

## **THE ANNEXES TO THE MODEL ADDITIONAL PROTOCOL: A QUARTER CENTURY ON**

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### **Abstract**

The Model Additional Protocol (MAP), approved in 1997 by the Board of Governors of the International Atomic Energy Agency (IAEA) is a voluntary legal instrument supplementary to safeguards agreements between States and the IAEA. An additional protocol based on the MAP gives the IAEA more tools to provide credible assurance as to the absence of undeclared nuclear activities or material in a State. Among these tools are expanded reporting requirements, including (but not limited to) those outlined in the MAP's two Annexes.

Article 2.a.(iv) of the MAP requires reporting to the IAEA on the scale of operations for each location engaged in activities contained in Annex I. Article 2.a.(ix) requires reporting on the exports and (upon request) imports of specified equipment and non-nuclear material listed in Annex II, which was crafted based on technological capabilities along the fuel cycle at the time the MAP was approved by the Board. A quarter century after the Board approved the MAP, the procedure outlined in the MAP to update the Annexes has yet to be pursued. Meanwhile, technological advancements since 1997 may necessitate the inclusion of further materials, technologies and activities that are not reflected in the Annexes but have implications for safeguards.

The paper includes a historical examination of how the Annexes were negotiated, how they are meant to improve the effectiveness and efficiency of the planning, implementation and evaluation of safeguards, and makes the argument for keeping them updated commensurate with the pace of technological advancements along the nuclear fuel cycle. On the latter point, the paper also provides insights and recommendations, drawing from lessons learned from past experiences, for how the IAEA and its Member States could choose to go about such an update.

### **1. INTRODUCTION**

In the 1990s, in large part driven by the discovery of a clandestine nuclear weapons programme in Iraq and concealed nuclear activities in North Korea, the International Atomic Energy Agency (IAEA) and its Member States embarked on the task of strengthening safeguards. One of the first activities undertaken was the Voluntary Reporting Scheme (VRS) on imports and exports of nuclear material and exports of specified equipment and non-nuclear material. This reporting scheme was approved by the Board of Governors (hereafter "the Board") in February 1993.

In December 1993, the effort to strengthen the effectiveness and improve the efficiency of the safeguards system was formalised as Programme 93+2, which concluded with a report by the Director General for consideration by the Board. [1] Contained in the report were so-called Part 1 measures, which the Secretariat determined could be implemented with existing legal authority, as well as Part 2 measures for which additional legal authority was recommended. The Board accepted the Director General's recommendation, prompting the Secretariat to implement Part 1 measures. This included, for example, more routine use of environmental sampling and the early provision of facility design information. [2] Subsequently, the Secretariat, in consultation with Member States, created a draft model protocol to operationalise the Part 2 measures. The draft was used as the basis for negotiations in the Committee on Strengthening the Effectiveness and Improving the Efficiency of the Safeguards System, also known as Committee 24. The result was the Model Protocol Additional to the Agreements Between State(s) and the International Atomic Energy Agency for the Application of Safeguards – commonly referred to as the Model Additional Protocol – which was approved by the Board on 15 May 1997. [3]

An additional protocol (AP) based on the model gives the IAEA more tools to provide credible assurance about the absence of undeclared nuclear activities or material in a country, among them expanded reporting

requirements such as those of the Model Additional Protocol's two Annexes. The Model Additional Protocol contains several important provisions related to the Annexes.

Article 2.a.(iv) of the Model Additional Protocol obligates States with APs based on the model to provide a declaration containing a "description of the scale of operations for each location engaged in the activities specified in Annex I." The activities listed in Annex I reflect key chokepoints in the nuclear fuel cycle that could be used to produce weapons-usable nuclear material. They relate to the manufacture, assembly or upgrading of certain equipment and materials related to enrichment, reactor operation, heavy water production and reprocessing of spent fuel.

Article 2.a.(ix) obligates States with APs based on the model to provide data pertaining to international transfers of specified equipment and non-nuclear material listed in Annex II. This information includes the identity, quantity, location of intended use and date of export, in the case of exports of such items, and, upon request from the IAEA, confirmation by importing countries of such information. The list in Annex II was based on the VRS as it stood in 1996 which, in turn was based on Annex B of the Trigger List of the Nuclear Suppliers Group (NSG), chosen simply as a practical matter to avoid having to negotiate a whole new list. [4]

Finally, Article 16(b) provides that the "list of activities specified in Annex I, and the list of equipment and material specified in Annex II, may be amended by the Board upon the advice of an open-ended working group of experts established by the Board." The Article also contains a simplified procedure for the update of the Annexes; should the Board accept the recommendations of the working group, the Annexes of all APs are automatically updated.

The year 2022 marks 25 years since the Model Additional Protocol's approval by the Board, and 25 years of advancements along the nuclear fuel cycle. Despite these advancements, Article 16(b) has yet to be invoked and the Annexes remain in their original form. Meanwhile, the information reported pursuant to the Annexes represents an important tool for the IAEA in painting the fullest possible picture of a State's nuclear activities and, as such, consideration of their update to account for technological advancements is appropriate.

## 2. NEGOTIATING THE ANNEXES TO THE MODEL ADDITIONAL PROTOCOL

Discussions between the Secretariat and the Member States about the provision of information related to what would become Annexes I and II began even before Programme 93+2. For example, in January 1993, nearly a year before Programme 93+2 commenced, the Secretariat recommended Member States provide the information about the exports and imports of specified equipment and non-nuclear material especially designed or prepared (EDP) for nuclear uses. The Secretariat further recommended INFCIRC/254/Rev.1/Part.1 (as amended from time to time) be used as a list for this equipment and material, as they were "tried and tested guidelines." [5] At the conclusion of Programme 93+2, the Secretariat's recommendations for the Part 2 measures entailing additional legal authority in GOV/2807 included the provision of such information, as well as information related to "the nature of each building and of the activities therein on sites on which there are located nuclear facilities, LOFs [locations outside facilities] or nuclear R&D activities".

As noted, following Programme 93+2 the Secretariat consulted intensively with Member States to create a draft model protocol to operationalise the Part 2 measures, which was then negotiated by Committee 24. The aforementioned recommendations became Annexes I and II of the Model Additional Protocol. During Committee 24, a number of points related to the Annexes were discussed. For example:

- The question of how to involve Member States which were not Board members in the process of amending the Annexes was the subject of much discussion. Two competing proposals were discussed. Some States argued that any proposals to amend the Annexes should be confirmed not just by the Board, but also by the General Conference. Others felt that getting approval from the General Conference would unnecessarily delay amendments from adoption and favoured the establishment of a special committee of experts for deliberations on amendments. In the latter case, some Member States felt that the committee should only be open to Member States with APs, while others argued that it should be open-ended. Ultimately, Committee 24 opted for the approach whereby an ad hoc, open-ended working group of experts would be convened by the Board for consideration of updating

the Annexes and such amendments would be presented to the Board itself for consideration without going to the General Conference. [6]

- One of the earlier drafts of Annex I contained reference to facilities for the manufacture of beryllium metal, boron-10 and facilities for the recovery of tritium. Beryllium metal is used in nuclear reactors as a neutron reflector, boron-10 is a common material used for the manufacture of control rods and tritium is a component in boosted-type nuclear weapons. All three materials are considered dual-use. While some delegations expressed the view that some or all of these facility types should be included in Annex I, others did not share that view. This question sparked an important debate on what sort of items should be included in the Annexes; should they only be single-use items, EDP for nuclear use, or might some be dual-use items? Ultimately, Committee 24 decided to exclude facilities for the manufacture of beryllium metal, boron-10 and facilities for the recovery of tritium. However, proposals to amend the title of Annex II to explicitly refer to EDP items were not accepted, meaning that there is no reason that amendments to either Annex must focus on single-use or EDP items. [7]

Interestingly, Committee 24 spent relatively little time discussing Annex II after the Secretariat recommended the NSG list. Then-Director of the Division of Concepts and Planning Richard Hooper noted that “he could not imagine any list that had been discussed at greater length and in greater detail by more experts”. The German representative in the room, Mr. Reinhard Loosch, further noted that “he was sure that the Board of Governors had known what it was doing when it approved the list [for the VRS] and also that it would not wish anyone to spend years going over it again.” [8]

### 3. ADVANCES ALONG THE FUEL CYCLE

A quarter century after the Board approved the MAP, the provision to update the Annexes has yet to be invoked. Meanwhile, technological advancements since the MAP’s approval may necessitate the inclusion of further materials and technologies that are not reflected in the Annexes but have implications for safeguards.

In 2021-2022, the Vienna Center for Disarmament and Non-Proliferation (VCDNP) carried out a technical analysis of technologies that are not covered under the Annexes to the Model Additional Protocol, but that have implications for the effectiveness and efficiency of safeguards planning, implementation and evaluation. [9] Rather than make specific recommendations on types of installations, non-nuclear material and sensitive equipment that should be included into the Annexes, the study was conducted with a view to demonstrating the need to consider establishing the open-ended working group of experts (pursuant to Article 16(b) of the Model Additional Protocol) that would deliberate on what, if anything, should be added to the Annexes. The VCDNP considered 38 technologies during the study and provided 12 case studies for consideration in its final report.

TABLE 1. CASE STUDIES OF TECHNOLOGIES INCLUDED IN THE VCDNP REPORT

Technology	Relevant Annex	Safeguards Significance
Accelerator-driven systems	Annex I	Reporting on the scale of operations for locations using accelerator-driven systems would help the IAEA provide credible assurance that its neutron flux is not misused to produce nuclear material.
Breeding blankets	Annex I	Reporting on the scale of operations for facilities engaged in the manufacture or assembly of breeding blankets would allow the IAEA to better understand the fuel cycle capabilities of the relevant State.
Tritium extraction	Annex I	Tritium is a component in boosted-type nuclear weapons and its presence may indicate nuclear activities having taken place, which is why it was considered during Committee 24.

Complete heavy water upgrade systems or columns therefor	Annex II	While Annex II provides for reporting on exports for EDP equipment for the production of heavy water (with the exception of ammonia synthesis converters noted below), it does not account for the need to upgrade heavy water.
EDP equipment for the fabrication of nuclear reactor fuel elements	Annex II	The Annex II section on plants for the fabrication of fuel elements does not include specific information about the kinds of equipment used for fuel fabrication, potentially leading to underreporting.
EDP systems for the conversion of UO <sub>2</sub> to UCl <sub>4</sub>	Annex II	The feedstock for the process of electromagnetic isotope separation (EMIS) is uranium tetrachloride (UCl <sub>4</sub> ), which must be converted from uranium dioxide (UO <sub>2</sub> ). While much of the equipment required to conduct the EMIS process is covered under Annex II, section 7 covering uranium conversion plants does not include the systems which are required to produce UCl <sub>4</sub> .
Electrorefiners	Annex II	The entry in Annex II on reprocessing primarily focuses on the Purex process, but does not address technologies which are used for some advanced reprocessing methods that utilise electrorefiners which are increasing in salience due to technological developments.
Neutron measurement systems for process control	Annex II	While section 3 of Annex II covers much of the equipment required for reprocessing of irradiated fuel elements, it does not cover the neutron measurement systems specific to reprocessing activities for process control.
NH <sub>3</sub> synthesis converters or synthesis units	Annex II	Annex II covers each of the EDP items related to common heavy water production processes with the exception of ammonia (NH <sub>3</sub> ) converters, used to take the synthesis gas from the exchange towers and return the synthesised ammonia.
Primary coolant pumps or circulators	Annex II	This entry in Annex II does not explicitly include coolant circulators and notes antiquated and vague standards for the coolant pumps it explicitly does cover.
Special shut-off and control valves	Annex II	The entry of Annex II pertaining to EDP auxiliary systems, equipment and components for gas centrifuge enrichment plants does not explicitly cover the shut-off and control valves meant to regulate the feed, product or tails for UF <sub>6</sub> gas streams.
Zero energy reactors	Annex II	Annex II currently exempts zero energy reactors, which it defines as those with a maximum rate of production of plutonium not exceeding 100 grams per year.

While the VCDNP study provides technical analysis on technologies, the inclusion of which into the Annexes could improve the effectiveness and efficiency of safeguards, the list provided above is not meant to be comprehensive. Rather the list and the study that produced it are meant to demonstrate that a review of the Annexes and what they contain should be a regular activity. A review of the Annexes may not necessarily or exclusively be focused on adding further entries; it is entirely conceivable that an open-ended working group would decide to remove entries, the reporting on which is no longer helpful for the IAEA to draw sound conclusions about

safeguards for a State. For example, in the time since the Model Additional Protocol was approved by the Board, the accessibility to what is considered nuclear-grade graphite has increased significantly. Should a 16(b)-style group of experts be convened, it may well conclude that reporting on nuclear-grade graphite is no longer beneficial to the effectiveness and efficiency of safeguards.

#### 4. CHALLENGES AND OPPORTUNITIES TO UPDATING THE ANNEXES

Any consideration of what a potential update to the Annexes might consist of should be informed by the technical and political aspects of what that process may entail.

##### 4.1. Establishing an open-ended working group of experts

In the course of the VCDNP project, many remarked on the importance of sequencing. Article 16(b) notes that the Annexes may be amended by the Board upon the advice of the open-ended working group of experts established by the Board. As such, it holds to reason that the Board must take the first step to establish such a working group. However, consultations conducted in the process of the VCDNP project indicated that it would be beneficial for the IAEA Secretariat, as the body that would be receiving the information resultant from an update to the Annexes, to be prepared to provide insights on what kinds of material, technologies and activities would be useful for improving the efficiency and effectiveness of safeguards. As such, a robust dialogue between the Agency and Member States on the Annexes would be an important aspect of the process of their update. The Secretariat may also wish to include language in the Director General's annual report on safeguards implementation to the General Conference or in the annual Safeguards Implementation Report to the Board, should it consider updating the Annexes to be a priority.

Should a serious discussion about establishing an open-ended working group of experts take place, it will also be very important that such a discussion takes place on "fertile ground," meaning that political conditions are conducive to an update. If the process is politicised from the outset or if the process is not driven by Board members' openness to consider an update, it is unlikely to succeed. In this same vein, Article 16(b) specifies an open-ended working group of experts; this means a group of *technical* experts. One of the downfalls of Committee 25 – a process aimed at further strengthening safeguards that took place from 2005 to 2007 – was that from its outset it was a politically driven process. Should a serious consideration of whether the Annexes should be updated and what such an update should comprise begin, the discussion must remain technical in nature and be isolated from outside political considerations.

##### 4.2 Considering recommendations on updates for consideration by the Board

Should the Member States decide to establish an open-ended working group of experts with the mandate to consider potential updates to the Annexes, the group will have to bear in mind several questions and be prepared to mitigate several risks.

Perhaps most important will be the group's relationship with the Board. First, the group will need to ensure that the Board, and by extension experts in national capitals, are kept informed of the nature of potential updates to the Annexes, particularly for those Member States not participating in the open-ended working group. If the Board encounters a set of recommendations that its members have never seen before, the process is likely to be unsuccessful. Moreover, it would likely be necessary for recommendations to be cleared in national capitals before Board members are inclined to accept any recommendations of any kind. Second, the group will need to mitigate misunderstandings about the purpose of the Annexes. The Annexes are not, for instance, meant to function as a control list. They are not designed to control or regulate the export or import of any material, technologies or installations; rather, the Annexes are designed to assist the Agency in drawing the most complete picture of a State's nuclear activities when planning for, implementing and evaluating safeguards for a State.

Another risk that the group will have to mitigate, ideally with the assistance from other Board members, is the perceived relationship between Annex II and the NSG's Trigger List. When Committee 24 decided to use Annex B of the NSG Trigger List as the basis for Annex II of the Model Additional Protocol, it became a separate document, completely independent of the NSG. As such, the open-ended working group can, and should, consider updates to the Annexes that are not included in the Trigger List today. In other words, though the open-ended

working group certainly *may* decide that Annex II should keep parity with the Trigger List, there is no reason that it *must* do so.

The other question the open-ended working group of experts will have to consider is the technical nature of suggested new entries. The technical parameters of some entries of Annex II are no doubt outdated and may require revision to bring them in line with modern standards. An obvious example of this is entry 1.7 on primary coolant pumps, which notes that definition provided covers pumps certified to NC-1 or equivalent standards. The NC-1 standards are U.S. national standards of the American Society of Mechanical Engineers (ASME) (Section III, Division I, Subsection NC), which have been revised since 1997. The use of outdated or antiquated standards that are no longer used by industry may lead to declarations of exports that do not include pumps which newer codes do cover, or conversely to incorrect reporting or overreporting of pumps which are covered under older codes but not under newer ones. In this vein, the open-ended working group would also need to consider how specific technical parameters should be. Is it more useful to have Annex II, in particular, as a list with detailed technical specifications to ensure that States neither over or underreport, or rather that the list continue to be viewed as illustrative rather than prescriptive, meaning that States are expected to report all primary coolant pumps EDP for nuclear use without specifying the standard with which they must be associated? This question is beyond the scope of this paper and will be a question for an open-ended working group, should one be convened.

### 4.3 Ensuring sustainability

Those consulted during the VCDNP project repeatedly noted that the review contained in the final report on “Reflecting on the Annexes to the Model Additional Protocol in Support of Nuclear Governance” was timely and useful, but also that such a review should be conducted on a regular basis to ensure that the Annexes continue to reflect technological developments along the nuclear fuel cycle. In addition to ensuring that the Model Additional Protocol and its Annexes remain fit for purpose and contribute maximally to the effectiveness and efficiency of the safeguard system, this kind of review would help to prevent the update provision in Article 16(b) from atrophying to the point where invoking it would be an inherently politicised act. Indeed, as noted previously, the process of updating the Annexes is meant to be a technical one, driven by purely technical considerations rather than political ones.

In this regard, the Board of Governors could initiate a review of the Annexes on a regular basis, without respect to a decision to affect any updates, to keep stock of developments along the nuclear fuel cycle relevant for the planning, implementation and evaluation of safeguards. Should an initial review be successful, the Board may also wish to create an open-ended working group as a standing or semi-permanent body, subject to the continued support of the Board.

## 5. CONCLUSIONS

INFCIRC/153, paragraph 6 provides that the Agency should “take full account of technological developments in the field of safeguards” in implementing its safeguards responsibilities. [10] As such, and considering that the vast majority of APs in force were concluded in connection with safeguards agreements based on INFCIRC/153, it is timely and proper to consider an update to the Annexes today, a quarter century after the Model Additional Protocol was approved by the Board.

This paper has detailed the origins of the Annexes to the Model Additional Protocol, examples of technologies that are not covered under the Annexes that are significant for safeguards, and considerations for the Board with regard to challenges and opportunities for a potential update. It is for the Member States, in particular the Board, to decide if the Annexes are to be updated and, if so, what form such an update might take. However, it is the view of the author that, as technologies along the fuel cycle continue to advance at an ever-increasing pace, it would be a mistake to allow the Model Additional Protocol’s provision to amend the Annexes as outlined in Article 16(b) of INFCIRC/540 to atrophy. As such, the quarter century anniversary of the Model Additional Protocol may be just the right time for such a discussion in the Board to begin.

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