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

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Purpose of Talk

- Linked with the presentation on Safety Report On Occupational Radiation Protection in the Mining and Processing of Uranium (SR-100)

To outline:

- Introduction & assessment of findings of the Survey of Global Uranium Mining and Processing Occupational Doses

IAEA ORPNET

UMEX – The Idea

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

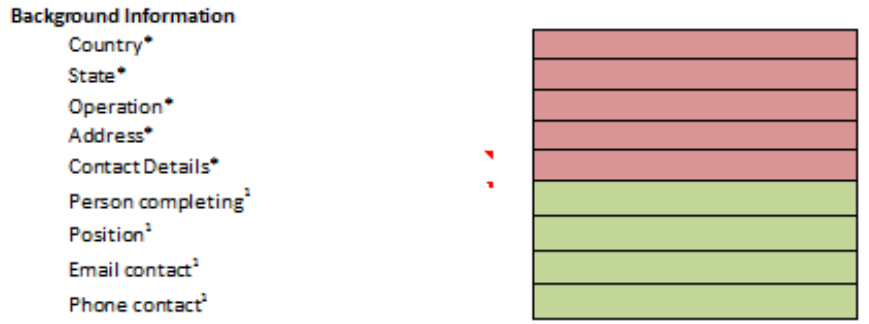
UMEX – Requirements

- 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
- 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 Questionnaire

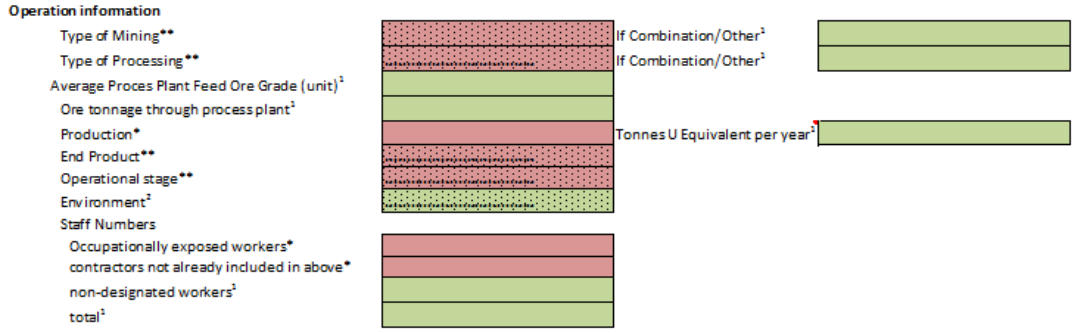
- The final questionnaire developed was EXCEL based (to ease data merging and structure data entry) and covered the following key areas:

  - **Background information**
  - **Operation information**
  - **Monitoring approach**
  - **Dose calculation**
  - **Radiation controls**
  - **Auxiliary controls**
  - **Workgroup dose data**

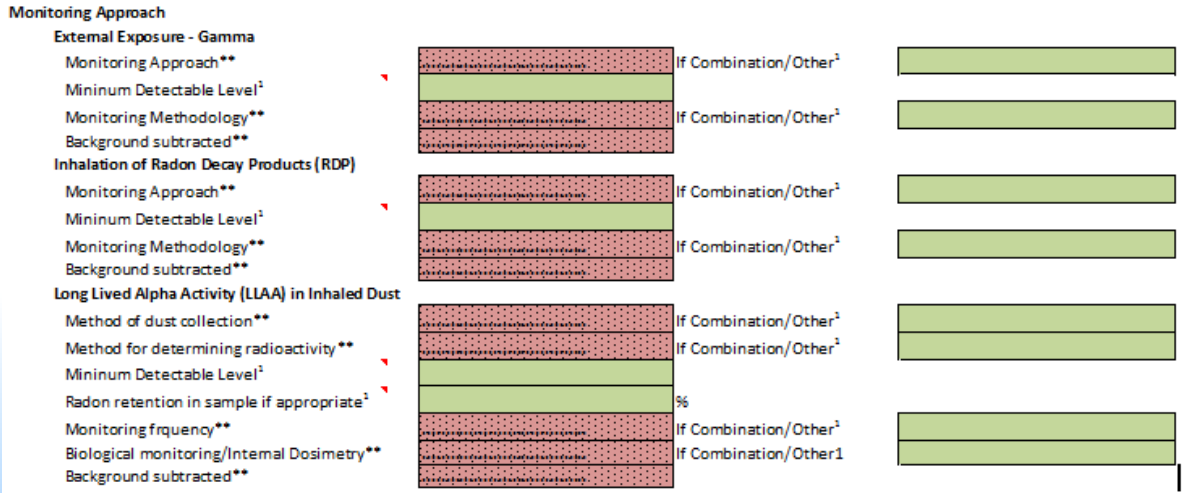


UMEX- Operation & Monitoring

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

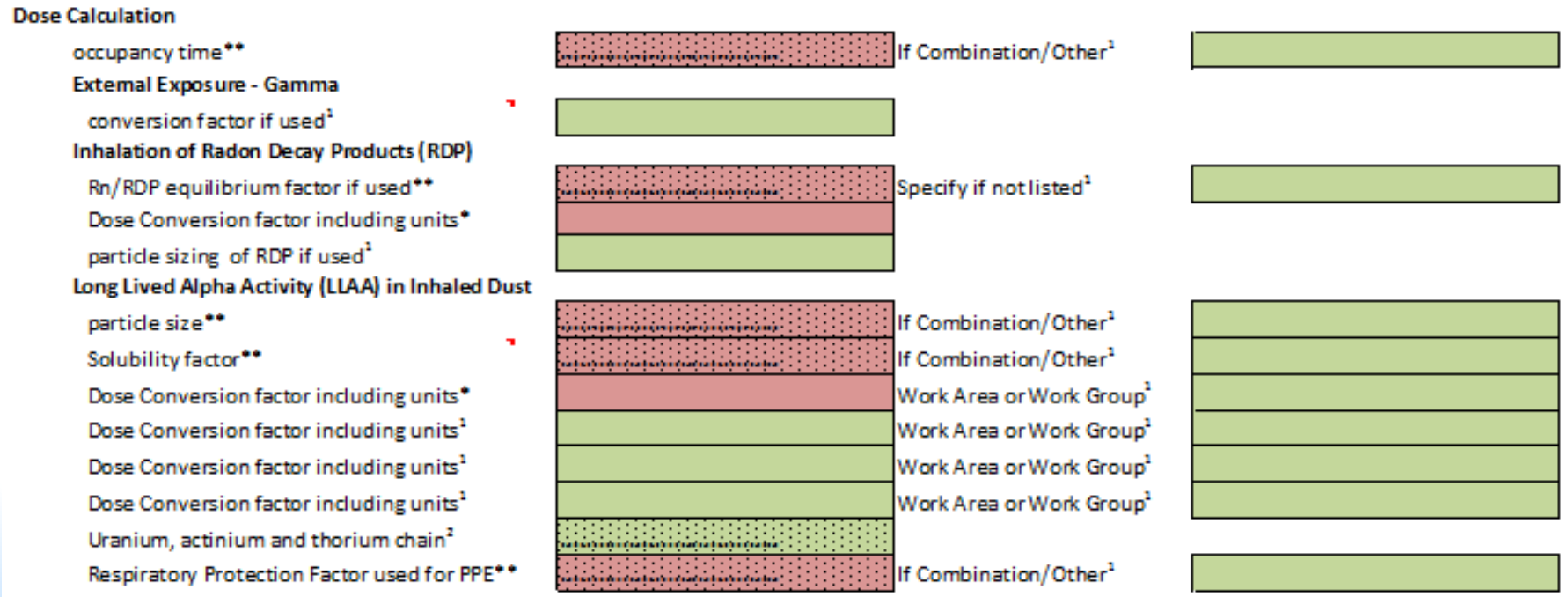


Details about the monitoring by exposure pathway and whether background is subtracted



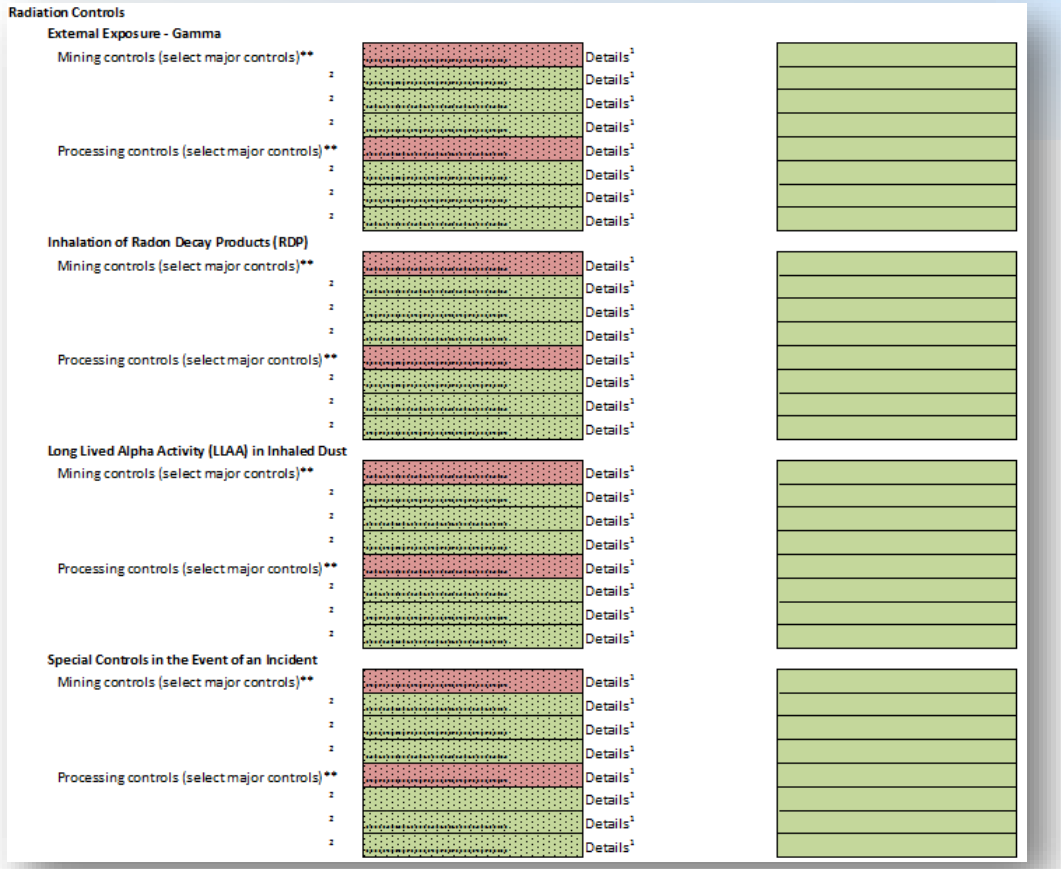
UMEX- Dose Calculation

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- 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

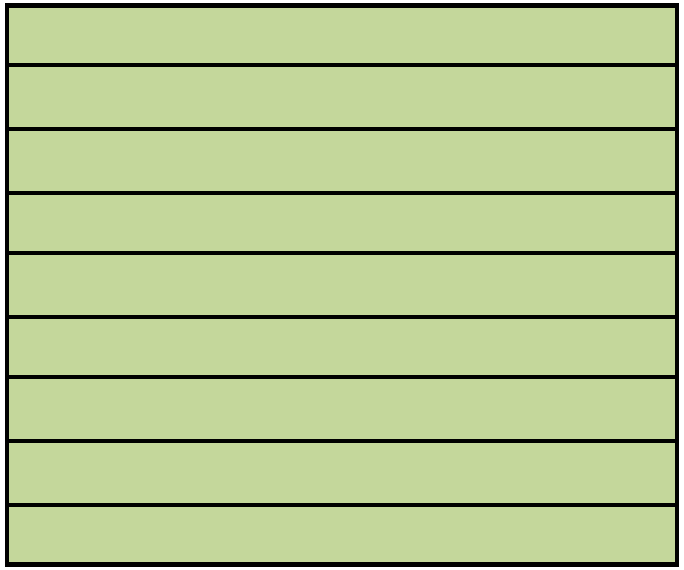


UMEX- Auxiliary Controls

- General administrative controls for radiation safety

Auxillary Controls

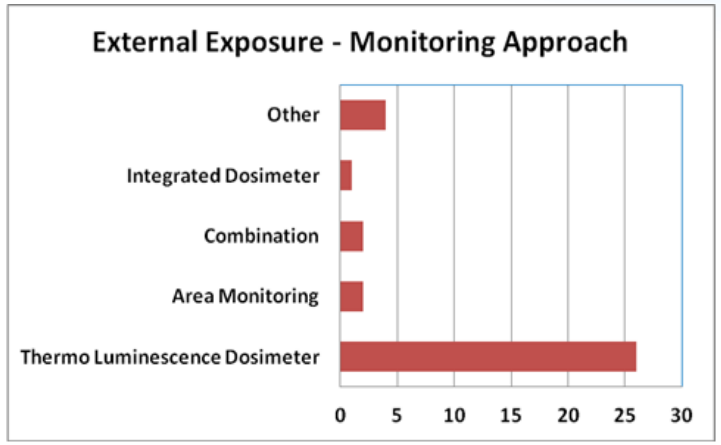
- Radiation induction[1]
- Radiation Training[1]
- Designated vs non-designated[1]
- supervised and controlled areas[1]
- Contamination controls[1]
- QA systems[1]
- Record keeping[1]
- Radiation Staffing[1]
- Restricted release Zones[1]

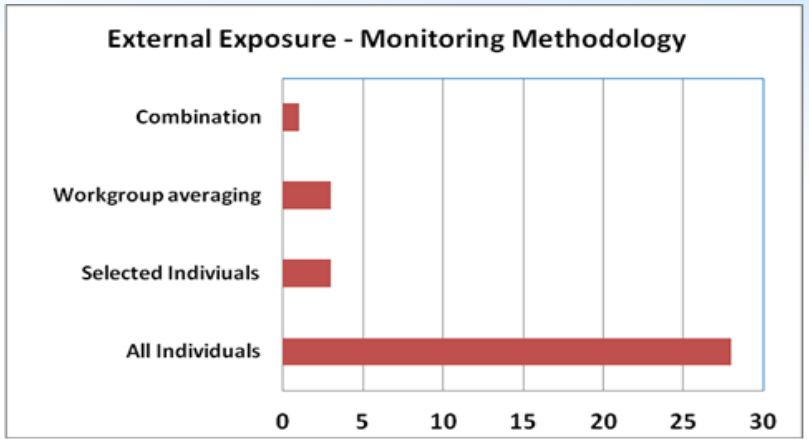


UMEX – The Response

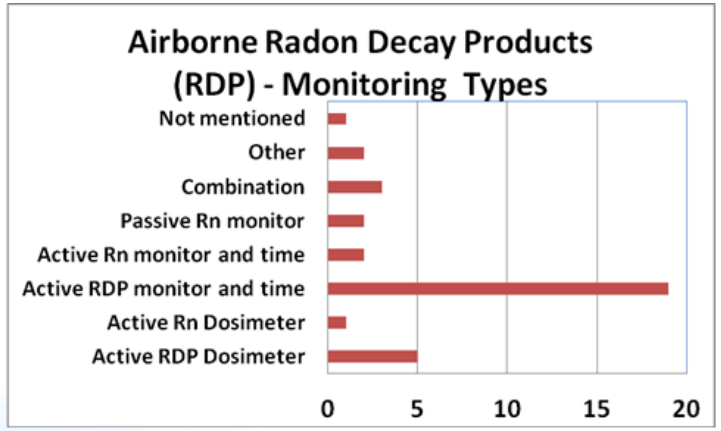
- The survey provides a snapshot of the doses in the 2012 calendar year
- Occupational data from 36 operating facilities were received
- This covers a production of 58 344t of uranium or approximately 85% of global uranium production
- Data was received from in excess of 30000 workers
- The data received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

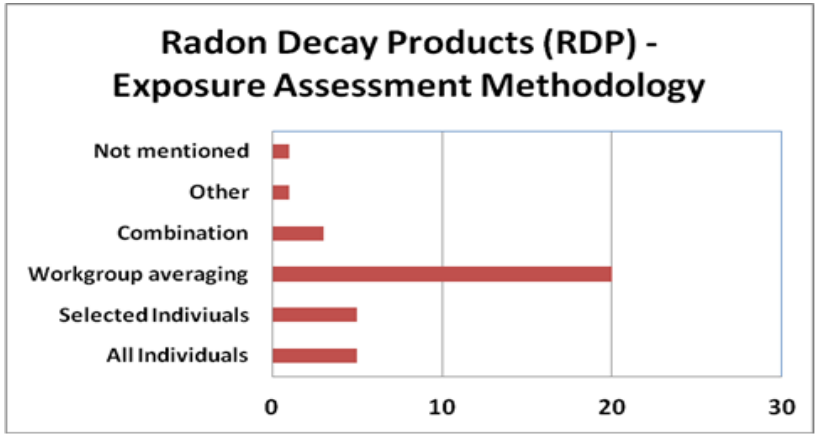
External Exposure Monitoring Methodology



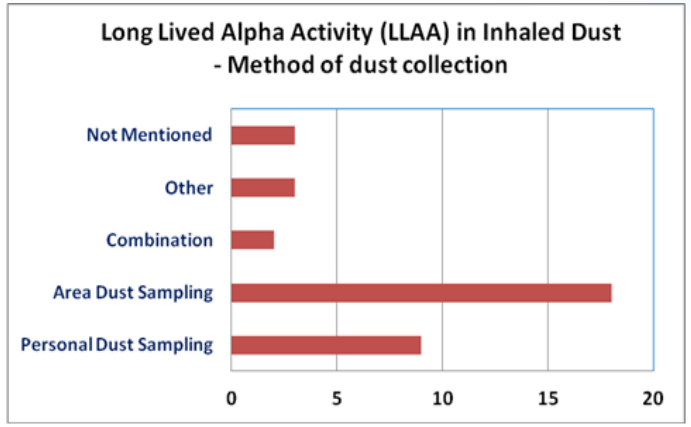


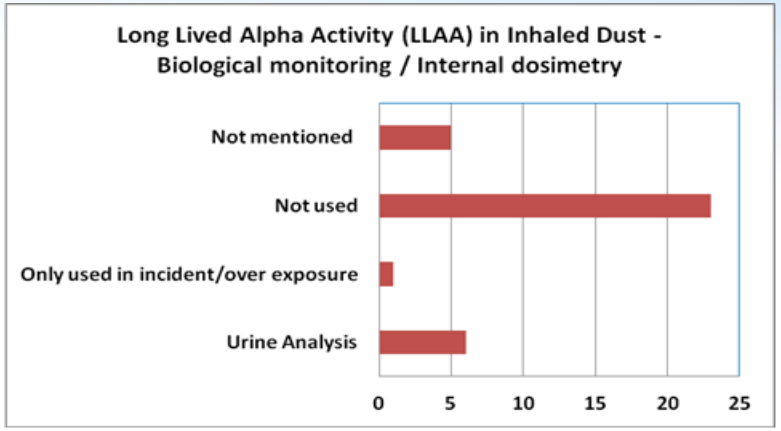
Radon Decay Product Monitoring Methodology





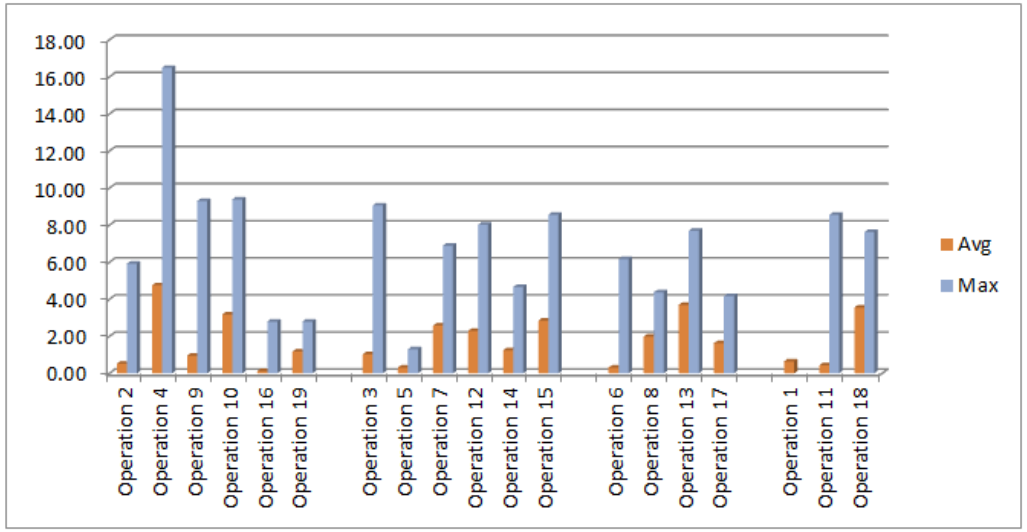
Inhaled Dust Monitoring Methodology



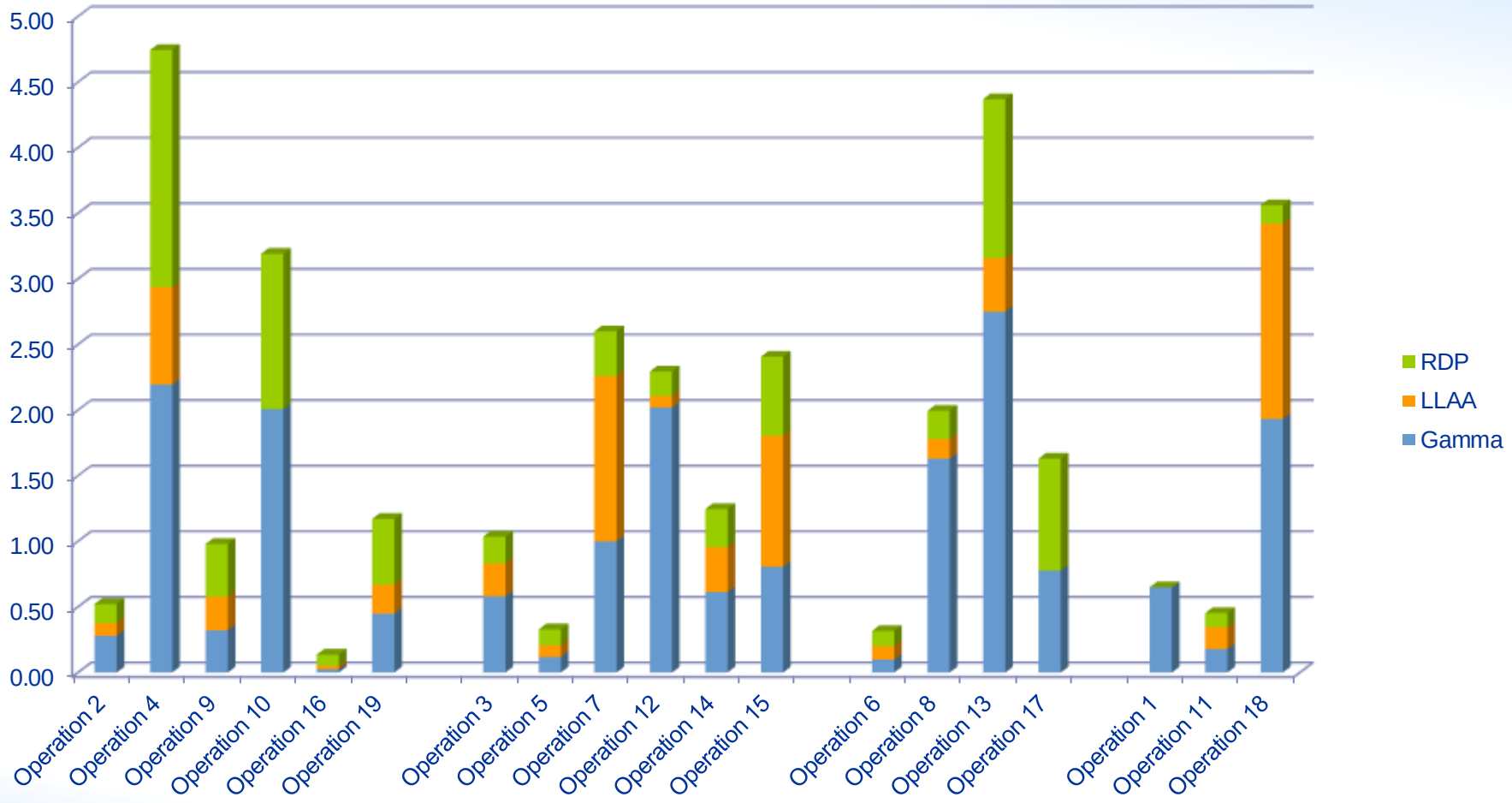


Average and Maximum Doses by Operation

mSv



Breakdown of Average Doses by Pathway and Operation



UMEX – Observations and Learnings

- Changes in Radon (Decay Products) Dose Conversion Factors
- The UMEX data allows determination of potential impacts on the uranium mining industry

Workplaces	
ICRP 65 (1993)	5 mSv/WLM
ICRP 137 (2018)	≈ **10 mSv/WLM** – for underground mines and buildings 20 mSv/WLM – indoor work involving substantial physical activity, exposure in tourist caves
International BSS (2014)	**1000 Bq/m^3 ≈ 10 mSv in a year**
Homes	
ICRP 65 (1993)	40 Bq/m^3 ≈ 0.7 mSv in a year (300 Bq/m^3 ≈ 5 mSv)
International BSS (2014)	40 Bq/m^3 ≈ 1.4 mSv in a year (300 Bq/m^3 ≈ 10 mSv)

DCF Rn progeny : 1.4 mSv/mJh m^{-3} → 3 mSv/ mJh m^{-3}

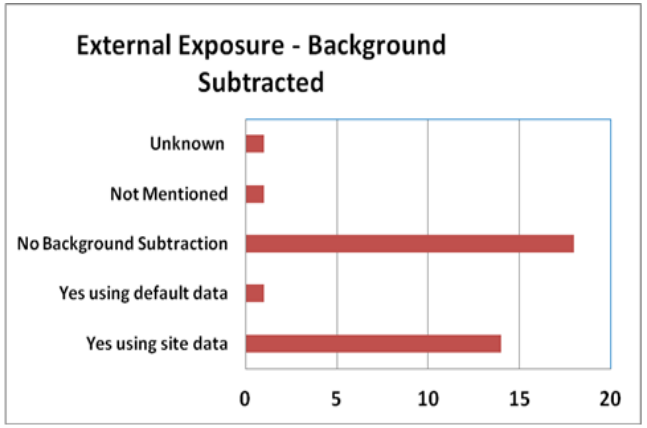
DCF Tn progeny : 0.48 mSv/mJh m^{-3} → 1.5 mSv/ mJh m^{-3}

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

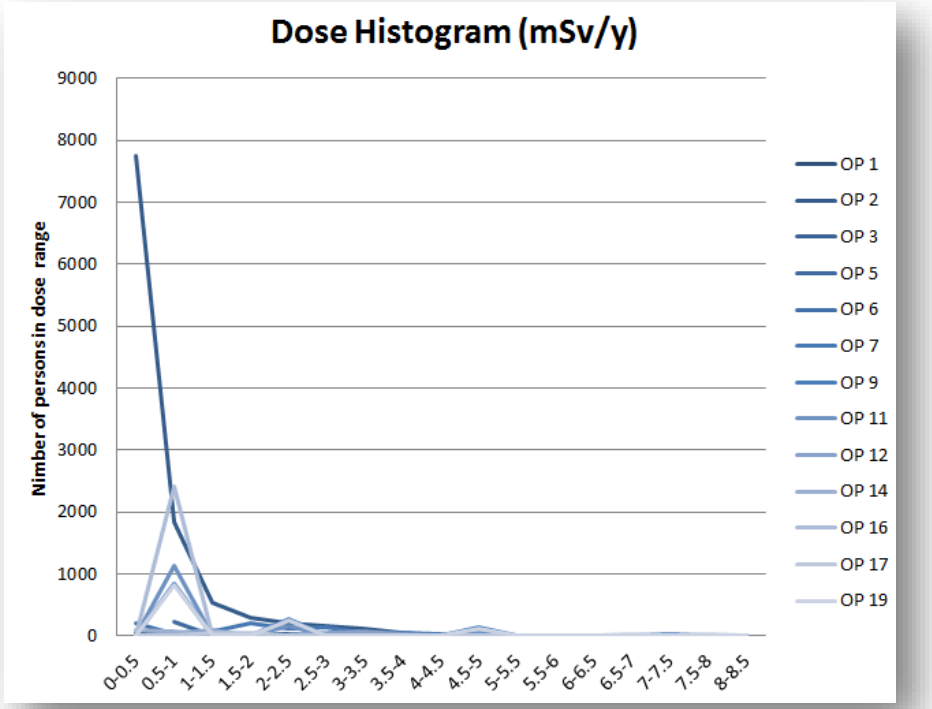
- For gamma exposure the majority of operations used TLD's (or equivalent)but a high proportion did not subtract background
- This was particularly apparent in the ISL mines where gamma was by far the dominant pathway
- By not subtracting background the operational derived worker dose was likely over-estimated 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



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

- 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



Consultancy meetings (2019)

- **Consultancy meeting on development of a Training Package on Occupational Radiation Protection in Uranium Mining and Processing Industry, 4 – 8 March 2019**

  To review the Safety Report on Occupational Radiation Protection in Uranium Mining and Processing Industry, make decision on the content of the training package based on the report and prepare the training material

- **Consultancy meeting on review and re-design of the global survey on Information System on Occupational Radiation protection in Uranium Mining (UMEX), 11-13 March 2019**

  To review the UMEX questionnaire and make necessary modifications to reconduct the survey on a web platform

Conclusions

- The UMEX provides a snapshot of occupational doses in the uranium industry
- The response covers approximately 85% of global uranium production
- The doses show compliance with international recommendations and represent good practice globally
- The importance of the data collected is high and opportunity for improvements
- The findings of the survey are included in the IAEA SR-100
- Reviewed & re-designed in 2019, when to conduct is under discussion (IT development!) (announcements through ORPNET)

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Thank you!

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