Conference on Disarmament

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Letter dated 11 September 2012 from the Permanent Representatives of the Netherlands and Germany to the Conference on Disarmament addressed to the Secretary-General of the Conference transmitting the report of the second meeting of scientific experts on technical issues related to a treaty banning the production of fissile material for nuclear weapons and other nuclear explosive devices based on resolution 66/44 of the General Assembly of the United Nations, held in Geneva on 28 and 29 August 2012

We have the honour to transmit to you a report on the second Scientific Experts Meeting organized by the Netherlands and Germany on *Technical Issues Related to a Treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices*, which took place at the Palais des Nations in Geneva on 28 and 29 August 2012.

Following the first meeting which took place in Geneva on 29 and 30 May 2012, based on resolution 66/44 of the General Assembly of the United Nations of 12 January 2012 entitled *"Treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices"* which i.a. *"encourages interested Member States (…) to continue efforts, including within and on the margins of the Conference on Disarmament, in support of the commencement of negotiations, including through meetings involving scientific experts(…)"* this meeting again examined ways of ensuring the principle of irreversibility in a future treaty banning the production of fissile material for nuclear weapons and other nuclear explosive devices.

This time the following issues were addressed:

(1) The role and limitations of 'nuclear archaeology' in the verification of a future Fissile Material Cut-off Treaty (FMCT), with special attention to the detection of secret and/or undeclared activities.

(2) Is an FMCT-specific way for managed access a necessary and acceptable tool and if so, how may it be designed, and how does it relate to other verification provisions to ensure the non-diversion of nuclear material for prohibited purposes?

These issues are of relevance to the Conference on Disarmament's agenda item 1 *"Cessation of the nuclear arms race and nuclear disarmament"* and its agenda item 2 *"Prevention of nuclear war, including all related matters."*

Representatives of 57 States attended the event, including experts from capitals, as did representatives from the EU Mission, the United Nations Office for Disarmament

Affairs (UNODA), the International Atomic Energy Agency (IAEA), the International Panel on Fissile Materials (IPFM), Princeton University, as well as independent advisors.

The Delegations of the Netherlands and Germany to the Conference on Disarmament would appreciate if you could issue this letter together with the attached report as an official document of the Conference on Disarmament and distribute it to all Member States to the Conference, as well as Observer States participating in the Conference.

The Delegations of the Netherlands and Germany intend to propose at the appropriate time that the submission of the reports of both meetings be duly reflected in the Report of the Conference on Disarmament to the General Assembly of the United Nations.

Yours sincerely,

(signed) Paul **van den Ijssel**
Ambassador
Permanent Representative of the Netherlands
to the Conference on Disarmament

(signed) Hellmut **Hoffmann**
Ambassador
Permanent Representative of Germany
to the Conference on Disarmament

Scientific Experts Meeting on technical issues related to a treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices based on resolution 66/44 of the General Assembly of the United Nations

Geneva, 28/29 August 2012

About this report

This report reflects the personal summary of the two co-chairs of the presentations and discussions, both of them being fully aware of the difficulty to do justice to all points made by participants. The content of this report is therefore their sole responsibility. As discussions took place under Chatham House rules, none of the comments made can be attributed to participating persons, countries and/or organizations. The purpose of this report is to inform and support the work of the CD and to stimulate further substantive exchanges on the topics discussed.

I. About the event

1. On August 28 and 29 2012, the Netherlands and Germany co-hosted a Scientific Experts Meeting on a treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices, often shortly referred to as a Fissile Material Cut-off Treaty (FMCT) in Geneva. The event was the second of two expert meetings in 2012 that have been co-hosted by Germany and the Netherlands. The first meeting was also held in Geneva on 29 and 30 May 2012.

2. Representatives of 57 STATES attended the event, including experts from capitals and the International Atomic Energy Agency (IAEA). The total of participants was nearly one hundred.

3. The meeting was chaired by Mr. Paul van den IJssel, Ambassador and Permanent Representative of the Netherlands to the Conference on Disarmament, and Mr. Hellmut Hoffmann, Ambassador and Permanent Representative of Germany to the Conference on Disarmament. Ms. Annette Schaper, Dr., Peace Research Institute Frankfurt, served as rapporteur.

4. In his opening remarks, Mr. Van den Ijssel, Ambassador, explained the purpose of the meeting. A FMCT has been on the agenda of the CD for a long time, and there is wide and strong support for the start of negotiations. Since it is not clear when negotiations will begin, the discussions in this seminar help us to prepare for negotiations. The speaker also stressed that these meetings themselves are not negotiations, not even pre-negotiations. But if negotiations would start, scientific aspects have an important role to play and so it is important to learn about them. They will show what is technically feasible, on which problems technical research should focus, and which options and variations there are to choose from.

5. Mr. Hoffmann, Ambassador, expressed his thanks to the delegation of The Netherlands for the preparation of the conference. Germany has a strong interest in a FMCT and perceives it as a step towards a world free of nuclear weapons. The technical expert meetings are based on resolution 66/44 dated 12 January 2012 of the General Assembly of

the United Nations. Mr. Hoffmann, Ambassador, expressed his hope for a successful meeting that would stimulate further thinking and preparations of future negotiations.

II. Presentations

6. The event consisted of two afternoon sessions. The agenda is attached to this report as annex I.

First session

7. The first session on 28 August dealt with the topic of "The role and limitations of nuclear archaeology in the verification of a future FMCT, with special attention to the detection of secret and/or undeclared prohibited activities."

8. Mr. Alexander Glaser, Dr., of Princeton University, and member of the International Panel of Fissile Materials (IPFM), gave the first presentation on verification challenges of a FMCT with regard to verifying the non-production of HEU. The second presentation was given by Ms. Therese Renis, International Atomic Energy Agency (IAEA). She explained how the IAEA detects undeclared activities at declared facilities.

Verification challenges of a FMCT with regard to verifying the non-production of HEU

9. Mr. Glaser started his presentation with an overview of the data of worldwide quantities of fissile materials that the International Panel of Fissile Materials has collected. Most of these data are estimates by non-governmental analysts, only some are official declarations by governments. The term "fissile materials" is officially not defined. IPFM uses the following working definition: "Fissile materials" are those nuclear materials that can sustain an explosive fission chain reaction. They are mainly highly enriched uranium (HEU) and plutonium. Most of the HEU is military; roughly 25 % of the HEU officially declared excess has been eliminated by blend-down for low enriched uranium fuel. Large quantities are reserved for use in naval reactors. The stocks of separated plutonium are half for civilian and half for military use.

10. The verification tasks of a FMCT cover (a) the non-production of HEU at previously operating enrichment plants, (b) the non-diversion of plutonium at previously operating reprocessing plants, (c) the verification that no undeclared enrichment or reprocessing takes place in nuclear fuel facilities or elsewhere, (d) the non-diversion of HEU from the naval fuel cycle, and (e) the non-diversion of material declared excess for military purposes but which is in classified form. At the same time, IAEA safeguards should be cost-effective.

11. Most enrichment plants are already under safeguards, including some in nuclear weapon states. Exceptions are the large Russian enrichment plants that are now producing low-enriched uranium for power reactors and those in India and Pakistan that still produce for weapons purposes. All new enrichment plants under construction or planned have been offered international safeguards.

12. Special verification challenges arise at previously operated enrichment facilities. They require retrofitting of safeguards measures. Some of them are potentially contaminated with HEU from previous operating history. Nevertheless, covert HEU production must be detected. There are specific methods and tools available for this purpose: continuous flow and enrichment monitors and environmental monitoring systems can determine throughput and enrichment levels of U-235 flows. The identification of HEU particles is possible with swipe sampling techniques. Facility baselines can be established

to obtain distributions and isotopic signatures of particles from historic plant operations. This way, a “fingerprint” is created. Future inspections require a closer look only if the baseline of the fingerprint changes.

13. One challenge will be the distinction between historic production before entry into force of the treaty and production after this date. Age determination of nuclear material on a swipe sample based on fractional concentration of decay products is possible, but particularly challenging for uranium. Microgram quantities of a sample are needed. Most HEU was produced some decades ago which facilitates the task. However, it is likely that the host of an inspected plant does not want to reveal the isotopics of his former production. For this reason, so-called information barriers are needed.

14. The speaker concluded by noting that the technical challenges are significant, but not as significant as the political challenges. There are special scientific questions that need further research and development. It would be easier if HEU production ended altogether.

IAEA safeguards: Detection of undeclared activities at declared facilities

15. Ms. Therese Renis presented an overview on the methods the IAEA applies in order to detect any undeclared activities at declared facilities. There could be two kinds of such activities: (a) the undeclared production or processing of nuclear material and (b) the diversion of declared material. The basis of safeguards are declarations on material flows and inventories and facility designs by the states, of which the correctness and completeness is then verified by the IAEA. The IAEA evaluates the consistency of the declared information with verification results and other safeguards-relevant information.

16. Some inspection approaches rely on the verification of so-called “mailbox-data”, which are data on the operation of a plant that the operator feeds into an information system that cannot be changed thereafter. The inspectors have access to the information and verify it on a random basis.

17. The speaker then talked more specifically on safeguards at gas centrifuge enrichment plants. The task is to detect any diversion of declared nuclear material, the misuse of the facility to produce undeclared product from undeclared feed, or misuse to produce product with a higher enrichment than declared. The IAEA verifies design information and declared nuclear material flows and inventories, and analyzes material balances and the facility operations. The speaker gave an overview and explained the methods that are used, including unattended non-destructive analysis (NDA) and containment and surveillance (C/S), limited frequency unannounced access (LFUAs) to cascade halls, randomized (short notice) confirmation of operational status at other strategic points, and environmental sampling.

18. The second part of the presentation focused on safeguards at spent fuel reprocessing plants. Again, the verification tasks are the detection of any diversion of declared nuclear material, and any misuse of the facility to produce undeclared products from undeclared fuel assemblies. Safeguards at reprocessing plants include design information verification, verification of declared nuclear material flows and inventories, material balance evaluation, and verification of facility operations. The methods include unattended NDA and C/S, solution monitoring, and randomized, short notice confirmation of operational status at other strategic points.

19. Reprocessing plants pose specific challenges: the ability to conduct design information verification at existing plants is limited. In case of verification measures at existing previously unsafeguarded plants, any instrumentation would need to be retrofitted. The material unaccounted for (MUF) will increase with throughput.

20. Finally, the IAEA also applies safeguards verification at other facility types, namely the detection of any irradiation of undeclared targets in reactors, the detection of changes of research reactor power or operation, and the detection of diversion of material flows at fuel fabrication plants.

21. Summarizing, the speaker noted that the IAEA has a toolbox of complementary verification measures to select from, depending on the circumstances.

Second session

22. The second session on 29 August addressed the question: "Is a FMCT-specific way for managed access a necessary and acceptable tool and if so, how may it be designed, and how does it relate to other verification provisions to ensure the non-diversion of nuclear material for prohibited purposes?"

23. Mr. Frank von Hippel, Dr., Professor of Public and International Affairs, Princeton University, and co-chair of the International Panel on Fissile Materials (IPFM), talked about FMCT verification challenges and research agendas, focusing on two specific problems, (a) Military nuclear sites and (b) Naval fuel cycles. Mr. Bart Dal, Dr., coordinator of Nuclear Security and Safeguards, Human Environment and Transport Inspectorate, of The Netherlands Ministry of Infrastructure and the Environment, talked about security and safeguards at gas centrifuge enrichment plants. Mr. Ben Dekker, Advisor on International Safeguards, Safety and Security Affairs, the Netherlands, gave a presentation on experiences with managed access to classified areas in enrichment plants, centrifuge research and development (R&D) facilities and centrifuge manufacturing facilities.

FMCT verification challenges and research agendas: (a) Military nuclear sites, and (b) Naval fuel cycles

24. Mr. Frank von Hippel, Prof., started his presentation by stating that it would be useful for interested governments to support research on technical issues relating to the verification of a FMCT now, even before negotiations begin. Irrespective of what will be the future scope of the treaty, the commitments of the weapon states will include: (a) not to operate undeclared and unsafeguarded enrichment or reprocessing facilities; and (b) not to divert freshly produced HEU from naval fuel cycles, provided the scope of a FMCT will permit such production. Up to today, the non-diversion of HEU for naval fuel has never been verified.

25. In both nuclear and non-nuclear weapon states, the verification task will be to create assurance that there is no undeclared production. In weapon states this verification will also cover nuclear weapon production facilities, which is a special challenge because of the sensitive information in such facilities.

26. In order to clarify the suspicion that clandestine reprocessing is going on, environmental sampling off site would probably be sufficient because reprocessing releases characteristic isotopes. For the preparation of this task it would be valuable to collect and analyze measurements of radioisotope concentrations around smaller reprocessing plants including in the non-weapon states. It can be detected to a high precision whether operations are going on.

27. In case of clandestine centrifuge enrichment, distant measurements are less promising, they must be conducted nearby. Measurements of uranium with fluorine (in UF2O2) in soil and vegetation around centrifuge enrichment plants should be taken and analyzed. A promising technology for such measurements is laser-induced breakdown

spectroscopy. The speaker recommends exploring such methods in a joint study at enrichment plants.

28. In case a FMCT would allow the production of HEU for the use as fuel in military naval vessels, confidence-building measures should be developed to assure that a country is not diverting HEU from its naval fuel cycle to nuclear weapons. IAEA safeguards agreement with non-weapon NPT States allows the "Non-application of safeguards to nuclear material to be used in non-peaceful activities" (INFCIRC/153, para. 14). This however, has never been applied or explored. Details of how to create assurance that no HEU is diverted have never been worked out, and should be studied.

29. The speaker presented an overview on countries possessing nuclear propelled ships and the enrichment of their fuel. Only few countries use HEU. The United States of America, United Kingdom of Great Britain and Northern Ireland and the Russian Federation will not need to produce HEU for naval reactor use for many decades. They could avoid doing so even then by deciding to design their next generation of propulsion reactors to use LEU as France has.

30. The speaker concluded his presentation by noting that a research program on FMCT verification would be valuable. Non-nuclear weapon states could play leading roles, since some have enrichment and reprocessing plants. Cooperation from one of the countries with nuclear ship propulsion would be helpful in developing approaches to build confidence of non-diversion of HEU from the naval fuel cycle.

Nuclear Security & Safeguards

31. Mr. Bart Dal, Dr., started his presentation by explaining how governments have always worked together on centrifuge enrichment and its security and protection. In 1970, the governments of Germany, The Netherlands and the United Kingdom of Great Britain and Northern Ireland signed the Treaty of Almelo, which regulates the cooperation, protection, and safeguards of their joint uranium enrichment for civil purposes (URENCO). In 1992, this treaty was expanded by the Treaty of Washington, which allows for use of the technology in the United States of America, in 2006 by the Treaty of Cardiff, and in 2012 by the Treaty of Paris. These last two treaties allow a technology agreement with Areva of France, which bought half of the shares of the URENCO centrifuge technology to set up facilities elsewhere. Governments are obligated to protect the technology, which remains in a "black box" for non-proliferation and commercial reasons.

32. Treaty obligations regulate security and safeguards. Safeguards in nuclear weapon states must be equivalent to those in non-nuclear weapon states. The sensitive technology is protected by a "black box", with no access except by specialized supplier personnel. France and the United States of America have no knowledge of design details of the centrifuge technology that is in the black box. There are also regulations for exports: materials and technology must serve exclusively civilian purposes. Regulations for security and classification are the same for the five countries and are regulated by a handbook, worked out by a Joint Committee.

33. The speaker explained several agreements and regulations for international safeguards that create assurance of compliance on the one hand and protect sensitive technology on the other: The Hexapartite Agreement was negotiated between 1980 and 1983 between six technology holders: the United States of America, United Kingdom of Great Britain and Northern Ireland, Germany, the Netherlands, Japan, and Australia, and two safeguards authorities, the IAEA and Euratom. Integrated Safeguards (IS) are a combination of traditional safeguards measures (INFCIRC/153) and the Additional Protocol (AP, INFCIRC/540), with the aim to achieve maximum effectiveness and efficiency by adapting safeguards tailored to facilities and states. Urenco uses the mailbox-

data system, which includes data definitions and certain information restrictions. Furthermore, there are partnership agreements between the IAEA and Euratom that result in joint team efforts.

34. The current situation is as follows: There are eleven interim inspections per year, one physical inventory verification (PIV), ten limited-frequency unannounced access (LFUA) inspections, complementary access, managed-access, and regular training of inspectors. The IAEA joins Euratom in some cases, but not always, and the IAEA also has the right to come alone.

35. There will be many similarities between the verification of a FMCT and the NPT, which should be explored. The nature of the inspections will be similar, and lessons can be learned from past experiences with centrifuge enrichment. It is advisable to conduct not only technical studies, but also prepare practical arrangements for inspections, managed access, etc.

Experiences with Managed Access

36. Mr. Ben Dekker started his presentation by explaining the concept of "managed access", which is a procedure that allows access to classified areas by unauthorized persons in such a way that sensitive information is not disclosed. The topic of his presentation was experiences of how this has been done in centrifuge enrichment plants and centrifuge R&D and manufacturing facilities.

37. There are several reasons for classification: secrecy, non-proliferation, protection of commercial secrets, or national security. Whatever the reason, the approach for managed access is similar, but must be customized to the specific situation.

38. Managed access has been defined in the Additional Protocol (AP), as a special form of the Complementary Access required. Experience with managed access has been obtained already before the AP through the Limited Frequency Unannounced Access (LFUA) inspections, developed in 1983 by the Hexapartite Safeguards Project (HSP) for centrifuge enrichment plants. LFUA manages specifically the access to cascade halls with centrifuge arrangements.

39. Cascade halls are restricted areas, and inspector access is conditional during a limited number of inspections per year. The inspections are typically unannounced but may be delayed by a maximum of two hours. Inspectors have to follow pre-defined routes, the number of inspectors is limited, and inspectors are escorted at all times. Design information remains at the facility, but is sealed. There are several features that are typical for a cascade hall in operation: The cascade configurations are "static", and the cascade configurations are "repetitive". The centrifuge arrangements are "transparent", but, normally, no centrifuge components are disclosed. There may be adaptations to the access conditions in case of maintenance campaigns. Mobile sampling systems are present and may be in use. There are no LFUA to cascade halls still under construction, but complementary access applies there.

40. Elements that are verified during an LFUA are: design information, routing of main headers, individual connection of cascades, the absence of interconnections, and the absence of undeclared feed and take-off systems. In addition, swipe samples may be taken. Note taking and use of cameras and cell phones are not allowed.

41. The Additional Protocol, which has been in force for the Netherlands and Germany since 2004, requires complementary access to non-nuclear, but classified areas, such as: centrifuge R&D, and manufacturing areas, and production areas for stable isotopes (SI). The circumstances in these areas are quite different from those in the cascade halls. In the R&D, manufacturing and SI areas, there is more exposure to technology and components,

there is more variety in equipment and the situation may change rather frequently. The approach for the managed access to these areas has been refined accordingly.

42. The inspectors have to verify the type and scale of operation and the absence of undeclared uranium enrichment. The bases for the verification are the site declaration, the 10-year program declaration and the export declarations. These declarations are not comparable with the type of design information in traditional safeguards and the scale of operation cannot be verified by item counting or whatsoever. Experience and intuition is an important factor for success and the results of on-site inspections can and have to be combined with other information gathered.

43. The protection of sensitive information is the key element for managed access. It includes limiting the view to what has to be seen. When visual access from a distance is sufficient, physical access is not necessary. If needed, certain details can be shrouded in advance, but this may delay access. The residence time of the inspector has to be limited, as is the number of inspectors. Photos or notes are not allowed and the inspectors are escorted at all times.

44. It is important that, the verification measures are agreed in advance and that the inspectors, as well as facility personnel, are well trained to understand and appreciate the tensions between providing and protecting information. Unannounced inspections have to be possible.

45. The speaker noted that the managed access approach needed for FMCT facilities is likely more comparable with the experience in centrifuge R&D and manufacturing facilities than with the centrifuge enrichment cascade halls.

46. In conclusion, access to classified areas is a challenge, but can very well be managed, based on rules that have been carefully negotiated and agreed by all stakeholders.

III. Discussion

47. Discussions took place after each session and in the course of the wrap-up session. They are summarized as follows.

48. A point of interest was the dating of swipe samples. Participants asked what the limit of precision is, and what could be done if the samples were too small for precise analysis. On the other hand, some states do not want to release too precise data of their past HEU production. A solution could be information barriers, which is a technical method that is being explored for the verification of the dismantlement of nuclear warheads. Age determination had not been very important, and only little has been published. The topic will become more significant. It is a challenge, and it is advisable to invest in some more research and to establish a baseline.

49. Another question related to the role that material accountancy can play in verification which is more difficult due to imprecise nuclear material accounting systems. This would need to be investigated in more detail and would depend on the verification levels required.

50. It was suggested to use shut down enrichment plants for measurement experiments.

51. The discussion also focused on the scenario that inspectors may find some HEU samples at LEU plants. This has already happened in the past, and it has been possible to clarify the situation. It has happened, for example, that HEU particles have been carried over from one plant to another through equipment and /or persons. Similarly, clarification will be possible for a FMCT.

52. Further questions were raised on how to proceed with the transition of enrichment and reprocessing plants from a pre-safeguarded to a safeguarded stage. Plants are probably contaminated, so an initial inventory must be established. Furthermore, design verification is needed, and perhaps an initial clean up. Should there be a baseline of contamination level in existing plants? Are there some plants available for studies? It must also be possible to detect a clandestine centrifuge plant in a building.

53. Ms. Renis explained that, in reprocessing plants, it would be possible to have an understanding of how the plant would be operating. Mr. Glaser, Dr., suggested that a possible cooperative approach towards enrichment plants could take a plant that actually has a contamination and pursue studies there. However, some nuclear weapon states might be concerned about revealing the isotopics of their HEU. Therefore in a new approach, the use of information barriers should be studied. Such an information barrier would be a device that takes samples, and has a red and a green light button. It would only reveal whether the measurements are acceptable, but no more information on isotopics would be given.

54. It was also asked which costs can be expected. The IAEA can only give an answer to this question when it would be clear what is required and which assumptions are made. It was suggested to task the IAEA with a cost study that examines a set of several verification scenarios. It was noted that there could be different levels of intrusiveness. Some participants noted that the intrusiveness should be the same as the verification of the NPT, others noted that the delegates must decide how much assurance of compliance would be sufficient, and to consider what the NWS are likely to accept. Different legal obligations are difficult to be accepted. Initially, there will be differences in precision of verification because with large numbers of warheads, one more or less only makes a small difference, but when you progress with nuclear disarmament, the precision becomes more important, and the two systems have to convert.

55. Some questions and problems will need some more detailed studies, in order to answer the question whether they can be solved. These are both political and technical challenges.

56. Participants noted that a real challenge is an inspection in a previously unknown place. This happens with the Chemical Weapons Convention and has successfully been tested. Another example is the many inspection exercises that the CTBTO undertakes. The IAEA has a lot of experience with managed access inspections.

57. It was noted that it is impossible to forecast every eventuality and to design very precise procedures in advance. It would be better to establish some key principles and to be flexible with specific facilities and situations. Others countered that much is already known beforehand, so a lot of work can be done in advance. The IAEA has extensive experience in developing facility-specific safeguards approaches. For a FMCT, all problems should be clearly on the table so that they can be discussed. This must be done before they arise.

58. The question was asked whether it is really necessary to consider future production of HEU for military naval fuel, as there are still stocks that would be sufficient for many decades to come. The naval reactors of the United States of today will need such fuel, but the next generation of reactors could be designed to use LEU. The last United States of America study of 1995 that examined the use of HEU for naval fuel is already old. Since then, more modern new fuels have been invented.

59. Participants finally noted that it would be beneficial to set up a Group of Scientific Experts. There have already been such attempts in the past.

IV. Concluding remarks

60. Mr. van den Ijssel, Ambassador, thanked the experts and the participants for their interesting contributions. He stressed that there is need for further work. It is important that this kind of work will develop into more specific questions. The help of scientists and practitioners is needed for progress. The political challenges are bigger than the scientific challenges. Also financial challenges must be considered. There is the hope that meetings like this will lay the basis for more progress. He announced that the presentations by the speakers will be circulated.