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AFTER ACTION REPORT Eleventh Annual Radiation Measurement Cross Calibration Workshop (RMCC XI) Applications to Nuclear Safeguards and Security

M. L. Davisson, M. J. Kristo, E. Fei

January 4, 2017

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This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

AFTER ACTION REPORT

Eleventh Annual Radiation Measurement Cross Calibration Workshop (RMCC XI)
Applications to Nuclear Safeguards and Security

Amman, Jordan December 2016

US TEAM:

Ed Fei	Nuclear Smuggling Detection and Deterrence, International Nuclear Forensics Cooperation Sub-Program (DOE/NSDD/INFC NA-213)
Michael Kristo	Lawrence Livermore National Laboratory (LLNL)
M. Lee Davisson	Lawrence Livermore National Laboratory (LLNL)

DESTINATION: *Amman - Jordan*
DATES: *10-15 December 2016*

PURPOSE/SUMMARY:

The intent of this trip was to initiate discussion with the appropriate Jordanian authorities on US collaboration in their development of a nuclear forensic capability. This required firstly to determine which agency has been legally mandated to receive and analyze nuclear forensic evidence and to review their current state of readiness to assess what assistance the US would need to provide. An additional purpose, was to introduce nuclear forensic analysis by example to the several Middle East and north African country labs present at this annual meeting.

TIMELINE

Day	Activity
Saturday 10 December 2016	Departure US
Sunday 11 December 2016	Arrival hotel Amman, Jordan
Monday 12 December 2016	1 st day of RMCC workshop
Tuesday 13 December 2016	2 nd day of RMCC workshop Discussion and tour of JAEC laboratories Discussion and tour of EMRC laboratories
Wednesday 14 December 2016	3 rd day of RMCC workshop
Thursday 15 December 2016	Return to US

MEETING LOCATION AND BACKGROUND

The RMCC workshop was held at the Middle East Scientific Institute for Security (MESIS) in Amman, Jordan (Figure 1). MESIS is an independent Jordanian non-governmental organization associated with the Royal Scientific Society. MESIS was established in 2002 under its previous name, the Cooperative Monitoring Center, Amman. MESIS facilitates



Figure 1. Participants of RMCC XI workshop December 12-14, 2016

dialogue among the scientific community in the Middle East and north African region to come together to discuss chemical, biological, radiological and nuclear (CBRN) risks whether deliberate, natural or accidental and provides a space for training.

Having many radiological scientists from Middle East and north African countries in a single location afforded an excellent opportunity for the US to introduce nuclear forensic analysis by way of example to an important region of the world. The meeting coordinators also facilitated the introduction of Jordanian counterparts and site tours of radiological analysis labs to initiate a nuclear forensic collaboration between US and Jordan.

RADIATION MEASUREMENT CROSS CALIBRATION WORKSHOP

The RMCC workshop provides a platform to improve and develop regional standards for laboratory analytical radiation measurement capabilities in the Arab world for detecting the presence of radioactive sources, preventing the illicit use of radiological materials, responding to accidental radiation releases, and disposing of radioactive sources safely.

Workshop Content

The 3-day workshop comprised a little over two days of presentations and one day of laboratory tours. The meeting agenda can be found in Appendix A.

Day 1

The first day started with opening remarks by the managing director of MESIS Al-Sharif Nasser bin Nasser. Following was an extensive presentation by Dr. Mamoun Makahleh who is the Director of Research Laboratories and Information at the Jordan Atomic Energy Commission (JAEC). His presentation focused on the mission relevant efforts the JAEC is undertaking in processing and analysis of large number of multi-media samples for gamma emitters. A major portion of their work load is analysis of geological material for uranium content in support of uranium source exploration in Jordan for their fledgling nuclear power

industry. JAEC has gamma, beta, and alpha spectrometry capabilities, along with ICP-OES and ICP-MS. They also have a ^{252}Cf source for prompt and delayed neutron activation analysis and support noble gas measurements for CTBTO. They also have a radiochemistry preparation lab. They also support dosimetry measurements in hospitals, universities, and industry. They further provide calibration services for radiological survey meters.

This presentation was followed by George Detsis from the US DOE with the Mixed Analyte Performance Evaluation Program (MAPEP). Many of the participating countries in the workshop utilized MAPEP in proficiency tests of their laboratory capabilities, so there was much discussion of results. Apparently, MAPEP allowed the participation of foreign laboratories without cost. As part of a cost-saving measure, MAPEP now requires foreign laboratories to cover the marginal cost of their participation (estimated at a few thousand dollars). Since many of the laboratories represented at RMCC have utilized MAPEP as part of their quality assurance system, this development was greeted with dismay. There was some discussion as to whether MESIS might be able to assist in providing funding for the inclusion of RMCC laboratories in MAPEP.

The next presentation was by Mike Kristo who reviewed LLNL's results from the CMX-4 exercise conducted in 2014 and sponsored by the Nuclear Forensics International Technical Working Group (ITWG). This presentation guided the audience through LLNL's process for conducting a nuclear forensic investigation of an interdicted material.

In the afternoon, Wacel Hamani of the Comprehensive Test Ban Treaty Office presented on establishment and verification procedures for the world-wide monitoring network of radiological, sound, and seismic stations that have been established in preparation of implementation of the treaty.

This talk was followed by Ed Fei of NSDD who provided an overview and international context of establishing a nuclear forensic capability.

The last talk of the day was by Dr. Abdul-Wali Ajlouni of Prince Nayef University in Saudi Arabia who provided overview of forensics and nuclear forensics in a regional context of the Middle East. Although the interpretation was unclear at times, due to Dr. Ajlouni's animated and fast speaking style, it was clear that he had spent a great deal of time investigating the field of nuclear forensics and had thought about its application in the context of the Middle East.

Day 2

The second day entailed laboratory tours and discussion at the JAEC and the Energy and Minerals Regulatory Commission. The JAEC has a mission to develop nuclear energy in Jordan to alleviate the pressures of importing fossil fuel energy. The JAEC tour started with a presentation on the development and management of laboratory accreditation ISO 17025, for which JAEC has 12 of 13 procedures established with international accreditation. They have dedicated staff that oversees the QA/QC and adherence to the accreditation requirements. Accreditation is important to the JAEC because of the numerous analyses they perform for industry and medical systems in Jordan.

The tour entailed visiting first the counting laboratories that include four gamma spectrometers, one with an auto-sampling capability, scintillation counter for beta activity, and alpha spectrometers. Following we toured the ICP-OES and ICP-MS laboratories. JAEC has ongoing

analytical contracts with Jordan Energy Resources, Inc., a private arm of the JAEC, and some limited work for Rio Tinto an Australian based company. Facilities also includes a physical preparation for drying, grinding and sieving material prior to analysis. They also have a radiochemistry laboratory that primarily dissolves material and prepares alpha counting samples by electroplating, and extraction of uranium using UTEVA based chromatography.

After lunch the US team were transported to the EMRC to meet and discuss nuclear forensics with Ahman Shanan, lab director, and Dr. Majd Hawwari, who is one of the commissioners of the EMRC and educated in the US as a nuclear engineer. His biography can be found in Appendix B. The EMRC is a licensing agency and regulates energy resources. They maintain the database of radiological sources and operate portal radiation detectors. Dr. Hawwari was quite clear that EMRC has been legally delegated as the receiving and analysis laboratory for any interdicted nuclear material requiring forensic analysis. Currently, their laboratory capability is limited to two gamma spectrometers, a scintillation counter, an alpha spectrometer, which is not operational yet, and a gross alpha/beta counter. They have a radiochemistry preparation laboratory that has not been equipped with glassware or reagents as of this visit but planned in the very near future. The lab employs two physicists and two chemists. Dr. Hawwari said that they would utilize the analytical capabilities of JAEC if necessary, but it was clear that EMRC would control the nuclear forensics analysis from start to finish.

Dr. Hawwari has been directing a country-wide effort to measure natural radioactivity in the Jordanian environment with the intent of deriving an annual dose rate the average Jordanian experiences. He was excited about the US interaction opportunity in nuclear forensics and eager for collaboration that entails technology transfer. He considered our suggestion of an Analytical Plan Development workshop an excellent opportunity for developing the know-how.

Day 3

The third day entailed more presentations starting with Dr. Othmane Bouhali from Texas A&M in Qatar. He spoke on the new x-ray synchrotron accelerator being developed in Jordan and its facilitation of physics and chemistry experiments for the Middle Eastern university community. This talk was followed by Lee Davisson who presented an overview of the Durban South Africa yellowcake interdiction forensic investigation, providing a real-world example of nuclear forensic analysis. The remaining presentations illustrated radioanalysis capabilities for each participating country.

Workshop Participants

Workshop participant list can be found in Appendix C.

KEY CONTACTS:

Name	Title/Contact Info
Dr. Majd Hawwari	Commissioner, Energy and Minerals Regulatory Commission
Dr. Mamoun Makahleh	Director, Research Laboratories and Information at the Jordan Atomic Energy Commission
Al-Sharif Nasser bin Nasser	Managing Director, Middle East Scientific Institute for Security

KEY ISSUES AND OBSERVATIONS:

1. The EMRC has the legal mandate to receive and analyze an interdicted nuclear material, but the current state of their laboratory capability likely limits them to categorization of the material with very limited characterization.
2. JAEC has more advanced laboratory capability that would allow them to perform more extensive characterization of an interdicted sample. The only capability they lack compared to US or EU is sector-based mass spectrometry for high resolution actinide isotope measurements. Higher resolution results in a more accurate age-dating methodology.
3. However, JAEC has tailored and accredited their analytical operations to a relatively narrow concentration range to serve the needs of the uranium exploration efforts. This range is around 500 ppm or less.
4. It is not clear at this point if JAEC personnel have a research or investigative approach to sample analysis, currently they operate more along the lines of an analytical service. In the case of EMRC, they demonstrated an investigative mindset.
5. We sensed some competition between EMRC and JAEC. This is to be expected given their overlapping capabilities and mission space.

NEXT STEPS:

1. There is a ministerial level effort to develop a bilateral relationship between Jordan and South Africa, leveraging US training of personnel at the Nuclear Energy Corporation of South Africa.
2. If a US bilateral engagement with Jordan were to be initiated, then the most relevant direction would be to hold an Analytical Plan Development workshop in Amman. Some preparatory effort would be needed to identify stakeholders and determine the level of collaboration and coordination between EMRC and JAEC.

IMPACT ON COUNTRY PLANNING

The trip identified the laboratories and personnel that would potentially be involved in any nuclear forensic sample analysis in Jordan. Analytical capabilities were also scoped and determined to be sufficient to propose an Analytical Plan Development workshop.

Attachment A: Workshop agenda



Eleventh Annual Radiation Measurement Cross Calibration Workshop (RMCC XI) *Applications to Nuclear Safeguards and Security* December 12-14, 2016 | Amman, Jordan

Day 1: Monday, December 12, MESIS Premises

- 08:00** **Departure from Hotel**
**Please meet in the hotel main lobby at 07:45*
- 08:30** **Arrival and Registration of Participants**
- 09:00** **Welcome Remarks and Introduction of Participants and Overview of the Radiation Measurement Cross Calibration Project (RMCC)**
- Al-Sharif Nasser Bin Nasser, Managing Director, *Middle East Scientific Institute for Security (MESIS)*
- 9:30** **Host Country Session on Radioanalysis Laboratory Capabilities and Issues**
- Dr. Mamoun Makahleh, Director of Research Laboratories and Information, *Jordan Atomic Energy Commission (JAEC)*
- 10:30** **Group Photo and Coffee Break**
- 11:00** **The Mixed Analyte Performance Evaluation Program (MAPEP) and Laboratory Audit Findings – Discussion of RMCC Participants in DOE's Quality Assurance Program and New Developments in the Program**
- Mr. George Detsis, Program Manager, *U.S. Department of Energy / MAPEP*
- 12:00** **Lunch Break**
- 13:00** **Presentation on CMX-4 Exercise**
- Dr. Michael Kristo, Group Leader, *Lawrence Livermore National Laboratory (LLNL)*
- 13:45** **Coffee Break**
- 14:00** **The Role of Measurements in Nuclear Safeguards, Security, and Treaty Verification, *continued***
- **CTBTO's Radionuclide Monitoring Network**
Mr. Wacel Hamani, Maintenance Engineer, *The Comprehensive Nuclear-Test-Ban Treaty Organization*
- **The Growing Field of Nuclear Forensics**
Mr. Ed Fei, Foreign Affairs Office, *U.S. Department of Energy*
- **A Regional Perspective of Nuclear Forensics**
Dr. Abdul-Wali Ajlouni, Vice-Dean, *Prince Nayef University*
- 16:15** **Closing**
- 20:00** **Group Dinner hosted by MESIS**



Day 2: Tuesday, December 13, Jordan Atomic Energy Commission

08:30 **Departure from Hotel**

**Please meet in the hotel main lobby at 08:15*

09:00 **Opening Remarks**

09:15 **Laboratory Management and Quality Assurance at JAEC: The Realities of Implementing International Standard ISO/IEC 17025:2005**

- Dr. Mamoun Makahleh, *Jordan Atomic Energy Commission (JAEC)*

10:00 **JAEC Laboratory Facilities Tour and Presentation on Laboratory Proficiency, Validation, and Corrections**

Proficiency and validation tests in a wide range of environmental matrices, software for validation and corrections, and audits, visits, and expert missions in radioanalytical procedures including:

- In-situ gamma spectroscopy best practices, for example HPGe and NaI detectors, etc.
- Gross alpha/beta assay
- Radionuclides in water such as Bi-210, Ra-226, Pb-210, Thorium, Uranium, Other
- Reference materials for high-density media (soils)
- Best practices for soil and water sampling
- Validation of measurements for NORM/TENORM radionuclides such as Ra-226, Ra-22

12:00 **Lunch Break**

13:00 **Announcements and Adjourn**

Free Afternoon for Participants



Day 3: Wednesday, December 14, MESIS Premises

- 08:30** **Departure from Hotel**
**Please meet in the hotel main lobby at 08:15*
- 09:00** **Special Session: Qatar Foundation Project at CERN to develop charged particle and radiation detectors that are used for monitoring and detection in high energy, nuclear and medical physic applications**
- Dr. Othmane Bouhali, Research Associate Professor, *Texas A&M University, Qatar*
- 10:00** **Presentation on Nuclear Forensics Project**
- Ms. Olena Taberko, Governmental Partnership Program Manager, *Science and Technology Center in Ukraine (STCU)*
- 11:00** **Coffee Break**
- 11:20** **Presentation on the Durban Case**
- Dr. Morton Lee Davisson, Scientist, *Lawrence Livermore National Laboratory (LLNL)*
- 12:20** **Country Radioanalysis Laboratory Capabilities and Issues**
(15 Minutes per Country + 5 Minutes Discussion)
- Iraq
- Morocco
- 13:00** **Lunch Break**
- 14:00** **Country Radioanalysis Laboratory Capabilities and Issues**
(15 Minutes per Country + 5 Minutes Discussion)
- Tunisia
- Saudi Arabia
- Jordan
- 15:00** **Group Discussion: Common Challenges and Opportunities for Cooperation and Collaboration**
- All
- 15:45** **Coffee Break**
- 16:00** **Update on RMCC Project: Website Features and Member Services**
- Mr. Iyad Aldasouqi, *MESIS*
- 16:30** **RMCC Member Radiation Data Sharing: Prospects of Building a Regional Early-Warning System**
- 17:00** **Closing Remarks and Discussion of Sustainability and Future Steps**

Attachment B: Dr. Majd Hawwari Biography

Dr. Hawwari attended Jordan University of Science and Technology to earn his Bachelor of Science in Electrical Engineering with a specialization in Communications and Electronics. And he served as an avionics engineer at the Royal Jordanian Airlines, Amman.

Dr. Hawwari moved to the United States to obtain his Master of Science and Ph.D. in Nuclear Engineering from University of Cincinnati (UC) Cincinnati, OH in the United States. His field of emphasis was radiation measurements, dosimetry, spectrometry, and the utilization of ionizing radiation in medical applications.

Dr. Hawwari worked as the deputy chief of physics at King Hussein Cancer Center in Amman-Jordan, where 145 patients were treated daily with radiation, and state of the art techniques were used for the treatment, such as intensity modulated radiation therapy, stereotactic body radiotherapy, and image guided radiotherapy. Dr. Hawwari updated the quality assurance program for the radiation oncology department and performed acceptance testing and commissioning for new linear accelerators. In addition, Dr. Hawwari served as an adjunct professor at the department of physics at the University of Jordan, where he taught two graduate level courses (Radiation Measurements, and Digital Signal Processing) and Radiation Physics for the radiation oncology resident physicians, and served on the PhD committee for a number of students in the department of physics at the University of Jordan.

Dr. Hawwari was appointed with a royal decree as the Director General for Jordan Nuclear Regulatory Commission (JNRC), and currently he is a commissioner at the Energy and Minerals Regulatory Commission (EMRC). Through his current position Dr. Hawwari has a major role in the development and oversight of all aspects of the regulatory framework of the Jordanian Nuclear Energy Program. The projects Dr. Hawwari worked on within the Jordanian Nuclear Energy Program were the Subcritical Assembly at Jordan University of Science and Technology, Jordan Research and Training Reactor (JRTR), Nuclear Engineering program at Jordan University of Science and Technology, Synchrotron Light Source, the Uranium Exploration and Mining project, and Future Nuclear Power Plants.

In addition, Dr. Hawwari has other duties in licensing and monitoring radiation exposure and use in the medical and industrial fields. Also, border monitoring and control for illicit trafficking of radioactive sources.

Attachment C: RMCC XI Participant List

No.	Name	Job Title	Organization	Country	Email
1	Wacel Hamani	Radionuclide Engineer	CTBTO	International	wacel.hamani@CTBTO.ORG
2	Michael Dignam	President and CEO	CRDF Global	International	mdignam@crdfglobal.org
3	Abier Aharin	Director	CRDF Global	International	aaharin@crdfglobal.org
4	Mohammed Jasim Al-Dulaimi	Head of Research	Iraq Radioactive Sources Regulatory Authority	Iraq	mima1967@yahoo.com
5	Kamal Ali	Prof. Geophysics & Radioecology	University of Baghdad	Iraq	kkak1967@yahoo.com
6	Belal Qtaishat	Head of Quality & Samples Management Department	JAEC	Jordan	belal.qtaishat@jaec.gov.jo
7	Nedal Elayan	Head of Gamma Section & sample preparation Section	JAEC	Jordan	nedal.elayan@jaec.gov.jo
8	Khaled Ananzeh	Health, safety & environment(HSE) engineer scientific writer	JAF Retired - X CIT group	Jordan	kananzeh@yahoo.com
9	Ahmad SHANAN	Director / Laboratories and Radiological Monitoring	EMRC	Jordan	Ahmad.Shanan@emrc.gov.jo
10	Ahmad Yousef Bani Mfarej	Head of Nondestructive Tests Department	Royal Jordanian Air Force	Jordan	maintchem@riaf.mil.jo
11	Mohammad Yousef Garadat	Head of Nondestructive Tests Division	Royal Jordanian Air Force	Jordan	maintchem@riaf.mil.jo
12	Osama Alatawneh	Radiation Inspector	EMRC	Jordan	osama.alatawneh@emrc.gov.jo
13	Loai Nsairat	Director of Operational Labs	JRTT / JAEC	Jordan	loai.nsairat@JAEC.GOV.JO
14	INAD MARZOUQ HADDADIN	RADIATION officer	King Hussein Cancer Center	Jordan	ihaddadin@khcc.jo
15	Mamoun Makahleh	Director of Research Laboratories and Information	JAEC	Jordan	mamoun.makahleh@JAEC.GOV.JO
16	ABDUL-WALI ALLOUNI	Vice Dean of college of Forensic Sciences	Naif Arab University for Security Sciences (NAUSS)	KSA	abdul-wali@nauss.edu.sa
17	Tahar EL KHOUKI	Head of Environmental Monitoring Unit	CNESTEN	Morocco	khouki@cnesten.org.ma
18	Najat AMECHMACHI	Senior Radiological measurement and QA/QC officer	CNESTEN	Morocco	amechmachi@gmail.com
19	Dr. Othmane Bouhali	Professor	Qatar Foundation	Qatar	othmane.bouhali@qatar.tamu.edu
20	Mohamed BEN ABDALLAH	RADIATION PROTECTION and measurement Engineer	National Center For Nuclear Sciences and Technologies	Tunisia	medinsturn@gmail.com
21	Elena Taberko	Governmental Partnership Program Manager	Science and Technology Center in Ukraine	Ukraine	elena.taberko@stcu.int
22	Ed Fei	Foreign Affairs Office	US Department of Energy	USA	Ed.Fei@amsa.doe.gov
23	George Deisis	Analytical Services Programme Manager	US Department of Energy	USA	george.deisis@hq.doe.gov
24	Michael Kristo	Group leader	Livermore Labs	USA	kristo2@llnl.gov
25	Morton Lee Davission	Scientist	Livermore Labs	USA	davission2@llnl.gov
26	Amir Mohageghi	Scientist	Sandia National Labs	USA	ahmohag@sandia.gov