



## FANR Radiological Environmental Laboratory: Capabilities and Issues

**Radiation Measurements Cross Calibration (RMCC-10) Workshop, 19-Oct-2015**

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### Objectives

1. Discuss current status of FANR radiochemistry laboratory
2. Describe the conceptual FANR REMP
3. Present some analytical results collected to date
4. Discuss issues and ongoing work



## Part 1 – Current Lab Status

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### Instrumentation (Current Laboratory)

- **Gamma spectrometer**
  - Operational
  - Calibrated
  - Limited geometries
  - Analysis Capability/IAEA
- **Liquid Scintillation Counter**
  - Operational
  - Not calibrated
  - No analyses
- **Gas Flow Proportional Counter**
  - Operational
  - Not calibrated
  - No analyses



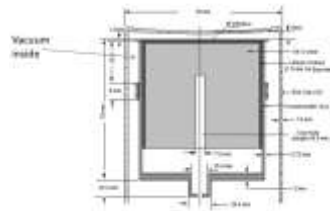
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## Gamma Spectrometer

- **Two Detectors**
  - 60% efficient (operational)
  - 40% efficient (not operational)
  - ORTEC
  - Canberra
- **Limited availability of calibration sources**
  - Administrative barriers to obtaining full compliment of calib. sources
  - Mixed gamma sources for energy calibration
  - 3 calibration sources
    - 0.5-L & 1-L marinelli,  $\rho = 1 \text{ g/cc}$  & 0.5-L marinelli,  $\rho = 1.7 \text{ g/cc}$
- **Energy and Efficiency Calibration, Trend Graphs**
- **ORTEC Analysis Software (Gamma Vision 7)**
- **Used for routine analyses**

Germanium detector



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## Part 2 – Conceptual REMP

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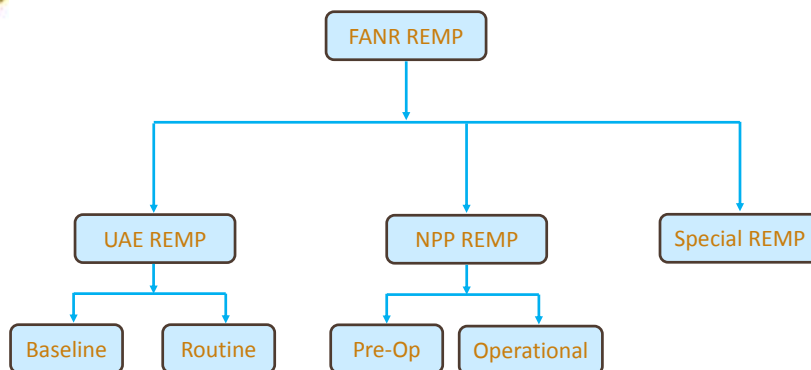


## FANR REMP

- REMP = Radiological Environmental Monitoring Program
- FANR procedure CP-5, “NPP Environmental Radiation Monitoring” requires:
  - collecting samples (independently and splits)
  - reporting FANRs results (“analytical report”), annually
  - reporting NPP results (“public report”), annually
- FANR is collecting samples of:
  - Soil (independently and collaboration planned with EAD)
  - Water (independently)
  - Date Palm Fruit (collaboration with AI Foah)
  - Continuous monitoring, gamma monitoring network
- FANR is developing a REMP strategy and sampling plan
- A draft, conceptual plan is on the following slides



## REMP Pictorial





## REMP Description

- **FANR REMP is the umbrella program comprised of:**
  - One REMP for UAE
    - » entire land mass and Gulf
    - » Called **UAE REMP** in this presentation
    - » General monitoring of licensees
  - One REMP for NPP Licensee
    - » Approximately 8 km radius of Barakah
    - » Called **Barakah REMP** in this presentation
  - Special REMP
    - » For any special sampling
    - » Not part of UAE or Barakah REMP
- **Each REMP (except “Special”) will be comprised of:**
  - Initial REMP (or “preoperational” or “baseline” REMP)
  - Routine REMP (or “operational” REMP)



## REMP Sampling

- **Sample Types**
  - Gamma monitors (current, real time, collaboration with NCMS)
  - Water (surface water, ground water, drinking water)
  - Soil/Sand/Sediment (current)
  - Foodstuffs (dates, fish, etc)
  - Vegetation (future)
  - Air Monitoring Stations (future, potential)
  - TLDs (future, potential)
- **Some sample types are currently being collected**
  - Independently or in collaboration
  - Some sample media to be added in future
  - FANR is looking for additional opportunities for collaboration



## Synopsis of FANR Radiological Environmental Monitoring Program 2015, UAE National, Baseline

DRAFT

Sample Type	Sampling Frequency <sup>1</sup>	Number of Locations	Number of Samples Collected <sup>2</sup>	Analysis	Analysis Frequency <sup>1</sup>	Number Analyzed
Seawater	M	1	10	Gamma Isotopic	M	9
Direct Radiation	Continuous	12 (1 location removed)	450,000	Gross Gamma (Gamma Monitoring Network, GM+Nal)	10-min avg	450,000 <sup>3</sup>
Soil/Sand	Once/Location	3	15	Gamma Isotopic	M	10
Date Palm Fruit	M (Growing Season)	16	18	Gamma Isotopic	M	0
Fish	SA (in season)	TBD	0	Gamma Isotopic	SA	0
Vegetation	TBD (Growing Season)	TBD	0	Gamma Isotopic	M	0

1. W=Weekly, M=Monthly, Q=Quarterly, SA=Semiannual, A=annual, C=composite
2. Beta counting is performed after >72 hour decay, Gamma Spectroscopy performed on monthly composites of weekly samples
3. Samples collected as of 19-Oct-2015.
4. Assumes no loss of data communication.

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## REMP LLDs (Power Plant Nuclides)

Nuclide	Water (Bq/L)	Airborne Particulates (Bq/m <sup>3</sup> )	Fish (pCi/kg wet)	Milk (Bq/L)	Food Products (pCi/kg wet)	Sediment (pCi/kg dry)
Gross Beta	0.148	3.70E-04				
H-3	740					
Mn-54	0.555		4.81			
Fe-59	1.11		9.62			
Co-58	0.555		4.81			
Co-60	0.555		4.81			
Zn-65	1.11		9.62			
Zr-95	0.555					
Nb-95	0.555					
I-131	0.037	2.59E-03		0.037	2.22	
Cs-134	0.555	1.85E-03	4.81	0.555	2.22	5.55
Cs-137	0.666	2.22E-03	5.55	0.666	2.96	6.66
Ba-140	0.555			0.555		
La-140	0.555			0.555		

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## Part 3 – Analysis Results

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### Gamma Emitters in Seawater

- Corniche Beach
- Near shore
- Surface water
- No anthropogenic nuclides detected
- Counting Time, Currently 4.5 hours
- K-40 Results Shown
- NORM Under Review (Bkg)
- Prior to 2015, samples were counted
  - Qualitative (not calibrated)
  - ~10-20 hour count time
  - 10 samples in 2014

Seawater, Corniche Beach, 18- Feb-2015 10:30	Average, 8 counts bq/kg	2 sigma uncertainty bq/kg
Radionuclide		
K-40	17.7	6.6



## Gamma Emitters in Soil/Sand

- Samples have been counted
  - Qualitative (not calibrated efficiency table for density)
  - ~10-20 hour count time
  - 77 samples 2013
  - 38 samples 2014
  - 15 samples 2015
- Just received standard reference material for soil matrix last week



## 35 Soil Sampling Locations (2013-2015)







## Correlation of Soil/Sand to Gamma Network

- Soil/sand samples to be correlated to gamma dose from gamma monitoring network
- Radioactive Mineral Components
  - K-40
  - U-238 (Bi-214)
  - Th-232 (Tl-208)
- Use Bq/kg from HPGe analysis
- Use dose conversion factors from UNSCEAR-1988, "Sources, Effects and Risks of Ionizing Radiation"
- Calculate expected gamma exposure rate
- Similar studies conducted in Oman, Lebanon, other

**TABLE 3**  
Average activity mass concentrations of potassium-40, uranium-238 and thorium-232 in soil and absorbed dose rate in air 1 m above the ground surface [43].

Radionuclide	Dose rate per unit activity mass concentration in soil (μSv h <sup>-1</sup> per Bq kg <sup>-1</sup> soil weight)	Average activity mass concentration in soil (Bq kg <sup>-1</sup> )	Absorbed dose rate in air (μSv h <sup>-1</sup> )
K-40	0.045	350 (100-700)	16 (4-30)
U-238	0.427	25 (10-50)	11 (4-21)
Th-232	0.661	25 (1-50)	17 (5-33)

of the typical range is given in parenthesis.



## Gamma Emitters in Date Palm Fruit

- Samples – Collaboration – Al Foah
- Sample preparation issues
  - Dry, wet ("fresh"), whole, pitted, grind...
  - Want to relate analysis to fresh dates (RTE)
- Previous samples counted
  - Qualitative (not calibrated)
  - ~10-20 hour count time
- Sampled 10-Nov-2014
  - Fresh dates
  - With pits
  - Bulk Density 0.9 g/cc
  - Flesh Density ~1.4 g/cc (RTE)
- No anthropogenic nuclides detected
- Analysis Currently 4.5 hours

Date Palm Fruit, Sih Al Khair (Dabbas), 10-Nov-14, Source = FANR 192	Average, 8 Counts	2 sigma uncertainty
Radionuclide	Bq/kg	Bq/kg
K-40	248.6	12.0

Fresh, Whole Dates, No Density Attenuation Applied



## IAEA Interlaboratory Comparison - 2015

- FANR's first participation with IAEA Proficiency Testing
  - IAEA sent water, rice, and soil samples
- FANR's Analytical capability limited to water samples
- Analyzed 3 water samples (gamma emitters only)
  - 2 unknowns
  - 1 QC (known, Eu-152, 193.1 Bq/kg, uncertainty 1.7 Bq/kg)
- FANR sent results of 2 unknowns to IAEA
- FANR's analysis of QC sample indicated 193.0 Bq/kg Eu-152, uncertainty 4.2 Bq/kg
- QC results are encouraging/cautiously optimistic



## Issues and Ongoing Work

- Infrastructure (desks, tables, instruments, supplies...)
- Delays in obtaining standard reference materials (sources)
- Training
  - Gamma isotopic analysis training is underway
  - Liquid scintillation counter training is next
  - Gas flow proportional counter planned
- Procedures
- Trend Charts
- Background Subtraction (NORM, LLDs for NORM)
- Coincidence corrections
- ORTEC attenuation corrections (for reference and comparison)



## Questions

*Open discussion*

*Questions*

*Closing Comments*



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Thank you

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