

## International Workshop on Gamma Spectrometry Analysis Codes for U/Pu Isotopics

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Over the past twelve years, the United States Department of Energy (DOE) and the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) have collaborated to develop nuclear safeguards technologies and methodologies under a bilateral safeguards cooperation agreement. The methods and techniques developed under this agreement are used by ABACC to conduct inspections at nuclear fuel cycle facilities in South America. As part of this initiative, a regional Isotopic Measurement Working Group (IMWG) was created to study software used to perform isotopic measurements on uranium. Currently, ABACC and the international safeguards community use various versions of software and measurement systems to determine the isotopic abundances for uranium and plutonium. Inconsistencies in the hardware and software have resulted in data discrepancies that often have to be manually corrected. Due to the success of the ABACC and DOE cooperative effort, the participants decided to continue this initiative by enlarging the participation to include the international community, broadening the scope to include plutonium isotopic measurements, and establishing a working group that would respond to the needs expressed by the international safeguards community. As a result, a *Working Group on Gamma Spectrometry Techniques for U/Pu Isotopics* was created to provide a forum to exchange information, discuss technical developments, and validate and test gamma spectroscopy techniques used to verify facility declarations. Under the purview of this newly formed working group, the Institute of Nuclear Material Management (INMM) and European Safeguards Research and Development Association (ESARDA) will co-host an *International Workshop on Gamma Spectrometry Analysis Codes for U/Pu Isotopics* at the Oak Ridge National Laboratory in November 2008. The workshop will provide a unique opportunity for code developers, commercial distributors and end users to interact in a hands-on laboratory environment to develop

solutions for programmatic and technical issues associated with each code's capabilities, limitations, applicability, sustainability, and version control. The workshop will also provide an international forum for discussing development of an internationally accepted standard test method. This paper discusses issues related to formation of the working group, its goals and objectives as well as its planned activities. The paper also describes how the international workshop contributes to the goals and objectives of the working group.

### **Previous International Efforts**

In October 1994, the Institute for Reference Materials and Measurements (IRMM) of the Joint Research Centre (JRC) of the European Commission organized the *1<sup>st</sup> International Workshop on the Pu Isotopic Evaluation Codes*, which at that time initially focused on the performance of the Multi Group Analysis (MGA) code developed at the Lawrence Livermore National Laboratory in Livermore, CA, USA. Since then, expanded practical experiences in the field of plutonium isotope abundance measurements by high-resolution gamma spectrometry (HRGS) were realized both with the MGA code as well as with its counterpart, the Fixed-Energy Response-Function Analysis with Multiple Efficiency (FRAM) code developed at the Los Alamos National Laboratory in Los Alamos, New Mexico, USA.

However, over the past several years measurement situations have changed, posing new problems and challenges for these codes when used as a safeguards tool by national and international inspectors. For example, the trend to increasingly higher burnup plutonium materials, measurements on freshly separated nuclear material in reprocessing plants or the presence of actinides other than uranium and plutonium in materials designed for future fuel cycles have, in some situations, resulted in failure of these codes.

Because of this situation, it was deemed appropriate to convene, one decade after the first workshop, another workshop on the subject for a critical review and discussion of the current situation and of future trends in plutonium and uranium isotope abundance measurements utilizing HRGS.

In November 2005, an International Workshop on "*Gamma Evaluation Codes for Plutonium and Uranium Isotope Abundance Measurements by High-Resolution Gamma Spectrometry: Current Status and Future Challenges*" was held in Karlsruhe, Germany. This workshop was attended by many of the primary experts in gamma spectrometry techniques

including many of the initial code developers. One of the main issues discussed during that meeting addressed the concerns of the inspectorate authorities (International Atomic Energy Agency (IAEA), European Atomic Energy Community (EURATOM) and ABACC) about the standardization and sustainability of gamma evaluation codes. Clear guidelines were identified for future challenges (including technical developments). As a follow-up, the IAEA issued a roadmap for future developments of gamma codes. As a follow-up, the IAEA issued a roadmap for future developments of gamma codes, followed by a request of support for this project to several Member State Support Program's (MSSPs) to the IAEA, namely the United States, the European Community and France. The institution of the International Working Group on Gamma Spectrometry Techniques for U and Pu Isotopics is also answering to this IAEA request.

### **International Working Group on Gamma Spectrometry Techniques for U and Pu Isotopics**

In parallel to the JRC activities referenced above, a different initiative was carried out under the framework of the United States-DOE/ABACC bilateral safeguards cooperation agreement with the establishment of the regional IMWG. This working group focused only on the use of these codes for uranium isotopics because of its applicability to ABACC inspections. The regional IMWG was comprised of experts from the US, Brazilian and Argentinean laboratories with the goal to *“test and evaluate existing uranium isotopic and enrichment software through an interactive and cooperative process among users and developers and make recommendations for standardized software that meets regional and international quality assurance (QA) requirements for the safeguards community”*. The work under Action Sheet 14 (AS 14) was successfully completed concerning the initial scopes.

Therefore, it was considered by those involved in the development, control and use of these gamma evaluation codes to expand the participation in the project to the international community, to broaden the scope in order to include plutonium isotopic measurements, and to establish a working group that would respond to the needs expressed by the IAEA and other national and international inspectorates.

Since AS 14 already includes many of the American subject matter experts, it was quite straightforward to look at ESARDA, and in particular to the Non-destructive Assay (NDA) working group as the catalyst for the institution of this dedicated working group. The proposal to

launch the institution of an international *Working Group on Gamma Spectrometry Techniques for U/Pu Isotopics* was decided in a meeting organized in Aix-en-Provence on May 21, 2007.

## **Working Group Terms of Reference**

### Scope

The scope of the working group is to provide a forum for exchange of information, technical developments, validation and testing of gamma spectroscopy techniques used to determine the isotopic composition of uranium and plutonium samples in nuclear safeguards applications. Specifically, but not exclusively, it will address issues related to gamma evaluation codes, such as their applicability, capability and limitations, standardization, sustainability and version control.

### Composition

In principle, any stakeholder involved in gamma spectrometry applications, either as a technique developer or as an end-user for safeguards applications can join the working group. Typical membership will include: national and international research laboratories, nuclear plant operators, inspection authorities, code developers, and instrument manufacturers.

It is recognized that instrument manufacturers have extensive experience with respect to integration of such codes into comprehensive measurement systems. In addition, it is recognized that commercial entities currently provide support and sustainability for codes that they currently market. Therefore, participation of detector manufacturers is encouraged but strictly monitored to address any conflict of interest because the scope of the working group is purely scientific and not for profit. Representatives of the commercial companies will be permitted to:

- attend and actively participate in the meetings,
- provide information and experience regarding feedback on their products,
- have access to the results and documents produced by the Working Group,
- participate in the development of international standards with the consensus of other subject matter experts, and
- participate in drafting recommendations for technical specifications and requirements with the consensus of non-commercial subject matter experts.

The commercial entities will be excluded from participating in comparative evaluation of the techniques to eliminate the potential for a conflict of interest.

## Management

The working group will have no financial budget. Each participating organization will contribute to the working group bearing its own costs for manpower and missions. The deliverables (reports and other documents) of the working group will be available free of charge to all the participants.

The working group will be formally hosted within the ESARDA-NDA working group to profit from the existing network and e-infrastructure. The working group will be coordinated by the NDA-Working Group chairman and a co-chairman elected by the participants, whose main role will be the organization and management of the meetings, distribution of the official documents produced by the working group, establishing links with international institutions and administrative bodies for project funding such as the U.S. DOE, the IAEA, various MSSP's and other non-government organizations.

## Activities

Activities will be planned and agreed upon by the working group in regular meetings. These activities can cover, but are not limited to, any of following topics:

- set-up and maintenance of a web forum for discussions and information repository of gamma spectroscopy related issues,
- organization of experimental round robins and evaluation benchmarks,
- selection of a commonly agreed platform containing a set of gamma reference spectra to be used for test and evaluation of gamma codes,
- maintenance, upgrade and availability of the testing platform,
- analysis and validation of hardware and software techniques,
- issue guidelines for quality assurance, best practice guides, recommendations on the application-dependant use of hardware setups and/or evaluation codes,
- propose/sponsor production of reference material for calibration purposes,
- recommend standardization of nuclear data,
- perform a version control of the main codes, recommending the last fully-validated version and advising working group members of the issue of new releases by checking the validation process,
- collect users' needs and convene them to the developers,
- assure that codes are maintained and updated according the rules expressed by the regulators,

- monitor advances in gamma spectrometry, such as new detectors, and
- notify members of planned workshops and encourage attendance.

The JRC, which is providing the secretariat of ESARDA and hosting the website of the Association, will provide the e-infrastructure for all the WG activities within the ESARDA website.

The working group will meet once a year (initially alternating between Europe and America) possibly in conjunction with major safeguards events such as the Institute of Nuclear Material Management (INMM) or ESARDA conferences, to minimize the travel inconveniences of the participating members. Advance notification of such meetings will be posted on the website and distributed to other nuclear non-proliferation and nuclear safeguards organizations to ensure the information is disseminated to all personnel who want to attend.

### **Workshop on Gamma Spectrometry Analysis Codes for U and Pu Isotopics**

In reference to the Terms of Reference provided above, under the purview of this newly formed working group, the INMM Central Chapter and ESARDA will co-host an *International Workshop on Gamma Spectrometry Analysis Codes for U/Pu Isotopics* at the Oak Ridge National Laboratory in November 2008. The workshop will allow the end users to interact with many of the original code developers and current commercial distributors in a hands-on, laboratory environment to better understand the application and limitations of the various codes. It will provide an opportunity for the three groups to develop cooperatively solutions for programmatic and technical issues associated with each code's capabilities, limitations, applicability, sustainability, and version control. It will also provide a unique opportunity for code developers and commercial distributors to interact with the user community to better understand the challenges that the user community faces when utilizing the codes in a laboratory or field environment. Finally, the workshop will also provide an international forum for discussing development of an internationally-accepted standard test method for such codes. The workshop will include lectures from each of the various code developers and presentations from many end users of the codes. All workshop participants will actively participate in gamma spectroscopy system operation, data collection, data evaluation, and error propagation.

The workshop will be a five-day event. The first day is dedicated to presentations from code developers. The presentations will provide information on drivers for why the codes were developed, theory of operation for the codes, techniques used for validating and verifying results

generated by each code, and information on the codes applications and limitations. The morning sessions of the second and third day will focus on presentations from end users. End users will be encouraged to address issues related to application of the codes in the field and recommendations for improving the codes. The remainder of the week will include conducting measurements and analysis for codes in a laboratory environment and discussions on issues related to sustainability, version control, and development of a standard test method. A tour of the Oak Ridge National Laboratory will also be included in the activities for the week. In addition, vendors are invited to demonstrate measurement related technologies. All presentations will be in English. The registration for the workshop is open at the INMM and ESARDA websites.<sup>1,2</sup> The registration form along with the lodging and other information are also provided in the workshop brochure.

This workshop will facilitate the goals and objectives of the Working Group on Gamma Spectrometry Techniques for U/Pu Isotopics by providing a forum for the international safeguards community to discuss issues related to gamma evaluation codes identified by the community and develop possible solutions to many of the challenges faced by the international safeguards community. Hopefully, this will be the first of a series of successful events and activities for this working group.

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<sup>1</sup> <http://inmm.org/events/gamma/>

<sup>2</sup> [http://esarda2.jrc.it/internal\\_activities/WG-NDA/index.html](http://esarda2.jrc.it/internal_activities/WG-NDA/index.html)