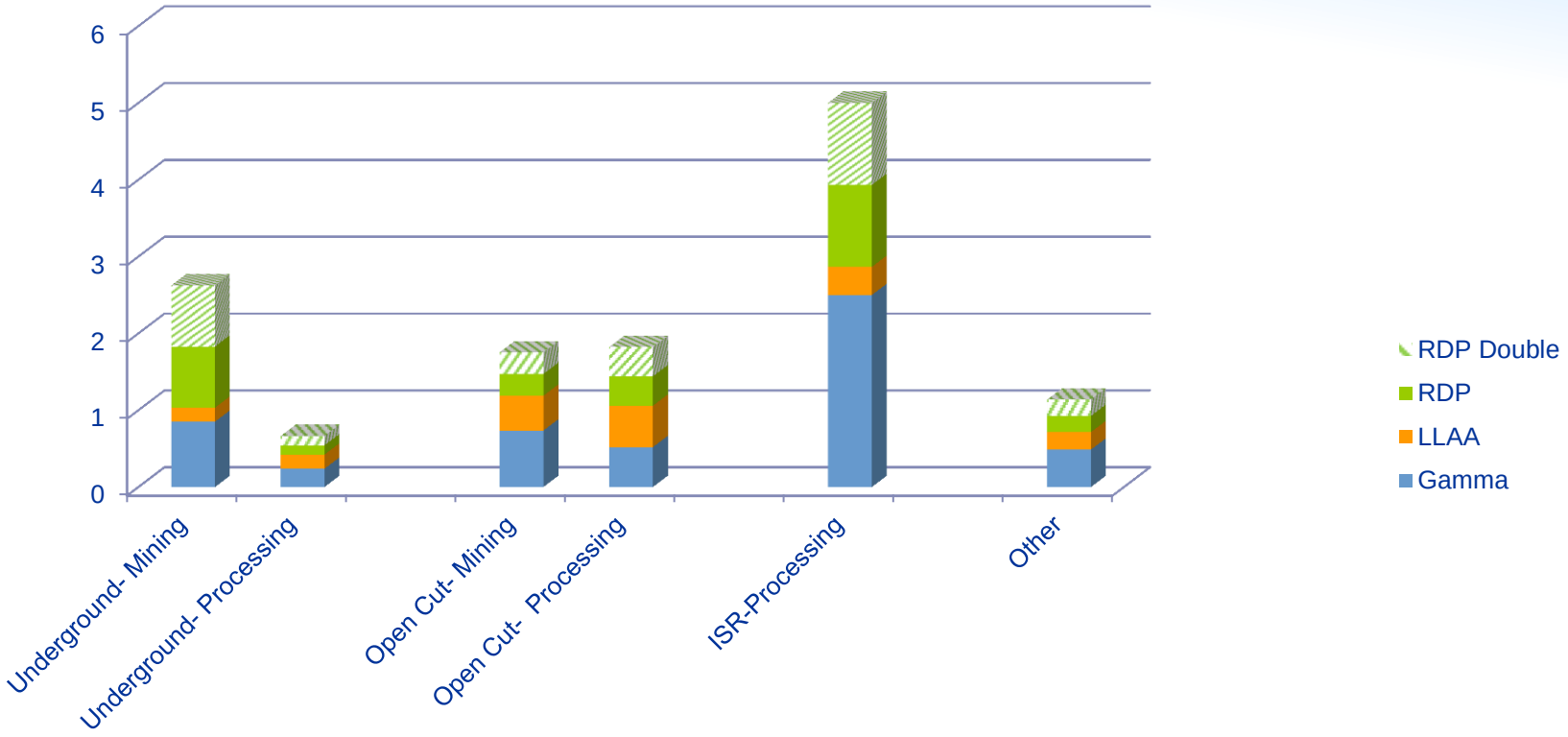
UMEX – Observations and Learnings

- Potential Changes in Radon (Decay Products) Dose Conversion Factors
- High Dose and Corrective Actions
- Background Subtraction
- Different Dose Distributions

Potential Changes in Radon Dose Conversion Factors

- ICRP are currently recommending a change in the DCG for radon and radon decay products
- Likely to be a factor of 2.4 higher (TBC)
- The UMEX data allows determination of potential impacts on the uranium mining industry

Potential Changes in Radon Dose Conversion Factors



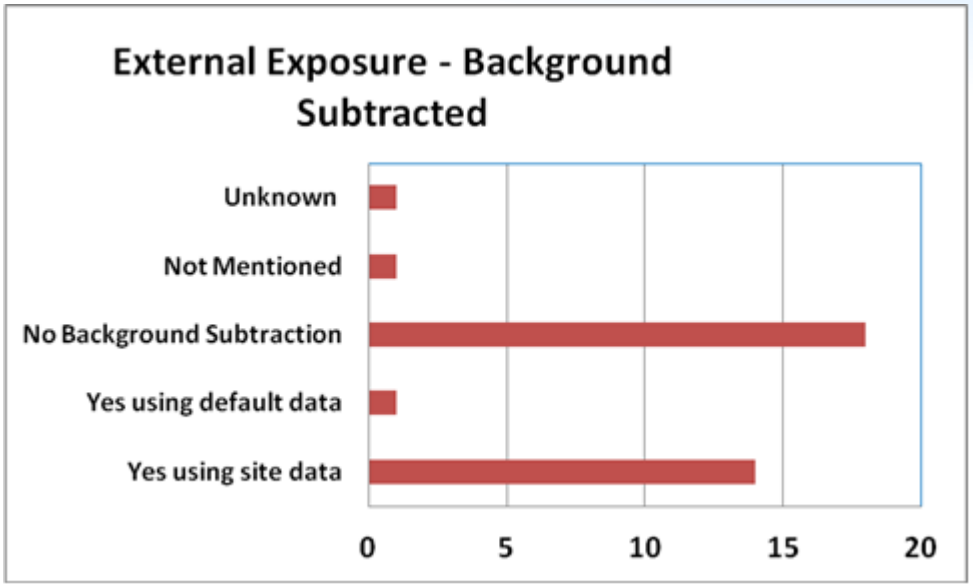
High Dose and Corrective Actions

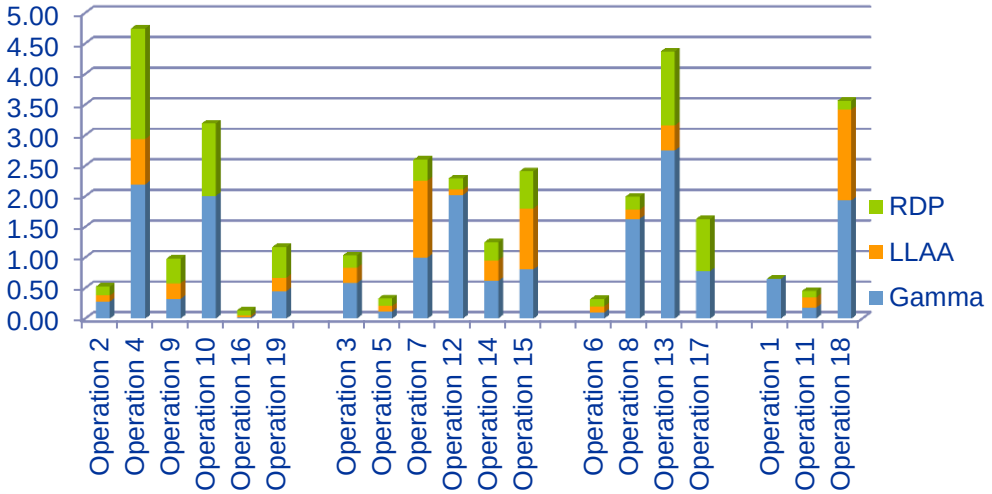
- In the initial survey results one operation recorded a maximum dose of 31mSv/y
- Examination of the data showed 30mSv was from gamma exposure
- The UMEX team believed the dose was incorrect and subsequent investigation by the regulator and operator confirmed that the data was both suspect and impossible for the individual to have received
- The individuals doses was corrected to reflect the workgroup average for gamma by the regulator

Background Dose Subtraction

- For gamma exposure the majority of operations used TLD's (or equivalent)but a high proportion did not subtract background
- This was particularly apparent in the ISL mines where gamma was by far the dominant pathway
- By not subtracting background the operational derived worker dose was likely over-estimated by between 0.5 and 1 mSv/y
- Recommendations on appropriate methodology for the use of control and traveller badges were provided to assist in removing the natural background component

Background Dose Subtraction



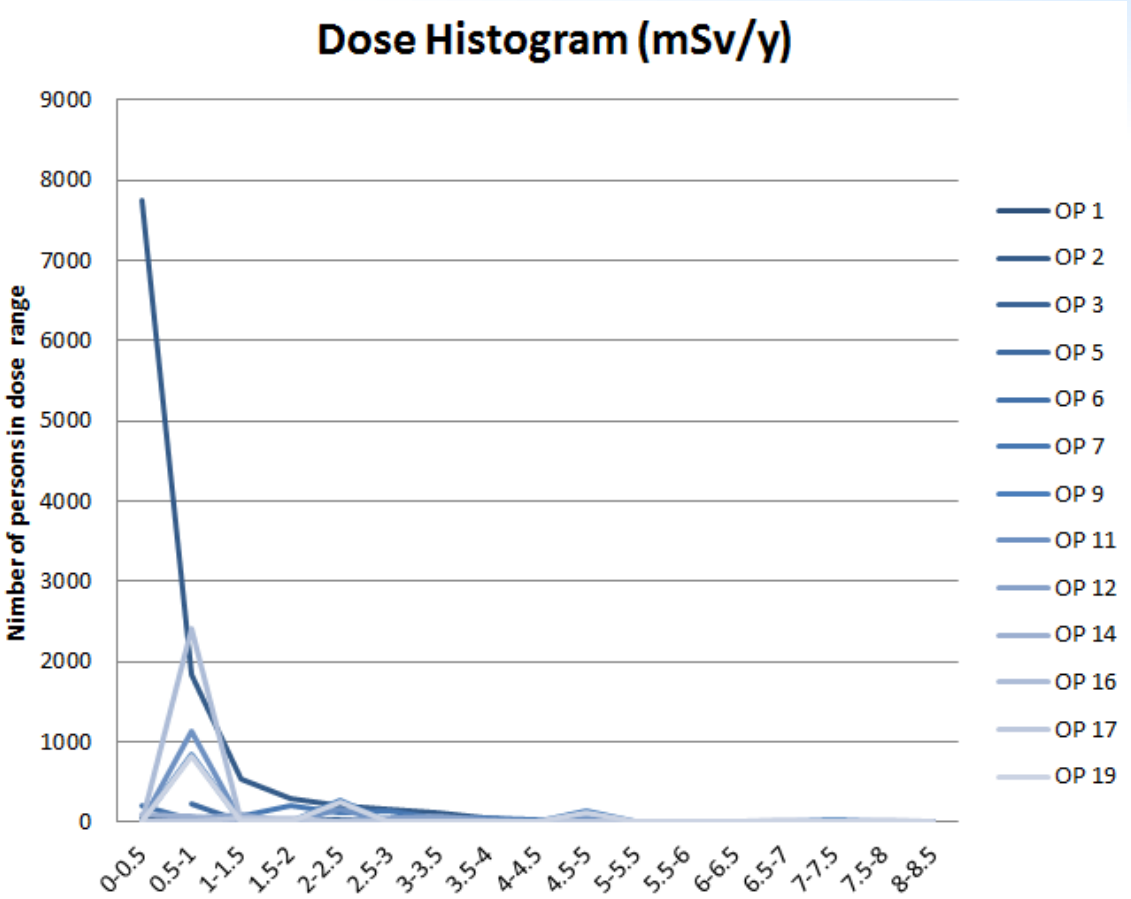


Different Dose Distributions

- Distributions of doses heavily influenced by the choice of workgroup and who is included
- This distribution variability raises questions about the use of normal statistical methods for interpreting doses
- Also may call into question the use of average dose and how workgroups are defined

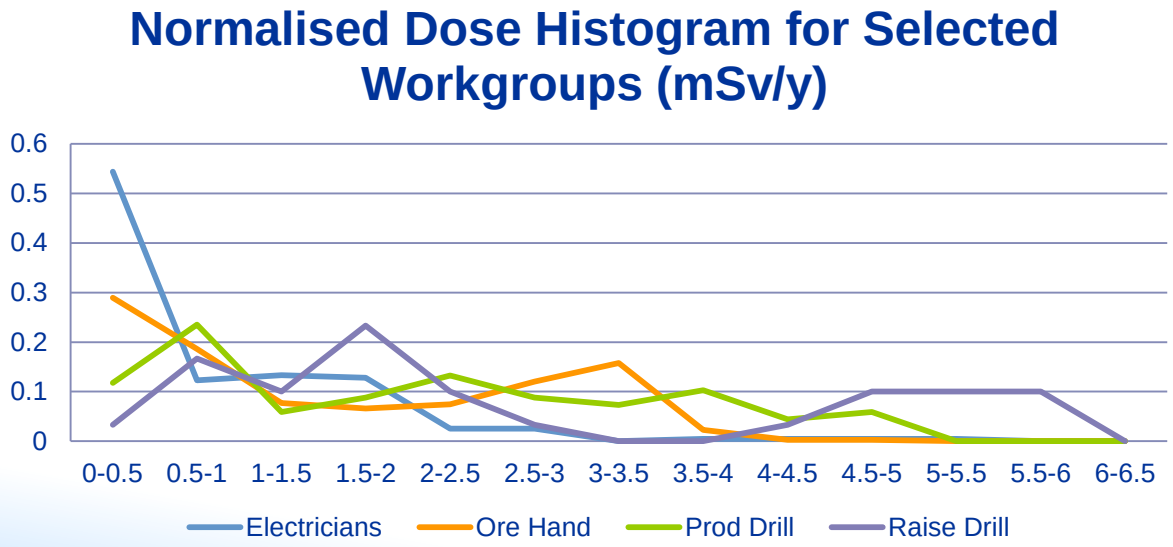
Lots of (non) Radiation Workers

- Some operations have a high majority of workers in the 0-0.5 mSv/y range
- Are these true radiation workers or are they made up of people not exposed to uranium or short term workers
- In one operation this was very apparent and the regulator and operator are currently addressing this



Multiple Distributions in a Workgroup

- A workgroup is expected to be homogeneous with similar exposures
- Often see multiple clumps of doses
- Likely to be people with different work practices (supervisor vs face worker)



UMEX – Next Stages

- The report on UMEX is planned to be incorporated in a Safety Report on Occupational Radiation Protection in the Uranium Mining and Processing Industry
- May be potential to renew the data into the future to look at time trends in doses within the uranium industry

Conclusion

- The UMEX provided a snapshot of occupational doses in the uranium industry
- The response covered approximately 85% of global uranium production
- The doses show compliance with international recommendations and represent good practice globally
- The importance of the data collected was high and there were a number of improvement approaches identified upon analysing the data
- The findings of the project will be incorporated in the upcoming IAEA Safety Report

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Thank you!