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Development of an IAEA Training Course for Future U.S. Inspectors

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Abstract

U.S. citizens currently make up only 12% of the positions held in the IAEA’s Department of Safeguards. While the United States has maintained a high level of support for the Agency over the duration of its history, the number of American inspectors currently in the field does not reflect this level of involvement. As a result, the National Nuclear Security Administration’s Office of Nuclear Safeguards & Security (NA-241), as part of the Next Generation Safeguards Initiative (NGSI) mission, has tasked Idaho National Laboratory (INL) to develop a rigorous two week hands-on training program to encourage and operationally acclimatize U.S. Citizens who are interested in applying for IAEA inspector positions using IAEA authorized equipment at INL. Idaho National Laboratory is one-of-a-kind in its ability to train IAEA inspectors by including training at nuclear facilities on site and includes, for example, direct measurement of an active spent fuel storage cooling pond. This accredited course will introduce and train attendees on the major IAEA systems used in collecting nuclear safeguards data and performing safeguards inspections. Unique in the United States, these classes will give attendees direct hands-on training and will address equipment purpose, function, operating principles, application, and troubleshooting, based upon what would be expected of an IAEA Safeguards Inspector in the field and in the office. Upon completion, U.S. applicants will be better qualified to pursue a position in the IAEA Department of Safeguards Operational Divisions. In support, INL has recently established a new laboratory space to house state of the art nuclear safeguards instrumentation. Currently, equipment installed in the laboratory space includes attended systems: 3DLR (3-D Imaging Laser) for design information verification, a Digital Cerenkov Viewing Device for measurement of spent fuel, HM-5 handheld radiation detectors, quantitative neutron and gamma systems; unattended monitoring systems including: NGAM and MiniGRAND radiation systems and a DMOS camera system, and VACOSS/EOSS Optical Sealing Systems.

Introduction

The International Atomic Energy Agency (IAEA) Department of Safeguards is responsible for verifying state declarations regarding nuclear materials. This is accomplished primarily through inspections and facility monitoring, with an average of 2200 inspections occurring annually at 900 facilities worldwide by 245 inspectors. Based on the ratio of inspectors to inspections, inspectors are expected to execute 9 inspections per year, assuming only one inspector per inspection. There’s a clear need for more inspectors. Of these 245 inspectors, roughly 30 (12%) are inspectors from the United States. In recognition of this expanding mission, the United States must increase its inspector support to the IAEA.

Though the United States has an active nuclear program and 104 operating reactors, safeguards inspectors require fairly specialized training. An increase in US support to inspector staff must
be correlated with an increased applicant capability. In order to ensure the United States provides well-trained staff, a pre-inspector program is crucial. INL holds a special position in its ability to host such a program. INL has invested significant amounts of capital to acquire standard IAEA equipment and has deployed that equipment in field configuration. With multiple active facilities, including an active electrochemical reprocessing line, the operating Advanced Test Reactor (ATR) and its fresh and spent fuel storage, program participants will receive the best in-field training available outside of the IAEA directly.

This course will introduce and train attendees on the primary systems used by the IAEA to perform safeguards inspections and associated activities. Upon completion, future applicants will be better qualified to pursue a position in the IAEA Department of Safeguards Operational Division, and will possess a significantly better international safeguards understanding. As an accredited course, students will acquire a previously unavailable, documented measure of qualification distinguishing them from other IAEA applicants. Additionally, this accreditation offers the opportunity for nuclear engineering students around the country to benefit academically from pursuing safeguards training at a national laboratory, an exceptional benefit that separates this program from others.

This project, with the support of National Nuclear Security Administration’s Office of Nuclear Safeguards & Security (NA-241), has developed 24 instrument-specific training modules, a historical international safeguards overview, and an overview of the nuclear fuel cycle role in the weapons material cycle. Training will be conducted by former IAEA inspectors and international safeguards subject matter experts in support of the NNSA Next Generation Safeguards Initiative (NGSI) to promote and train future safeguards professionals for the IAEA.

**Course Goals**

The primary goal is to provide American participants with adequate experience operating IAEA standard field equipment. This approach will enhance American inspector candidate’s applicable experience and facilitate an increased level of qualification for a position as an IAEA inspector. This accredited course will provide both theoretical and hands-on learning experiences, providing participants with competent instruction in the use of the IAEA equipment in a laboratory/classroom facilitated setting.

**Participants and Class Size**

The anticipated participants will be those who are eligible for employment in the IAEA Department of Safeguards Operational Division. This includes those with military experience, university students (whether at the undergraduate or graduate level), the national laboratories, the nuclear power industry, safeguards equipment manufacturers, and current or previous federal employees. Admittance to the course will be based on how well the participant would fulfill the requirements set out by the IAEA for various positions, which are posted in the IAEA job descriptions.

The class size will be kept to a minimum, to maximize the individual attention and hands-on experience for each student. At this point, 12 students per session can be accommodated; based on the space available, quantities of equipment, and numbers of instructors. It’s believed that a class of this size will work best during the beginning years of the program.
Accreditation

This training course will be accredited by the International Association for Continuing Education and Training (IACET) as a Continuing Education Credit (CEU). The accreditation will provide a level of value to the training, and allow participants to qualify their experience upon completing the classes. Accreditation is possible due to the level of preparation that has been completed by INL and by the consistent and organized methodology employed in the teaching of the course. The unaccredited pilot version to be taught in June 2011 will allow the instructors and organizers the opportunity to make both minor and major changes based on feedback from participants. Once the accredited version is finalized, minimal changes will need to be made in the future. This consistency will assure that no matter when a student completes the training, they are receiving the same information.

Course Structure, a Sample Module, and Equipment

Course Structure

The training course will be taught in two weeks, over 80 hours. This intensive structure will be comprised of lectures, laboratory exercises, homework, and exams. The accompanying lab component will be completed at a nearby in-town facility or at the ATR, utilizing active sources for a complete and accurate illustration of how the safeguards equipment works and what the resulting data might look like in a field setting. Daily homework will be given covering the lessons from each day, which will reinforce the material and allow participants an opportunity to determine if they need to ask more questions or clarify material. Finally, exams will be given to students periodically which will allow both students and instructors to gauge the depth of understanding in participants.

Modules will be taught over many of the key pieces of IAEA equipment owned by INL, explaining the equipment purpose, function, operating principles, application, data review, and troubleshooting.

For example, Figure 1 below indicates what the agenda for the first and third day of the course would look like.
This agenda shows the overview of why the IAEA conducts inspections, and also shows how the lectures and laboratory exercises are run consecutively to maximize retention.

**Sample Training Module: HM-5**

One of the major benefits of this training program is the breadth and depth of information covered. As seen in Figure 2 below, even a seemingly simple piece of equipment like an HM-5 has a range of topics being covered.
HM-5 Features

- Small
- Handheld
- Battery powered
- Gamma radiation dose-rate meter
- Gamma spectrometer & MCA
- Built in gamma spectrum library
- Automatic identification of unknown gamma emitting materials
- On-board software allows the instrument to perform a variety of safeguards relevant functions

Safeguards Verification Activities Cont.

- Verification of Active Length of Nuclear Fuel
  - Used to determine boundaries of the nuclear fuel zone in fuel pins and assemblies
  - Note – the nuclear fuel zone boundaries should be measured carefully to determine the total uranium and U-235 content of the fuel

- Detecting Undeclared Nuclear Activity
  - In dose-rate mode, permits detection of gamma radiation from undeclared nuclear material processing
  - Including: Fuel reprocessing, enriching uranium, and production of HEU

- Detecting Undeclared Nuclear Material
  - In isotope identifier mode, permits detection of undeclared nuclear materials, which aids in identifying undeclared nuclear activities
  - Including: Pu-239, U-235, Cs-137, Sr-90, Th-232, and Am-241

  Note – To confirm the presence of undeclared nuclear material, the inspector should collect a sample of the material or an environmental (swipe) sample
  - Note – Secure the unknown material with an IAEA seal

Tips

- The HM-5 is a sensitive instrument used for non-destructive assay (NDA)
- Avoid dropping or mishandling instrument
- The instrument should be charged using local power and the transformer/charger as provided in the HM-5 kit
- Charge the instrument overnight before use the following day
- Note – Available electrical power varies from 100 to 220 VAC around the world and requires different plug adaptors in different countries
  - Know and have the correct plug adaptors for the country where the instrument will be used
- Avoid contaminating the instrument

Figure 2- Excerpts from HM-5 Module

It’s important to note that these modules have been assembled by those with hands on experience using the equipment. This means that in addition to the physical description of the equipment publicly available, there’s also advice and lessons learned from former IAEA inspectors. A key facet of this program is that students won’t simply be learning how to use the equipment; they’ll also be learning why the equipment is used with background information on the IAEA’s use of the equipment.

Course Equipment

There is a wide variety of equipment used by the IAEA in fuel cycle and safeguards verification. This training course focuses on both attended and unattended systems employed by the IAEA, as each serves a specific purpose. The unattended systems that students will train on include the Digital Multi-Camera Optical System (DMOS), modern electro-optical sealing systems (VACOSS and EOSS), Next Generation ADAM Module (NGAM), and the Mini-Grand (Gamma-Ray and Neutron Detector). The attended systems students will train on include the Handheld Monitor version 5 (HM-5), the 3-Dimensional Laser Ranger Finder (3DLR), and the Digital Cerenkov Viewing Device (DCVD). A sample of this equipment is illustrated in Figure 3.
The Digital Multi-Camera Optical Surveillance (DMOS) System is a safeguards video surveillance system with an automated surveillance review using the General Automated Review System (GARS). The DMOS system features authentication and encryption capabilities, inside in a tamper-resistant and tamper-indicating housing. This is an integral part of the safeguards monitoring conducted by the IAEA.

The modern electro-optical sealing systems include the Variable Coding Optical Sealing System (VACOSS) and the next generation Electro-Optical Sealing System (EOSS). The VACOSS fiber optic seals are tremendously tamper resistant, and can provide up to two years of surveillance. The data recorded includes dates and times, to offer inspectors a wide variety of information during their inspections. The EOSS is a surveillance system which records any attempted integrity violations, with the ability to record encrypted inspection data.

The Next Generation ADAM Module (NGAM) is the latest generation of the data acquisition module (ADAM), originally produced as part of the spent fuel bundle counter and monitoring system for CANDU on-load refueled reactors. The Mini-GRAND (Gamma-Ray and Neutron Detector) is a flexible gamma and neutron detector system for the monitoring of uranium and plutonium bearing materials. The Mini-GRAND is designed to adapt to changing environments without loss of data, and includes an integrated battery in case the external power supply is interrupted for a length of time.

The Handheld Monitor version 5 (HM-5) is the current IAEA handheld radiation monitor commonly used by the IAEA to quickly assess the presence of, and identify declared and undeclared nuclear material and/or activities. The 3-Dimensional Laser Range Finder (3DLR) is used for the computerized mapping and surveying of nuclear facilities in three dimensions to verify safeguards relevant facility design information. The Digital Cerenkov Viewing Device (DCVD) is used for the semi-quantitative verification of spent fuel stored underwater in spent
fuel ponds and is based on the detection of the collimated Cerenkov glow in the UV spectrum characteristic of spent nuclear fuel.

**Looking Forward**

After the unaccredited, pilot version of the course is given, full accreditation will be acquired through IACET. Once the course receives accreditation, the goal is to offer the training again in Fall 2011. As the course progresses, more will be held with the possibility of increasing class size if deemed necessary. As new equipment becomes standard use by the IAEA, updates will also be made.

The measure of success for this training course would be the number of participants who go on to be hired by the IAEA Departments of Safeguards Operational Divisions. INL’s long term hope is to begin safeguards equipment development based on the intricacies learned by teaching this course.

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