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Bringing Small Devices, Giving Design Advice: Introducing Radiation Protection Practices in Greece via the IAEA's Visiting Professor Program**

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Summary: This paper examines how an International Atomic Energy Agency (IAEA) expert mission for technical assistance in the late 1950s to Greece was effectively transformed into a mission to achieve the IAEA's central objective: to consolidate its position as the leading global authority on radiation protection. The study focuses on the work of Alfred Maddock, a professor at the University of Cambridge. In 1959, Maddock arrived in Greece as part of one of the IAEA's original missions, contributing to an educational program on radioisotopes. Beyond providing educational services, Maddock accomplished something more significant. As the Agency's facilitator, he introduced radiation protection materials and concepts to the country in accordance with the IAEA protocols. He introduced dosimetry devices (film badges) and, at the same time, reviewed, modified, and created architectural plans for the laboratories of the Greek Nuclear Centre to meet the IAEA safety standards. It is argued that Maddock's visit to Greece transcended a mere one-sided enforcement process. Rather, it catalyzed a dynamic interaction between Greece and the IAEA, characterized by robust elements of mutual cooperation. This mission stands as a prime example

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of the gradual integration of IAEA culture within a member state, tailored to local needs and conditions.

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1. Introduction

“I have the honour to submit a request for a Lecturer in radiochemistry to participate in the next Radioisotopes Training Course to be organised by the Greek Atomic Energy Commission.” With these words, in February 1959, the President of the Greek AEC, Athanasios Spanidis, submitted a request to the International Atomic Energy Agency, regarding IAEA’s first Technical Assistance Mission to the Greek Atomic Energy Commission. He went on to specify that the country would provide the IAEA envoy with adequate teaching facilities, as well as with a “chemical laboratory meeting the Agency’s health physics regulations.”¹ However, both the Greek authorities and IAEA officials knew that this was not accurate. At that time, Greece had not yet enacted a set of radiation protection regulations. In fact, this phrase was an oblique promise from Athens’ side that it would follow Vienna’s directions, in order to benefit from the Agency’s technical assistance in setting up its nuclear center.²

Meanwhile, on the day this letter was sent off from Athens, two high-ranking IAEA officials were in Greece as part of a short IAEA visit. In fact, this letter, like many similar ones for other occasions, was drafted by the Greeks in consultation with the two IAEA officials. These two officials, having gained a full picture of the nuclear situation in Greece, made very careful moves to earn the trust of the Greek authorities, in their effort to align the country with the IAEA agenda.³

At that time, the IAEA had not yet completed two years of operation. Having been formally established in 1957, after three years of intensive preparation and diplomatic negotiations between various states, it was just beginning to establish itself as a major player in the global nuclear order. For this reason, the Agency’s identity and role at that time were somewhat fluid.⁴ In contrast to the current perception of the IAEA as a nuclear watchdog, in its early years, it likely functioned more as a promoter of atomic energy worldwide.⁵ This focus probably also served as a unifying element among its core member states with Technical Assistance being presented as a lever for nuclear development. After all, the promise of offering nuclear development to

¹ Athanasios Spanides to IAEA, 10 February 1959, International Atomic Energy Agency Archives, Vienna (henceforth IAEA Archives), SC/216-1 GRE-1, Box 8620.

² On IAEA’s establishment and history, see Roehrllich 2022.

³ For a more detailed presentation of the IAEA mission by Ole Pedersen and Herbert Vetter to Greece, see Freris, forthcoming-b.

⁴ Roehrllich 2022.

⁵ Hamblin 2020.

so-called underdeveloped states⁶ through technical assistance was one of the most important reasons the Soviet Union agreed to sit at the negotiating table for an American-inspired agency on nuclear issues.⁷ By cooperating with the IAEA, the Soviet Union could demonstrate solidarity with developing countries and counterbalance the influence of the US, which had the “patent” on technical assistance in the nuclear field.⁸

In this context, with the offer of technical assistance being one of the Agency’s priorities, it is not surprising that just a few days after the Greek request was sent, all the necessary arrangements were completed for its smooth processing. The IAEA had entrusted this task to Alfred Maddock, an esteemed lecturer in radiation chemistry at the University of Cambridge. Although Maddock readily accepted the mission, at the outset of his engagement with Greece, he was confronted with considerable uncertainty regarding the laboratory equipment. Specifically, he harbored serious reservations about whether the available resources would be adequate for the successful execution of a pivotal aspect of his mission: the delivery of a seminar series at the Greek Isotope School.⁹

It was a time when basic laboratory facilities were just starting to develop around the nuclear reactor under construction in Greece.¹⁰ Assessing the situation, Maddock expressed his concerns to the IAEA that, given the circumstances, the course had very little chance to succeed. In a letter marked by a sense of urgency, Maddock underscored the imperative need for deploying the Mobile Radioisotope Laboratory in Greece. He asserted that there was, without a doubt, a “very strong case” for such an intervention.¹¹ This communication set in motion the mechanism that would dispatch the IAEA’s

⁶ In the UN jargon of that period, the terms “developing,” “underdeveloped,” and “less developed” countries were used interchangeably.

⁷ Angela Creager and Maria Rentetzi have described the IAEA as a “brainchild of the US.” Creager and Rentetzi 2022, on 112. After all, the 1953 speech by then US President D. Eisenhower, which has been remembered as a speech by Atoms for Peace, is considered ground zero in the history of the founding of the IAEA. For the “Atoms for Peace,” see Krige 2006.

⁸ Roehrich 2022; Mateos and Suárez-Díaz 2020.

⁹ C. Ribeiro to A. Maddock, 17 February 1959; A. Maddock to C. Ribeiro, 23 February 1959; A. Maddock to H. Vetter, 27 February 1959, IAEA Archives, SC/216-1 GRE-1, Box 8620.

¹⁰ On the development of Greece’s nuclear research program, see: Rentetzi 2010; Rentetzi 2009.

¹¹ A. Maddock to H. Vetter, 27 February 1959, IAEA Archives, SC/216-1 GRE-1, Box 8620.

Mobile Radioisotope Laboratory—the Agency’s first truly major technical assistance program—to its initial travel, from Vienna to Athens.¹²

[If1]

Nevertheless, the mobile laboratory was not Maddock’s only initiative. He actively took on the responsibility of introducing radiation protection principles and fostering a culture aligned with the IAEA protocols. His contributions included the integration of dosimetry devices, such as film badges, and the thorough review, modification, and initiation of architectural plans for the radiochemical laboratories. These meticulous adjustments aimed at ensuring strict adherence to the IAEA radiation protection standards. What is highlighted here is that, whether or not radiation protection was explicitly stated as an objective during these expert missions, it consistently played an integral role in advancing the overarching goal of solidifying the IAEA’s status among its member states as the primary global authority in radiation protection. Given the evolving role of the IAEA and the politically sensitive nature of its statutory safeguard’s responsibilities, the promotion of radiation protection principles through technical assistance missions has constituted a primary focus for the Agency in its early years.¹³

While these initiatives were undertaken without the involvement of the Greek side, the radiation protection principles of the Agency, as conveyed during the Maddock mission, were not imposed through force and coercion. On the contrary, this historical example foregrounds the dynamic interaction between Greece and the IAEA within the context of a Technical Assistance Mission. Maddock’s introduction of the IAEA culture—ideas, concepts, theories, techniques, practices, and data—was embraced by the Greeks not out of subjugation to the IAEA, but rather because they recognized the IAEA as an ally in their nuclear development. Moreover, this historical episode highlights that the IAEA’s culture was not rigidly transferred from the experts to the Member State, but rather adapted. The adoption of specific practices was closely tied to the unique contexts and needs of local environments, reflecting the differing expectations, needs, and agendas of the communities involved. In

¹² The IAEA technical assistance project featuring two mobile radioisotope laboratories has sparked interest among many science historians in recent years. As demonstrated by Gisela Mateos and Edna Suárez-Díaz in two studies on the case of Latin America, the mobile laboratory emerged as the ideal material medium for globally conveying the profound symbolism of the “friendly atom” and the developmental prospects it promised: Mateos and Suárez-Díaz 2019; Mateos and Suárez-Díaz 2023. For a study examining the transformation of Mobile Radioisotope Laboratory—a technoscientific artifact—into a diplomatic gift entailing political commitments for both the donor and the recipient, see Rentetzi 2021. For an extended study of the IAEA’s laboratory visit to Greece, see Freris 2018. For the mobile lab in Ghana, see Osseo-Asare 2019. For a study on the two mobile laboratories as part of an educational program with anti-communist objectives, see Hof 20204. For a study spotlighting diplomatic negotiations that enabled the mobile lab introduction in Greece and ultimately transformed it into a diplomatic bag, see Rentetzi and Freris, forthcoming.

¹³ In its initial years of operation, the IAEA encountered considerable obstacles in establishing itself as a nuclear non-proliferation observer. The provision of technical assistance to its member states has proven to be a more politically advantageous strategy. For further details, see: Hamblin 2021; Roehlich 2022; Creager and Rentetzi 2022.

other words, it was a gradual process that required adjustments by the organization transferring its practices and incremental commitment from the ‘learner’ country.

The film badge dosimeters were introduced so that the IAEA would guarantee the safe use of radioactive substances. In Greece, however, there was no existing film badge service capable of measuring and evaluating these devices.¹⁴ The IAEA, leveraging its network and prestige, engaged another Viennese institution for this task, providing Greeks with a sense of security and earning their trust. In the realm of architectural design for nuclear facilities, Maddock’s visit to Greece illustrates how knowledge adapts to unique geographical conditions. The departure from established norms, which mandated the construction of exclusively single-story radiochemical laboratories, became imperative when confronted with a steep slope in Greece.¹⁵ This shift underscores the flexibility of regulation in addressing challenges posed by local topography. In contrast to the rigid and unchanging nature of radiation protection discourse, what emerges here is the dynamic and adaptive knowledge shaped by the constantly evolving interaction of local conditions and human efforts.

2. Searching for a Lecturer in Radiochemistry

During the first ten days of February 1959, two IAEA officials were in Greece: Ole Pedersen, Senior Officer in the Division of Economic and Technical Assistance, and Herbert Vetter, Senior Officer in the Division of Radioisotopes.¹⁶ These two IAEA officials were conducting a small-scale Preliminary Assistance Mission (PAM). PAMs were missions aimed at conducting on-site studies and devising suitable strategies according to the IAEA, thus enabling what the IAEA classified as developing nations to enter the atomic age. Essentially, they were missions designed to align the member states of the then newly established Agency with its agenda.¹⁷

As Mateos and Suárez-Díaz aptly argued for the IAEA PAMs—missions similar to those of Vetter and Pedersen in Greece—, their primary objective was to facilitate “the request for future assistance.”¹⁸ Here, the term “assistance” refers to the technical support provided by the Agency to its members, including an extensive fellowship program, expert missions, and equipment.¹⁹

¹⁴ This changed a few years later, with the active participation of the IAEA. On this, see Freris, forthcoming-b.

¹⁵ Until recently, this general principle was proposed by the IAEA: “A radioisotope production facility is preferably constructed as a single storey building to remove any doubt whether the top floor can carry the weight of shielding.” IAEA 2004, on 2.

¹⁶ Ole Pedersen and Herbert Vetter, Report on Mission to the Greece (1–11 February 1959), 1 January 1959, IAEA Archives, Technical Assistance Country Files Greece Folder.

¹⁷ For the first such mission of the IAEA, see Mateos and Suárez-Díaz 2021.

¹⁸ *Ibid.*, on 91.

¹⁹ For an examination of the material and practical implementation of the institution of Technical Assistance linked with development, see Mateos and Suárez-Díaz 2020.

The fellowship program enabled young scientists from various countries to receive training in large nuclear laboratories abroad, where they acquired knowledge about laboratory equipment and local experimental practices. These fellows then transferred the knowledge they gained to their home countries. On the other hand, the expert missions allowed the IAEA to gain an understanding of the prevailing conditions worldwide, with experts focusing on modernizing laboratory equipment in different member states according to the IAEA standards. In short, the role of Technical Assistance can be described as a perpetual circulation of knowledge across national borders.²⁰ Furthermore, as has been argued, one of the primary objectives of the IAEA Technical Assistance was to facilitate the transfer and establishment of a common culture of radiation protection among the member states.²¹

Since joining the IAEA in 1957, the year of the Agency's establishment, Greece has viewed this international organization as an ally in its nuclear development efforts. The Greek Atomic Energy Commission was established a few years earlier, in 1954.²² As part of the Dwight Eisenhower's "Atoms for Peace" program, Greece signed a bilateral agreement with the USA in 1955 to acquire a research nuclear reactor. This reactor was inaugurated in the summer of 1961 on the outskirts of Athens, marking the establishment of Greece's first, and ultimately only, nuclear research center, "Demokritos."²³

In 1959, as the construction of the reactor and its supporting laboratories progressed, the Greek AEC was in the process of organizing an educational program on radioisotopes (the Isotope School), scheduled to commence in March of the same year in collaboration with the University of Athens. This marked the fourth cycle of the Isotope School to be conducted in the country.²⁴ There was an immediate need to train young scientists at such a level that they could undergo further training abroad, if not work directly at Demokritos, the Greek nuclear center.²⁵ The Commission's aspiration was to create a seminar series similar to that held at Oak Ridge Laboratories in the

²⁰ Krige 2022, on 3.

²¹ Freris, forthcoming-b.

²² Freris, forthcoming-a.

²³ Rentetzi 2010; Rentetzi 2009; Dimitrokali 2018.

²⁴ The third cycle ended in May 1958. Minutes of the Greek National Atomic Energy Commission, 23 May 1958, Greek Atomic Energy Commission Archives, Athens (please note that instead of consulting the original, I have consulted a copy of this document in the possession of Maria Rentetzi[lif2]).

²⁵ The Greek Isotope School played a pivotal role in the education of young Greek scientists, who would later emerge as the first researchers at the Greek nuclear research center, Demokritos. Apart from being the sole repository of such knowledge in Greece during that period, the school also served as a tank for individuals destined for further training abroad. To be eligible for the foreign fellowships administered by the Greek AEC, attendance at this school was a prerequisite. Ole Pedersen and Herbert Vetter, Report on Mission to the Greece (1–11 February 1959), 1 January 1959, IAEA Archives, Technical Assistance Country Files Greece Folder.

USA or the British Harwell.²⁶ Faced with the absence of a qualified expert in radiochemistry, on 10 February 1959, under the guidance of two IAEA officials, the president of the Greek Atomic Energy Commission formally requested the IAEA's assistance in securing a "Lecturer in radiochemistry."²⁷ The intended role involved not only providing crucial support to Greek initiatives within the Isotope School framework, but also offering guidance on constructing the radiochemistry laboratory. This request by the Greek AEC marked the first formal written appeal for technical assistance to the IAEA. Simultaneously, it represented the inaugural instance of the Agency establishing the institution of a visiting professor in one of its member states.²⁸

In response to Greece's request, the Agency promptly invited Alfred Maddock to undertake this task. At that time, Maddock, a professor at Cambridge, had already built a significant career in nuclear research. Beginning with the Tube Alloys Project, the UK's nuclear weapons secret research program during World War II, he then joined Frédéric Joliot's team at the Cavendish Laboratory in 1941 and later relocated to Canada, where he assisted in the design of the Chalk River nuclear reactor. After the war, he played a role in designing the radiochemical laboratory at Harwell and contributed to the establishment of the Argentine nuclear research program in 1953.²⁹ Having gained recognition for his expertise and connections, the IAEA considered him an ideal candidate for such an assignment.

Maddock accepted the invitation, expressing his pleasure in joining the mission in Greece. Although Herbert Vetter, having closely followed the situation in Greece, provided him with some feedback about the country, the short notice and lack of information from the Greek AEC left him working in the dark.³⁰ In response to potential shortages of experimental devices and laboratory materials in Greece, Maddock took proactive measures. He inquired with Vetter about the Agency's resources, specifically mentioning the availability of two mobile units equipped with counting equipment. This inquiry coincided with a circular letter from Sterling Cole, the Agency's first General Director, issued three days before, outlining the Agency's major Technical Assistance program involving two mobile laboratories. Two mobile units, in fact two radioisotope laboratories mounted on truck chassis, were constructed in Oak Ridge and donated to the IAEA by the United States.³¹

According to Maria Rentetzi, this initiative was not a naive donation from the US. Instead, it embodied the US vision of promoting its research

²⁶ These schools not only educated participants but also facilitated the transfer of knowledge from the United States and Britain to numerous locations across the globe. Those involved in these programs played a pivotal role in realizing "Atoms for Peace" in their nations. See Herran 2006; Krige 2010.

²⁷ A. Spanides to IAEA, 10 February 1959, IAEA Archives, SC/216-1 GRE-1, Box 8620.

²⁸ Press Release, 26 March 1959, IAEA Archives, PR 59/22.

²⁹ Bethell 1995, on 518; Bancroft and Ebsworth 2009.

³⁰ H. Vetter to A. Maddock, 23 February 1959; A. Maddock to H. Vetter, 27 February 1959, IAEA Archives, SC/216-1 GRE-1, Box 8620.

³¹ S. Cole, circular letter to all members states, 24 February 1959, IAEA Archives, Box 106; Rentetzi 2021.

institutions and experimental practices, concurrently advancing political and diplomatic objectives and enabling the US to uphold its leadership in nuclear energy regulation. From the Agency's perspective, these two mobile laboratories represented a significant asset. They could efficiently and inexpensively facilitate the training of emerging scientists and engineers worldwide in the detection and measurement of radioactive materials. The primary goal was to acquaint science students from various nations, who had limited or no access to equivalent equipment, with state-of-the-art instrumentation and methodologies for handling radioisotopes in critical economic sectors like agriculture, medicine, and industry.³² As Barabara Hof put it, this donation should be viewed in the context of the US policy of offering training opportunities to foreign nationals from carefully selected nations.³³ Maddock, who was experienced enough to understand the logic behind this move, considered it an appealing solution for Greece.

3. Film Badges: Tiny Devices with a Big Job

When Maddock welcomed the mobile laboratory in Athens, he was essentially greeting the arrival of the International Atomic Energy Agency's material culture on wheels.³⁴ He was now prepared to commence his lectures for young scientists in Greece. However, there was still one thing missing. A week before, he had sent a letter to the IAEA headquarters, notifying them of his arrival in Athens. In the same letter, he addressed Arturo Cairo, the acting director of Training and Exchange Programs at the IAEA, requesting a favor. "From what I gather, no Film Badge Service has been established in Greece," he wrote, adding, "I believe it would be most convenient for you to arrange the supply of 24 film badges from Vienna, and for me to return the exposed badges for processing. Do you think this could be accomplished without significant difficulty?"³⁵

The film badges Maddock was referring to were small, portable devices that performed a crucial task. They were essentially dosimeters containing photographic film. Radiation workers wore these badges, usually on their clothes or in their pockets. The film inside the badge was exposed to radiation during their work. After a specific period, the film was developed and analyzed to measure the amount of radiation to which the worker had been exposed—specifically, by measuring how much darker the photographic paper had become.

Film dosimetry, a technique for assessing radiation, originated in the early 1900s, coinciding with the "Golden Age of Radiology."³⁶ Experts in this field advised radiation workers to keep an unexposed dental X-ray film in their

³² Rentetzi 2021.

³³ Hof 2024.

³⁴ Rentetzi and Ito 2021.

³⁵ A. Maddock to A. Cairo, 31 March 1959, IAEA Archives, SC/216-1 GRE-1, Box 8620.

³⁶ Brodsky and Willis 1995.

pockets. After a designated period, they would assess the extent of darkening on the film, correlating it with the level of radiation exposure. Over time, advancements refined this method, introducing a specialized badge equipped with filters for enhanced accuracy. Additionally, the establishment of a standardized unit for measuring radiation, known as the roentgen, facilitated a more comprehensible and comparable evaluation of radiation exposure.³⁷

The Manhattan Project in World War II greatly advanced film badge development, driven by the imperative of radiation safety during nuclear energy research for atomic weapons. The Health Division of the Manhattan Project, led by figures like Ernest Wollan, played a crucial role.³⁸ Wollan's contribution, drawing from his experience at the Chicago Tumor Institute and his expertise in radiation dosimetry, was critical when the Metallurgical Laboratory of the Manhattan District was established at the University of Chicago around 1941. His focus on measuring radiation exposure led to the creation of the first reliable film badge dosimeter. This innovation proved instrumental in accurately monitoring cumulative radiation exposure for scientists and medical personnel, anticipating health and radiation challenges from the nuclear chain reaction.³⁹

Back in Greece and in Maddock's mission, on the day Maddock's lectures at the Greek Isotopes School began, the IAEA envoy received a telegram from Vienna. In it, Arturo Cairo informed Maddock about the progress of his request.⁴⁰ "We have this morning sent, by air, 27 badge films, ready for use," Maddock would read a few days later when he received a regular letter in the mail. Cairo added, "The film of the badge is particularly sensitive to X-rays. I give you this information, but know that you know perfectly well how to use and handle them."⁴¹ Cairo was acquainted with Maddock and his scientific prowess. As a matter of fact, the two had known each other since Cairo, working as a chemist, became the director of the newly established General Chemistry Laboratory in Argentina in the early 1950s.⁴²

And he would certainly know how to use them. Both Maddock and the other nuclear scientists in leading laboratories and universities at the time were aware of the importance of these dosimeters. In 1949, the US Atomic Energy Commission convened its first tripartite conference in Chalk River, Canada. Experts from the US, UK, and Canada gathered to scrutinize diverse health and safety facets of the atomic energy program, including discussions on the ideal placement of dosimeter badge tapes on the body.⁴³ Likewise, the inaugural publication endorsed by the IAEA, titled "Safe Handling of Radioisotopes" in 1958, unequivocally asserted that the "film dosimeter" stood as "the preferred device" for gauging absorbed radioactivity. Notably, the

³⁷ Hamilton 2018; Brodsky and Willis 1995.

³⁸ Brodsky and Willis 1995; Hacker 1987.

³⁹ Snell et al. 1984.

⁴⁰ A. Cairo, telegram to A. Maddock, 7 April 1959, IAEA Archives, SC/216-1 GRE-1, Box 8620.

⁴¹ Ibid.

⁴² Bethell 1994, on 518.

⁴³ Taylor 1984; Boudia 2007.

manual's authors underscored the imperative need for adhering to established protocols when employing dosimeters for radiation protection, cautioning that without the adoption of standardized procedures, "serious errors may occur."⁴⁴ In essence, the communicated message was that Member States must adopt the IAEA standards if they wish to navigate the atomic age safely. This manual, like other similar regulatory standards, had one main purpose: to promote uniform standards. Through them, the IAEA sought to promote the safe and manageable use of atomic energy and its applications.⁴⁵

However, the publication of a set of regulations does not automatically imply their enforcement, and this was not something unique to Greece.⁴⁶ The enforcement of regulations, or rather, their acceptance by the apprentice, is contingent on the adoption of a particular practice and also on access to a specific material culture. For instance, as early as the late 1940s, the US National Committee on Radiation Protection (NCRP)—successor to the pre-war US Advisory Committee on X-rays and Radium Protection—recommended weekly monitoring of staff exposure to ensure that radiation exposure remained below the specified levels.⁴⁷ In an effort to promote compliance with these safety guidelines, the NCRP's Isotope Division made film badges available to purchasers of radioisotopes. These badges could be returned to Oak Ridge, which would process them and then provide the users with their results.⁴⁸ Their small size gave the nuclear authority great flexibility. As Joseph Masco notes, during the early nuclear age, dosimeters were "a central means of transforming nuclear physics into immutable mobiles, texts that can travel and be repurposed within a wide range of narrative structures."⁴⁹

Something akin to this practice occurred during Maddock's mission in Greece. Given that no services were available in the country for processing dosimeters and measuring the radiation exposure of individuals wearing them, Maddock had to carry out this procedure abroad. During this period, it had recently been disclosed that an IAEA laboratory was to be constructed in Seibersdorf, near Vienna;⁵⁰ however, the IAEA could not yet provide and process dosimeters. To assist Maddock, the Agency collaborated with the Physical-Technical Testing Institute for Radiology and Electromedicine (Physikalisch-Technische Prüfanstalt für Radiologie und Elektromedizin) in Vienna. The proposed arrangement entailed the IAEA borrowing dosimeters from the Vienna Institute. As Maddock prepared to return to Vienna, he received a specific directive from the IAEA: "Please bring the list [of users] and all 27 badges with you when you return." Subsequently, the dosimeters would be

⁴⁴ IAEA 1958, on 21.

⁴⁵ Creager and Rentetzi 2022.

⁴⁶ Similarly complex was the transition from theory to practice in Thailand in the 1960s, when the World Health Organization, through an expert, attempted to implement the written guidelines for the safe use of atomic energy. Richards 2014, on 85.

⁴⁷ Taylor 1979.

⁴⁸ Creager 2015.

⁴⁹ Masco 2022, on 55–56. For the concept of "immutable mobile," see Latour 1986.

⁵⁰ Rentetzi 2022.

processed by the Institute, and the results would be forwarded to the Greek authorities.⁵¹

Although the institute cooperated with the IAEA and sent those dosimeters, it should be understood that there was fluidity in radiation protection measures and in the ways they were enforced at that time. Even in Vienna—a city with a rich tradition in radioactivity research before World War II⁵²—the enforcement of radiation protection rules was not a simple matter. The Physical-Technical Testing Institute for Radiology and Electromedicine was founded in 1955 by merging two older research institutes. Under its mandate, it issued certificates and expert opinions for the entire federal territory, covering both medical and technical applications of radiation. Although the tasks spanned the fields of radiology, atomic dosimetry, and electromedicine, radiation protection was, at that time, only a marginal issue, given the absence of legal regulations or generally recognized rules. It was only after 1969, following the passage of the Radiation Protection Act in Austria, that the main institutionalized tasks of the institute included periodic inspections of radiation facilities in accordance with the relevant law.⁵³

In this context, the importance of the introduction of dosimeters in Greece becomes even more evident. For many, if not all those who participated in the Isotope School and in the educational experiments that would take place under the supervision of the IAEA delegate, it would be the first time they would use such a dosimeter. It is noteworthy that the young researcher Eleni Sifaki, who was among the trainees, would wear such a badge on her body for the first time. A few months later she would leave Greece to go to Bologna, Italy—becoming the first Greek woman to receive a scholarship from the IAEA—where she received training in photodosimetry principles. The assignment of photodosimetry, often seen as a tedious or administrative task in the scientific world, was frequently relegated to women, deemed more “naturally suited” for such tasks in a gendered division of labor.⁵⁴ Sifaki’s career reflects both the structural limitations and opportunities for women in science at the time. Upon her return she would be the one who would essentially set up from scratch the department of photographic dosimetry at Demokritos and then record, for many years, the doses of ionizing radiation received by those handling radioactive materials in the country.

When Maddock left Greece for Vienna, he took the borrowed Viennese dosimeters with him to return them, as required by the IAEA. However, it was realized that, out of the 27 badges sent to Greece, only 8 had arrived in Austria. The rest had remained in Greece, which probably did not satisfy the Viennese Institute. “I am therefore sure you will understand that this Austrian institution requires them for its own use,” Cairo wrote to the president of the Greek AEC, Athanasios Spanidis, adding that since the film badges are

⁵¹ A. Cairo to A. Maddock, 7 April 1959, IAEA Archives SC/216-1 GRE-1, Box 8620.

⁵² Rentetzi 2008.

⁵³ Schmidt and Steger 2014.

⁵⁴ Klempay, forthcoming. For the gender-based division of scientific work in post-war era, see Rossiter 1995.

“difficult to replace,” the Institute “has asked for the return of the remaining 19 from the total of 27 which were sent to you early in April.”⁵⁵

The archival data do not provide an explanation as to why some of the dosimeters were left behind. One plausible scenario is that the Greeks retained them for use during the remaining weeks of the Isotope School, which continued after Maddock’s departure. However, given the absence of a film badge service in Greece—meaning a service capable of interpreting the results contained within these small boxes—these 19 dosimeters were rendered useless to them. Thus, what stands out is the fact that, during that period, these compact dosimeters held a value so significant that even a prominent Austrian institute could not overlook. In any case, the Greeks eventually returned the dosimeters, and a month later, they received a letter from the IAEA. They enclosed “two copies of the list we have received from the Physikalisch-Technische Pruefanstalt, Vienna, providing the results.”⁵⁶ Notably, the Greek trainees, whose radiation exposure was being measured, were entirely absent throughout this process. In fact, from the early days of dosimeters until today, their analysis has been done in the absence of those who wore them.⁵⁷

Furthermore, the available records do not include the list of individuals who wore these dosimeters and the corresponding doses they received. However, it seems that this list has been obtained by the Greeks, and it could be assumed that all dosimeter results were likely within safety boundaries, especially since other records attest to the successful conclusion of Maddock’s mission to Greece. In any case, reasonable questions arise. For example, what if radiation limits were surpassed? At that time, Greece lacked legislation on safe radiation thresholds and had not formally adopted the IAEA’s recommendations. Therefore, it is evident that this procedure was characterized by a high degree of vagueness.

The IAEA, in cooperation with the Vienna Institute, seems to have attempted to pass on to the Greeks a specific practice; sequence of procedures: I pin the film badge on my clothes; after a designated period, I submit it for measurement; I receive the results, and so forth from the beginning. In other words, film badges represented one of the most critical links in the bureaucratization of radiation protection.⁵⁸ Furthermore, it is crucial to acknowledge that, “dosimeters have never been ‘purely scientific.’”⁵⁹ They operated in a manner that turned exposure to low-level radiation into a routine affair. In other words, they instilled a sense of security for users of radioactive substances while absolving the state or the Agency of responsibility for anything other than serious health incidents.⁶⁰ In doing so, the film badges

⁵⁵ A. Cairo to A. Spanidis, 6 May 1959, IAEA Archives, SC/216-1 GRE-1, Box 8620.

⁵⁶ C. Ribeiro to A. Spanidis, 9 June 1959, IAEA Archives, SC/216-1 GRE-1, Box 8620.

⁵⁷ Rentetzi 2020, on 488.

⁵⁸ For an analysis that views film badges as a “bureaucratic medium” of radiation protection, see Klempay, forthcoming.

⁵⁹ Rentetzi 2020, on 488.

⁶⁰ Masco 2022. There are historical research examples showing that film badges were not the most reliable technology. For instance, in the early 1960s in Thailand, it was observed that due to the heat and humidity, film badges did not always function properly. Richards 2014, on 84.

served as a material means “for increasing the social acceptability of controversial technologies”⁶¹ within a risk society⁶²—a small box embodying an international system for regulating radiation risks.

4. Architectural and Material Manifestation of Radiation Protection

When Maddock arrived in Greece in 1959, construction work on the reactor building and other facilities that would constitute the Greek nuclear center Demokritos was still in early stages. Although the project’s construction had commenced in 1956 with the land acquisition and was set to be completed in 1961, only a few temporary laboratories had reached an advanced stage of construction at that time. These temporary laboratories, comprising three to four wooden chambers known among the limited staff as “the sheds,” were intended to accommodate the radiochemistry and radiobiology laboratories, as well as the dosimetry laboratory.⁶³ Maddock’s responsibilities included overseeing the construction of the temporary radiochemical laboratory, but, more importantly, he was tasked with studying the plans for the permanent radiochemical laboratory, recently submitted by the Greek architect.

Maddock demonstrated significant dedication to this role effectively dispelling the persistent misconception that scientists are exclusively focused on the narrow confines of their specific disciplines.⁶⁴ According to the timeline included in the report he drafted for the IAEA, during the two weeks from 7 April to 20 April, Maddock engaged in daily exhaustive meetings with the architect and members of the IAEA. These meetings, lasting seven hours each day from 8:00 am to 3:00 pm, involved Maddock personally visiting the Demokritos laboratories’ site. His detailed observations indicate that he gained a comprehensive overview of the construction process. Although generally satisfied with the temporary laboratory, he did not share the same opinion regarding the plans for the permanent radiochemical laboratory. When expressing his perspective on the matter, Maddock conveyed dissatisfaction. He pointed out a deficiency in provisions for ordinary hot laboratory facilities, despite the inclusion of a hot cell for “very high activities,”⁶⁵ the details of which had yet to be finalized. The perceived lack of balance in the plans was not attributed to the architect, Georgios Kyriakos, who, as Maddock stated, surprisingly brought significant experience to the table. Kyriakos had previously worked in the architectural offices of the French Atomic Energy project and was well-acquainted with the Saclay laboratories (Centre CEA de Saclay).

⁶¹ Boudia 2007, on 402.

⁶² Boudia and Jas 2007.

⁶³ Rentetzi 2010.

⁶⁴ Forgan 1989. For more on the relationship between science and architecture, see Galison and Thomson 1999.

⁶⁵ A. Maddock, Report on a Mission to the Greek Atomic Energy Commission, Athens made by A. G. Maddock, 19 June 1959, IAEA Archives, Box 06329.

According to Maddock, the difficulty arose from the Greek AEC's inability to give comprehensive instructions to the architect due to their own lack of experience. Furthermore, he highlighted the absence of a detailed development program for activities at the Demokritos site, which, in his view, made the realization of satisfactory plans for the permanent laboratory even more challenging.⁶⁶

During that time, the Greek AEC had only hired a handful of new researchers. Those who were to be hired later, during those days were attending post-graduate training abroad to keep up with the latest developments in their fields. Physicist Nikolaos Chrysochoidis, one of the first junior scientists recruited by the Greek AEC after his training in the US, recalls, "We couldn't have scientific staff immediately. They had to go out to study and so on."⁶⁷ This led to a delay in establishing an immediate scientific workforce. In the early years, the responsibility of establishing nuclear physics research in Greece fell on Greek academics. However, according to Maddock, many of them had "old and inflexible minds."⁶⁸ Laodamas Sklavenitis, a young researcher who assisted greatly in setting up the Greek Health Physics department, also referred to the academic establishment, stating, "In general, in the field of science, they lagged behind because, during that period, professors were appointed as a kind of 'dowry'—professors with intelligence but lacking awareness of modern developments. Only a few had been abroad."⁶⁹

In this context, Maddock found himself in the arduous task of persuading the Executive Committee of the Greek AEC regarding the optimal modus operandi for the forthcoming laboratory. The main difficulty of Maddock's mission was advising on the creation of a "hot" isotope laboratory, specially designed and equipped to handle radioactive materials of high activity,⁷⁰ as part of the chemical laboratory. The proposition laid forth by the Greeks suggested having all radiochemistry facilities within a multi-story building. Maddock, however, viewed this proposal with profound misgivings, particularly in the context of establishing a hot laboratory. His rationale unfolded on a dual axis. Firstly, outside the hot laboratory, an array of essential facilities such as changing rooms equipped with toilets, showers, and repositories for protective laboratory attire, corresponded to the indispensable requirements within the

⁶⁶ Ibid.

⁶⁷ Nikolaos Chrysochoidis, interview by Loukas Freris, 29 January 2021, Istorima Digital Archive, <https://archive.istorima.org/interviews/10345> (accessed April 2025).

⁶⁸ A. Maddock, Report on a Mission to the Greek Atomic Energy Commission, Athens made by A. G. Maddock, 19 June 1959, IAEA Archives, Box 06329.

⁶⁹ Laodamas Sklavenitis, interview by Loukas Freris, 23 May 2022. This was not a peculiarity unique to Greece; it characterized many nations attempting to enter the atomic age. For example, despite the vast cultural, historical, and geographical differences between Greece and South Korea, their approaches to atomic energy reveal some unexpected similarities. Both countries, for instance, relied on young scientists who received scholarships to train abroad to staff their national atomic energy agencies. According to DiMoia 2022, what makes this approach particularly noteworthy is that these young scientists were regarded as vital assets to their national atomic programs even before completing their overseas training.

⁷⁰ Anon. 1976.

lab. The fragmentation of these rooms across different floors would require the unnecessary—under normal circumstances—reproduction of identical equipment. The second prong of Maddock's argument focused on the imperative of insulation, which was indispensable at these specialized laboratories. Adhering to stringent radiation protection norms, these areas needed special shielding. So, if laboratories were compartmentalized on different floors, a considerable outlay for shielding between the floors would be unavoidable, and the increase in costs would be disconcerting.⁷¹

Indeed, the prevailing architectural layout for a hot laboratory involved a single-story structure. In the late 1940s, for example, the US AEC crafted laboratory scale-models tailored to equipment needs for radioisotope applications during this period. These models included a two-room configuration suitable for beta-emitting radioisotopes and a three-room laboratory capable of handling both beta-emitting and gamma-emitting radioisotopes.⁷² These scale-models were implemented on a single floor. However, when Maddock visited the site that would house the Greek nuclear center, he was confronted with a landscape that deviated from the established standards. Unlike the convenient plains, the Greek nuclear facility was situated on uneven terrain at the foot of Mount Hymettus, one of the four mountains of Attica. After visiting the site and understanding the unique local conditions, he wrote in his report: "The site itself is situated on a rather steep hillside so that single storied buildings of any extent are difficult or expensive to place. Indeed, the nature of the site is such that it must appreciably increase the construction costs."⁷³

This case was not the exception but rather the rule. Globally, the challenges faced by IAEA experts in providing technical assistance often included unexpected local conditions and a lack of adequate facilities and equipment to conduct even the most basic training activities. As Mateos and Suárez-Díaz aptly put it, "Local material conditions dissolved and dissociated the planned packages of development theories into a myriad of challenges and immediate repurposings."⁷⁴

Finally, considering the local geographical conditions, Maddock prepared architectural plans for a multi-story workshop, emphasizing that "a multi-storied construction is possible but generally much more expensive." These highly detailed drawings were created "to assist," as he noted, "the architect by instructing him in the approximate sizes and desirable relative positions of the various types of laboratories required." In these drawings, he situated the low radiation level (or ordinary) lab facilities in the basement and on the ground floor. On the first floor, he arranged the facilities for the hot lab.

On both the ground floor and the first floor, he allocated space for both male and female toilets. Additionally, just outside the hot lab, he provided

⁷¹ A. Maddock, Report on a Mission to the Greek Atomic Energy Commission, Athens made by A. G. Maddock, 19 June 1959, IAEA Archives, Box 06329.

⁷² Creager 2015, on 210–211.

⁷³ A. Maddock, Report on a Mission to the Greek Atomic Energy Commission, Athens made by A. G. Maddock, 19 June 1959, IAEA Archives, Box 06329.

⁷⁴ Mateos and Suárez-Díaz 2020, on 418.

separate changing rooms for both genders, equipped with personnel monitors, clothing lockers, showers, wash basins, and WCs.⁷⁵ This allocation, explicitly outlined in the architectural plans, underscores the deliberate design to accommodate the inclusion of women in the lab.⁷⁶ Although the initial years saw a low representation of women recruited by the Greek AEC and Demokritos, this dynamic shifted over time. The percentage of women in the workforce increased, albeit maintaining an uneven distribution in favor of men. From 1956 to 1978, the overall percentage of women scientists stood at 24%.⁷⁷ Concurrently, the percentage of women receiving fellowships from the IAEA during the same period mirrored this figure, with women comprising 28% of total fellows.⁷⁸ In comparison to analogous figures for female physicists in the USA, the representation of women in the Greek lab was notably higher. For instance, between 1956 and 1958, only 40 women, constituting 5.29% of full-time professionals, were engaged in the fields of atomic and nuclear physics in the USA.⁷⁹ It is reasonable to assert that the absence of a pre-war tradition in radioactivity studies in the country may have provided an advantageous environment for women scientists. Without an overwhelming presence of male counterparts in the field, women had the opportunity to navigate this scientific domain without encountering the traditional gender imbalances that often prevail in more established areas of research within the country.

Maddock's directives for the hot lab were notably stringent, underscoring the imperative need for meticulous measures to mitigate the risk of enduring contamination within the designated area. A paramount focus was placed on the construction materials, emphasizing the use of corrosion-resistant, smooth, impermeable finishes whenever feasible. Prohibitions were outlined against any exposed surfaces, specifically unpainted or absorbent plaster and stonework. Furthermore, he mandated the integration of sturdy armor into the walls against potential hazards, particularly radiation contamination.⁸⁰

Clearly, the goal of the IAEA, facilitated by intermediary experts, was not merely to offer theoretical guidance for the development of atomic energy and its applications in its Member States, but to actively engage. As evidenced by historical research, the Agency evolved into a pivotal hub within the expanding nuclear market in developing regions, encompassing everything from small components to large reactors. This involvement extended to providing guidance on both the selection of equipment to be acquired and the construction of local facilities.⁸¹ Maddock meticulously outlined the necessary laboratory equipment, specifically for hot labs.

⁷⁵ A. Maddock, Report on a Mission to the Greek Atomic Energy Commission, Athens made by A. G. Maddock, 19 June 1959, IAEA Archives, Box 06329.

⁷⁶ Rentetzi 2008, on 59.

⁷⁷ Rentetzi 2007, on 51–53.

⁷⁸ Fellows from Greece, 1957–1978, IAEA Archives.

⁷⁹ Rossiter 1995, on 101; Rentetzi 2007.

⁸⁰ A. Maddock, Report on a Mission to the Greek Atomic Energy Commission, Athens made by A. G. Maddock, 19 June 1959, IAEA Archives, Box 06329.

⁸¹ Mateos and Suárez-Díaz 2020.

Fume cupboards, hot cells, and glove boxes; crucial laboratory apparatus, representing key components of the material culture of radiation protection endorsed by the IAEA, were central in his report. This equipment aimed to ensure minimal risk for workers handling radioactive materials. A decade after Maddock's visit to Greece, during which the IAEA sponsored numerous similar expert visits to member states, a handbook titled "Safety Aspects of the Design and Equipment of Hot Laboratories" was published. The objective, as stated, was to "assist individuals, particularly in developing countries, involved in planning the construction of a new hot laboratory or modifying an existing one."⁸²

Within this manual, all the radiation protection concepts advocated by the IAEA during the laboratory design and also articulated by Maddock, were presented confidently and reassuringly. Despite the manual underscoring the significance of these measures for worker safety, actual radiation protection practices did not always align. As has been convincingly argued, glove boxes, for example, have proven to be a significant source of accidental overexposure. Nevertheless, the advocacy for glove boxes and other secure containers for handling radioactive materials in the nuclear sector and research facilities had a dual impact.⁸³ It not only created a misleading sense of safety for those involved in production and research but also contributed to the establishment and application of nuclear regulations, thereby bolstering the IAEA's pursuit of leadership in global radiation protection.

5. Conclusion

The historical episode under study centered on Alfred Maddock's visit to Greece in 1959, within the framework of technical assistance provided by the International Atomic Energy Agency. This visit marked the inception of a visiting professorship program within IAEA member states and was accompanied by a series of proactive measures initiated by Maddock. Rather than traveling alone, Maddock was accompanied by the IAEA's Mobile Radioisotope Laboratory and housed in a sizable truck-style vehicle. Concerned about the adequacy of Greek laboratory equipment for his seminars at the Greek Isotope School, Maddock took decisive steps to ensure the presence of this vehicle, which represented familiar material culture to him.

Furthermore, Maddock's initiatives extended even further: they encompassed the integration of dosimetry tools such as film badges and the comprehensive review, modification, and initiation of architectural plans for radiochemical laboratories to ensure compliance with the IAEA radiation protection regulations. Maddock's actions did not exemplify isolated efforts but rather reflected the early policy stance of the IAEA. Radiation protection consistently emerged as a cornerstone of the Agency's operations, evident not only in Technical

⁸² IAEA 1969.

⁸³ Rentetzi 2017.

Assistance missions directly related to health physics but also in various IAEA missions addressing radiation protection concerns, albeit minor.

Despite subsequent expert missions primarily focusing on health physics, it was Maddock's initial endeavors that discreetly introduced dosimetry devices to Greece, underscoring the holistic involvement of the IAEA in radiation protection. This highlights the IAEA's involvement in radiation protection extending beyond specific missions to encompass the entirety of its technical assistance program. The objective was to promote protection against the adverse effects of ionizing radiation in alignment with the Agency's culture. Whether or not radiation protection was explicitly outlined as one of their written objectives, expert missions ultimately contributed to the same overarching goal: establishing the IAEA as the preeminent global authority on radiation protection in the eyes of its member states.

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