

MAJOR RESEARCH PAPER

HOW EFFECTIVE ARE IAEA SAFEGUARDS?

THE CASE OF IRAN, 2003-2006

Submitted by

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In partial fulfillment of the requirements

For the Degree of Master of Arts

University of Ottawa

Ottawa, Ontario

Fall 2017

ABSTRACT

The purpose of this paper is to critically examine the International Atomic Energy Agency (IAEA) safeguards system, a set of technical measures through which the Agency aims to prevent the diversion of nuclear energy from peaceful purposes to military uses. The main finding of this paper is that the Agency's safeguards system faces challenges in the initial detection and reporting of non-compliance.

To assess the effectiveness of the IAEA safeguards, this paper looks at the case of Iran (2003-2006) on two levels: (a) capability of the Agency to detect undeclared nuclear material, nuclear activities, and nuclear facilities; and (b) capacity of safeguards as an early warning system to the international community. Following a section on the link between nuclear energy and nuclear weapons, the evolution of the safeguards regime is examined in order to fully understand the nature and scope of the Agency's activities in Iran. This paper demonstrates that, despite improvements over decades, the safeguards regime is not perfect, particularly as it relates to the detection of undeclared nuclear material, activities, and facilities. However, where the Agency is considerably more effective is in its capacity as an early warning system to the international community.

The last part of the paper offers the major conclusions on the capabilities and limitations of the safeguards system, including the implications on the IAEA's ability to monitor and verify Iran's commitments under the Joint Comprehensive Plan of Action.

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Introduction

Commonly referred to as the United Nations' 'nuclear watchdog', the International Atomic Energy Agency (IAEA) has come a long way from its origins as a failed provider of civilian nuclear energy services. While the Agency continues to supply nuclear technical assistance and training programs as a means of furthering economic development in less-developed countries, the Agency's responsibilities have grown considerably. Arguably, its most important responsibility today is the administration of nuclear safeguards, a set of technical measures through which the Agency aims to provide credible assurances about the peaceful nature of declared nuclear material, activities and facilities and the absence of undeclared nuclear material, activities and facilities in states.¹ Under the Non-Proliferation Treaty (NPT), each non-nuclear-weapon State Party undertakes to accept safeguards, as set up in an agreement with the IAEA, for the purpose of preventing the diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices. However, the Agency's record in this regard has been shown to be inadequate on several occasions. For over two decades, the Agency failed to adequately detect clandestine nuclear weapons programmes in South Africa, North Korea, and Libya. The IAEA also failed to detect clandestine nuclear activities in Iran, Egypt, and South Korea. These developments thus raise the following question: to what extent is the safeguards system effective?

¹ "Statement to Preparatory Committee for the 2020 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT)." IAEA. May 02, 2017. Accessed August 22, 2017. <https://www.iaea.org/newscenter/statements/statement-to-preparatory-committee-for-the-2020-review-conference-of-the-parties-to-the-treaty-on-the-non-proliferation-of-nuclear-weapons-npt>.

To answer this question, this paper will use the case study of Iran from 2003 to 2006. Between 2003 and 2006 the IAEA discovered that Iran had considerably understated the extent of its nuclear programme. In particular, Iran had not declared the full range of its nuclear material, nuclear activities, and nuclear facilities contrary to its obligations under its Comprehensive Safeguards Agreement (CSA). In this context, the case of Iran is useful for a number of reasons. First, given the spotlight on Iran's nuclear programme over the years, there is an abundance of resources to study, both scholarly and governmental. For instance, compared to the four reports on Libya from 2004-2008 and the fourteen reports on Syria from 2009-2014, the IAEA Board of Governors has released over eighty reports on Iran from 2003-2017, fourteen of which during the three-year period examined in this study. The Iran case is therefore uniquely positioned to offer insights on the inner workings of IAEA safeguards inspections. Second, the Iran case during this period also allows to study the safeguards regime at its fullest potential because Iran voluntarily implemented the Additional Protocol (AP) to its Comprehensive Safeguards Agreement from December 2003 to February 2006. The AP was designed to enable the Agency to deliver credible assurances about the absence of undeclared nuclear activity in a state. Assessing to what extent the AP was instrumental in Iran during this time period is thus an important exercise which can tell us empirically what we can and cannot expect out of the IAEA safeguards system. Third, as the most difficult and longest-running case in the IAEA's history, the Iranian case can tell us how safeguards fare against potential proliferators which are adept at concealment and deception tactics. It is one thing to evaluate the effectiveness of safeguards against states that are forthcoming and open in their cooperation with the Agency, but it is altogether a different, and frankly more important, issue to see how safeguards fare against states

that pursue covert nuclear activities and make determined efforts to conceal these activities from the IAEA.

The question of the effectiveness of IAEA safeguards also has broader implications. For one, assessing the extent to which safeguards are effective has a direct bearing on the viability of the Joint Comprehensive Plan of Action (JCPOA) negotiated in 2015 to block Iran's pathways to a nuclear weapon. Currently under fire from the Trump Administration, the JCPOA includes a number of additional verification measures beyond those included in CSAs and APs. Therefore, should IAEA safeguards be deemed ineffective, observers may wish to be cautious in taking at face value the Agency's conclusions on Iranian implementation of the JCPOA. Further, as the only mechanism by which the international community can verify the NPT, IAEA safeguards "bear directly on the effectiveness of the NPT, in that a finding of non-compliance with a comprehensive safeguards agreement amounts inherently to a finding that the state is in violation of Article III of the NPT (the obligation to accept safeguards), and also, depending on the evidence, Article II (not to seek or acquire nuclear weapons)."² In addition, a number of other non-proliferation mechanisms depend on IAEA safeguards. For example, the Nuclear Suppliers Group (NSG), an export control regime of dual-use equipment and material, encourages states to require safeguards when transferring nuclear technology and materials. As a result, the efficacy of the NSG in mitigating the perils of peaceful nuclear cooperation is directly tied to the utility of IAEA safeguards.³ Finally, while nuclear energy programmes are currently on the decline since the Fukushima Daichi incident (2011), a recent report by the IAEA projects that the world's

² Carlson, John. "Strengthening the NPT and IAEA Safeguards: Recommendations of the International Commission on Nuclear Non-Proliferation and Disarmament." Paper presented to the Annual Meeting of the Institute of Nuclear Materials Management, Baltimore, 11-15 July 2010.

³ Fuhrmann, Matthew. *Atomic Assistance: How "Atoms for Peace" Programs Cause Nuclear Insecurity*. Cornell University Press, 2012. P.209

installed nuclear power capacity could increase by 123% in 2050 compared to 2016 levels.⁴ This means that safeguards will become all the more important in the near future to ensure that nuclear energy remains solely for peaceful uses.

Methodology and Objective of Study

The purpose of this paper is to critically assess the effectiveness of IAEA safeguards with a view to exploring the capabilities and limitations of the system. Measuring effectiveness, however, is not a simple, linear affair—there is no straightforward way to operationalize the concept of effectiveness. For instance, Paul Nitze, chief negotiator of the Intermediate-Range Nuclear Forces treaty (INF), suggested four conditions for the ‘adequate’ effectiveness of a verification system: *capability to detect*, identification of militarily significant violation, *timely manner*, and *effective response*.⁵ More specific to the IAEA, Pierre Goldschmidt, former Deputy Director General for Safeguards, notes that “In fulfilling its nonproliferation mandate, the most important task of the IAEA is *the prompt detection and reporting* of unauthorized nuclear work in any non-nuclear-weapon state that is a party to the NPT.”⁶ This paper will thus borrow from these two concepts and assess the safeguards system in two respects: capability to detect undeclared nuclear material, activities, and facilities; and capacity as an early warning mechanism to the international community. While the latter does not per se relate directly to the

⁴ "Long-Term Potential of Nuclear Power Remains High: IAEA Report." IAEA. August 07, 2017. Accessed September 01, 2017. <https://www.iaea.org/newscenter/news/long-term-potential-of-nuclear-power-remains-high-iaea-report>.

⁵ U.S. Congress. Senate Committee on Foreign Relations. Hearings on the INF Treaty, 100th Cong., 2d sess. Cong. Washington: U.S. G.P.O., 1988. P. 41.

⁶ Goldschmidt, Pierre. "Safeguards Noncompliance: A Challenge for the IAEA and the UN Security Council." Arms Control Association. January 2010. Accessed September 01, 2017. http://www.armscontrol.org/act/2010_01-02/Goldschmidt#10.

technical aspect of safeguards (i.e. detection), it is nonetheless highly relevant as it shows an important side to the overall safeguards system, namely that effective enforcement of safeguards relies on political judgements made by Member States in the IAEA Board of Governors (the Agency's policymaking body), rather than from the Agency itself. Hence, this paper will concern itself with the following questions: how effective is the IAEA in detecting undeclared nuclear material, activities and facilities, and how effective is it in alerting the international community so that corrective actions may be put into force?

As will be shown, while the Agency failed in detecting Iran's covert nuclear activities and facilities for over a decade, the Agency was considerably more effective between 2003 and 2006 when it was benefitting from substantial intelligence cooperation and open-source information to locate potential undeclared facilities. That said, the Agency's investigative powers should not be overestimated: the experience in Iran underscores that effective verification relies on the cooperation and goodwill both of the state subjected to inspections and other states for intelligence information. In addition, absent some nexus to nuclear material, the Agency suffers from a lack of authority when investigating possible military dimensions of nuclear energy programmes. As for the Agency's capacity as an early warning mechanism, it will be demonstrated that, in the broad sense of the term, the Agency's safeguards did act as an early warning mechanism to enable negotiations between the EU-3 (France, Germany, United Kingdom) and Iran. These negotiations ultimately led to a number of (failed) agreements that achieved the partial suspension of Iran's nuclear programme. At the same time, however, the delay in finding Iran in non-compliance and reported to the UN Security Council also had profound consequences with which the international community continues to grapple with.

The paper is organized as follows. The first section will present a brief literature review. The second section will give a brief overview of the link between peaceful nuclear energy programs and nuclear weapons as a primer and to illuminate the importance of IAEA safeguards. The third section will explore the evolution of the IAEA and its safeguards regime from early proposals made at the UN Atomic Energy Commission in 1945, to the IAEA's inception in the 1950s, to the present-day safeguards system. Safeguards have evolved over time to meet new technical, legal, and political challenges. In order to fully understand the nature and scope of the Agency's activities in Iran, it is thus necessary to sketch out their evolution. The fourth section will evaluate the effectiveness of IAEA safeguards on two levels: detection of undeclared nuclear material, activities and facilities; and as an early warning system to enable further responses from the international community. A fifth section will conclude the paper and present the main findings of the case study.

Literature Review

Due to its importance in the non-proliferation regime, there exists a broad literature on the effectiveness of the IAEA safeguards system. Broadly speaking, the literature can be divided into three groups: those that assess the technical effectiveness of safeguards against diversion of nuclear material; those that look at the capability of safeguards to detect undeclared nuclear activities, material, and facilities; and those that examine the effectiveness of the safeguards system in responding to violations.

In the first instance, a number of authors argue that the IAEA cannot safeguard nuclear material in principle. Henry Sokolski⁷, Victor Gilinsky⁸, Robert Zarate⁹, Alan J. Kuperman, David Sokolow, and Edwin S. Lyman¹⁰ all argue that safeguards cannot effectively detect the diversion of declared nuclear material due to erroneous criteria. Specifically, the Agency's 30-year old criteria for how much nuclear material is needed to make a nuclear weapon ("significant quantity") and how much time is required to convert such materials into a nuclear explosive device ("conversion time") are too high. This, in turn, negatively impacts the Agency's timeliness detection goal as it corresponds roughly to conversion time. Hence, the Agency cannot theoretically detect diversion of nuclear material in time before it is converted to a weapon. A similar point is raised with regards to bulk-handling facilities, such as those involved in uranium enrichment and plutonium reprocessing. Trevor Findlay, for instance, points out that these facilities handle such large volumes of nuclear material that significant amounts will be unaccounted for, lodged in pipes or other equipment, or subject to accounting and measurement errors.¹¹ Hence, safeguards cannot provide sufficient assurance of non-diversion of fissionable material from bulk-handling facilities.

Beyond assessing the technical effectiveness of safeguards, others have looked at the system more broadly. In his study of sixteen cases of nuclear weapons programs, Matthew Furhmann examines two aspects of the safeguards system to determine effectiveness: deterrence

⁷ Sokolski, Henry, editor. *Falling Behind: International Scrutiny of the Atom*. Strategic Studies Institute, 2008.

⁸ Gilinsky, Victor, and Henry Sokolski. "Serious Rules for Nuclear Power Without Proliferation." *The Nonproliferation Review*, 21, no. 1 (2014): 77-98.

⁹ Zarate, Robert. "The NPT, IAEA Safeguards and Peaceful Nuclear Energy: An "Inalienable Right" But Precisely to What?" Non-Proliferation Policy Education Center. September 2007. Accessed July 24, 2017.

¹⁰ Kuperman, Alan J., David Sokolow, and Edwin S. Lyman. *Can the IAEA Safeguard Fuel-Cycle Facilities?* University of Texas at Austin. March 18, 2014. Accessed September 2, 2017.

¹¹ Findlay, Trevor. *The future of nuclear energy to 2030 and its implications for safety, security and nonproliferation: Part 4, Nuclear nonproliferation*. Waterloo, Ontario: The Centre for International Governance Innovation, 2010. P.50

and early detection. His conclusion is scathing: proliferators repeatedly engaged in violations of their safeguards agreements, suggesting that the safeguards system did not effectively deter states from launching nuclear weapons programs. Furthermore, Fuhrmann argues that when violations did occur, the IAEA rarely detected them in a timely fashion.¹² The end result, according to Fuhrmann, is that nuclear safeguards and the non-proliferation treaty have had a limited effect in reducing the perils of atomic assistance for nuclear weapons proliferation.¹³

David Sloss, meanwhile, introduces a comparative perspective to assessing the safeguards system. Writing in 1994, Sloss contends that the IAEA's legal authority to investigate activities at undeclared sites in NPT non-nuclear-weapon states is more substantial than those emanating from other international arms control agreements such as Strategic Arms Reduction Treaty (START) and the Intermediate-range Nuclear Forces Treaty (INF). However, Sloss concludes that the Agency is still constrained in obtaining information necessary to locate potential undeclared nuclear sites and lacks enforcement measures.¹⁴ Indeed, the difficulty of safeguards to detect undeclared nuclear activities is a major theme recurring in the literature. Olli Heinonen, for instance, remarks that the safeguards system is robust enough to detect diversion of nuclear material, but, despite improvements over the last decade, still falls short of any foolproof method to detect clandestine facilities.¹⁵¹⁶ In the case of Iran, for example, Mark Hibbs notes that from November 2004 onwards the Agency had little difficulty in re-assuring that all of

¹² Fuhrmann, *Atomic Assistance: How "Atoms for Peace" Programs Cause Nuclear Insecurity*, 2012.

¹³ Ibid.

¹⁴ Sloss, David. "It's Not Broken, So Don't Fix It: The International Atomic Energy Agency Safeguards System and the Nuclear Nonproliferation Treaty ." *Virginia Journal of International Law* 35, no. 4 (Summer 1995): 841-93.

¹⁵ Heinonen, Olli. "Strengthening the IAEA Safeguards Regime." Paper, Belfer Center for Science and International Affairs, Harvard Kennedy School, November 13, 2013.

¹⁶ Heinonen, Olli. "The IAEA Verifications System in Perspective." In *The Nuclear Nonproliferation Regime at a Crossroads*. vol. 137. May 2014. 165-175.

Iran's declared nuclear material and activities were accounted for. However, he stresses that the Agency had comparatively more difficulty finding undeclared nuclear material and activities until this information was provided by third parties (although he concedes that the Agency may have been hindered in making findings by the absence of an Additional Protocol in Iran before December 2003).¹⁷ Hence, according to John Carlson, the detection of undeclared nuclear activities, especially centrifuge enrichment activities, is the greatest single challenge facing the safeguards system which does not yield to simple solutions.¹⁸ For Carlson, then, national intelligence information will continue to have a vital role in the detection of undeclared nuclear material, activities and facilities. This, however, does not mean that the IAEA has no role to play. James Acton, for instance, argues that national intelligence organizations and international verification organizations such as the IAEA have complementary roles. Hence, according to Acton, the IAEA's strength is through on-site inspections to monitor declared nuclear activities, material, and facilities due to its legitimacy as an impartial, technical organization. Furthermore, the Agency's on-site inspections are necessary to conclusively uncover safeguard violations.¹⁹

Finally, a great deal of the literature examines the safeguards system from the aspect of reporting non-compliance and subsequent enforcement by the international community once detection has come to light. In the first instance, there are those such as Pierre Goldschmidt that argue for a machine-like, automatic process for reporting non-compliance. In their case study of Iran non-compliance reporting, Goldschmidt and Gerami note that the handling of the Iran case

¹⁷ Hibbs, Mark. "Iran and the Evolution of Safeguards." In *Verification & Implementation: A biennial collection of analysis on international agreements for security and development*, 1-26. London: VERTIC, 2015.

¹⁸ Carlson, John, Russell Leslie and Annette Berriman. "Detection of Undeclared Nuclear Activities: Does the IAEA Have the Necessary Capabilities?" Paper presented to the Annual Meeting of the Institute of Nuclear Materials Management, Nashville, 16-20 July 2006.

¹⁹ Acton, James M. "International Verification and Intelligence." *Intelligence and National Security* 29, no. 3 (2014): 341-56.

by Director General Mohamed Elbaradei risked politicizing what should have remained the purely technical work of the IAEA Secretariat.²⁰ Furthermore, the delay in finding Iran in non-compliance effectively allowed Iran to advance its nuclear programme.²¹ Hence, to avoid similar outcomes, Goldschmidt argues that any state-specific report by the IAEA Secretariat to the Board of Governors on safeguards-implementation issues, unless the report explicitly states otherwise, be deemed to be a report of non-compliance. These cases, in turn, should automatically be reported by the Board of Governors to the UN Security Council.²² Trevor Findlay, on the other hand, disagrees with such a machine-like and automatic process. Rather, he argues that the non-compliance reporting process should remain flexible in order to permit diplomatic and technical solutions.²³ John Carlson offers a similar argument in that a mechanistic, black-and-white approach would be inconsistent with the Board of Governors' judgment and would risk unintended consequences such as trivializing the concept of non-compliance.²⁴

Besides the issue of when and whether to find a state in non-compliance, several observers have assessed the safeguards system from the point of view of enforcement. Pierre Goldschmidt, for instance, argues that the weakest link in the non-proliferation regime is not so much the performance of the IAEA Department of Safeguards (i.e. the technical work of the Agency) but rather the IAEA Board of Governors—the IAEA's political, policymaking body

²⁰ Gerami, Nima, and Pierre Goldschmidt. *The International Atomic Energy Agency's Decision to Find Iran in Non-Compliance, 2002-2006*. Report. Center for the Study of Weapons of Mass Destruction, National Defense University. Case Study Series. Washington D.C.: National Defense University Press, 2012. 1-29.

²¹ Ibid.

²² Goldschmidt, Pierre. "Exposing Nuclear Non-compliance." *Survival* 51, no. 1 (2009): 143-64.

²³ Findlay, Trevor. *Proliferation Alert! The IAEA and Non-Compliance Reporting*. Report. Project on Managing the Atom. Cambridge, MA: Belfer Center for Science and International Affairs, 2015.

²⁴ Carlson, John. "Defining Noncompliance: NPT Safeguards Agreements." Arms Control Association. 2009. Accessed July 20, 2017. https://www.armscontrol.org/act/2009_5/Carlson.

composed of Member States—and the UN Security Council in responding to non-compliance.²⁵ Indeed, in her study of the Agency’s investigation in, and response, to Syrian safeguards violations, Tanya Ogilvie-White concludes that divided responses in the Board of Governors continue to hamper the overall effectiveness of safeguards.²⁶

In short, the literature on IAEA safeguards is both broad and detailed. Arguably, a consensus has emerged over the single greatest challenge facing IAEA safeguards, namely the detection of undeclared nuclear material, activities, and facilities. This is particularly important given the fact that proliferators are more likely to use undeclared nuclear facilities to produce the fissile material necessary for a nuclear weapon. However, what is lacking is a comprehensive study written in plain language which includes both the IAEA’s investigation in Iran and the international response within the IAEA Board of Governors. In doing so, this paper will help clear misunderstandings over the IAEA’s ‘failure’ in Iran, particularly those relating to the IAEA’s response. Contrary to Fuhrmann, this paper argues that the Agency’s findings in Iran, while not timely in the true sense of the word, enabled to ring the proliferation alarm sufficiently early. Likewise, by following the detailed investigations into Iran during this period, this paper will generate a better understanding of the inner workings of the safeguards system, a highly technical and somewhat muddled enterprise. Hence, this paper’s contribution to the literature will be both a synthesis and detailed study of the capabilities and limitations of the safeguards system.

²⁵ Goldschmidt, Pierre. "Safeguards Noncompliance: A Challenge for the IAEA and the UN Security Council." Arms Control Association. 2010. Accessed September 24, 2017. https://www.armscontrol.org/act/2010_01-02/Goldschmidt.

²⁶ Ogilvie-White, Tanya. "The IAEA and the International Politics of Nuclear Intelligence." *Intelligence and National Security* 29, no. 3 (2014): 323-40.

Nuclear Energy and Nuclear Weapons: What is the Link?

The proliferation risks inherent to peaceful nuclear energy programmes have long been a concern to the international community. In November 1945, a trilateral declaration from Canada, the United Kingdom, and the United States noted that both military uses and peaceful uses of nuclear energy depended to a substantial degree on the same methods and processes, and committed the three governments to withhold nuclear information until effective safeguards were in place.²⁷

Broadly speaking, nuclear energy programs can contribute towards nuclear weapons in two ways. First, any civilian uranium enrichment facility can be converted to produce weapons-grade fissile material. Though it is less than one percent of naturally occurring uranium, uranium-235 (U-235) powers both nuclear reactors and nuclear bombs.²⁸ In order to fuel nuclear reactors, the concentration of uranium-235 must be increased to five percent (low-enriched uranium). Today, uranium enrichment is largely done through gas centrifuges—casings containing cylindrical rotors which rotate at high speeds. Uranium is then fed into the rotor as gaseous uranium hexafluoride (UF₆) until the UF₆ gas is separated into enriched U-235 and depleted U-235. While nuclear devices using material with somewhat lower enrichment levels have been built by advanced weapons laboratories, explosive devices containing U-235 enriched to 20 percent cannot be realistically detonated as the amount of fissile material needed to reach criticality is too large.²⁹

²⁷ Scheinman, Lawrence. *The International Atomic Energy Agency and World Nuclear Order*. Washington D.C.: Resources for the Future, 1987. P.16

²⁸ Barzashka, Ivanka. "Converting a civilian enrichment plant into a nuclear weapons material facility." *Bulletin of the Atomic Scientists*. November 07, 2013. Accessed May 14, 2017. <http://thebulletin.org/converting-civilian-enrichment-plant-nuclear-weapons-material-facility>.

²⁹ International Panel on Fissile Materials. *Global Fissile Material Report 2007*. Princeton, NJ. P.114

The proliferation risk posed by uranium enrichment is much higher if a state is capable of enriching beyond 20 percent. Should U-235 be enriched to 90 percent, it becomes weapons grade fissile-material (highly enriched uranium). This is particularly problematic as it is estimated that roughly two-thirds of the enrichment required to produce highly enriched uranium (HEU) has already been done if a state begins the process with LEU.³⁰ This means that the volume of material required is significantly less if a state has access to LEU, reducing the chance of being caught if being done clandestinely.³¹ A civilian enrichment facility can thus contribute towards a state's 'break-out' capability either by enriching beyond declared levels at a disclosed facility or by diverting nuclear material to another, secret facility.³² This problem is all the more aggravated since the shift in enrichment technology towards centrifuges makes it much easier to realign a plant to produce HEU than with older, gaseous diffusion systems.³³ As a result, a typical 1,000-megawatt nuclear reactor which uses 27,000 kilograms of LEU in a year has the capacity to produce about *twenty* nuclear bombs per year.³⁴

The spent fuel from a nuclear reactor poses a second major proliferation risk. The irradiation of uranium fuel in any reactor produces plutonium, which, unlike uranium, is a bomb material regardless of its composition or chemical form.³⁵ Because it is highly diluted, the plutonium contained in discharged spent fuel is only a proliferation risk if it is extracted by "reprocessing" the spent fuel behind heavy radiation shielding and chemically separating the

³⁰ Alger, Justin. "Nuclear Alibi: The Nuclear Revival and Proliferation." MA thesis, Carleton University, 2009. P.81

³¹ Ibid.

³² Barzashka, "Converting a civilian enrichment plant into a nuclear weapons material facility."

³³ Sokolski, Henry. "Is the IAEA's Safeguard Strategic Plan Sufficient?" Paper presented at the International Safeguards Symposium: Linking Strategy, Implementation and People, Vienna, October 20 2014. P.2

³⁴ Barzashka, "Converting a civilian enrichment plant into a nuclear weapons material facility."

³⁵ Lovins, Amory B., L. Hunter Lovins, and Leonard Ross. "Nuclear Power and Nuclear Bombs." Foreign Affairs. October 1, 2017. Accessed May 1, 2017. <https://www.foreignaffairs.com/articles/1980-06-01/nuclear-power-and-nuclear-bombs>.

purified plutonium.³⁶ Although a complex process, reprocessing is generally considered to be simpler to master than enrichment. It has therefore been the path of choice towards a nuclear device for most states. The US, the Soviet Union, the U.K., France, India and North Korea all used plutonium from a dedicated production or research reactor to conduct their first nuclear tests. Nonetheless, this distinction between dedicated weapon production facilities and civilian facilities does not mean that the latter does not present a proliferation risk. According to the US Department of Energy, reprocessing spent power reactor fuel involves handling about twenty-five times the amount of radioactivity as handling the spent fuel from a dedicated weapons production reactor.³⁷ Thus a state with a nuclear energy program involving a reprocessing capability is overqualified to handle radioactivity stemming from reprocessing weapons-grade material.

It should be said, however, that the plutonium produced as a by-product of nuclear-power generation (i.e. from power reactors) is not optimal for a nuclear device. Whereas the optimal irradiation time to produce the plutonium isotope best suited for a nuclear device (Pu-239) is a few weeks, in practice, reactor operators irradiate fuel for two to six years, which results in ‘reactor-grade’ plutonium that has a larger quantity of less desirable plutonium isotopes such as Pu-238 and Pu-240.³⁸

In addition to providing the fissile-material for a nuclear weapon, civilian nuclear energy programs can be used as a cover to receive dual-use equipment, facilities, and know-how.

³⁶ Ibid.

³⁷ Alger, Justin. *From Nuclear Energy to the Bomb: The Proliferation Potential of New Nuclear Energy Programs*. Nuclear Energy Futures Paper 6. Waterloo: Centre for International Governance Innovation, 2009. P.7

³⁸ *Nuclear programmes in the Middle East: in the shadow of Iran*. London: International Institute for Strategic Studies, 2008. P.142

France's initially civilian nuclear program, for example, provided the technical base and produced key advocates for a nuclear weapons program.³⁹ In fact, every case of successful nuclear weapons development since the Nuclear Non-Proliferation Treaty (NPT) came into effect in 1970 occurred under the guise of a peaceful nuclear program with the assistance of nuclear supplier states.⁴⁰ South Africa, for instance, publicly announced and justified the construction of its enrichment plant as being in support of its civilian nuclear energy program.⁴¹

Of greater consequence, however, is the training of scientists in various disciplines as part of a civilian nuclear energy program. As George Perkovich notes, "There is a tendency to talk about dual-use technology, but dual-use scientists and technologists are even more important. Civil nuclear programs, with or without a nuclear power reactor, enable the training of dual-use talent."⁴² In particular, nuclear energy programs enable training in a variety of subjects valuable to developing nuclear weapons such as nuclear engineering, chemical engineering, metallurgical engineering, mechanical engineering, electrical engineering, and physics.⁴³ To a certain extent, this problem originates from the NPT and the IAEA Statute—both encourage the spread of nuclear expertise. Paragraph 2 of Article IV of the NPT, for instance, calls upon all parties to the treaty to facilitate the "fullest possible exchange of equipment, materials and scientific and technological information" on peaceful uses of nuclear energy.⁴⁴ As a result, India, Israel, North Korea, Pakistan and South Africa all used peaceful nuclear education, training and

³⁹ See, for instance, Scheinman, Lawrence. *Atomic Energy Policy in France Under The Fourth Republic*. Princeton, NJ: Princeton University Press, 1965.

⁴⁰ Findlay, Trevor, *The Future of Nuclear Energy to 2030*, P.41.

⁴¹ Albright, David. "South Africa's Secret Nuclear Weapons." Institute for Science and International Security. May 1, 1994. Accessed August 21, 2017. <http://isis-online.org/isis-reports/detail/south-africas-secret-nuclear-weapons/13>.

⁴² Findlay, Trevor, *The Future of Nuclear Energy to 2030*, P.14.

⁴³ Ibid., P.13.

⁴⁴ Treaty on the Non-Proliferation of Nuclear Weapons, March 5, 1970. Accessed May 14, 2017. <http://www.un.org/en/conf/npt/2005/npttreaty.html>

technical assistance provided by advanced nuclear states to enhance their eventual nuclear weapons programmes.⁴⁵ While such assistance has declined since the 1960s as a result of proliferation concerns, peaceful nuclear assistance continues in some cases. The JCPOA, for instance, requires the United States to provide assistance in modernizing Iran's Arak Heavy Water Reactor plant.⁴⁶

In short, civilian energy programs can contribute towards nuclear weapons programs in a number of ways, which poses a challenge for the Agency's safeguards. Given the latent nuclear capability that accompanies these programs, former IAEA Director General Mohamed Elbaradei has stated that "we are dealing with almost, as I call them, virtual nuclear weapons states."⁴⁷ Indeed, while there has never been an instance of a state diverting uranium or plutonium from a civilian nuclear power plant for use in a nuclear device, this does not mean that it is impossible. An International Institute for Strategic Studies (IISS) strategic dossier estimates that successful diversion of fissile material from a civilian facility would require "the clockwork operation of many steps and good luck at every stage [but] the possibility of such a diversion cannot be dismissed."⁴⁸

A note must be made, however, on the correlation between possessing the technical capacity to produce weapons-grade fissile material and the decision to launch a nuclear weapons program. As Justin Alger notes, "Assessing capability is not the same as assessing a state's motivation or the likelihood of new nuclear-armed states emerging. To equate capability with the

⁴⁵ Findlay, Trevor, *The Future of Nuclear Energy to 2030*, P.13

⁴⁶ U.S. Department of State. "Transforming the Iranian Arak Nuclear Reactor." News release, November 23, 2015. Accessed August 3, 2017. <https://2009-2017.state.gov/r/pa/prs/ps/2015/11/249896.htm>

⁴⁷ "IAEA predicts more nuclear states." BBC News. October 16, 2006. Accessed May 16, 2017. <http://news.bbc.co.uk/2/hi/europe/6055984.stm>.

⁴⁸ *Nuclear programmes in the Middle East: In the Shadow of Iran*. P.143

inevitability of proliferation would be little more than a throwback to long-dismissed theories of technological determinism.”⁴⁹ Long-established research indicates that a state’s decision to move toward or away from nuclear weapons is more affected by a variety of security, political, and bureaucratic factors.⁵⁰

From the Baruch Plan to the Model Additional Protocol: The Evolution of Safeguards

1945 to the 1960s: Atoms for Peace and Early Safeguards

The concept of nuclear safeguards to ensure that nuclear material would be used solely for peaceful purposes has evolved considerably since its inception in 1945. Early efforts and proposals entertained at the United Nations Atomic Energy Commission in the aftermath of the Second World War interpreted safeguards in sweeping terms, focusing on obtaining total control of nuclear energy to prevent misuse.⁵¹ The Acheson-Lilienthal Report, for instance, argued that it was not enough to rely on an international inspection system and thus called for an “international authority” with the exclusive right to control and operate all nuclear activities.⁵² Drawing on this conclusion, the Baruch Plan (1946) envisioned safeguards as embracing virtually all forms of control over nuclear activities from material accounting and inspection, to licensing, and to directing power and authority over decisions governing day-to-day operations.⁵³

⁴⁹ Alger, *From Nuclear Energy to the Bomb*, P.10

⁵⁰ See Sagan, Scott D. "The Causes of Nuclear Weapons Proliferation." *The Annual Review of Political Science*, no. 14 (2011): 225-44.

⁵¹ Brown, Robert L. *Nuclear Authority: The IAEA and the Absolute Weapon*. Washington, DC: Georgetown University Press, 2015. P.41

⁵² Fischer, David. *History of the International Atomic Energy Agency: the first forty years*. Vienna: IAEA, 1997. P.19

⁵³ Burns, Richard Dean., and Philip E. Coyle. *The challenges of nuclear non-proliferation*. Lanham: Rowman & Littlefield, 2015. P.39

Beginning in the 1950s, safeguards gradually took on a different meaning. Under Atoms for Peace, President Eisenhower put forward a far less radical proposal which would form the basis of the IAEA Statute. Behind the proposal was an assumption that international control over fissionable material was impossible, but that countries which produced nuclear material could agree to transfer some of these materials to an international agency which would then spread the benefits of nuclear energy. In the end, however, this element came to nothing and, rather than focus on a notion of international monopoly, the approach taken in creating the IAEA favoured a system of international verification on nationally owned facilities.⁵⁴ The more limited IAEA Statute thus outlines the following as its purpose:

- To establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities, and information made available by the Agency or at its request or under its supervision or control are not used in such a way as to further any military purpose;
- To apply safeguards, at the request of the parties, to any bilateral or multilateral arrangement, or at the request of a State, to any of that State's activities in the field of atomic energy;⁵⁵

However, despite these references to safeguards in the Statute, the Agency actually lagged behind in developing a comprehensive safeguards system. IAEA safeguards developed incrementally and reflected a sensitivity to state sovereignty at every stage.⁵⁶ As David Fischer points out, “Despite the importance that the negotiators of the [IAEA] Statute had assigned to the IAEA’s safeguards, the 1957 Initial Programme of the Preparatory Commission (Prepcom) contained...only a rather perfunctory reference to this crucial aspect of the IAEA’s work.”⁵⁷ In fact, until the mid-1960s, opposition from the Soviet Union and India prevented the IAEA from

⁵⁴ Scheinman, *The International Atomic Energy Agency and World Nuclear Order*, P.123

⁵⁵ IAEA Statute art. III, § 5. .

⁵⁶ Burns and Coyle, *The challenges of nuclear non-proliferation*, P.42

⁵⁷ Fischer, *History of the International Atomic Energy Agency*, P.243

implementing a comprehensive safeguards system.⁵⁸ The first IAEA safeguards were applied on an ad hoc basis in 1959 to safeguard the natural uranium fuel provided by Canada to Japan for a small research reactor.⁵⁹ Two years later, the first formal IAEA safeguards agreement was developed (INFCIRC/26). The overall objective was to ensure that *specified* materials and equipment and any fissionable material produced by their use would not be used in such a way to further any military purpose.⁶⁰ However, from the outset, INFCIRC/26 was plagued by a number of limitations. For one, the IAEA Board of Governors (BOG) had not been able to agree on a list of specific items, non-nuclear materials, and other type of assistance that would require safeguards, resulting in a lack of guidance to states as to what they should request the application of agency safeguards on their bilateral or multilateral supply arrangements.⁶¹ In addition, together with the establishment of the Inspectors Document in June 1961, INFCIRC/26 did not include the concepts of short notice and unannounced inspections which are increasingly important features of safeguards today.⁶² At least one week's notice was to be given of each inspection, and the notice had to include the names of the inspectors, the place and time of arrival, and the items to be inspected.⁶³ Finally, INFCIRC/26 applied only to small reactors of less than 100 megawatts, and thus concerned itself only with the experimental and research reactors of the day.⁶⁴

As technology evolved, the early safeguards system underwent several revisions, fixing some of the earlier limitations but also creating new ones in the process. In 1964, safeguards

⁵⁸ Ibid., 43-44.

⁵⁹ Ibid., 82.

⁶⁰ INFCIRC/26/, "The Agency's Safeguards" (Vienna, IAEA, 1961)

⁶¹ Willrich, Mason. "Safeguarding Atoms for Peace." *The American Journal of International Law* 60, no. 1 (1966): 43.

⁶² Fischer, *History of the International Atomic Energy Agency: the first forty years*, P.247.

⁶³ Ibid.

⁶⁴ Scheinman, *The International Atomic Energy Agency and World Nuclear Order*, P.128.

were revised to include coverage to large reactors (INFCIRC/26/Add.1) and added the crucial right of “pursuit”—the automatic application of safeguards to successively produced generations of nuclear material. A year later, the safeguards system was thoroughly revamped (INFCIRC/66) to include procedures for safeguarding principal nuclear facilities and nuclear material at other locations.⁶⁵ Subsequently, between 1965 and 1967, INFCIRC/66 was revised to include safeguards for reprocessing plants (INFCIRC/66/Rev.1) and fuel-fabrication plants (INFCIRC/66/Rev.2). Today, only India, Israel, and Pakistan possess INFCIRC/66/Rev.2 agreements with the IAEA.

In spite of this expansion of safeguards to facilities where nuclear material might be used, processed, or stored, the safeguards rights under INFCIRC/66 are not absolute. A general limitation concerns the fact that safeguards should be implemented “in a manner designed to avoid hampering a state’s economic or technical development.”⁶⁶ More importantly, INFCIRC/66 agreements are narrow scope in scope as it requires the application of safeguards only in connection with the items *specified* in the safeguards agreement, thus leaving the route open for legal, parallel covert programs such as was the case in Brazil.⁶⁷ INFCIRC/66 also has no provisions for enrichment or heavy-water production facilities as none of these facilities were in non-nuclear weapons states and hence thought not necessary to be covered.⁶⁸ Finally, INFCIRC/66 contains provisions allowing for the exemption and suspension of safeguards as

⁶⁵ INFCIRC/66, “The Agency’s Safeguards” (Vienna, IAEA, 1965)

⁶⁶ *Ibid.*, Article I.A.3.

⁶⁷ In 1979, Brazil had not ratified the NPT—its nuclear activities were thus subject only to an INFCIRC/66-type agreement. This allowed Brazil to create a secret, parallel program outside of international safeguards. In the mid-1980s, Brazil took steps to dismantle and publicly acknowledge the program.

⁶⁸ Boureston, Jack, and Charles D. Ferguson. “Strengthening Nuclear Safeguards: Special Committee to the Rescue?” Arms Control Association. December 2005. Accessed August 12, 2017.

https://www.armscontrol.org/act/2005_12/DEC-Safeguards.

well as for the substitution of unsafeguarded for safeguarded nuclear materials under specified conditions. For example, when originally drafted, up to one kilogram of fissionable material and specified amounts of natural uranium could be exempted from safeguards at the request of the state.⁶⁹

1970s to the 1980s: the NPT and Comprehensive Safeguards

The Non-Proliferation Treaty marked a new phase for the Agency’s safeguards—for the first time safeguards were to be applied to all nuclear material within a country. Under the NPT, safeguards (reproduced as INFCIRC/153) are to “be followed with respect to source or special fissionable material whether it is being produced, processed, or used in any principal nuclear facility or is outside any such facility,” and they are to be applied on “all source and special fissionable material in all peaceful nuclear activities within the territory of the state, under its jurisdiction, or carried out under its control anywhere.”⁷⁰ This was a drastic improvement, as the new safeguards system was now designed to be able to verify the flow of nuclear material in a way that had hitherto been impossible when safeguards applied only to individual nuclear plants or to shipments of fuel under INFCIRC/66.⁷¹ INFCIRC/153 also permits the IAEA to apply sanctions as soon as it is unable to verify that nuclear material has not been diverted—a substantial augmentation over INFCIRC/66 where sanctions are not applied until an actual violation has been *verified*.⁷² Finally, the NPT standardized safeguards for all non-nuclear weapons states—INFCIRC/153 was a more precise and less flexible document compared to its

⁶⁹ INFCIRC/66/REV.2, “The Agency’s Safeguards” (Vienna, IAEA, 1968) paragraph 21.

⁷⁰ Treaty on the Non-Proliferation of Nuclear Weapons, March 5, 1970, Article III, para. 1

⁷¹ Fischer, *History of the International Atomic Energy Agency*, P.255

⁷² See INFCIRC/66, paragraph 44 vs. INFCIRC/153, paragraph 90.

predecessor.⁷³ Under this system, states have an obligation to declare to the IAEA all nuclear material and facilities subject to safeguards by concluding a Comprehensive Safeguards Agreement (CSA) with the IAEA.

Like previous safeguards agreements, however, INFCIRC/153 represents a compromise between those states who have lobbied for stronger safeguards and those states which feared stronger safeguards would impede their access to peaceful nuclear energy. The document is thus replete with provisions designed to ensure safeguards would not be too intrusive. For instance, INFCIRC/153 agreements did not cover the complete nuclear fuel cycle—the various activities associated with the production of electricity which begins with the mining of uranium and ends with the disposal of nuclear waste; routine access to facilities was limited in terms of frequency and locations; there were broad safeguard exemptions for nuclear material; and there were no safeguards required on the export of equipment or facilities.⁷⁴ Moreover, when originally devised, INFCIRC/153 called for inspecting so-called ‘strategic points’ of facilities, rather than entire complexes. In other words, IAEA inspectors were limited to verifying nuclear material at locations that had been declared by the State and had their access also limited to agreed ‘strategic points’ within the nuclear plant itself. Thus, on many occasions during the 1980s, IAEA inspectors were discouraged from asking questions or looking beyond strategic points of nuclear plants.⁷⁵

⁷³ Fischer, David. *Safeguards: Past, Present, and Future*. Publication. 4th ed. Vol. 39. IAEA Bulletin. Vienna: IAEA, 1997. 33

⁷⁴ Coppen, Tom. *The law of arms control and the international non-proliferation regime: preventing the spread of nuclear weapons*. Leiden: Brill Nijhoff, 2017. P.139

⁷⁵ Bragin, Victor, John Carlson, and Russell Leslie. “Integrated Safeguards: Status and Trends.” *Nonproliferation Review*, Summer (2001): 103.

Of greater consequence, INFCIRC/153 safeguards were not designed to detect clandestine weapons production in the form of undeclared nuclear material and activities. As described by INFCIRC/153, the technical objective of safeguards is “the *timely detection of diversion* of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and *deterrence of such diversion by the risk of early detection*.”⁷⁶ The Agency primarily does this through material accounting, monitoring the quantities of nuclear material present in a nuclear facility and the changes in these quantities over time.⁷⁷ According to Fischer, it was thought that material accounting would make the evaluation of safeguards a precise scientific operation in which subjective assessments would disappear.⁷⁸ Though the drafters of INFCIRC/153 recognized the possibility that undeclared facilities and nuclear activities might exist, it was tacitly assumed that if such plants and activities were carried out, they would be detected by other means.⁷⁹ Rudolph Rometsch, head of the IAEA safeguards department during the negotiations, said that the Committee 22 meetings led to :

A sort of dogma for field work – if not a taboo. It was a question of whether inspection should be designed also to detect undeclared facilities. The conclusion was clear at the time: looking for clandestine activities was out of the question and the inspection system was designed accordingly.⁸⁰

Thus, when originally devised, INFCIRC/153 focused only on assessing the *correctness* of a state’s declaration of nuclear material—it did not look for undeclared nuclear material,

⁷⁶ INFCIRC/153, “The Agency’s Safeguards” (Vienna, IAEA, 1970) paragraph 28.

⁷⁷ *IAEA Safeguards: Stemming the Spread of Nuclear Weapons*. Report. Vienna: IAEA. 2.

⁷⁸ Fischer, “Safeguards: Past, Present, and Future,” 33.

⁷⁹ *Ibid.*

⁸⁰ Wedekind, Lothar H., and James A. Larrimore. “IAEA Symposium on International Safeguards: Mirror of the Times.” *IAEA Bulletin* 36, no. 3 (1994): 14.

activities or facilities even if it had some of the tools to do so.⁸¹ As the experience in Iraq in the 1990s, proved, however, this was insufficient.

1990s: From Accountancy to Detection

The experiences of the 1990s were a watershed in improving safeguards. Together with the experience gained from verifying South Africa's nuclear disarmament in 1993, the discovery in the early 1990s of a clandestine nuclear weapons program in Iraq demonstrated the need to strengthen safeguards. Only as a result of the First Gulf War (1991-93) did the international community (including the IAEA) become aware of an Iraqi nuclear weapons program in spite of the latter having a Comprehensive Safeguards Agreement since 1972.⁸² Amongst other violations, Iraq had operated an undeclared installation at the Tuwaitha Nuclear Research Center that was located within yards of an IAEA-monitored research reactor.⁸³ Thus, while safeguards had been adequate to verify that there had been no significant diversion of nuclear material from the declared Iraqi programme, this episode demonstrated that routine inspections of declared material and plants was not sufficient to detect Iraq's clandestine programmes, which had made no use of nuclear material that Iraq had declared to the Agency.⁸⁴ This conclusion prompted the Board of Governors to decide that a Comprehensive Safeguards Agreement should not be limited to a state's declared nuclear material but should instead encompass all relevant nuclear material

⁸¹ In theory, the IAEA may carry out 'special inspections' if the Agency believes that the State concerned is not providing all the required information about its nuclear material. In practice, however, this tool has only formally been invoked twice (Romania in 1992 and the DPRK in 1993) due to the accusatory and political overtones which accompanies such a decision.

⁸² Hirsch, Theodore. "The IAEA Additional Protocol: What It Is and Why It Matters." *Nonproliferation Review*, Fall 2004, 142.

⁸³ Ibid.

⁸⁴ Fischer, *History of the International Atomic Energy Agency*, P.282

in a state, thereby broadening the objective of safeguards to verifying the *completeness* of a state's declaration of nuclear material (INFCIRC/153 Corrected).⁸⁵

In response to the Board of Governors' decision, Programme 93+2 was launched in 1997. In general, the aim of Programme 93+2 was "to gain a broader horizontal view" of the nuclear programmes of the States concerned, instead of "piling up controls vertically on existing nuclear facilities."⁸⁶ This programme proceeded in two parts. Strengthening measures which were determined to be within existing IAEA authorities were adopted promptly. This included the use of environmental sampling—the practice of taking swipes to find the presence of leftover material—to find undeclared activities at declared facilities and the use of open source and third-party information in assessing safeguards compliance.⁸⁷ The former was particularly significant as the use of environmental sampling in North Korea in 1992 and 1993 had proven its worth by detecting a species of plutonium which was not declared by Pyongyang, suggesting the presence of additional plutonium somewhere.⁸⁸

However, additional measures such as requiring states to provide additional information on nuclear research & development not involving nuclear materials and including broader access to declared sites and other locations were deemed to require additional authorities beyond those in INFCIRC/153. Consequently, the Model Additional Protocol (INFCIRC/540) was launched in

⁸⁵ Hobbs, Christopher, and Matthew Moran. "Armchair Safeguards: The Role of Open Source Intelligence in Nuclear Proliferation Analysis." In *Open Source Intelligence in the Twenty-First Century*, 71. New York, NY: Palgrave Macmillan, 2014.

⁸⁶ Pellaud, B. "Safeguards: The Evolving Picture." *IAEA Bulletin* 38 no.4 (1996): 2.

⁸⁷ Doyle, James E. *Nuclear safeguards, security and nonproliferation: achieving security with technology and policy*. Oxford: Butterworth-Heinemann, 2008. P.24

⁸⁸ "Leading to Strengthened Safeguards, Part 2." Proceedings of The Path towards Strengthened Safeguards: Experiences in Iraq, South Africa, and North Korea. October 22, 2010. Accessed June 5, 2017. <http://cgs.pnnl.gov/FoIS/doclib/7.24.pdf>

1997 as a voluntary measure that could be adopted in addition to a state's safeguards agreement. For the first time, the effectiveness of safeguards was framed in terms of the capacity to detect clandestine nuclear activities, reflecting a shift of political expectations about the purposes of safeguards.⁸⁹ Under the provisions of the Additional Protocol (AP), states are required to provide an expanded declaration on a broad array of nuclear related activities such as "nuclear fuel-cycle related research and developments activities" and "the location, operational status and the estimated annual production of uranium mines and thorium concentration plants."⁹⁰ In addition, the level of access to nuclear facilities is increased. The AP provides the IAEA with "complementary access" to any location specified by the Agency as well as all facilities specified in the expanded declaration. Contrary to conventional wisdom, however, this standard falls short of "anytime, anywhere" inspections.⁹¹ As Simon Chin and Valerie Lincy note, "The IAEA's right to access undeclared sites is restricted to localized environmental sampling for the purposes of resolving "a question relating to the correctness or completeness" of a country's declaration. That right is further qualified: if a country "is unable to provide such access, every reasonable effort shall be made to satisfy Agency requirements, without delay, at adjacent locations or through other means."⁹² Nonetheless, without an AP in force, the IAEA has concluded that it cannot give credible assurances about the absence of undeclared nuclear activities and material in a state.⁹³ Such a conclusion is normally accomplished through reviewing facility operating histories,

⁸⁹ Fischer, David, Ben Sanders, Lawrence Scheinman, and George Bunn. *A New Nuclear Triad: The Non-Proliferation of Nuclear Weapons, International Verification and the International Atomic Energy Agency*. PPNN Study 3. University of Southampton, UK: Programme for Promoting Nuclear Non-Proliferation (PPNN), 1992. P.14

⁹⁰ INFCIRC/540, "The Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards" (Vienna, IAEA, 1997)

⁹¹ Chin, Simon, and Valerie Lincy. "Is the Additional Protocol Sufficient to Verify Iran's Nuclear Program?" Wisconsin Project on Nuclear Arms Control. April 05, 2017. Accessed August 6, 2017.

⁹² Ibid.

⁹³ Gustavo Zlauvinen, Presentation to the UN General Assembly First Committee, October 17, 2007 (IAEA director-general representative to the United Nations).

comparing declared facilities and material types/amounts with other information available to the IAEA (including from inspections) and resolving any resulting inconsistencies.⁹⁴ It should be noted, however, that even a positive conclusion on the absence of undeclared nuclear facilities and activities is not unqualified—credible assurance does not equate certainty. Hence, the IAEA has recognized that it is necessary to draw its conclusions on the balance of probabilities.⁹⁵

Besides legal and technical improvements, safeguards were also thoroughly revamped from an analytical standpoint. Since the 1990s, the safeguards system has evolved to looking at states as a whole (the state-level concept). Though it has faced opposition by a number of countries on the grounds that it is not objective⁹⁶, the state-level concept is now an integral part of the strengthened safeguards system. In collecting and analyzing a broad range of information (including state-supplied reports, third-party and open source information), the Agency now aims to verify the absence of undeclared nuclear material and activities in order to reach a broader safeguards conclusion. For instance, although the IAEA cannot verify intent, the Agency now looks at a broad range of information on a state's past behaviour with respect to its nuclear declarations, its compliance with international treaties, its nuclear export behaviour, and the enforcement of domestic safeguards to reach a safeguards conclusion.⁹⁷ In addition, the state-level concept is used to tailor safeguards to a state by taking into consideration relevant state-specific factors (such as the nuclear fuel cycle and related technical capabilities of the state) alongside an 'acquisition path analysis'. In other words, safeguards are implemented on all

⁹⁴ Hooper, Richard "The Changing Nature of Safeguards", *IAEA BULLETIN* 45 no. 1. (2003): 8.

⁹⁵ Carlson and others "Detection of Undeclared Nuclear Activities: Does the IAEA Have the Necessary Capabilities?", P.3

⁹⁶ Hibbs, Mark. "The Plan for IAEA Safeguards." Carnegie Endowment for International Peace. November 20, 2012. Accessed September 25, 2017. <http://carnegieendowment.org/2012/11/20/plan-for-iaea-safeguards/ekyb>.

⁹⁷ Doyle, *Nuclear safeguards, security and non-proliferation*, P.25

plausible acquisition paths or acquisition strategies that a State may use to acquire nuclear material usable for the manufacture of a nuclear explosive device.⁹⁸

2000s: Integrated Safeguards

Faced with budgetary challenges and years of zero growth in the Agency's budget, the early 2000s saw the development of the concept of 'integrated safeguards'. According to one IAEA official, "Integrated safeguards is the search for the optimum combination of traditional safeguards measures with the measures of the [Model] Additional Protocol to ensure a system that is cost efficient while achieving a high degree of effectiveness."⁹⁹ In essence, once a State has had the AP in force for a number of years and the Agency has been able to draw a positive safeguards conclusion, verification and inspection measures are lessened. For instance, if the IAEA can draw a positive conclusion regarding the absence of undeclared reprocessing facilities for the production of plutonium, it thus needs to spend less effort verifying that there had been no diversion of irradiated nuclear fuel in that state. Hence, the timeliness goal for detecting the diversion of irradiated fuel is extended from three months to one year.¹⁰⁰ There is, however, considerable debate as to whether lessening safeguards measures is sound in principle. As Sokolski notes, "reducing the frequency of on-site inspections increases the risks that a member state might divert materials to make bombs without the IAEA finding out until it is too late."¹⁰¹

⁹⁸ Budlong Sylvester, Kory W., Joseph F. Pilat, and Chantell L. Murphy. "Developing State-Level Approaches under the State-Level Concept." Proceedings of IAEA Symposium on International Safeguards, Vienna. 2014. Accessed August 4, 2017.

⁹⁹ Boureston and Ferguson. "Strengthening Nuclear Safeguards: Special Committee to the Rescue?"

¹⁰⁰ Cooley, Jill N. "Integrated Nuclear Safeguards: Genesis and Evolution" In *Verification Yearbook 2003*, 38 London: VERTIC, 2003.

¹⁰¹ Sokolski, Henry D. "Assessing the IAEA's Ability to Verify the NPT." Edited by Henry D. Sokolski. In *Falling Behind: International Scrutiny of the Atom*, 21. PA: Strategic Studies Institute, 2008.

In sum, the safeguards regime has considerably evolved since its inception in the early 1960s. Today, the IAEA Secretariat has defined three safeguards objectives that are common to all states with Comprehensive Safeguards Agreements. The IAEA seeks to detect undeclared nuclear material and activities, undeclared production or processing of nuclear material at facilities and at “locations outside facilities,” and diversion of declared nuclear material at facilities and locations outside facilities.¹⁰² Having examined the evolution of safeguards, this paper now turns to the case of Iran’s nuclear program between 2003 and 2006.

Case Study: Iran (2003-2006)

As the Agency’s longest-running and most-complex case to date, the Iranian case study demonstrates that, despite improvements made over decades, the safeguards system is still limited in what it can achieve. For over twenty years, Iran was able to maintain a clandestine nuclear programme without raising large-scale suspicions from the IAEA. This situation changed in August 2002 when the National Council of Resistance in Iran (NCRI) claimed during a news conference in Washington that Iran engaged in covert nuclear activities at sites in Esfahan, Natanz, and Arak. Suspicion was raised further when, on December 13, 2002, CNN aired a documentary about the Institute for Science and International Security’s (ISIS) report that included satellite images of the three nuclear sites. These public revelations ultimately dragged the Agency into a twelve-year long investigation which culminated in the JCPOA achieved in 2015 between Iran and the P5+1.

¹⁰² Rauf, Tariq, and Robert Kelley. "Nuclear Verification in Iran." Arms Control Association. September 2014. Accessed August 25, 2017. https://www.armscontrol.org/act/2014_09/Features/Nuclear-Verification-in-Iran.

The first section of this chapter describes the three-year long investigation into Iran's nuclear programme by the Agency between 2003 and 2006 with a view to examining the Agency's efforts to reveal activities Iran attempted to conceal for twenty years. As will be shown, while the Agency failed in detecting Iran's covert nuclear activities and facilities for over a decade, the Agency was considerably more effective between 2003 and 2006 when it was benefitting from substantial intelligence cooperation and open-source information to locate potential undeclared facilities. That said, the Agency's investigative powers should not be overestimated; the experience in Iran underscores that effective verification relies on the cooperation of the state in question. In addition, absent some nexus to nuclear material, the Agency suffers from a lack of authority when investigating possible military dimensions of nuclear energy programmes.

The second section of this chapter examines the effectiveness of the safeguards system from a broader angle: did the safeguards system act as an early warning mechanism in order to enable corrective mechanisms to be put in place by the international community? Considerable debate exists over whether the IAEA failed in its duty to report the Iranian non-compliance case to the Security Council immediately in 2003. Hence, this section describes the corrective actions taken by the IAEA and the European Union. It will be demonstrated that, in the broad sense of the term, the Agency's safeguards did act as an early warning mechanism to enable negotiations between the EU-3 (France, Germany, United Kingdom) and Iran. These negotiations ultimately led to a number of (failed) agreements that achieved the partial suspension of Iran's nuclear programme. At the same time, however, the delay in finding Iran in non-compliance and reported to the UN Security Council also had profound consequences with which the international community continues to grapple with.

Detecting Non-Compliance

1. Uranium Route

1.a Natanz Pilot and Fuel Enrichment Plants

Following the public revelations made by the NCRI in 2002, IAEA Director General Mohamed Elbaradei visited Tehran on February 22nd 2003, four months after the visit was originally scheduled, where Iran admitted that the facility under construction at Natanz was a large uranium enrichment plant.¹⁰³ Tehran had argued that it was not legally obligated to inform the IAEA of the facility until 180 days before the introduction of nuclear material since it had not committed to the revised subsidiary arrangements (specifically Code 3.1) of its Comprehensive Safeguards Agreement. The revised subsidiary arrangements affirmed that nuclear facilities must be declared once a decision had been made to construct it.

A day later, Elbaradei and his team headed to Natanz to inspect the facility, where Iranian officials insisted they had not used any nuclear material in testing and that Iran's centrifuge development program was entirely indigenous.¹⁰⁴ Iranian authorities claimed that the entire project was launched in 1997 with information obtained from open sources, modelling, and 'simulation studies'.¹⁰⁵ Agency inspectors, however, were suspicious. The presence of a centrifuge cascade—the connection of multiple centrifuges in order to enrich U-235 beyond 3 percent—in the Natanz pilot enrichment plant led IAEA inspectors to doubt Iranian claims that they had not introduced nuclear material into any facility for testing purposes.¹⁰⁶ Indeed,

¹⁰³ Elbaradei, Mohamed. *The Age of Deception: Nuclear Diplomacy in Treacherous Times*. New York, NY: Metropolitan Books, 2011. P.114.

¹⁰⁴ *Ibid.*, 115.

¹⁰⁵ GOV/2003/40, paragraph 8.

¹⁰⁶ Gerami and Goldschmidt. *The International Atomic Energy Agency's Decision to Find Iran in Non-Compliance, 2002-2006*, P.4

inspectors discovered that the centrifuges at Natanz were twice as efficient than Iranian data had indicated.¹⁰⁷ Moreover, Iran could not prevent IAEA inspectors from noticing similarities between the IR-1 centrifuges installed at Natanz with the Pakistani model P-1, which had originally derived from the European model by URENCO.¹⁰⁸ This was later to prove crucial in suspecting the Pakistani A.Q. Khan network's involvement in Iran's nuclear programme.

Besides physical inspections, the Agency's use of environmental sampling in Natanz also began to reveal information. Results from environmental samples taken in March revealed HEU contamination at Natanz which was inconsistent with Iran's previous declaration. The IAEA had found numerous particles of U-235 enriched to 54%.¹⁰⁹ This had caused quite a consternation among Iranian authorities.¹¹⁰ Impressed by the Agency's inspection capabilities, Iran decided not to dispute the results. Instead, the Atomic Energy Organization of Iran (AEOI) changed its story and claimed that centrifuge components had actually been imported from abroad, and speculated that the HEU particles had come from contaminated centrifuge parts.¹¹¹

After months of requesting documents and information from Iran, in August 2005, the Agency broadly concluded that Iran's statements regarding contaminated imported components was in line with its findings. However, the Agency also concluded that it would need more information than what was forthcoming in order to reach a definitive conclusion.¹¹² Indeed, this

¹⁰⁷ "Iran Nuclear Update - 2003." Wisconsin Project on Nuclear Arms Control. September 1, 2003. Accessed August 16, 2017. <http://www.wisconsinproject.org/iran-nuclear-update-2003/>.

¹⁰⁸ Gaietta, Michele. *The Trajectory of Iran's Nuclear Program*. New York, NY: Palg, 2015. P.81

¹⁰⁹ GOV/2004/83, paragraph 38 (f).

¹¹⁰ "Beyond the Challenges Facing Iran and the IAEA Concerning the Nuclear Dossier." Iran Watch. November 01, 2004. Accessed August 07, 2017. <http://www.iranwatch.org/library/government/iran/ministry-foreign-affairs/beyond-challenges-facing-iran-and-iaea-concerning-nuclear-dossier>.

¹¹¹ Elbaradei, *The Age of Deception*, 117.

¹¹² GOV/2005/67, paragraph 47.

pattern of intransigence continued up to 2006 when Elbaradei noted that Iran continued to decline access to certain operating records at the Pilot Fuel Enrichment Plant at Natanz and thus “Iran has not addressed the long outstanding verification issues or provided the necessary transparency to remove uncertainties associated with some of its activities.”¹¹³

1.b P-1 Centrifuge Program

In June 2003, Iran reiterated that its research and development on centrifuges had commenced only in 1997, with centrifuge testing (without nuclear material) having taken place in the Tehran Nuclear Research Center. By August 2003, however, the IAEA publicly concluded that Iran’s centrifuge program could not have reached its demonstrated level of sophistication without more experimentation and testing than Iran was admitting to.¹¹⁴ Faced with this revelation, Iran amended its declaration and informed the Agency that the decision to launch a centrifuge enrichment programme had actually been taken in 1985 and that Iran had in fact received drawing of the P-1 centrifuge through a foreign intermediary (later revealed to be the A.Q. Khan network). This was contrary to its original statement that its centrifuge program was entirely indigenous.

Despite this revelation, however, the Agency had considerable difficulty assessing the origin of the P-1 centrifuge program, partly because Iran was not forthright in its cooperation. In August 2003, the Agency first requested information on the origin of the components but this did not come until several months later. In October and November 2003, and again in October 2004, the Agency interviewed a former official of the AEOI who provided details on the negotiations

¹¹³ GOV/2006/53, paragraph 28.

¹¹⁴ Elbaradei, *The Age of Deception*, P.120

that resulted in the procurement of the P-1 centrifuge in 1987.¹¹⁵ No documentation was presented to the Agency, however, until January 2005 when Iran showed the Agency a handwritten one-page document reflecting the 1987 offer.¹¹⁶ That same month Iran also presented shipping documents to the Agency which appeared to contradict earlier statements regarding initial meetings with the A.Q. Khan network for the procurement of the P-1 centrifuge. As it turned out, P-1 components had been delivered in January 1994, seven months before what had been declared to be the first meeting with A.Q. Khan. Iran explained that passport stamps of the official responsible indicated trips had actually occurred in August and December 1993.¹¹⁷

1.c Kalaye Electric Company

The Kalaye Electric Company was first mentioned as a possible site of undeclared nuclear activity in 1991. However, a visit in 1992 did not turn up evidence of undeclared activities.¹¹⁸ Suspicions surrounding the Kalaye Electric Company were raised once again when a press conference held by the NCRI on February 20th alerted the IAEA to potential centrifuge testing activities in a workshop of the Kalaye Electric Company.¹¹⁹ Iranian officials claimed that only ‘simulation studies’ had been carried out at this workshop without nuclear material and that the Kalaye Electric Company was only involved in the production of components for centrifuges.¹²⁰ Hence, the Agency was not authorized to inspect the facility under Iran’s INFCIRC/153 agreement.

¹¹⁵ GOV/2004/83, paragraph 34.

¹¹⁶ GOV/2005/67, paragraph 14.

¹¹⁷ Ibid., paragraph 18.

¹¹⁸ Alger, Justin. "Nuclear Alibi: The Nuclear Revival and Proliferation." MA thesis, Carleton University, 2009. P.446

¹¹⁹ "Iran's Clandestine Nuclear Projects." Iran Watch. February 20, 2003. Accessed August 04, 2017.

<http://www.iranwatch.org/library/ncri-mullahs-clandestine-nuclear-projects-2-20-03>.

¹²⁰ GOV/2003/40, paragraph 8.

The Agency's dogged determination, however, eventually paid off. In March 2003, Iran allowed the Agency limited access to the facility—Iranian authorities refused access to one of the workshop buildings, claiming that it was used for storage. Iranian authorities also refused to allow the Agency to take environmental samples at the site.¹²¹ Environmental sampling was finally permitted in August 2003, at which time the inspectors noted that the facility had undergone “considerable modification” since the March 2003 visit and worried that it could have an effect on the accuracy of the environmental results.¹²² Nevertheless, in September 2003 Agency inspectors noted that the presence of enriched uranium particles in the samples demonstrated that nuclear material had in fact been used in centrifuge testing.¹²³ Specifically, environmental sampling showed U-235 enriched to 36% from one room but only negligible traces of 36% HEU on imported components, suggesting more than just trace quantities.¹²⁴ Like the results obtained from Natanz, the results from the Kalaye Electronic Workshop were inconsistent with Iran's declaration that it had not enriched uranium beyond 1.2%, thwarting the initial Iranian attempts not to declare the exact chronology and extent of its nuclear program. Indeed, Iran later acknowledged that centrifuges were tested between 1998 and 2002 using 1.9kg of UF₆ which it had attempted to conceal by attributing the loss of the material to leaking.¹²⁵

Despite this initial success, the issue of HEU contamination at Kalaye and Natanz was notoriously difficult for the Agency. Only in August 2005 did the Agency decide that its findings of HEU contamination at Natanz and at the Kalaye Electric Workshop Company were

¹²¹ "Kalaye Electric Company." Institute for Science and International Security. Accessed August 26, 2017. <http://www.isisnucleariran.org/sites/detail/kalaye/>.

¹²² GOV/2003/63, paragraph 32.

¹²³ Elbaradei, *The Age of Deception*, 116.

¹²⁴ GOV/2004/11, paragraph 39.

¹²⁵ Gaietta, *The Trajectory of Iran's Nuclear Program*, 148.

reasonably compatible with Iranian claims that contamination originated from imported components. This conclusion was made possible by Agency inspections in Pakistan where the components originated. However, the Agency declared that it remained unable to determine the extent of Iran's prior enrichment activities without far greater disclosure of Iranian efforts to buy, build and operate centrifuges.¹²⁶

1.d P-2 Centrifuge

In December 2003, new evidence emerged that casted doubt on the completeness of Iran's declaration. Part of this new information derived from the dismantling of the A.Q. Khan network and the Libyan nuclear weapons program. After the interception of a cargo ship containing centrifuges for Libya's nuclear program and the arrest of several individuals belonging to the A.Q. Khan network, the IAEA began to suspect that Tehran had also obtained the design and components of the more advanced P-2 centrifuge from Pakistan.¹²⁷ This was corroborated by IAEA inspections earlier in the year which unearthed strong evidence that Pakistani scientists and intermediaries were important suppliers of Iran's nuclear program.¹²⁸ Drawing on this knowledge, IAEA inspectors pressed Iran on whether it had obtained P-2 centrifuge design information. Once again, Iran had to acknowledge facts after the Agency had discovered them. On January 20th, 2004, Iran acknowledged that it had received drawings for P-2 centrifuges back in 1994.¹²⁹ While Iran was only legally obligated to declare centrifuge design if it had an Additional Protocol in force, this omission did run counter to the comprehensive

¹²⁶ De Jong, Derek. *A Chronicle of Non-Compliance: The Iran Case*. Issue brief. Ottawa: Canadian Centre for Treaty Compliance, 2011. 8.

¹²⁷ Gaietta, *The Trajectory of Iran's Nuclear Program*, 98.

¹²⁸ Albright, David, and Corey Hinderstein. "Uncovering the Nuclear Black Market: Working Toward Closing Gaps in the International Nonproliferation Regime." Proceedings of 45th Annual Meeting of the Institute for Nuclear Materials Management (INMM), Orlando. July 2, 2004. Accessed May 17, 2017.

¹²⁹ GOV/2004/11, paragraph 44.

report submitted by Iran on October 22th, 2003, which was supposed to fully disclose Iran's past and present activities.¹³⁰

Responding to international criticism, Iran explained that it had neglected to include information on the P-2 drawing due to time pressure and maintained that it had not obtained P-2 centrifuges or components from abroad, but had manufactured all components domestically.¹³¹ Iran acknowledged that a private company had made enquiries with a European intermediary for the procurement of 4000 magnets with specifications suitable for use in P-2 centrifuges, but that no magnets were actually delivered.¹³² However, in response to further Agency enquiries, Iran later acknowledged that it had actually imported some magnets relevant to P-2 centrifuges from Asian suppliers.¹³³

Further discussions between Iran and the Agency revealed more information regarding Iran's P-2 programme, though the Agency continued to be hampered by a lack of complete cooperation from Iran. In August 2004, Iranian authorities stated that, although the P-2 drawing had been acquired in 1995, no work on P-2 centrifuges had occurred until early 2002. This was in spite of frequent contacts between 1995 and 1999 on P-1 centrifuge issues with the intermediaries that had provided both the P-1 and P-2 drawings.¹³⁴ After a number of requests by the Agency, on 19 October 2004, Iran finally provided the Agency with copies of the contract and the report, which had been informally translated by Iran in April 2004. These documents

¹³⁰ Elbaradei, *The Age of Deception*, 121.

¹³¹ GOV/2004/11, paragraph 46.

¹³² GOV/2004/34, paragraph 22

¹³³ *Ibid.*, paragraph 23.

¹³⁴ GOV/2004/60, paragraph 24.

appeared to confirm the Iranian statements about the nature of the work on the P-2 centrifuge carried out by the contractor between 2002 and 2003.¹³⁵

1.e Uranium Conversion

Iran first denied experiencing with uranium conversion (i.e. conversion of UO_2 to UF_4 , UF_4 to UF_6) at the Uranium Conversion Facility in Esfahan in a February 2003 statement. Conversion is the process that purifies uranium yellowcake—a refined form of uranium ore after it has been milled—into a form that can then be enriched into material that is suitable for nuclear power generation or nuclear weapons. However, in response to Agency enquiries, Iran acknowledged that it had received 1000kg of UF_6 , 400kg of UF_4 and 400kg of UO_2 from China in 1991. Both China and Iran had initially denied the deal in the mid-1990s.¹³⁶ Furthermore, Iran acknowledged having used some of these materials for testing certain stages of the conversion process though it continued to deny having done any testing on the full conversion process (i.e. UO_2 to UF_4 , UF_4 to UF_6).¹³⁷ However, Iran admitted in August 2003 that it had carried out bench-scale tests and experiments at the Tehran Nuclear Research Center to convert UO_2 to UF_4 during the 1990s. Critically, this activity was only acknowledged by Iran after a July 2003 waste analysis by the Agency indicated the presence of depleted UF_4 mixed with natural UF_4 , meaning that natural uranium had been processed for uranium conversion.¹³⁸

On October 9th, Iran further acknowledged that, contrary to its previous statements, “practically all of the materials important to uranium conversion had been produced in laboratory and bench scale experiments between 1981 and 1993 without having been reported to the

¹³⁵ GOV/2004/83, paragraph 43.

¹³⁶ Alger, "Nuclear Alibi: The Nuclear Revival and Proliferation," P.450.

¹³⁷ GOV/2003/40, paragraph 21.

¹³⁸ GOV/2003/75, paragraph 22.

Agency.”¹³⁹ For instance, Iran’s letter of October 22th, 2003 revealed that it had used the nuclear material imported in 1991 to conduct experiments on the conversion of UF₄ to UF₆ and UO₂ to UF₄.¹⁴⁰

In September 2004, the Agency concluded that Iran’s statements and declarations regarding uranium conversion experiments were consistent with what was ascertained by the Agency as a result of its investigations.¹⁴¹

1.f Processing UF₆ and UF₄

As noted earlier, Iran initially denied having tested centrifuges using UF₆ in Natanz and at the Kalaye Electric Company. However, when, in response to Agency enquiries in March 2003, Iran presented the three cylinders containing the UF₆ imported in 1991, Agency inspectors noted that UF₆ material was missing.¹⁴² Iran explained that the UF₆ had gone missing due to leaking. However, Agency inspectors did not believe this explanation to be technically credible. In fact, in a meeting with the IAEA in November 2003, Iran finally admitted that the UF₆ previously stated to have leaked, had in fact been used in centrifuge testing, a clear example of diversion of nuclear material.¹⁴³

A similar pattern of deception and attempted concealment occurred with regards to the processing of UF₄. Following the Agency’s request to verify the nuclear material imported in 1991 from China, Iran admitted that, of the 402kg UF₄ imported, 376kg had been converted to uranium metal at the previously undeclared Jabr Ibn Hayan Multipurpose Laboratories. This was

¹³⁹ Ibid., paragraph 23.

¹⁴⁰ GOV/2003/75, paragraph 21.

¹⁴¹ GOV/2004/60, paragraph 33.

¹⁴² GOV/2003/40, paragraph 19.

¹⁴³ GOV/2003/75, paragraph 32.

an important revelation since neither Iran's light water reactors nor its planned heavy water reactors at the time required uranium metal for fuel to the concern of IAEA inspectors.¹⁴⁴

1.g Laser Program (AVLIS)

Public revelations made by the NCRI in May 2003 led the IAEA to suspect two sites where undeclared nuclear activity may have taken place (Lashkar and Ramandeh).¹⁴⁵ Upon being asked permission to visit the sites however, Iran initially denied the request, stating that the sites were involved in agricultural and medical work.¹⁴⁶ The Agency was finally given permission to visit a laboratory at Lashkar Ab'ad in August 2003 but did not permit environmental samples to be taken. During the visit, the IAEA found a sophisticated program for the production and testing of lasers but did not find activities directly related to laser uranium enrichment.¹⁴⁷ Later that month, Iran admitted for the first time that it had a substantial R&D program on vapor lasers, but continued to deny that it had a laser uranium enrichment program. In November 2003 Iran finally admitted that it had established a pilot plant for laser enrichment in 2000 (AVLIS). Iran further acknowledged that, between October 2002 and January 2003, it had conducted uranium laser enrichment experiments using previously undeclared natural uranium metal.¹⁴⁸

Parallel to these declarations, Iran stated that the production capability of the AVLIS equipment was able to enrich uranium up to a contracted level of 3% U-235. In May 2004, however, Iran presented laboratory reports to the Agency indicating that the average enrichment

¹⁴⁴ GOV/2003/40, paragraph 20.

¹⁴⁵ "Lashkar Ab'ad - Laser Uranium Enrichment." Institute for Science and International Security. Accessed August 27, 2017. <http://www.isisnucleariran.org/sites/detail/lashkar-abad-laser-enrichment/>.

¹⁴⁶ GOV/2003/63, paragraph 42.

¹⁴⁷ "Lashkar Ab'ad ." Iran Watch. January 26, 2004. Accessed August 27, 2017. <http://www.iranwatch.org/iranian-entities/lashkar-abad>.

¹⁴⁸ GOV/2003/75, paragraph 40.

levels had been 8% to 9%, with some samples of up to 15%.¹⁴⁹ Subsequent investigations by the Agency concluded that, had the entire package of equipment for the AVLIS been delivered, the site would have been capable of limited HEU production, to the surprise of Iranian AVLIS experts.¹⁵⁰

In November 2004, the Agency concluded that Iran's descriptions of the amounts of material used and the levels of enrichment achieved were consistent with the information available to the Agency.

2. Plutonium Route

2.a Arak Heavy Water Reactor (IR-40) and Hot Cells

Like the facilities in Natanz, the heavy water reactor in Arak was first revealed by the NCRI in August 2002. This was confirmed by Iran several months later, when in May 2003, it informed the Agency for the first time that it was building a heavy water reactor in Arak as a research reactor for the production of medical and industrial isotopes (e.g. for use as nuclear medicine). This ran counter to Iran's prior claims that it was stopping the production of heavy water technology.¹⁵¹ In July, the technical design of the reactor was presented to Agency inspectors at which point the inspectors noted that the drawings did not include plans for 'hot cells', special chambers to process radioactive material such as plutonium. This was of interest to the Agency as it had prior knowledge of Iranian efforts to procure from abroad components that would be used in hot cells.¹⁵² In fact, third-party information provided to the IAEA on Iran's

¹⁴⁹ GOV/2004/32, paragraph 33.

¹⁵⁰ GOV/2004/60, paragraph 35.

¹⁵¹ "French Presentation to the Nuclear Suppliers Group on the Latest Developments in Iran's Nuclear Program, in Particular on the Plutonium Way." Iran Watch. November 01, 2003. Accessed August 24, 2017.

¹⁵² Elbaradei, *The Age of Deception*, 120.

efforts to procure hot cells indicated that the specification for hot cells was somewhat excessive for the stated radioisotope production and was more indicative of that required for handling spent fuel (i.e. plutonium reprocessing).¹⁵³

In its letter of October 22th, 2003, Iran finally admitted that two hot cells had been foreseen for the IR-40 reactor but that neither the design nor detailed information was available. In May 2004 Iran revised its statement and stated that, due to difficulties associated with obtaining technical information and subsequent purchase of components, the construction of hot cells was no longer under consideration.¹⁵⁴ In August 2004, Iran provided to the Agency detailed drawings for hot cells which were to have been constructed at a different facility in Esfahan. Iran explained that it had not made detailed plans for hot cells at Arak, but had instead used information from those drawings for the procurement of hot cells for the IR-40 reactor.¹⁵⁵

2.b Reprocessing

Concerns over possible plutonium reprocessing were first raised as a result of Iran's letter of October 22th, 2003. In it, Iran acknowledged the irradiation of depleted UO₂ at the Tehran Research Reactor and subsequent reprocessing experiments at the Tehran Nuclear Research Centre.¹⁵⁶ Neither the activities nor the separated plutonium had been previously declared to the Agency. According to Iranian authorities, 7kg of UO₂ was irradiated, 3kg of which was processed to separate plutonium. These experiments had taken place between 1988 and 1992 with a purpose of learning about the nuclear fuel-cycle and gaining experience in reprocessing.¹⁵⁷

¹⁵³ GOV/2004/34, paragraph 47.

¹⁵⁴ GOV/2004/34, paragraph 49.

¹⁵⁵ GOV/2004/60, paragraph 41.

¹⁵⁶ GOV/2004/11, paragraph 21.

¹⁵⁷ Alger, "Nuclear Alibi," P.463.

On November 8th, 2003, Iran presented the separated plutonium for Agency inspection. However, samples taken by the IAEA showed a discrepancy: in its report to the Board of Governors in June 2004, the Agency noted that Iran had understated the amount of plutonium produced, although only in the milligram range. Further, the Agency concluded that the age of the plutonium was less than the 12-16 years declared by Iran, meaning that plutonium separation could have been undertaken more recently. After several requests for more information to explain the discrepancies, in April 2005 Iran acknowledged that the plutonium solutions contained in two of the bottles had been purified (one in 1995 and the second in 1998), and that plutonium disks had been produced as a result. Iran explained that there was “a clear distinction between the date of termination of the research project on plutonium and the dates of the other activities.”¹⁵⁸ However, other inconsistencies in the Agency’s results¹⁵⁹ led the Agency to declare in April 2006 that it “cannot exclude the possibility...that the plutonium analyzed by the Agency was derived from source(s) other than the ones declared by Iran.”¹⁶⁰ Indeed, by the end of 2006, the Agency concluded that Iran had not provided sufficient clarification on its experiments with plutonium.¹⁶¹

3. Possible Military Dimensions

3.a Parchin and Lavizan-Shian

By the Fall of 2004, new suspicions emerged over a possible military dimension to Iran’s nuclear programme, mostly thanks through open source information. In September, ABC News aired a story about an Iranian weapons-testing facility at Parchin, and the possibility that Iran

¹⁵⁸ GOV/2005/67, paragraph 23.

¹⁵⁹ In August 2005, IAEA verification of unprocessed irradiated UO₂ indicated that the duration of irradiation was longer than Iran had previously claimed.

¹⁶⁰ GOV/2006/27, paragraph 17.

¹⁶¹ GOV/2006/64, paragraph 13.

was testing detonation devices for high explosives. According to Elbaradei, the Agency had been reviewing data from open sources on Parchin for some time and had discussed with Iran its interest in visiting the site several times.¹⁶² At the time, Iran denied the Agency's request, citing security concerns over Agency access to a sensitive military site that is beyond the purview of the Agency.¹⁶³ As the Agency's legal authority is focused on the diversion of nuclear material and that it did not have evidence of nuclear-related activity having taken place at Parchin (only high-explosives testing), it had no legal grounds to demand Iran to comply with a visit. As noted by the IAEA's report to the Board of Governors in November 2004, "absent some nexus to nuclear material, the Agency's legal authority to pursue the verification of possible nuclear weapons related activity is limited."¹⁶⁴ Nevertheless, after agreeing on modalities under which the visit could take place in January 2005, Iran agreed to permit the Agency to visit a site located at the Parchin facility as a transparency measure beyond what it was required to do under its CSA and the Additional Protocol. The Agency was given access to five buildings and was allowed to take environmental samples. Neither the results from the samples nor the physical inspection revealed the presence of nuclear material or relevant dual use equipment.¹⁶⁵ A subsequent visit to another area of Parchin in November 2005 also did not reveal unusual activity. It should be noted, however, that the IAEA did not have permission to see the entire Parchin complex in either visit. Furthermore, the Agency was not aware at this time of the high-explosives testing chamber located at Parchin which is currently of interest to the international community.

¹⁶² Elbaradei, *The Age of Deception*, 139.

¹⁶³ "Iran bans U.N. nuke visits on some sites." China Daily. March 03, 2005. Accessed August 14, 2017.

¹⁶⁴ GOV/2004/83, paragraph 113.

¹⁶⁵ GOV/2005/67, paragraph 41.

A similar scenario played out with regards to the Lavizan-Shian site. The Agency had received information that radiation detectors had been procured for use at the site and satellite photos showed that at some point after August 2003, the site had been razed, suggesting an effort at concealment.¹⁶⁶ Iran stated that the site had been razed in response to a decision ordering the return of the site to the Municipality of Tehran in connection with a dispute between the Municipality and the Ministry of Defense. In response to further enquiries, Iran provided a detailed description and chronology of the activities at Lavisan-Shian. According to Iran, a Physics Research Centre had been established at the site in 1989 for the purpose of “preparedness to combat and neutralization of casualties due to nuclear attacks and accidents.” Iran further stated that no nuclear material or nuclear activities were carried out at the site though it declined to provide a list of the equipment used at the Centre due to security concerns.¹⁶⁷ Iran finally gave access to the Agency in June 2004 and permitted the collection of environmental samples, the results of which did not reveal the presence of nuclear material. However, the Agency explicitly noted in its report that “detection of nuclear material in soil samples would be very difficult in light of the razing of the site.”¹⁶⁸

Further delays also impeded the Agency’s investigation. In January 2006, Iran provided new information regarding the potential involvement of the Physics Research Centre (PHRC) in the purchase of dual-use materials and equipment that could be used for uranium enrichment and conversion activities.¹⁶⁹ The IAEA had been waiting on this information since late 2004, and, when asked for further clarifications in February 2006, Iran declined to discuss the matter

¹⁶⁶ Elbaradei, *The Age of Deception*, 127

¹⁶⁷ GOV/2004/60, paragraph 42.

¹⁶⁸ GOV/2004/83, paragraph 102.

¹⁶⁹ GOV/2006/15, paragraph 34.

further. By the end of 2006, the Agency concluded that “Iran has not yet responded to the Agency’s long outstanding requests for clarification concerning, and access to carry out further environmental sampling of, equipment and materials related to the Physics Research Centre (PHRC).”¹⁷⁰

3.b Polonium-210

In January 2004, Elbaradei confronted Iranian authorities over Iran’s production of polonium (Po-210), an intensively radioactive radioisotope that could be used for certain civilian applications (e.g. nuclear batteries) but also for military purposes as a neutron initiator in some designs of nuclear weapons.¹⁷¹ In September 2003, Agency inspectors noticed from available records that bismuth metal samples had been irradiated in the same general period as undeclared uranium irradiation at the Tehran Research Reactor between 1989 and 1993. Although bismuth is not nuclear material required to be declared under a CSA¹⁷², its irradiation produces polonium-210. Iran explained that the bismuth irradiation had been part of a feasibility study for the production and use of Po-210 in nuclear batteries for civilian use, not neutron sources.¹⁷³ Iran also made available for interview two Iranian scientists involved in the bismuth irradiation who confirmed that the purpose of the project had been for research on the chemical separation of polonium and the development of nuclear batteries.¹⁷⁴ Later, in February, Iran also said the experiments were part of a study about neutron sources since commercially available neutron sources were not obtainable due to import restrictions though this explanation was later

¹⁷⁰ GOV/2006/64, paragraph 18.

¹⁷¹ GOV/2004/11, paragraph 28.

¹⁷² Mousavian, Seyyed Hossein. *The Iranian Nuclear Crisis: A Memoir*. Washington, D.C.: Carnegie Endowment for International Peace, 2012. P.122

¹⁷³ GOV/2004/11, paragraph 29.

¹⁷⁴ *Ibid.*, paragraph 30.

redacted.¹⁷⁵ To support its original claim, in November 2004, Iran provided a copy of original documentation relating to the project. However, since the Agency did not have any information contradicting the stated purpose of the project it had no developments to report between November 2005 and the end of 2006.¹⁷⁶

3.c Green Salt Project and the Uranium Metal Document

By October 2005, developments emerged concerning the possible military dimension (PMD) of Iran's nuclear programme. In July, the IAEA received third-party intelligence that Iran had engaged in high-explosives testing and sought to design a nuclear-capable warhead. This information was based on electronic documents retrieved from Iran in 2004 via the German BND.¹⁷⁷ In December, the Agency requested a meeting with Iranian authorities to discuss the project but was initially rebuffed on the grounds that the allegations were baseless.¹⁷⁸ In January and February 2006, the Agency finally discussed the so-called alleged studies with Iran at which time Iran repeated that the allegations were baseless and would provide clarifications later. This information, however, never materialized as Iran later refused to discuss information relating to the Green Salt project for the remainder of 2006, negatively impacting the Agency's investigation.

Parallel to these developments, in October and November 2005, Iranian authorities disclosed on their own volition documents reflecting an offer made to Iran in 1987 for centrifuge components and equipment by intermediaries affiliated with the A.Q. Khan network.

Alarming, among these documents was a 15-page document describing procedures for the

¹⁷⁵ GOV/2004/83, paragraph 82.

¹⁷⁶ GOV/2006/27, paragraph 20.

¹⁷⁷ De Jong, *A Chronicle of Non -Compliance: The Iran Case*, 8.

¹⁷⁸ GOV/2006/15, paragraph 38-39.

casting on enriched uranium metal into hemispherical forms, which is related to the fabrication of nuclear weapon components.¹⁷⁹ According to Iran, this document was provided on the initiative of the A.Q. Khan network, rather than at the request of the Atomic Energy Organization of Iran.¹⁸⁰ However, the Agency has had difficulty fully understanding the scope of the offer made by the A.Q. Khan network in 1987. Iran only permitted inspectors to examine the document in January and August 2006 and repeatedly refused Agency requests for a copy of the document.¹⁸¹

4. The Additional Protocol (AP)

In October 2003, Tehran agreed to sign and voluntarily implement an AP as part of a deal struck with the EU (the Tehran Joint Declaration) to avoid a finding by the Board of Governors of non-compliance by Iran with its safeguards agreement and a concomitant reporting of Iran to the United Nations Security Council. This, ElBaradei told the Board of Governors in November 2003, was a major development, since “the IAEA’s ability to reach a conclusion on the nature of Iran’s nuclear programme and the correctness and completeness of Iran’s declaration of its nuclear activities will very much depend on the Agency being allowed by Iran to implement in full the verification measures provided for in the safeguards agreement and the Additional Protocol.”¹⁸²

While some of the most significant revelations between 2003 and 2006 had come from Iranian declarations and Agency findings with only a CSA in force, the AP contributed to the Agency’s findings in a number of ways. First, the AP allowed the IAEA to send inspectors to

¹⁷⁹ GOV/2005/87, paragraph 6.

¹⁸⁰ Ibid.

¹⁸¹ GOV/2006/27, paragraph 10.

¹⁸² "Iran Signs Additional Protocol on Nuclear Safeguards." IAEA. December 17, 2003. Accessed August 29, 2017.

investigate sites where it believed it had credible reports of undeclared nuclear-related activities and thus acted as a facilitator for Agency inspectors—the Agency could now inspect enrichment and other facilities (though not necessarily military sites) without disputes with Iran over whether nuclear material had been used such as had happened at the Kalaye Electric Company.¹⁸³ Second, the AP allowed the Agency to discover certain enrichment and reprocessing R&D activities that Iran had not declared. For instance, complementary access to mass-spectrometry laboratories at Karaj in December 2003 allowed inspectors to examine two mass spectrometers that had not been included in Iran’s October 2003 statement. In response to Agency enquiries, Iran acknowledged that the mass spectrometers had been used in the past to provide support to the laser uranium enrichment programme (AVLIS).¹⁸⁴ In addition, between June and September 2004, the IAEA carried out complementary access at six locations related to: centrifuge enrichment and testing; laser development; uranium conversion, purification, and casting; plutonium separation; uranium mining and ore processing; and other theretofore undisclosed R&D activities.¹⁸⁵ Thus, as Findlay notes, “By agreeing to abide by the Additional Protocol, Iran has been obliged to reveal more information than it would have liked to, which in turn has led to further incriminating questions and more intrusive on-site inspections.”¹⁸⁶

In sum, the Agency had considerable success in detecting undeclared nuclear material, activities, and facilities between 2003 and 2006. This was because it collected documents, conducted interviews and inspections, and carried out environmental sampling which revealed contradictions in Iran’s statements, forcing it to acknowledge that it had a more advanced nuclear

¹⁸³ Elbaradei, *The Age of Deception*, 127.

¹⁸⁴ GOV/2004/11, paragraph 53.

¹⁸⁵ Hibbs, "Iran and the Evolution of Safeguards," 8.

¹⁸⁶ Findlay, Trevor 'Why Treaties Work, Don't Work and What to do About It?' Presentation, Canadian Institute of International Affairs, 2006.

programme than it originally claimed. In particular, the Agency uncovered the fact that Iran had made considerable efforts to master the nuclear fuel-cycle (e.g. uranium enrichment and plutonium reprocessing), had substantial interactions with the A.Q. Khan proliferation network, and had obtained documentation relevant to the fabrication of nuclear weapon components. A pattern can thus be identified in terms of IAEA-Iran interactions, one which is not particularly conducive to quick results. The IAEA's investigation focused on verifying the correctness and completeness of Iran's declarations through technical expertise and material accounting—it did not comb over the territory of Iran in search of possible undeclared nuclear material, activities, and facilities. As a result, the IAEA's investigation included a considerable back and forth; once new information was brought to light, the Agency discussed this matter with Iran, and then looked to confirm the initial Iranian declaration pertaining to such information. In this way, the Agency's investigation was limited by a number of factors, including the reliance on third party and open source information for identifying possible locations of interest to the Agency (i.e. Natanz, Kalaye). A great deal of the IAEA's discoveries also relied to a considerable extent on the voluntary cooperation and declarations made by Iran (e.g. Iran's October 22 report when it fully disclosed certain nuclear activities). This is a sobering finding as it means that the effective verification of nuclear safeguards cannot be accomplished independently from the state in question. Indeed, in many cases, Iran did not supply in a timely manner the information and documentation requested by the Agency, which led to inconclusive and drawn-out interactions. For instance, the question of the possible military dimensions of Iran's nuclear programme was not resolved during this three-year period because Iran would not entertain any discussion on the subject. The IAEA's absence of legal authority to demand unconditional access to military sites such as Parchin compounded this issue. This was of particular concern at the time because the

Agency had knowledge of Iran's Defence Ministry's administrative connection to the nuclear energy programme.¹⁸⁷

The end-result of the Agency's three-year investigation can therefore be described as mixed. On the one hand, the IAEA had been able to confirm certain aspects of Iran's declarations, particularly on uranium conversion activities, laser enrichment, fuel fabrication, and the heavy water research reactor programme.¹⁸⁸ Beginning in November 2004, the Agency also began to verify that all the nuclear material declared by Iran had been accounted for.¹⁸⁹ On the other hand, however, because Iran was not entirely forthcoming with information requested by the Agency, "the Agency was unable to make progress in its efforts to provide assurance about the absence of undeclared nuclear material and activities in Iran."¹⁹⁰

Safeguards as an Early Warning System

Non-Compliance Reporting: Theory vs. Practice

According to Elbaradei, the safeguards system has three main functions: it operates as a "confidence-building measure, an early warning mechanism, and the trigger that sets in motion other responses by the international community if and when the need arises."¹⁹¹ Hence, beyond the detection of undeclared nuclear activities, material, and facilities, the safeguards system is also responsible to report these violations to the international community by acting as an early warning mechanism. As envisioned by the IAEA Statute, the early warning mechanism takes the

¹⁸⁷ GOV/2004/11, paragraph 37.

¹⁸⁸ GOV/2006/15, paragraph 47.

¹⁸⁹ GOV/2006/27, paragraph 33.

¹⁹⁰ GOV/2006/27, paragraph 9.

¹⁹¹ *Nonproliferation of Nuclear Weapons & Nuclear Security: IAEA Safeguards Agreements and Additional Protocols*. Report. Vienna: IAEA, 2005.

form of reporting non-compliance to the UN Security Council, the only organ which can take significant enforcement action against a non-compliant state. While there is no agreed-upon definition of what constitutes non-compliance, the IAEA Secretariat's Safeguards Glossary, which does not have legal status, defines non-compliance as being a "violation by a State of a safeguards agreement with the IAEA."¹⁹² More specifically, Pierre Goldschmidt, offers the following as clear-cut examples of non-compliance: diversion of nuclear material or the failure to declare nuclear material required to be under safeguards; undeclared production of nuclear material (i.e. through irradiation); obstruction of the activities of IAEA inspectors, interference with the operation of safeguards equipment, or prevention of the IAEA from carrying out its verification activities, all of which conduct Iran had engaged in.¹⁹³

Reporting non-compliance can be done via three routes: two are found in the IAEA Statute, the third is found in Comprehensive Safeguards Agreements. In the first instance, Article XII.C of the Statute sets out a basic, almost automatic, process. In the event of non-compliance being detected by the Agency's inspectors they are *obliged* to report the matter to the Director General, who in turn is *obliged* to report it to the Board of Governors. If it determines that non-compliance has occurred, the Board of Governors is then *obliged* to report the matter to the UN Security Council (Article XII.C uses the language 'shall' which means an obligation).¹⁹⁴ Alternatively, the Statute also contains Article III.B.4, which requires the Agency to submit annual reports to the UN General Assembly on its activities and, when appropriate, to the Security Council. Specifically, the Statute outlines that "in connection with the activities of the Agency, should there arise questions that are within the competence of the Security Council, the

¹⁹² IAEA *Safeguards Glossary*. International Nuclear Verification Series, No. 3. Vienna: IAEA, 2001. P. 13.

¹⁹³ Goldschmidt, "Exposing Nuclear Non-compliance," 148.

¹⁹⁴ Findlay, *Proliferation Alert!*, 7.

Agency *shall* notify the Security Council, as the organ bearing the main responsibility for the maintenance of international peace and security...”¹⁹⁵ Hence, according to Trevor Findlay, “the idea appears to have been that the inspectors would sound the proliferation alarm and, as a result, the non-compliance sequence, as broadly outlined in the Statute, would be automatically triggered.”¹⁹⁶

In contrast to the procedures set forth in the Statute, however, Comprehensive Safeguards Agreement contain different wording that avoid the automaticity implied by the Statute.¹⁹⁷ Paragraph 19 of a CSA outlines that “if the Board... finds that the Agency is not able to verify that there has been no diversion of nuclear material required to be safeguarded under this Agreement, to nuclear weapons or other explosive devices, it *may* make the reports provided for in paragraph C of Article XII of the Statute of the Agency.”¹⁹⁸ Furthermore, while the Statute is silent on the matter, CSAs oblige the Board of Governors to “afford” the state “every reasonable opportunity to furnish the Board with any necessary reassurance” before it can be reported to the Security Council.¹⁹⁹

Thus, while CSAs relax the automaticity implied in the Statute, all three routes refer to the Security Council as the main organ for enforcement against a non-compliant state. Furthermore, the process described above demonstrates that a formal finding of non-compliance and subsequent reporting to the UNSC relies on the IAEA Board of Governors, not the IAEA Secretariat or Department of Safeguards. The latter’s responsibility is to pass along clear,

¹⁹⁵ IAEA Statute art. III, § B.4

¹⁹⁶ Findlay, *Proliferation Alert!*, 9.

¹⁹⁷ *Ibid.*, 8.

¹⁹⁸ INFCIRC/153, “The Agency’s Safeguards” (Vienna, IAEA, 1970) paragraph 19.

¹⁹⁹ *Ibid.*

technical information on whether non-compliance has occurred. As will be shown, however, the process is infinitely more complex in practice—contrary to what we might expect from the Statute, the Iranian case was only reported to the Security Council three years after the Agency initially reported violations. Furthermore, the roles of Agency inspectors, the Department of Safeguards, and of the Director General have considerably evolved since the creation of the Statute so that they have had some flexibility in dealing with Iran.²⁰⁰ Nevertheless, through its investigations and regular reporting to the Board of Governors, the safeguards system acted as an early warning mechanism to the international community, which in turn, took corrective measures in the form of diplomatic negotiations and agreements between the EU-3 and Iran. Importantly, the Agency was able to alert the international community sufficiently early as Iran had not yet mastered the nuclear fuel cycle at the time—the process of enriching uranium which has both peaceful and military uses.

The Tehran Joint Declaration (2003)

The discovery by the Agency of numerous undeclared nuclear material, activities, and facilities opened an important phase in trying to come to an agreement with Iran over its nuclear programme. In June 2003, Elbaradei issued his first written report to the Board of Governors, which spoke of “safeguards issues that need to be clarified and actions that need to be taken with regard to ... implementation” of Iran’s safeguards agreement with the Agency.²⁰¹ Ringing the alarm, the report stated that there had been “a number of failures by Iran to report the material, facilities and activities in question in a timely manner” and described this as “a matter of concern.” With this information in hand, the United States immediately lobbied the Board of

²⁰⁰ Findlay, *Proliferation Alert!*, 6.

²⁰¹ GOV/2003/40, paragraph 1

Governors to find Iran in non-compliance with its safeguards agreement and reported to the United Nations Security Council, as the Board of Governors had swiftly done with North Korea in 1993.²⁰² In addition, the United States pressed Elbaradei to issue a clear finding of non-compliance, relying on the perceived ‘trigger mechanism’ of the term to have Iran reported to the UNSC.²⁰³ The Director General, however, declined and argued that the IAEA’s verification was a “work in progress” that needed more time for completion.²⁰⁴

Despite the DG’s refusal to find Iran in non-compliance in June 2003, the Agency’s discoveries led the international community to take action albeit without the Security Council’s involvement. In early August, France, Germany, and the UK (EU-3) wrote to Iran proposing that it cease its nuclear enrichment activities in exchange for technical cooperation. Deep divisions between the EU-3 and the United States had been created as a result of the invasion of Iraq so that the former preferred to have the issue settled at the IAEA. The EU-3 feared that reporting Iran to the Security Council could escalate the crisis and be used as a pre-text by the United States to launch another invasion in the Middle East.²⁰⁵

As a result, the “tough resolution” the United States had sought from the IAEA to have Iran reported to the UNSC was beginning to unravel. Ahead of the September 2003 Board of Governors meeting, the EU-3 had decided not to press Iran to be reported to the Security Council, splitting from the United States and other like-minded countries. Meanwhile, the US

²⁰² Bolton, John R. *Surrender Is Not an Option: Defending America at the United Nations and Abroad*. New York: Threshold Editions, 2007. P.138

²⁰³ Findlay, *Proliferation Alert!*, 56.

²⁰⁴ "Intervention on Iran During the IAEA Board of Governors Meeting." IAEA. June 17, 2003. Accessed September 16, 2017. <https://www.iaea.org/newscenter/statements/intervention-iran-during-iaea-board-governors-meeting>

²⁰⁵ Gerami and Goldschmidt. *The International Atomic Energy Agency's Decision to Find Iran in Non-Compliance, 2002-2006*, 5.

Ambassador to the IAEA, Kenneth Brill, argued that “the facts already established” justified an immediate finding of non-compliance by Iran with its safeguards obligations.²⁰⁶ Under pressure from other members of the Board of Governors, however, the United States relented and agreed “to give Iran one last chance to stop its evasions.”²⁰⁷

By October, EU-3 efforts to reach a negotiated solution with Iran entered a new, more intensive efforts. The three foreign ministers, Dominique de Villepin of France, Jack Straw of the UK, and Joschka Fischer of Germany, traveled to Tehran on October 21st to negotiate with Hassan Rouhani of Iran’s Supreme National Security Council. At the meeting, Rouhani told the ministers that Iran was willing to consider adopting the Additional Protocol and working with the IAEA to resolve outstanding issues. In exchange, the EU-3 would need to accept Iran’s right to peaceful nuclear energy, agree to technical assistance, and block any referral of Iran to the Security Council. Within hours, the EU-3 and Iran announced they had secured an agreement. Known as the Tehran Joint Declaration, Iran agreed to sign and implement the Additional Protocol, which would give more intrusive inspective powers to the Agency. Iran further stated that it would “voluntarily suspend all uranium enrichment and reprocessing activities as defined by the IAEA” as a confidence-building measure.²⁰⁸ The EU-3, for their part, agreed to recognize Iran’s right to peaceful nuclear energy and to open a dialogue for broader cooperation with Iran. Finally, the EU-3 informed Iranian officials that, “in their view, full implementation of Iran’s

²⁰⁶ Rebecca Johnson, “IAEA Adopts Critical Resolution in Deepening Crisis over Iran’s Nuclear Program,” *Disarmament Diplomacy*, no. 73, October–November 2003, available at <http://www.acronym.org.uk/old/archive/dd/dd73/73news02.htm>

²⁰⁷ *Ibid.*

²⁰⁸ Cronberg, Tarja. *Nuclear Multilateralism and Iran: Inside EU Negotiations*. New York, NY: Routledge, 2017. P.18

decisions, confirmed by the IAEA's Director General, should enable the immediate situation to be resolved by the IAEA Board," rather than reporting the matter to the UNSC.²⁰⁹

The Tehran Joint Declaration marked an important point in the Iranian nuclear dossier at the IAEA. The agreement provided the guarantees Iran had sought to prevent its referral to the United Nations Security Council. This, according to Seyed Hossein Mousavian, spokesman for Iran's nuclear negotiating team at the time, facilitated cooperation between Iran and the IAEA so that the former was willing and able to present a 'complete' report on its nuclear program.²¹⁰ The October report admitted to several activities Iran had previously denied, including uranium conversion and enrichment experiments.

The Joint Declaration, however, did not remove Iran's nuclear programme on the IAEA's agenda as Iran had hoped. As it turns out, the November 2003 BOG meeting was to prove particularly controversial with regards to Iranian non-compliance. In his report to the BOG, Elbaradei stated that Iran had nearly mastered the front end of the nuclear fuel-cycle and though "the materials would require *further processing* before being suitable for weapons purposes, the number of failures by Iran to report in a timely manner the material, facilities and activities in question as it is obliged to do pursuant to its Safeguards Agreement has given rise to serious concerns." At the same time, however, Elbaradei concluded that "there is no evidence that the previously undeclared nuclear material and activities . . . were related to a nuclear weapons program," confusing the question of the standard of proof for a non-compliance finding.²¹¹ In addition, Elbaradei carefully left out the term 'non-compliance' from his report so as to avoid a

²⁰⁹ "Statement by the Iranian Government and Visiting EU Foreign Ministers," October 21, 2003, available at http://www.bits.de/public/documents/iran/Tehran_EU_Iran_Agreement03.pdf

²¹⁰ Mousavian, *The Iranian Nuclear Crisis: A Memoir*, 111.

²¹¹ GOV/2003/75, paragraph 52.

possible referral to the Security Council. Rather, the report stated that “The recent disclosures by Iran about its nuclear programme clearly show that, in the past, Iran had concealed many aspects of its nuclear activities, with resultant *breaches* of its obligation to comply with the provisions of the Safeguards Agreement.” Recalling in his memoir, Elbaradei said “I had long been careful to avoid using the word noncompliance, opting instead for synonyms such as breach or violation, so as not to prejudice the Board.”²¹² While Elbaradei was not legally obligated to use the term non-compliance, numerous commentators and Member States were furious. US Ambassador Kenneth Brill criticized the IAEA for “dismissing important facts that had been disclosed by its own investigation as irrelevant to the question of whether Iran has a nuclear weapons program.”²¹³ The Australian delegation, for its part, felt that by declining to use the word “non-compliance” in the Iran case, the Secretariat had let ‘political’ judgments intrude on what should have been a technical recommendation.²¹⁴ In the end, although the United States continued to press for Iran to be reported to the Security Council—as a strict application of the Statute required—China, Russia, the EU-3 and non-aligned movement members preferred to have the issue settled at the IAEA.²¹⁵

Nonetheless, the resolution achieved at the November 2003 BOG meeting did include language which kept alive the possibility of reporting Iran to the UNSC. According to the paragraph, “should any further serious Iranian failures come to light, the Board of Governors

²¹² Elbaradei, *The Age of Deception*, 145.

²¹³ “IAEA Governors Accept Iran's Additional Protocol; Talks on Resolution Delayed.” Nuclear Threat Initiative. November 21, 2003. Accessed July 30, 2017.

²¹⁴ Findlay, *Proliferation Alert!*, 58.

²¹⁵ Gerami and Goldschmidt. *The International Atomic Energy Agency's Decision to Find Iran in Non-Compliance, 2002-2006*, 7.

would meet immediately to consider... all options at its disposal, in accordance with the IAEA Statute and Iran's Safeguards Agreement."²¹⁶

The 2004 Brussels and Paris Agreements

Greeted with much fanfare, the Tehran Joint Declaration was actually to prove short-lived. In early 2004, Iran had to acknowledge that it had received P-2 centrifuge drawings and had irradiated bismuth for the production of polonium-210. The issue of HEU contamination at Natanz and the Kalaye Electric Company also complicated affairs. Elbaradei's report in February 2004 spoke of Iran's incomplete cooperation in supplying information to the Agency regarding the origin of contaminated centrifuge components.²¹⁷ These developments led to a split among Western members in the Board of Governors. On the one hand, the US, joined by Australia, Canada and Japan wished to condemn Iran and called for the inclusion of strong language in the February 2004 resolution. The EU-3, however, continued to oppose any move that might bring Iran closer to the Security Council. In the end, the Board passed a softer resolution, which, while pleasing to Iran and the US, deferred a formal finding of non-compliance to the June 2004 BOG meeting.²¹⁸

Parallel to these developments at the Board of Governors, disagreements over the scope of Iran's voluntary suspension were surfacing. Iran understood suspension to mean only suspending the introduction of UF₆ gas into centrifuges—it thus did not halt the assembly and installation of centrifuges at the Pilot Fuel Enrichment Plant in Natanz. This definition of suspension had apparently been agreed to in a private conversation between Elbaradei and Iran

²¹⁶ GOV/2003/81, paragraph 8.

²¹⁷ GOV/2004/11.

²¹⁸ GOV/2004/49.

leading up to the Tehran Joint Declaration.²¹⁹ A non-paper produced by the IAEA in November 2003, however, introduced a broader definition that included the suspension of production and assembly of centrifuge parts.²²⁰ This apparent contradiction illuminated the need for further clarifications, which were adopted in February 2004 under the Brussels Agreement. Under the agreement, Iran extended the scope of suspension to include enrichment activities (i.e. manufacturing and assembling of centrifuges).

By April, however, the Brussels Agreement began to unravel. In a letter to Director General Elbaradei, Iran announced its intention to carry out tests at the Uranium Conversion Facility at Esfahan for the production of UF₆—a step that was at odds with the Brussels Agreement according to the IAEA. The last straw came in June when the language of the IAEA June 2004 resolution persuaded President Khatami to declare the agreement null and void, and to resume the production, assembly, and testing of centrifuges.²²¹

A last attempt to negotiate a solution to the Iranian nuclear dossier came in November 2004. On November 14, a day before Elbaradei circulated his report to the Board of Governors, the EU-3 and Iran had agreed on another agreement. Known as the Paris Agreement, it called for negotiations to be launched by a joint European-Iranian committee that would establish working groups on a wide variety of subjects, including nuclear issues, security and defence, and economic and technology cooperation with a view to establishing a long-term relationship between Europe and Iran.²²² The agreement had also resolved inconsistencies regarding the

²¹⁹ Mousavian, *The Iranian Nuclear Crisis: A Memoir*, 124.

²²⁰ Ibid.

²²¹ Gaietta, Michele. *The Trajectory of Iran's Nuclear Program*. New York, NY: Palg, 2015. P.100

²²² Gerami and Goldschmidt, *The International Atomic Energy Agency's Decision to Find Iran in Non-Compliance, 2002-2006*, 11.

scope of Iranian suspension. As a result, the Board welcomed the Paris Agreement at the November 2004 meeting and again deferred a formal finding of non-compliance.²²³

The 2006 Non-Compliance Report

In early 2005, the Paris Agreement had looked like a stunning achievement. During the first half of 2005, no written IAEA safeguards reports had been issued by Elbaradei, the first time in two years. Elbaradei, with the EU-3's support, felt that oral reports were sufficient.²²⁴ The United States, for its part, offered to lift the block on Iran's membership to the World Trade Organization as an incentive.²²⁵

By mid-June 2005, however, Iran's determination to resume its enrichment program began to put strain on the Paris Agreement. In March, Iran presented a new offer to the EU-3 that would allow Iran to restart uranium conversion experiments and maintain a limited enrichment programme.²²⁶ The EU-3, however, remained firm in opposing any step that was at odds with the suspension of Iran's nuclear programme. In June, meanwhile, Mahmoud Ahmadinejad won Iran's presidential elections and within days decided to resume uranium conversion activities at Esfahan, thereby annulling the Paris Agreement.

By September 2005, the situation had dramatically changed. The September 2005 IAEA safeguards report listed all of Iran's past safeguards violations since November 2004 and noted issues that remained to be resolved. Amongst others, the IAEA was unable to definitively

²²³ Findlay, *Proliferation Alert!*, 61.

²²⁴ "Statement by Deputy Director General Goldschmidt (GOV/OR.1119) (Excerpts)." Iran Watch. March 01, 2005. Accessed August 30, 2017. <http://www.iranwatch.org/library/international-organization/international-atomic-energy-agency-iaea/iaea-report/statement-deputy-director-general-goldschmidt-govor1119>.

²²⁵ Gerami and Goldschmidt, *The International Atomic Energy Agency's Decision to Find Iran in Non-Compliance, 2002-2006*, 12.

²²⁶ *Ibid.*

conclude the source of HEU contamination and could not verify Iranian statements concerning its efforts to import, manufacture, and use P-1 and P-2 centrifuge designs.²²⁷ After two and a half years of intensive investigation, Elbaradei once again called on Iran to expand its transparency and confidence-building measures to “compensate for the confidence deficit.”²²⁸ Concerned with the lack of tangible results from its negotiations with Iran, the EU-3, with the support of the United States, Canada, Australia and other like-minded states, drafted a harsh resolution at the September 2005 Board of Governors meeting which called for Iran to be reported to the Security Council. China and Russia, however, opposed on the grounds that the Iranian nuclear issue could be resolved at the IAEA.²²⁹ Unwilling to force a vote without consensus, the EU-3 thus amended the resolution to find Iran in non-compliance but removed any reference to having Iran reported to the Security Council.²³⁰ Nonetheless, this marked the turning point in the Iranian non-compliance case. The resolution had for the first time declared that Iran’s “many failures and breaches of its obligations to comply with its safeguards agreement [as had been reported by ElBaradei in November 2003] constitute non-compliance in the context of Article XII.C” of the IAEA Statute.²³¹ The resolution further noted that Iran’s nuclear activities gave “rise to questions that are within the competence of the United Nations Security Council [as envisioned by Article III.B.4 of the Statute].” This had been the ‘trigger’ resolution the United States had sought for two years.

²²⁷ GOV/2005/67

²²⁸ Elbaradei, Mohamed. "Introductory Statement to the Board of Governors." IAEA. September 18, 2005. Accessed August 30, 2017. <https://www.iaea.org/newscenter/statements/introductory-statement-board-governors-27>.

²²⁹ Gerami and Goldschmidt, *The International Atomic Energy Agency's Decision to Find Iran in Non-Compliance, 2002-2006*, 13.

²³⁰ Bolton, *Surrender Is Not an Option*, 321

²³¹ GOV/2005/77, paragraph 1.

In spite of the supposed ‘trigger resolution’, however, the Board again deferred to have Iran reported to the Security Council at the November 2005 BOG meeting. Instead, the Board had agreed to support a Russian proposal for the establishment of a joint venture with Iran to operate a uranium enrichment facility on Russian territory. Iran, however, rejected the plan, reaffirming its intent and right to enrich uranium.²³² On January 3rd, 2006, Iran formally informed the IAEA of its decision to resume nuclear research and development activities and soon began to remove IAEA seals covering centrifuges at Natanz. In response, the BOG decided to hold an emergency session on February 2nd to draft a resolution calling for Iran to be reported to the Security Council. Three days later, the resolution passed 27-3 with five abstentions calling for Elbaradei to report Iran to the Security Council for non-compliance. Predictably, Iran responded forcefully, ending the provisional implementation of its Additional Protocol (it had never been ratified by the Majiles, the Iranian parliament). Three years after the IAEA began its investigations, Iran had finally been reported to the UNSC.

Whether Iran should have promptly been reported to the Security Council in 2003 is still a hotly debated question. On the one hand, the failure to promptly report non-compliance as the IAEA is statutorily required to do and on which effective deterrence relies, has had profound consequences. As Goldschmidt notes, “the failure to formally declare Iran in non-compliance in November 2003 effectively delayed the ability of the UNSC to adopt a resolution—without necessarily implementing sanctions—under Chapter VII of the UN Charter, which would have made the hitherto voluntary suspension of Iran’s enrichment-related and reprocessing activities legally binding.” Furthermore, “the decision to delay a formal finding of non-compliance

²³² "Iran Insists on Domestic Uranium Enrichment." Nuclear Threat Initiative. December 06, 2005. Accessed August 29, 2017. <http://www.nti.org/gsn/article/iran-insists-on-domestic-uranium-enrichment/>.

enabled Iran to advance its nuclear capabilities: in 2003, the Esfahan uranium conversion facility was not yet operational, Iran did not possess a significant stock of UF₆, and no enriched uranium had been produced at the Natanz enrichment plant. Only 2 years later, Iran had conducted experiments to acquire expertise for nearly every aspect of the nuclear fuel cycle and produced enriched uranium at Natanz.”²³³

Nonetheless, the failure to promptly report Iran to the UNSC does not mean that the Agency failed per se—it is important not to confuse the IAEA’s alert and the subsequent enforcement response. The latter relies on the Board of Governors, a political body, not the IAEA Secretariat or Department of Safeguards. Indeed, while the specific alerting mechanism did not take the form of a non-compliance report, the Agency’s safeguards system nevertheless acted as an early warning mechanism. Through its investigations and regular reporting to the Board of Governors, the IAEA routinely informed the BOG that it could not conclude that all nuclear material and activities in Iran were dedicated to peaceful uses. Critically, the Agency also rang the alarm sufficiently early: in 2003 Iran did not yet possess the capacity to enrich uranium on an industrial scale. Hence, the Agency fulfilled its responsibility to provide warning before a nuclear weapons program has proceeded beyond the point where intervention can be effective.²³⁴

²³³ Gerami and Goldschmidt, *The International Atomic Energy Agency's Decision to Find Iran in Non-Compliance, 2002-2006*, 15.

²³⁴ Carlson, John, and Andreas Persbo. *The IAEA safeguards function*. Issue brief. Vol. 21. London, UK: VERTIC, 2013. P. 3.

Conclusion

For 60 years, the IAEA has taken a leading role in preventing the spread of nuclear weapons and deterring the misuse of civilian nuclear energy. However, as this paper has shown, the IAEA safeguards system is by no means beyond reproach. The Iranian case study illustrates the practical challenges the Agency faces in detecting undeclared nuclear material, activities, and facilities. While it is true that the Agency may have been hindered by the lack of an Additional Protocol prior to December 2003, it is arguable whether the AP could have led to the discoveries in Natanz and other undeclared nuclear facilities. Even the former IAEA Director of Safeguards has conceded that the additional authority provided to the Agency under the Additional Protocol is not sufficient to ensure that it will be able to discover all undeclared activities at undeclared locations.²³⁵ Central to this issue is the Agency's reliance on open source information and third-party information to initially locate areas of interest. A close partnership between national intelligence organizations and safeguards is therefore necessary for the foreseeable future—the former is vital in identifying locations of interest, and the latter provide the means to investigate them. In the meantime, Adam Scheinman is arguably right when he notes that, "initial detection of undeclared activities is an extremely ambitious goal that is probably beyond the IAEA's reach."²³⁶

Once these facilities were located, however, the Agency was considerably effective in uncovering the scope and extent of Iran's nuclear programme. Through inspections, environmental sampling, and persistent queries, Iran's repeated denials grudgingly turned into

²³⁵ Goldschmidt, Pierre. "Nuclear Proliferation in the 21st Century: Will Multilateral Democracy Work?" Paper presented to the Danish Institute for International Studies, Copenhagen, August 25-26 2005. P. 2-3.

²³⁶ Scheinman, Adam M. "Calling For Action: The Next Generation Safeguards Initiative." *The Nonproliferation Review* 16, no. 2 (2009): 261.

admissions that it had in fact carried out a number of experiments previously undeclared to the Agency.²³⁷ This episode underscores an IAEA inspection body that is technically proficient, thorough, and persistent in its investigations.

That being said, the Agency's investigative powers should not be overestimated: while the Agency was able to reveal certain undeclared nuclear activities, others came from Iranian declarations. Hence, the Agency must not only rely on the goodwill of those with good intelligence, but also rely on the goodwill of those subjected to inspections.²³⁸ As Elbaradei noted, "An Additional Protocol, *coupled* with a policy of full transparency and openness on the part of Iran, is indispensable for such a [robust verification] system."²³⁹ Absent this cooperation, as demonstrated in regards to such issues as the P-2 centrifuge, the Agency's investigation can come to a standstill as it cannot enforce access to suspected sites and sensitive information. This is especially the case with regards to the possible military dimensions of Iran's nuclear programme. Iran refused to discuss the Green Salt project, permitted only highly restricted visits to the Parchin military site and did not cooperate fully with regards to the issue of dual-use equipment at Physics Research Centre nor on the issue of the uranium metal document received from A.Q. Khan. These developments demonstrate that the Agency suffers from a deficiency of authority under standard safeguards when it comes to weaponization activities not directly linked to nuclear material. Fortunately, this concern has been addressed in the context of the JCPOA, although in an imperfect manner. As part of the deal, the Agency is now charged with monitoring and verifying Iranian compliance with regards to restrictions on 'weaponization'

²³⁷ Elbaradei, *The Age of Deception*, 120.

²³⁸ Schulte, Gregory L. "Stopping Proliferation Before It Starts." *Foreign Affairs*. July 01, 2010. Accessed September 15, 2017. <https://www.foreignaffairs.com/articles/2010-07-01/stopping-proliferation-it-starts>.

²³⁹ GOV/2003/75, paragraph 52.

activities as set out in Section T of the JCPOA. Section T provides the IAEA the authority to access any site where any such activities may be conducted—military or civilian. Further, in the event that the IAEA is unable to resolve safeguards-related questions, Section Q of the deal provides the Agency very broad authority to seek clarification and, if necessary, demand access to verify “activities inconsistent with the JCPOA.” However, while important and necessary measures, these additional elements are not perfect. For instance, rather than inspections taking place regularly, inspections under Section T must first be prompted by evidence suggesting illicit work.²⁴⁰ Furthermore, the modalities for monitoring Section T commitments are not completely clear, which has implications on the Agency’s ability to monitor and verify compliance.

According to IAEA DG Yukiya Amano, “More clarification would be helpful ... Russia has a different view. They believe that it is not the mandate of the IAEA. Others have different views and discussions are ongoing.”²⁴¹ Expanding further, when prompted about the IAEA’s ability to verify Section T commitments, Amano stated that the Agency’s tools are limited: “In other sections, for example, Iran has committed to submit declarations, place their activities under safeguards or ensure access by us. But in Section T I don’t see any (such commitment).”²⁴² Consequently, this means that, independent of IAEA verification, national intelligence means will remain necessary, particularly in order to uncover any evidence required to prompt Section T inspections.

²⁴⁰ Nephew, Richard. "Preventing Iranian nuclear weapons work." Brookings. October 09, 2017. Accessed November 13, 2017. <https://www.brookings.edu/blog/markaz/2017/10/09/preventing-iranian-nuclear-weapons-work/>.

²⁴¹ Murphy, Francois. "IAEA chief calls for clarity on disputed section of Iran nuclear deal." Reuters. September 26, 2017. Accessed November 13, 2017. <https://www.reuters.com/article/us-iran-nuclear-iaea/iaea-chief-calls-for-clarity-on-disputed-section-of-iran-nuclear-deal-idUSKCN1C12AN/>.

²⁴² Ibid.

As for the capacity for the safeguards system to act as an early warning mechanism, however, it appears that the Agency is quite effective in this area though not without controversy. Through its investigations and regular reporting to the Board of Governors (even when no new developments were reported), the IAEA Secretariat effectively drew and sustained attention to Iran's nuclear programme so that the international community could put in place corrective mechanisms. That these corrective mechanisms failed should not mean to imply that safeguards failed—the failures had more to do with the IAEA Board of Governors than the IAEA Secretariat and Department of Safeguards whose sole responsibility is to effectively communicate information to the Board. In any case, the Iranian non-compliance episode demonstrates the political complexities of finding a state in non-compliance and the adverse consequences this may have on potential proliferation and the credibility of the safeguards regime.

Unfortunately, none of the deficiencies highlighted above lend themselves to easy solutions or generic approaches. In this respect, it is useful to keep in mind the verdict of the 1946 Acheson-Lilienthal Report: “A system of inspection superimposed on an otherwise uncontrolled exploitation of atomic energy by national governments *will not be an adequate safeguard*. If nations or their citizens carry on intrinsically dangerous [nuclear] activities it seems to us that the chances for safeguarding the future are hopeless.”²⁴³ While the safeguards system may never be perfect, however, it would be folly to conclude that nothing more can be done. To start, the IAEA should fully use the tools and rights it has at its disposal, including the use of special inspections to resolve safeguards-related issues. Special inspections are a powerful

²⁴³ Acheson, Dean, and David E. Lilienthal. *A Report on The International Control of Atomic Energy*. Washington, D.C.: U.S. Government, 1946. P. 12, 33.

verification tool that has regrettably seldom been used in the Agency's history. Furthermore, recommendations to incorporate verification elements of the JCPOA into the regular safeguards system as some observers have done is a positive step.²⁴⁴ However, this will likely face a pushback by a number of states for fear that this may compromise sensitive military facilities and block their rights to peaceful nuclear energy. Hence, more research is needed to explore how to make a strengthened safeguards system more palatable to such states.

²⁴⁴ See, for instance, "Tariq Rauf: Iran is now gold standard for verification at enrichment plants." Tehran Times. March 14, 2016. Accessed September 20, 2017. <http://www.tehrantimes.com/news/253784/Tariq-Rauf-Iran-is-now-gold-standard-for-verification-at-enrichment>.; Pickering, Thomas. "JCPOA: A New Gold Standard for Non-Proliferation Agreements." Atlantic Council. June 7, 2017. Accessed September 24, 2017. <http://www.atlanticcouncil.org/blogs/iraninsight/jcpoa-a-new-gold-standard-for-non-proliferation-agreements>.

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Annex A

Nuclear Fuel Cycle



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Source: IAEA, <https://www.iaea.org/OurWork/ST/NE/NEFW/Technical-Areas/NFC/home.html>

