Endeavour Vol. 41 No. 2

Determining Nuclear Fingerprints: Glove Boxes, Radiation Protection, and the International Atomic Energy Agency

Maria Rentetzi*

National Technical University of Athens, Department of Humanities, Social Sciences and Law, School of Applied Mathematics and Physical Sciences, Zografou Campus, Zografou 15780, Athens, Greece

In a nuclear laboratory, a glove box is a windowed, sealed container equipped with two flexible gloves that allow the user to manipulate nuclear materials from the outside in an ostensibly safe environment. As a routine laboratory device, it invites neglect from historians and storytellers of science. Yet, since especially the Gulf War, glove boxes have put the interdependence of science, diplomacy, and politics into clear relief. Standing at the intersection of history of science and international history, technological materials and devices such as the glove box can provide penetrating insight into the role of international diplomatic organizations to the global circulation and control of scientific knowledge. The focus here is on the International Atomic Energy Agency.

On June 13, 2014, the front page of an International Atomic Energy Agency (IAEA) news release featured Gabriele Voigt, director of the IAEA Office of Safeguards Analytical Services, together with Vladimir Sucha, the European Commission Director General of the Joint Research Center, in front of a large glove box. The heading read, "Nuclear Material Laboratory: Meeting Milestones Toward Full Operation."[1] What they considered to be a milestone was the delivery of the first of twenty brand-new glove boxes to the safeguards laboratory—currently the Nuclear Material Laboratory—that would enable safe handling of nuclear materials. "By the end of 2014," argued Mark Scheland from the Department of Safeguards, "the IAEA will be operating a state-of-the art laboratory to help carry out one of its core functions—providing credible assurance that states are not diverting nuclear material from peaceful purposes."[2]

A product of the Nuclear Non-Proliferation Treaty that came into force in 1970, the first Safeguards Analytical Laboratory was established in 1967, in a facility leased by the IAEA, in order to detect the misuse of nuclear materials and technology and to ensure that member states were honoring their safeguards obligations. As provided by the treaty, the IAEA had a mandate to verify that a member state was living up to its commitment to use nuclear materials for peaceful purposes and not for making nuclear weapons. As part of the verification process, nuclear samples collected by IAEA safeguards inspectors from nuclear fuel cycle processes were sent for analysis to the Safeguards Analytical Laboratory. Given the highly sensitive nature of samples derived from inspections in nuclear facilities worldwide, each of these analyses was and is still performed in a restricted and controlled area of the IAEA laboratory specially equipped to avoid cross contamination and tampering with samples. The glove box played a key role in this process. Using state-of-the-art instruments such as glove boxes allowed IAEA researchers to accurately analyze radioactive swipe samples in a safe environment, determine minute traces of uranium or plutonium, and detect illicit uranium enrichment activity (Figure 1).

As David Donohue, previously the head of the IAEA Clean Laboratory for Safeguards, described the process:

> Analysis of samples can determine 'nuclear fingerprints', and reveal indicators of past and current activities in locations handling nuclear materials, particularly those associated with uranium conversion, fabrication, and enrichment. Determining such cases, however, requires expertise and the right equipment—the fingerprints of different isotopes,

*Fax: +30 210 7721618.
E-mail address: mrentetz@vt.edu
URL: http://mariarentetzi.weebly.com/

[1] International Atomic Energy Agency, "Nuclear Material Laboratory: Meeting Milestones Toward Full Operation," accessed January 31, 2017, https://www.iaea.org/newscenter/news/nuclear-material-laboratory-meeting-milestones-towards-full-operation. The photograph can be viewed at the link above. Its caption reads: "Ms. Gabriele Voigt, Director, IAEA Office of Safeguards Analytical Services, and Mr. Vladimir Sucha, European Commission Director General for the Joint Research Center, inaugurate the first newly installed laboratory glove box in the IAEA Nuclear Material Laboratory."

Available online 18 March 2017

[2] Mark Scheland, "Nuclear Material Laboratory: Meeting Milestones Wards Full Operation," *IAEA News Release*, June 13, 2014, https://www.iaea.org/newscenter/news/nuclear-material-laboratory-meeting-milestones-towards-full-operation.

 http://dx.doi.org/10.1016/j.endeavour.2017.02.001

Figure 1. Shown is a series of glove boxes, which permit gram quantities of plutonium to be processed for analysis at the IAEA's Safeguards Analytical Laboratory, 1985. (Courtesy of the Archives of the International Atomic Energy Agency, no. A0739).

for example, can overlap, and an abundant constituent of one element can mask a rare one. Reaching conclusions can be tricky, often requiring multiple dimensional analytical approaches.[3]

In the mid-2000s it became obvious that IAEA could no longer meet the high demand for its analytical services using an aged facility that did not even meet the United Nations safety requirements. A modernization program was soon put forward in order to improve IAEA's analytical capabilities by completely renovating the safeguards laboratories. Glove boxes, as Voigt's and Sucha's photograph indicates, became the emblem of IAEA's modernization. The agency spent €0.680 million for the disposal of older glove boxes and €77.16 million in total for the modernization of its laboratories, generously sponsored by the European Union.[4]

But why, in 2014, did the IAEA trumpet the installation of glove boxes, which were among the first and most rudimentary tools of nuclear science, dating from the mid-1940s? Standing at the intersection of history of science and international history, technological materials and devices can provide penetrating insight into the role of international diplomatic organizations in the global circulation and control of scientific knowledge. Material objects define and contain the activities of scientific organizations. In the case of the IAEA, the glove box did not only have actual practical necessity, as a way to provide a safe and clean working environment. It had also symbolic significance to a newly redefined agency. The glove box, as a symbol, both points to major and real concerns over international nuclear security and underlines a significant evolution in the IAEA's mission. From promoting peaceful uses of nuclear energy and isotopes throughout the second half of the twentieth century, the IAEA of the twenty-first century has sifted focus—through elegant diplomatic negotiations—to more oversight authority, establishing a critical and influential policy mechanism in order to enforce the Nuclear Non-Proliferation Treaty in member states.

Without a doubt, the IAEA has played a crucial role in a number of scientific, political, and diplomatic issues ranging from the establishment of nuclear industry and the offer of technical assistance and the education of generations of scientists in nuclear matters in a number of countries worldwide to the exercise of political power and diplomatic influence in order to safeguard the use of nuclear energy. Operating at the intersection of nuclear science and diplomacy, the IAEA has attracted immense political attention throughout the second half of the twentieth century and continues to do so as we move well into the twenty-first. The growing presence of scientific and technical experts in IAEA's diplomatic affairs and the agency's central role in settling global scientific issues make clear that the precondition for any scientific collaboration among nations has been their political cooperation. This increasing intimacy of postwar nuclear science with global diplomacy and the need of exhaustive diplomatic negotiations in order to settle scientific issues on a global scale necessitates a diplomatic turn in the history of science: diplomacy becomes central in analyzing postwar science and technology. Attention to global diplomacy becomes necessary to understand how scientific knowledge and technological materials have been shaped in reference to and shaped the course of nuclear matters. Given the sensitive intertwinement of science and diplomacy throughout the IAEA's history, it is problematic that this has been largely left to in-house historians. At the same time, the rich material culture of IAEA's laboratories has been neglected. Here I began to fill in the history of both.

[3] David Donohue, "Key Tools for Nuclear Inspections: Advances in Environmental Sampling Strengthen Safeguards," *Bulletin of the IAEA* 44, no. 2 (2002): 17–23, on 20. The Clean Laboratory provides assurance that no undeclared activities have occurred in any member states while the Nuclear Material Laboratory provides assurance that member states are providing accurate information concerning the types and quantities of nuclear materials held on their territory.

[4] Caroline Aggestan-Pontoppida and Isabell Andernack, *Interpretation and Application of IPSAS* (Chichester, UK: Wiley, 2016), 267; Green Andrew and Aabha Dixit, "IAEA Safeguards Labs More Efficient and Accurate Thanks to Recent Upgrades," IAEA Press Release, June 10, 2016, https://www.iaea.org/newscenter/news/iaea-safeguards-labs-more-efficient-and-accurate-thanks-to-recent-upgrades.