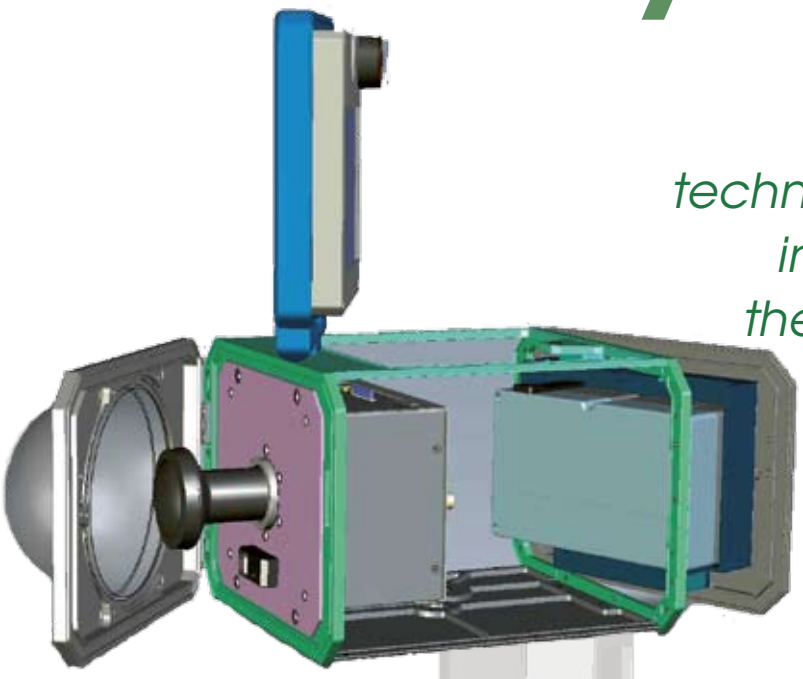
the tools of Today & Tomorrow

by Dana Sacchetti

A look at the evolution of the technology employed by safeguards inspectors for their work — where they've been, and what the future holds for verification tools.



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If the IAEA is going to live up to its billing as the 'world's nuclear watchdog' in the coming years, it certainly has its work cut out for it. Vast advances in technology, mounting proliferation challenges, and a quickly increasing workload all conspire to put increasing pressure on the IAEA in fulfilling its mission to implement effective nuclear safeguards.

The IAEA relies upon a wide array of devices and technologies to implement safeguards. Accounting for nuclear material calls for safeguards inspectors to quantitatively verify nuclear material during inspections. The inspectors do this by manually counting items such as fuel rods, assemblies, and nuclear material, as well as using nuclear-related techniques such as neutron counting or gamma ray spectrometry to distinguish if amounts of radioactive substances are in line with declared quantities.

Additionally, the IAEA has also to perform a "nuclear forensics" task, an activity that can trace the origin and history of nuclear material, typically in uranium conversion, enrichment and fabrication. Inspection experts in the field use handheld devices to collect and profile materials for their physical, chemical and isotopic properties, which can be further analyzed in the lab. Safeguards inspectors also employ environmental sampling techniques — identifying substances such as highly-enriched uranium particles and where they may have come from.

Remote monitoring has become an increasingly vital component of nuclear verification. By collecting images and data remotely, inspectors have pared down time spent in the field, saving money and time as a result. Providing an ability to monitor activities on a near real-time basis, remote monitoring also improves safeguards effectiveness. With transfer of data over secure networks becoming more economical each year, monitoring technologies are expected to increase in importance and use.

Another major change in safeguards technology has been the digitization of equipment, which made electronics smaller, lighter, and more capable. Though portable, the legacy devices that inspectors had traditionally brought into the field for measurements and analysis were bulky and unwieldy. "Some of the older instruments were huge. You had to be big and beefy just to carry them around!" explained Andrew Hamilton, Acting Section Head of the Safeguards Technical Support Coordination Section. "Devices that were once deemed portable wouldn't even be described that way anymore," said Hamilton.

Yet it's not simply the size of equipment that has changed over the years; their sophistication and complexities have also been improved. Some of the legacy devices and their resultant functionality have been combined into one device; machines that were used for single tasks have been integrated into more comprehensive, 'all-in-one' instruments.

While improvements have been made with the new equipment, some innovations have brought new challenges. In addition to an understanding of the technologies and nuclear facilities being inspected, a mastery of the complex set of tools available to complete the task is also required.

With most of today's inspection systems now driven by computers, it is incumbent upon inspectors to be proficient with technology.

"With every leap in technology, you solve certain problems, but you also introduce new issues that may be unforeseen," explained Michael Farnitano, Head of the Safeguards Support Programme Coordination Unit. "We typically go through cycles in equipment development. You develop a new technology, go through feasibility studies, deploy it, and then you gain experience and refine it. It takes 7-10 years to develop a major line of equipment."

The Tools of Tomorrow

Seeing far into the future to envisage which verification burdens may be placed on the IAEA is a sizeable task. With software and hardware development for safeguards already pushing against the laws of physics and technology, the onus is on the IAEA to ensure that the inspectorate of tomorrow knows what it will be up against. With the average piece of equipment taking nearly a half-decade to develop and deploy, IAEA safeguards has to look into its crystal ball to plan for the future.

Since a lot of the digital development was focused on simply upgrading analogue equipment for a digital age, what's the focus for the future of safeguards equipment?

Currently, certain measurements present a challenge to inspectors. Even with the latest technology, carrying out verification work with reprocessing and enrichment plant processes puts stress on the IAEA. With spent fuel, locating partial defects in fuel assemblies can be tricky. And with projections estimating that the volume of spent fuel will double during the next twelve years, the IAEA will need to design its safeguards approaches accordingly.

Further, due to the sensitive nature of the technology and access rights, monitoring the process of enrichment activities remains difficult. Yet the IAEA is currently at work on monitoring entire cascades of enrichment facilities to check if any deviations have occurred.

Additionally, new types of reactors and fuel cycle technologies will present new verification demands. Monitoring some of the next-generation nuclear installations in completely new venues — including pebble bed reactors, geological depositories, and pyroprocessing facilities, to name a few — will certainly keep IAEA safeguards tool developers on their toes.

It's no longer simply an understanding of the nuclear facilities and technologies that are being inspected, but also a mastery of the complex set of tools that are available to complete the task that are required.

To meet these challenges, the IAEA and its Member States are expected to embark on a new approach that would twin verification tool development with new plant and facility designs. When a new plant or reactor is designed, safeguards will be integrated into the build, helping to make 'safeguards friendly' installations. The instrumentation in new facilities will not just perform conventional measurements, but also can send detailed data to the IAEA on how the plant is operating and alert the inspectorate to any 'red flags' for further monitoring.

"With a new approach to collecting information, we are optimizing our verification activities through information-driven safeguards," said Hamilton. "Therefore, we expect that the life and skills of inspectors who are joining us in the coming years will be quite different from those of today."

To turn this concept into reality, the IAEA will work with plant vendors, Member States and other partners to bring this vision of shared instrumentation into the next generation of reactors, enrichment facilities, and reprocessing plants. The IAEA plans to accomplish this through multilateral meetings, sharing of roadmaps and, co-development of technology. Keeping ahead of the verification curve will require innovation and cooperation from both the IAEA and its Member States to meet tomorrow's challenges.

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