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Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran

Report by the Director General

1. This report on safeguards issues in the Islamic Republic of Iran (hereinafter referred to as Iran) responds to paragraph 7 of the Board of Governors' resolution GOV/2003/69 of 12 September 2003. It covers relevant developments from the time of the Director General's visit to Iran on 20-21 February 2003 and Iran's acknowledgement of its centrifuge enrichment programme, but concentrates on the period since his last report (GOV/2003/63 of 23 August 2003). This report begins with the background to the issues in question (Section A) and a chronology of recent events (Section B). Information on the Agency's verification activities is summarized in Section C, organized according to the various technical processes involved (the details of which are set out in Annex 1). Section D provides a summary of the Agency's findings, while Section E sets out its current assessment and next steps. Annexes 2 and 3 to this report contain, respectively, a list of the locations identified to date as relevant to the implementation of safeguards in Iran, and a map showing those locations. Annex 4 is a list of relevant abbreviations and terms used in the text of the report.

A. Background

2. At the meeting of the Board of Governors on 17 March 2003, the Director General reported on discussions taking place with Iran on a number of safeguards issues that needed to be clarified and actions that needed to be taken in connection with the implementation of the Agreement between Iran and the IAEA for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons (INFCIRC/214) (the Safeguards Agreement).

3. On 6 June 2003, the Director General submitted to the Board of Governors a report (GOV/2003/40) providing further information on the nature of the safeguards issues involved and the actions that needed to be taken, and describing developments in that regard since March 2003. In that report, the Director General stated that Iran had failed to meet its obligations under its Safeguards Agreement with respect to the reporting of nuclear material imported into Iran and the subsequent

processing and use of the material, and the declaring of facilities and other locations where the material had been stored and processed. He described these failures and the actions being taken by Iran to correct them.

4. On 18–19 June 2003, the Board considered the above report of the Director General. In its conclusions, the Board noted its concern about the number of past failures by Iran to report material, facilities and activities as required by its safeguards obligations, and noted the actions taken by Iran to correct those failures. The Board urged Iran to rectify promptly all of the safeguards problems identified in the Director General's report and to resolve questions that remained open. It welcomed Iran's reaffirmed commitment to full transparency and expressed its expectation that Iran would grant the Agency all necessary access. The Board encouraged Iran, as a confidence building measure, not to introduce nuclear material at the Pilot Fuel Enrichment Plant (PFEP) located at Natanz pending the resolution of related outstanding issues. The Board called on Iran to co-operate fully with the Agency in its ongoing work. It welcomed Iran's readiness to look positively at signing and ratifying an Additional Protocol, and urged Iran to promptly and unconditionally conclude and implement such a protocol, in order to enhance the Agency's ability to provide credible assurances regarding the peaceful nature of Iran's nuclear activities, particularly the absence of undeclared material and activities.

5. On 26 August 2003, the Director General submitted to the Board for its consideration a further report (GOV/2003/63) on relevant developments since June 2003. The report included: a summary of the state of the Agency's understanding of Iran's nuclear programme at that time; the Agency's findings and assessments, including the identification of some additional failures to report and the issues that needed to be clarified (particularly with regard to enrichment); and the corrective actions that needed to be taken. In the report, the Director General noted an increased degree of co-operation by Iran, while noting that some of the information and access were at times slow in coming and incremental, and that some of the information was in contrast to that previously provided by Iran.

6. At its meeting on 12 September 2003, the Board of Governors adopted a resolution (GOV/2003/69) in which it, inter alia:

- Called on Iran to provide accelerated co-operation and full transparency to allow the Agency to provide at an early date the assurances required by Member States (GOV/2003/69, para. 1).
- Called on Iran to ensure that there were no further failures to report material, facilities and activities that Iran is obliged to report pursuant to its Safeguards Agreement (GOV/2003/69, para. 2).
- Called on Iran to suspend all further uranium enrichment related activities and, as a confidence building measure, any reprocessing activities, pending provision by the Director General of the assurances required by Member States and pending satisfactory application of the provisions of the Additional Protocol (GOV/2003/69, para. 3).
- Decided that, in order to ensure Agency verification of non-diversion of nuclear material, it was essential and urgent that Iran remedy all failures identified by the Agency and co-operate fully with the Agency by taking certain specified actions by the end of October 2003 (GOV/2003/69, para. 4).
- Requested all third countries to co-operate closely and fully with the Agency in the clarification of open questions on the Iranian nuclear programme (GOV/2003/69, para. 5).
- Requested that Iran work with the Secretariat to sign, ratify and fully implement the Additional Protocol promptly and unconditionally, and as a confidence building measure to act henceforth in accordance with the Additional Protocol (GOV/2003/69, para. 6).

7. The Board also asked the Director General to submit a report to the Board, in November 2003 or earlier if appropriate, on the implementation of the Board's resolution, enabling it to draw definitive conclusions.

B. Chronology since September 2003

8. Between 14 and 18 September 2003, the Agency conducted a safeguards inspection at the Tehran Research Reactor (TRR) and at the PFEP in Natanz. The inspection activities at TRR included physical inventory verification and design information verification, as well as a number of activities to follow up on issues related to the natural uranium imported in 1991, including further examination of the cylinders from which imported UF_6 gas was said to have leaked (see GOV/2003/63, para. 18).

9. On 16 September 2003, the Agency met representatives of Iran to discuss the results of the analysis of the environmental samples taken at the Kalaye Electric Company in August 2003, which had revealed the presence of high enriched uranium (HEU) particles and low enriched uranium (LEU) particles which were not consistent with the nuclear material in the declared inventory of Iran. Also discussed were the results of the environmental sampling taken at PFEP, which had revealed the presence of other types of HEU particles, as well as LEU and other particles, not of a type on Iran's inventory.

10. The Deputy Director General for Safeguards (DDG-SG) and the Director of Safeguards Operations Division B (DIR-SGOB) travelled to Iran on 2–3 October 2003 to discuss the most urgent safeguards implementation issues that remained open. Following these discussions, a technical team of the Agency visited Iran from 4 to 12 October 2003 in order to carry out activities related to the verification of Iran's activities in the areas of uranium conversion and laser and gas centrifuge enrichment. Following up on recent open source reports of enrichment activities being undertaken at an industrial complex in Kolahdouz in western Tehran, the team was permitted on 5 October 2003 to visit three locations which the Agency had identified as corresponding to those mentioned in the reports. While no work was seen at those locations that could be linked to uranium enrichment, environmental samples were taken.

11. In a letter to the Agency dated 9 October 2003 from Mr. E. Khalilipour, Vice President of the Atomic Energy Organization of Iran (AEOI), Iran provided information that had not been provided earlier on research activities carried out on uranium conversion processes, including acknowledgement of laboratory and bench scale experiments. Specifically, Iran confirmed that, between 1981 and 1993, it had carried out at the Esfahan Nuclear Technology Centre (ENTC) bench scale preparation of UO_2 and, at the Tehran Nuclear Research Centre (TNRC), bench scale preparation of ammonium uranyl carbonate (AUC), UO_3, UF_4 and UF_6.

12. Between 13 and 22 October 2003, an Agency inspection team conducted safeguards inspections at PFEP and other facilities in Esfahan and Tehran. These inspections included follow-up activities related to the HEU and LEU particles found at the Kalaye Electric Company and at Natanz and to the newly acknowledged existence of nuclear material resulting from uranium conversion experiments.

13. On 16 October 2003, at the invitation of the Iranian Government, the Director General met in Tehran with H.E. Dr. H. Rohani, Secretary of the Supreme National Security Council of Iran, to discuss the open issues requiring urgent resolution. These issues related to the use of nuclear material in the testing of centrifuges (including the presence of LEU and HEU particles at the Kalaye Electric Company and at Natanz); the testing of conversion processes; the purpose of uranium metal

production; the existence of laser isotope enrichment; and details of Iran's heavy water reactor programme. At this meeting, Dr. Rohani stated that a decision had been taken to provide the Agency, in the course of the following week, with a full disclosure of Iran's past and present nuclear activities. He also expressed Iran's readiness to conclude an Additional Protocol and, pending its entry into force, to act in accordance with the Protocol and with a policy of full transparency.

14. Upon the request of the Iranian authorities, a meeting was held on 18–19 October 2003, also in Tehran, between legal, policy and technical staff of the Agency and Iranian officials to discuss issues related to the conclusion by Iran of an Additional Protocol.

15. As a follow-up to the 16 October 2003 meeting, in a letter to the Director General dated 21 October 2003 and received on 23 October 2003, H.E. Mr. R. Aghazadeh, Vice President of the Islamic Republic of Iran and President of the AEOI, reaffirmed that "the Islamic Republic of Iran ha[d] decided to provide a full picture of its nuclear activities, with a view to removing any ambiguities and doubts about the exclusively peaceful character of these activities and commencing a new phase of confidence and co-operation in this field at the international level." Mr. Aghazadeh stated further in his letter that Iran was prepared "to provide, in full transparency, any additional clarifications that the Agency may deem necessary."[1]

16. In that letter, Iran acknowledged that: between 1998 and 2002 it had carried out some testing of centrifuges at the Kalaye Electric Company using UF_6 imported in 1991; between 1991 and 2000 it had had a laser enrichment programme, in the course of which it had used 30 kg of uranium metal not previously declared to the Agency; and between 1988 and 1992 it had irradiated 7 kg of UO_2 targets and extracted small quantities of plutonium. Attached to the letter was significant additional information with respect to those activities, as well as information concerning Iran's conversion and heavy water reactor programmes.

17. Between 27 October and 1 November 2003, a technical team from the Agency, led by DIR-SGOB and including centrifuge technology experts, visited Iran to follow up on these and other issues, including, in particular, the source of HEU and LEU contamination.

18. On 10 November 2003, the Agency received from the Government of Iran a letter of the same date in which Iran conveyed its acceptance of the draft text of the Additional Protocol based on the Model Additional Protocol (INFCIRC/540 (Corr.)) Iran indicated that it was prepared to sign the Additional Protocol, and that, pending its entry into force, Iran would act in accordance with the provisions of that Protocol.

19. On the same day, the Iranian Government informed the Director General that it had decided to suspend, with effect from 10 November 2003, all enrichment related and reprocessing activities in Iran[2], and specifically: to suspend all activities on the site of Natanz, not to produce feed material for enrichment processes and not to import enrichment related items.

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[1] In his letter, Mr. Aghazadeh also referred to his Government's expectation that the Agency would "take cognizance, in preparing its report, of Iran's concerns and constraints for the full disclosure of detailed information about these activities in the past, notably the concern about expansion of illegal sanctions to prevent Iran from exercising its inalienable right to nuclear technology for peaceful purposes stipulated in Article IV of the [Treaty on the Non-Proliferation of Nuclear Weapons]."

[2] It should be noted also that, on 21 October 2003, the Iranian Government and the Foreign Ministers of France, Germany and the United Kingdom issued in Tehran an agreed statement on Iran's nuclear programme. In that statement, Iran indicated that it had "decided voluntarily to suspend all uranium enrichment and reprocessing activities as defined by the IAEA."

C. Verification Activities

C.1. Uranium Conversion

20. The Agency received preliminary design information on the Uranium Conversion Facility (UCF) under construction at ENTC in July 2000, and has been carrying out continuous design information verification (DIV) since then. In that design information, the facility was described as being intended for the conversion of uranium ore concentrate into UF_6, for enrichment outside Iran, and for the subsequent conversion (at UCF) of the enriched UF_6 into low enriched UO_2, enriched uranium metal and depleted uranium metal. Following its declaration of the enrichment facilities at Natanz in February 2003, Iran acknowledged that it intended to carry out the enrichment activities domestically using UF_6 to be produced by UCF.

21. At the time of the Director General's last report to the Board of Governors (GOV/2003/63), questions remained about the completeness of Iran's declarations concerning the chronology and details of its uranium conversion activities, in particular in light of its previous assertion that it had designed UCF without having used nuclear material to test the most difficult conversion processes.

22. While Iran acknowledged in February 2003 having used some of the *natural* uranium imported in 1991 for testing certain parts of the conversion process (i.e. uranium dissolution, purification using pulse columns and the production of uranium metal), it denied having tested other processes (e.g. conversion of UO_2 to UF_4 and conversion of UF_4 to UF_6), stating that they had been developed based on the supplier's drawings. In a letter dated 19 August 2003, Iran further acknowledged that it had carried out UF_4 conversion experiments on a laboratory scale during the 1990s at the Radiochemistry Laboratories of TNRC using imported *depleted* UO_2 which had previously been declared as having been lost during processing (process loss). This activity was acknowledged by Iran only after the Agency's July 2003 waste analysis results indicated the presence of depleted UF_4.

23. On 9 October 2003, 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 (in kilogram quantities) between 1981 and 1993 without having been reported to the Agency. These activities were carried out at TNRC and ENTC.

24. The information provided in Iran's letter of 21 October 2003 reveals that, in conducting these experiments, Iran had used nuclear material imported by Iran in 1977 and 1982, some of which had been exempted from safeguards, as well as safeguarded nuclear material which had been declared to the Agency as a process loss. Iran also declared that, using nuclear material imported in 1991 and reported to the Agency in February 2003, experiments had been carried out on the conversion of some of the UF_4 to UF_6, and on the conversion of UO_2 to UF_4. On 1 November 2003, Iran agreed to submit all relevant inventory change reports (ICRs) and design information to cover these activities.

25. In addition to the issues associated with the testing of UCF processes, the Agency had previously raised with Iran questions related to the purpose and use of nuclear material to be produced at UCF, such as uranium metal. In its letter of 21 October 2003, Iran acknowledged that the uranium metal had been intended not only for the production of shielding material, as previously stated, but also for use in the laser enrichment programme (as discussed below).

C.2. Reprocessing Experiments

26. In its letter of 21 October 2003, Iran acknowledged the irradiation of depleted UO_2 targets at TRR and subsequent plutonium separation experiments in a hot cell in the Nuclear Safety Building of TNRC. Neither the activities nor the separated plutonium had been reported previously to the Agency.

27. In the meetings held 27 October–1 November 2003, Iran provided additional information about these experiments. According to Iranian officials, the experiments took place between 1988 and 1992, and involved pressed or sintered UO_2 pellets prepared at ENTC using depleted uranium that had been exempted from safeguards in 1978. The capsules containing the pellets had been irradiated in TRR in connection with a project to produce fission product isotopes of molybdenum, iodine and xenon. The plutonium separation was carried out at TNRC in three shielded glove boxes, which, according to Iran, were dismantled in 1992 and later stored in a warehouse at ENTC along with related equipment. Iran stated that these experiments had been carried out to learn about the nuclear fuel cycle, and to gain experience in reprocessing chemistry.

28. According to Iran, a total of about 7 kg of UO_2 was irradiated, 3 kg of which was processed to separate plutonium. The small amount of separated plutonium was stored in a laboratory of Jabr Ibn Hayan Multipurpose Laboratories (JHL), while the remaining 4 kg of unprocessed irradiated UO_2 targets was placed in containers and stored at the TNRC site, and the wastes disposed of at the Qom salt marsh.

29. On 1 November 2003, Iran agreed to submit all nuclear material accountancy reports, and design information for ENTC and JHL, covering these activities. On that date, Iran also presented the separated plutonium and the irradiated unprocessed targets to Agency inspectors at JHL. Verification of the material, as well as of possible nuclear material hold-up in the dismantled glove boxes, is foreseen to take place during the 8–15 November 2003 inspection.

C.3. Uranium Enrichment

C.3.1. Gas Centrifuge Enrichment

30. In February 2003, Iran acknowledged the existence of two centrifuge enrichment plants under construction at Natanz: PFEP and a large commercial-scale Fuel Enrichment Plant (FEP). In February 2003, Iran also acknowledged that the workshop of the Kalaye Electric Company in Tehran had been used for the production of centrifuge components, but stated that there had been no testing of these components involving the use of nuclear material, either at the Kalaye Electric Company or at any other location in Iran. According to Iran, its enrichment programme was indigenous and based on information from open sources.

31. During the visit of 2–3 October 2003, the Agency was shown, for the first time, the centrifuge drawings previously requested by it (see GOV/2003/63, para. 28).

32. In its letter of 21 October 2003, Iran acknowledged that "a limited number of tests, using small amounts of UF_6, [had been] conducted in 1999 and 2002" at the Kalaye Electric Company. In a meeting with enrichment technology experts held during the 27 October–1 November 2003 visit, Iranian authorities explained that the experiments that had been carried out at the Kalaye Electric Company had involved the 1.9 kg of imported UF_6, the absence of which the State authorities had earlier attempted to conceal by attributing the loss to evaporation due to leaking valves on the cylinders containing the gas (see GOV/2003/63, para. 18).

33. During that visit, the Agency was able to meet with the individual who had been in charge of the centrifuge research and development work during the period 1992–2001 with a view to clarifying issues associated with these activities. Iran has agreed to provide the relevant ICRs and design information, and to present the nuclear material for Agency verification during the inspection scheduled for 8–15 November 2003.

34. As mentioned above, environmental samples taken by the Agency at PFEP and at the Kalaye Electric Company revealed particles of HEU and LEU indicating the possible presence in Iran of

nuclear material that had not been declared to the Agency. The Iranian authorities attributed the presence of these particles to contamination originating from centrifuge components which had been imported by Iran. In connection with its efforts to verify that information, the Agency requested, and Iran provided in October 2003, a list of imported and domestically produced centrifuge components, material and equipment, and an indication of the batches of items that Iran claims to have been the source of the contamination. The Agency carried out another sample-taking campaign in October 2003, at which time all major imported and domestically produced components, as well as various pieces of manufacturing equipment, were sampled.

35. In a meeting on 1 November 2003, the Iranian authorities stated that all nuclear material in Iran had been declared to the Agency, that Iran had not enriched uranium beyond 1.2% U-235 using centrifuges and that, therefore, the contamination could not have arisen as a result of indigenous activities. The Agency has now obtained information about the origin of the centrifuge components and equipment which Iran claims to be the source of HEU contamination. The Agency will continue its investigation of the source of HEU and LEU contamination, including through follow up with other relevant parties.

C.3.2. Laser Enrichment

36. As reflected in GOV/2003/63 (para. 41), Iran permitted the Agency to visit in August 2003 a laboratory located at Lashkar Ab'ad, which was described by Iran as originally having been devoted to laser fusion research and laser spectroscopy, but whose focus had been changed to research and development and the manufacture of copper vapour lasers (CVLs). In its 19 August 2003 letter to the Agency, Iran stated that it had had a substantial research and development programme on lasers, but that it currently had no programme for laser isotope separation.

37. During discussions which took place in Iran from 2 to 3 October 2003, in response to Agency questioning, the Iranian authorities acknowledged that Iran had imported and installed at TNRC laser related equipment from two countries: in 1992, a laser spectroscopy laboratory intended for the study of laser induced fusion, optogalvanic phenomena and photoionization spectroscopy; and in 2000, a large vacuum vessel, now stored at Karaj, for use in the spectroscopic studies referred to in the previous paragraph.

38. On 6 October 2003, Agency inspectors were permitted to take at Lashkar Ab'ad the environmental samples requested by the Agency in August 2003. The inspectors also visited a warehouse in the Karaj Agricultural and Medical Centre of the AEOI, where a large imported vacuum vessel and associated hardware were stored. The Iranian authorities stated that the equipment had been imported in 2000, that it had never been used, and that it had now been packed for shipment back to the manufacturer, since the contract related to its supply had been terminated by the foreign partner in 2000. The inspectors were informed that later during their visit to Tehran the equipment related to the laboratory imported in 1992 would be made available for examination and environmental sampling and the individuals involved in the projects would be available for interviews. However, these interviews and the presentation of the equipment were deferred by Iran.

39. In its letter dated 21 October 2003, Iran acknowledged that, starting in the 1970s, it had had contracts related to laser enrichment with foreign sources from four countries. These contracts are discussed in detail in Annex 1 to this report.

40. During the inspectors' follow-up visit to Iran between 27 October and 1 November 2003, Iran provided more information on Lashkar Ab'ad and acknowledged that a pilot plant for laser enrichment had been established there in 2000. The project for the establishment of the plant consisted of several contracts covering not only the supply of information, as indicated in Iran's letter of 21 October 2003 to the Agency, but also the delivery of additional equipment. Iran also stated that uranium laser

enrichment experiments had been conducted between October 2002 and January 2003 using previously undeclared natural uranium metal imported from one of the other suppliers. According to Iranian authorities, all of the equipment was dismantled in May 2003 and transferred to Karaj for storage together with the uranium metal. The equipment and material were presented to Agency inspectors at Karaj on 28 October 2003.

41. In the meeting of 1 November 2003, Iran agreed to submit all of the relevant ICRs and design information, and to present the nuclear material for Agency verification during the inspection scheduled for 8–15 November 2003.

C.4. Heavy Water Reactor Programme

42. On 12 July 2003, the Iranian authorities made a presentation on the technical features, said to have been based on indigenous design, of the Iran Nuclear Research Reactor (IR-40) to be constructed at Arak. The purpose of the reactor was declared to be research and development and the production of radioisotopes for medical and industrial use. Iran explained that it had tried to acquire a reactor from abroad to replace the old research reactor in Tehran (TRR), but that those attempts had failed, and that Iran had concluded, therefore, that the only alternative was a heavy water reactor which could use domestically produced UO_2 and zirconium. In order to have a sufficient neutron flux, a reactor with power on the order of 30–40 MW(th) was said to be required.

43. During their visit in July 2003, Agency inspectors were provided with drawings of the IR-40. Contrary to what would have been expected given the declared radioisotope production purpose of the facility, the drawings contained no references to hot cells. The Agency raised this issue during that visit, particularly in light of open source reports of recent efforts by Iran to acquire from abroad heavy manipulators and leaded windows designed for hot cell applications. The Agency indicated to the Iranian authorities that, given the specifications of the manipulators and windows which were the subject of those reports, a design for hot cells should have existed already and that therefore the hot cell, or cells, should already have been declared, at least on a preliminary basis, as part of the facility or as a separate installation.

44. In its letter of 21 October 2003, Iran acknowledged that two hot cells had been foreseen for this project. However, according to the information provided in that letter, neither the design nor detailed information about the dimensions or the actual layout of the hot cells was available yet, since they did not know the characteristics of the manipulators and shielded windows which they could procure. On 1 November 2003, Iran confirmed that it had tentative plans to construct at the Arak site yet another building with hot cells for the production of radioisotopes. Iran has agreed to submit the relevant preliminary design information with respect to that building in due course.

D. Findings

45. Iran's nuclear programme, as the Agency currently understands it, consists of a practically complete front end of a nuclear fuel cycle, including uranium mining and milling, conversion, enrichment, fuel fabrication, heavy water production, a light water reactor, a heavy water research reactor and associated research and development facilities.

46. Iran has now acknowledged that it has been developing, for 18 years, a uranium centrifuge enrichment programme, and, for 12 years, a laser enrichment programme. In that context, Iran has admitted that it produced small amounts of LEU using both centrifuge and laser enrichment processes,

and that it had failed to report a large number of conversion, fabrication and irradiation activities involving nuclear material, including the separation of a small amount of plutonium.

47. Based on all information currently available to the Agency, it is clear that Iran has failed in a number of instances over an extended period of time to meet its obligations under its Safeguards Agreement with respect to the reporting of nuclear material and its processing and use, as well as the declaration of facilities where such material has been processed and stored. In his June and August 2003 reports to the Board of Governors (GOV/2003/40 and GOV/2003/63), the Director General identified a number of instances of such failures and the corrective actions that were being, or needed to be, taken with respect thereto by Iran.

48. Since the issuance of the Director General's last report, a number of additional failures have been identified. These failures can be summarized as follows:

(a) Failure to report:

(i) the use of imported natural UF_6 for the testing of centrifuges at the Kalaye Electric Company in 1999 and 2002, and the consequent production of enriched and depleted uranium;

(ii) the import of natural uranium metal in 1994 and its subsequent transfer for use in laser enrichment experiments, including the production of enriched uranium, the loss of nuclear material during these operations, and the production and transfer of resulting waste;

(iii) the production of UO_2, UO_3, UF_4, UF_6 and AUC from imported depleted UO_2, depleted U_3O_8 and natural U_3O_8, and the production and transfer of resulting wastes;

(iv) the production of UO_2 targets at ENTC and their irradiation in TRR, the subsequent processing of those targets, including the separation of plutonium, the production and transfer of resulting waste, and the storage of unprocessed irradiated targets at TNRC;

(b) Failure to provide design information for:

(i) the centrifuge testing facility at the Kalaye Electric Company;

(ii) the laser laboratories at TNRC and Lashkar Ab'ad, and locations where resulting wastes were processed and stored, including the waste storage facility at Karaj;

(iii) the facilities at ENTC and TNRC involved in the production of UO_2, UO_3, UF_4, UF_6 and AUC;

(iv) TRR, with respect to the irradiation of uranium targets, and the hot cell facility where the plutonium separation took place, as well as the waste handling facility at TNRC; and

(c) Failure on many occasions to co-operate to facilitate the implementation of safeguards, through concealment.

49. As corrective actions, Iran has undertaken to submit ICRs relevant to all of these activities, to provide design information with respect to the facilities where those activities took place, to present all nuclear material for Agency verification during its forthcoming inspections and to implement a policy of co-operation and full transparency.

E. Assessment and Next Steps

50. 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. Iran's policy of concealment continued until last month, with co-operation being limited and reactive, and information being slow in coming, changing and contradictory. While most of the breaches identified to date have involved limited quantities of nuclear material, they have dealt with the most sensitive aspects of the nuclear fuel cycle, including enrichment and reprocessing. And although 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.

51. Following the Board's adoption of resolution GOV/2003/69, the Government of Iran informed the Director General that it had now adopted a policy of full disclosure and had decided to provide the Agency with a full picture of all of its nuclear activities. Since that time, Iran has shown active co-operation and openness. This is evidenced, in particular, by Iran's granting to the Agency unrestricted access to all locations the Agency requested to visit; by the provision of information and clarifications in relation to the origin of imported equipment and components; and by making individuals available for interviews. This is a welcome development.

52. The Agency will now undertake all the steps necessary to confirm that the information provided by Iran on its past and present nuclear activities is correct and complete. To date, there is no evidence that the previously undeclared nuclear material and activities referred to above were related to a nuclear weapons programme. However, given Iran's past pattern of concealment, it will take some time before the Agency is able to conclude that Iran's nuclear programme is exclusively for peaceful purposes. To that end, the Agency must have a particularly robust verification system in place. An Additional Protocol, coupled with a policy of full transparency and openness on the part of Iran, is indispensable for such a system.

53. In that context, Iran has been requested to continue its policy of active co-operation by answering all of the Agency's questions, and by providing the Agency with access to all locations, information and individuals deemed necessary by the Agency. One issue requiring investigation as a matter of urgency is the source of HEU and LEU contamination. The Agency intends to pursue the matter with a number of countries, whose full co-operation is essential to the resolution of this issue.

54. The recent announcement of Iran's intention to conclude an Additional Protocol, and to act in accordance with the provisions of the Protocol pending its entry into force, is a positive development. The draft Additional Protocol is now being submitted to the Board for its consideration.

55. Iran's decision to suspend its uranium enrichment related and reprocessing activities is also welcome.[3] The Agency intends to verify, in the context of the Safeguards Agreement and the Additional Protocol, the implementation by Iran of this decision.

56. The Director General will inform the Board of additional developments for its further consideration at the March 2004 meeting of the Board, or earlier, as appropriate.

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[3] It should be noted that Iran introduced UF_6 into the first centrifuge at PFEP on 25 June 2003, and, on 19 August 2003, began testing a small ten-machine cascade. On 31 October 2003, Agency inspectors observed that no UF_6 gas was being fed into the centrifuges, although construction and installation work at the site was continuing.

DETAILED TECHNICAL CHRONOLOGY

Uranium Conversion

The Uranium Conversion Facility (UCF)

1. According to Iran, UCF was originally based on a design provided by a foreign supplier in the mid-1990s. The plant was supposed to have been constructed by the supplier under a turnkey contract, but the contract was cancelled in 1997 and, according to Iran, the supplier did not provide any equipment to Iran. The AEOI has acknowledged having received from the supplier the blueprint of the facility, including equipment test reports and some design information on the equipment, but has stated that all the parts and equipment for the plant were manufactured domestically based on detailed designs developed without external assistance. Construction of the plant was begun in 1999.

2. Preliminary design information on UCF was submitted to the Agency on 31 July 2000. The Agency has performed DIV at UCF since then on a regular basis with a view to monitoring progress in construction and equipment installation, and to develop a safeguards approach. The proposed safeguards approach was given to the Iranian authorities in February 2002.

3. The design information provided to the Agency in July 2000 described the purpose of this facility as the conversion of uranium ore concentrate (UOC or U_3O_8) into natural UO_2, UF_6 and uranium metal. The production design capacity was said to be 200 t of UF_6 annually. The facility was described as having the following process lines: conversion of natural UOC into UF_6; conversion of low enriched UF_6 into UO_2 (30 t per year of UO_2 enriched to 5% U-235); conversion of depleted UF_6 to UF_4 (170 t per year of depleted UO_4); conversion of low enriched UF_6 LEU metal (30 kg per year of uranium metal enriched to 19.7% U-235), and the conversion of depleted UF_4 to depleted uranium metal. According to information provided by Iran, commissioning of the first line (for the conversion of U_3O_8 to ammonium uranyl carbonate (AUC)) is expected to begin in November 2003.

4. While conducting a DIV at the facility in 2002, inspectors noticed that the depleted uranium metal line had been changed to a line for natural uranium metal production. The updated design information, which was provided to the Agency on 9 April 2003, now includes an additional line for conversion to natural UO_2 and a line for conversion to natural uranium metal. In a letter dated 19 August 2003, Iran stated that the uranium metal production line could be used to produce shielding material, and that the natural UO_2 line was envisaged to meet the needs of the heavy water reactor programme.

Uranium Conversion Experiments and Testing

5. The explanations by Iran that it had not conducted any tests using nuclear material on certain parts of the conversion process and that those processes had been based on the supplier's drawings and test reports, raised questions, particularly given that the simpler steps of the conversion process (such as U_3O_8 dissolution and uranium purification using pulse columns) had undergone extensive testing. According to Agency experts, such an approach would be inconsistent with the normal practice of first validating the processes and carrying out pilot scale production before proceeding to the final design and construction of a commercial conversion plant.

6. As indicated in GOV/2003/63, Iran acknowledged in August 2003 that it had carried out some bench scale uranium conversion experiments in the early 1990s, experiments that Iran should have reported in accordance with its obligations under the Safeguards Agreement.

7. On 9 October 2003, the Agency received acknowledgement that, contrary to Iran's previous communications, practically all of the materials important to uranium conversion (AUC, UO_3, UF_4 and UF_6) had been produced in laboratory and bench scale experiments (kilogram quantities) conducted between 1981 and 1993 without having been reported to the Agency. On 1 November 2003, Iran explained that, due to foreign involvement in the design and construction of UCF, it was decided in 1993 to terminate domestic research and development on UF_4 and UF_6. Iran further explained that the facilities related to the UF_4 and UF_6 experiments had been dismantled, and that the equipment had been moved to waste storage at Karaj. This is being evaluated by the Agency.

8. For ease of reference, a summary of major processing experiments by Iran using imported uranium, based on information currently available to the Agency, is provided in Table 1.

TABLE 1: Major Processing Experiments by Iran Using Imported Uranium

Year of Import	Material Type & Quantity	Use by Iran
1977	20 kg U_3O_8 (depleted)	• At Iran's request the U_3O_8 was exempted from safeguards in 1978 (de-exempted in 1998). • Processing activities were carried out between 1981 and 1993 and reported to the Agency in 1998. 5.2 kg U_3O_8 was declared a process loss from the experiments.
	50 kg UO_2 (depleted)	• At Iran's request the UO_2 was exempted from safeguards in 1978 (de-exempted in 1998). • Fuel fabrication research was carried out between 1985 and 1993 at FFL and reported to the Agency in 1998; 13.1 kg depleted UO_2 was declared as a process loss from these experiments. • Lab-scale experiments using UO_2, reported in 1998 as a loss, were used between 1989 and 1993 to produce UF_4 at TNRC. • UO_2 targets were produced from 1988 to 1992 at ENTC using about 6.9 kg UO_2, previously declared as a process loss in 1998, subsequently irradiated at TRR; the resulting plutonium separated at TNRC was stored together with the irradiated unprocessed targets at TNRC.
1982	531 t U_3O_8 concentrate (natural)	• Processing of 85 kg U_3O_8 between 1982 and 1993 was carried out at UCL and reported to the Agency in 1998; 45 kg was declared as a process loss from these experiments. • Between 1982 and 1987 about 12.2 kg UO_2 was produced using U_3O_8 declared in 1998 as a loss. This UO_2, combined with some other materials, was used between 1989 and 1993 to produce about 10 kg UF_4 at TNRC.
1991	1005 kg UF_6 (natural)	• 1.9 kg UF_6 was used for testing of centrifuges at Kalaye Electric between 1999 and 2002.
	402 kg UF_4 (natural)	• 376.6 kg UF_4 was converted to U metal in 113 experiments at JHL; and about 9.4 kg UF_4, which had been declared earlier in 2003 as a process loss, was used to produce 6.5 kg UF_6 at TNRC between 1991 and 1993.
	401.5 kg UO_2 (natural)	• 44 kg UO_2 was used in testing of pulse columns and pellet production at JHL. • 1-2 g UO_2 was irradiated in experiments in TRR and processed at JHL. • 2.7 kg UO_2 was used to produce UF_4.
1993	50 kg uranium metal	• 8 kg uranium metal was used for AVLIS experiments from 1999 to 2000 at TNRC. • 22 kg uranium metal was used for AVLIS experiments from October 2002 to February 2003 at Lashkar Ab'ad.

9. In 1977, Iran imported 20 kg of depleted U_3O_8 and 50 kg of depleted UO_2. Upon request by Iran in 1978, these materials were exempted from safeguards. In 1982, Iran imported 531 t of natural U_3O_8 concentrate, which it reported to the Agency in 1990.

10. In 1981 and 1984, respectively, Iran commissioned with a foreign supplier the construction at ENTC of a Uranium Chemistry Laboratory (UCL) and a Fuel Fabrication Laboratory (FFL). The existence of these laboratories was disclosed to the Agency during a visit of the then DDG-SG in 1993, and formally reported to the Agency in 1998. Between 1981 and 1993, Iran carried out at UCL and FFL unreported activities involving the exempted depleted U_3O_8, the exempted depleted UO_2, and the U_3O_8 concentrate (see paras. 11 and 12 below). These activities were only reported to the Agency in 1998 after lengthy discussions between the Agency and Iranian officials. The material was de-exempted in 1998, and what remained of it was stored at ENTC. In 1998, Iran declared that UCL had been closed down since 1987. FFL is still in operation.

11. Between 1981 and 1993, processing activities involving the 20 kg of exempted depleted U_3O_8 and some of the 531 t of natural U_3O_8 concentrate were carried out at UCL. Of the original 20 kg of depleted U_3O_8, 5.2 kg was reported in 1998 as process losses by Iran. Iran also reported in 1998 that it had processed 85 kg of the 531 t of U_3O_8 concentrate, of which 45 kg was declared as process losses.

12. During the period 1985 through 1993, FFL was used for research in fuel fabrication, the main activity having been the manufacture of sintered pellets using the imported 50 kg of exempted depleted UO_2. Iran reported the existence of FFL, and the processing of the nuclear material there, in 1998, at which time it declared that 13.1 kg of the material had been lost during processing.

13. In a letter dated 19 August 2003, Iran acknowledged that it had carried out UO_2 to UF_4 conversion experiments on a laboratory scale during the 1990s at the Radiochemistry Laboratories of the TNRC using some of the imported depleted UO_2 referred to in the previous paragraph. Until August 2003, Iran had claimed that it had carried out no UF_4 production experiments. This activity was acknowledged by Iran only after the July 2003 waste analysis results of samples taken to verify experiments using nuclear material imported in 1991 indicated the presence of depleted UF_4 mixed with natural UF_4. Iran acknowledged that the UO_2 which had been used had been part of that previously declared by Iran as having been lost during experiments at FFL.

14. On 9 October 2003, Iran provided further details on these UF_4 experiments, stating that, between 1987 and 1993, there had been bench scale production of UF_4 at the Radiochemistry Laboratories. This information was further amplified in Iran's letter dated 21 October 2003 and in a subsequent meeting on 1 November 2003. According to that information, the UF_4 production experiments included testing of wet and dry production methods. Between 1982 and 1987, approximately 12.2 kg of natural UO_2 was produced at UCL using imported U_3O_8 concentrate that had been reported as a process loss in 1998 (see para. 11 above). This material, together with 1 kg of the UO_2 imported in 1991, and 1.23 kg of depleted UO_2 that had been reported in 1998 as a process loss at UCL (see para. 12 above), was used for the production of UF_4 at the Radiochemistry Laboratories through the wet method. In addition, 2.5 kg of UF_4 was produced with the dry method, using UO_2 imported in 1991 as the source material.

15. Between 1991 and 1992, 0.2 kg of UO_3 and 4.45 kg of AUC were produced in the Radiochemistry Laboratories using, as source material, some of the U_3O_8 concentrate imported in 1982.

16. On 1 November 2003, Iran agreed, as a corrective measure, to submit ICRs for UCL, FFL, JHL and the waste storage facility at Karaj, as well as design information for the waste storage facility.

17. Final evaluation of the information provided on these conversion experiments will depend on the results of the destructive and environmental sample analysis and the assessment of the experiment reports provided by Iran.

18. Following the import in 1991 of natural uranium (1005 kg of UF_6, 402 kg of UF_4 and 401.5 kg of UO_2), Iran carried out a number of experiments, on a laboratory scale, at JHL located at TNRC. The import of the nuclear material in question was only acknowledged by Iran in March 2003. The status of the imported material, as currently declared, is as follows:

- Of the 1005 kg of UF_6, 1.9 kg was found to have been missing from two cylinders in which the material is said to have been delivered. This loss was originally attributed by Iran to evaporation of the material due to high temperatures during storage of the material. Iran has now acknowledged that it used that material for testing centrifuges at the Kalaye Electric Company, as described below.
- Of the 402 kg of UF_4, 376.6 kg was converted to uranium metal. The conversion was declared by Iran in March 2003, and in June 2003, it was described as having been achieved through 113 experiments carried out at JHL in the early 1990s. In October 2003, Iran also acknowledged having used 9.43 kg of the UF_4 for conversion to UF_6, as described below.
- Of the 401.5 kg of UO_2, 44 kg was used in testing pulse column process and pellet production experiments at JHL. In addition, between June 1987 and February 1999, small amounts (1 to 2 g) of UO_2 were irradiated in TRR in about 50 experiments and sent to the Molybdenum, Iodine and Xenon Radioisotope Production Facility (MIX Facility) for separation of I-131. In October 2003, Iran acknowledged having used 2.7 kg of the UO_2 in conversion experiments to produce UF_4.

19. Iran has provided ICRs on its import of the material referred to in the preceding paragraph, as well as on its subsequent processing. Iran has also submitted physical inventory listings (PILs) and material balance reports (MBRs) reflecting the current status of nuclear material at JHL, including uranium metal, uranyl nitrate, UO_2 pellets and waste containing uranium.

20. JHL, where many of these experiments are declared to have been carried out, consists of several rooms where conversion activities took place using the nuclear material imported in 1991. The facility was declared to the Agency in March 2003. In May 2003, design information for JHL was received, and verification thereof commenced. Iran has been informed that the design information is not yet complete, and has been requested to provide an update.

Production and use of UF_6

21. Until recently, the Iranian authorities repeatedly asserted that the UF_6 imported in 1991 had not been processed, and specifically that it had not been used in any centrifuge, enrichment or other tests. The State authorities explained that the small amount of UF_6 (1.9 kg) missing from the two smaller cylinders in which the material had been imported might have been due to leaking valves, an explanation challenged by the Agency on the basis of its technical assessment and verification activities. In the information submitted on 23 October 2003, however, Iran acknowledged that it had used 1.9 kg of the imported UF_6 to test centrifuge machines at the Kalaye Electric Company workshop between 1999 and 2002, before the dismantling of the test facility at the end of 2002. This material is currently declared as hold-up in the dismantled equipment currently stored at PFEP.

22. The remaining container of the UF_6 imported in 1991, a large 30 B-type cylinder currently stored at Natanz, was presented to Agency inspectors, and appeared to have been intact. However, destructive analysis sampling of its contents need to be performed. This will be done as soon as the

necessary equipment is installed. In the meantime, environmental samples and non-destructive measurements have been taken in order to confirm the presence of natural uranium.

23. In contrast to its earlier declarations that it had not used nuclear material to test the production of UF_6, Iran acknowledged in its letter dated 21 October 2003 that, between 1987 and 1993, it had carried out in the Radiochemical Laboratories at TNRC bench scale preparation of UF_6 using as feed 9.43 kg of the UF_4 which had been imported in 1991. The laboratory equipment has since then been dismantled. On 12 October 2003, the equipment was presented for Agency verification in a container at the Karaj Nuclear Research Centre for Medicine and Agriculture, together with a number of cylinders containing approximately 6.5 kg of UF_6. Final evaluation will depend on the results of environmental sampling and assessment of experiment records provided by Iran.

24. On 1 November 2003, Iran agreed to submit ICRs for JHL, PFEP and the waste storage facility at Karaj and to provide design information for those facilities.

Production of uranium metal

25. In March 2003, Iran informed the Agency that most of the natural UF_4 imported in 1991 had been converted to uranium metal at JHL between 1995 and 2000 in the course of 113 experiments. Neither the experiments nor the facility where these experiments were conducted were declared to the Agency at the time the experiments were conducted. The nuclear material resulting from these experiments was verified by the Agency during its May 2003 inspection, and Iran has submitted the relevant ICRs, PILS and MBRs, as well as updated design information for JHL.

26. In its letter dated 21 October 2003, Iran admitted that the uranium metal production capabilities had also been intended for use in Iran's laser enrichment programme (see discussion below).

Reprocessing Experiments

27. In March 2003, Iran stated that some of the UO_2 imported in 1991 had been used for pellet fabrication experiments. In April 2003, Iran informed the Agency that some of the UO_2 had also been used in isotope production experiments involving irradiation at TRR of the *natural* UO_2 targets and the subsequent separation of molybdenum, xenon and iodine. The liquid uranium-containing waste resulting from these experiments is said by Iran to have been sent to Esfahan.

28. In its letter of 21 October 2003, Iran acknowledged the irradiation of *depleted* UO_2 targets at TRR and subsequent plutonium separation experiments in a hot cell in the Nuclear Safety Building of TNRC between 1988 and 1992. Neither the activities nor the separated plutonium had been reported to the Agency previously.

29. In the meetings held 27 October–1 November 2003, additional information was provided about the experiments involving the depleted uranium. Iran stated that they had been carried out to learn about the nuclear fuel cycle, and to gain experience in reprocessing chemistry. The experiments took place between 1988 and 1992, and involved 7 kg of pressed or sintered UO_2 pellets prepared at ENTC using depleted uranium that had been exempted, at the request of Iran, in 1978. In 1997, this material was reported as a process loss at FFL. The capsules containing the pellets were irradiated typically for two weeks in TRR in connection with a project to produce fission product isotopes of molybdenum, iodine and xenon. The plutonium separation, based on the Purex process, was carried out on the site of TNRC, on a laboratory scale, in three shielded glove boxes, which, according to Iran, were dismantled in 1992 and later stored in a warehouse at ENTC along with related equipment.

30. The Agency was informed that a total of about 7 kg of UO_2 was used, of which 3 kg had been irradiated and processed to separate plutonium. The remaining 4 kg of irradiated UO_2 targets was

placed in containers and stored on the TNRC site; the separated plutonium was stored in a laboratory of JHL following the dismantling of the glove boxes; and the wastes were disposed of at Qom.

31. In August 2003, Agency inspectors visited the waste storage location at Anarak where the waste referred to in paragraph 27 above had been stored. Iran has agreed to transfer that waste to JHL.

32. On 1 November 2003, Iran agreed to submit all nuclear material accountancy reports from 1988 through the present covering the manufacture of the UO_2 targets, their irradiation and subsequent processing and the storage of the remaining nuclear material and wastes. In addition, Iran has agreed to submit design information covering these activities and nuclear material at ENTC and JHL.

33. On 1 November 2003, Iran presented both the separated plutonium and the irradiated unprocessed targets to Agency inspectors at JHL. Verification of that material, as well as possible hold-up in dismantled glove boxes, is foreseen to take place during the forthcoming inspection.

Uranium Enrichment

Gas Centrifuge Enrichment

34. In February 2003, in response to inquiries by the Agency, Iran acknowledged the existence of two centrifuge enrichment plants under construction at Natanz: PFEP and the large commercial scale FEP. In February 2003, Iran also acknowledged that the workshop of the Kalaye Electric Company in Tehran had been used for the production of centrifuge components, but stated that there had been no operations in connection with its centrifuge enrichment development programme involving the use of nuclear material, either at the Kalaye Electric Company or at any other location in Iran. According to Iran, all testing had been carried out either in vacuum or using simulation studies. Iranian officials stated that the enrichment programme had been started in 1997 and that it was indigenous and based on information available from open sources, such as scientific publications and patents.

35. A team of Agency centrifuge technology experts met on 7–11 June 2003 with Iranian officials to seek clarification about Iran's centrifuge enrichment programme, in particular about its statement that the design and development, which was said to have been begun in 1997, had been based on information from open sources and extensive modelling and simulation, and that the tests of centrifuge rotors at the Amir Khabir University and on the premises of the AEOI in Tehran had been conducted without nuclear material. This meeting was followed by a round of technical discussions in Tehran in July 2003, and further meetings of the centrifuge technology experts with Iranian officials in Iran on 9–12 August 2003, 4–9 October 2003 and 27 October–1 November 2003.

36. Following up on recent open source reports of enrichment activities being undertaken at an industrial complex in Kolahdouz in western Tehran, the Agency was permitted on 5 October 2003 to visit three locations which the Agency had identified as corresponding to those mentioned in the reports. Iran stated that there were no nuclear related activities being carried out at this site. While no work was seen at those locations that could be linked to uranium enrichment, environmental samples were taken.

The Natanz Facilities

37. At the time Iran disclosed the construction of PFEP, in February 2003, over 100 of the approximately 1000 planned centrifuge casings had already been installed. Iran informed the Agency that the remaining centrifuges were scheduled to be installed by the end of 2003. Iran also informed the Agency that the commercial scale FEP, which is planned to contain over 50 000 centrifuges, was scheduled to start accepting centrifuges in early 2005, after the design is confirmed by the tests to be conducted in PFEP, but that FEP was not scheduled to receive nuclear material in the near future.

38. The Agency took baseline environmental samples at PFEP on several occasions between March and May 2003 before nuclear material was introduced in the facility, the results of which revealed particles of HEU indicating the possible presence in Iran of nuclear material that had not been declared to the Agency. In June 2003, the results were provided to Iran for comments. In August 2003, the Iranian authorities attributed the presence of HEU particles to contamination originating from centrifuge components that had been imported by Iran.

39. Subsequent environmental samples revealed the presence in Iran of natural uranium, LEU and at least two other types of HEU particles. It was also noted that there had been differences among the samples taken from the surfaces of the centrifuge casings installed for the single machine tests. The Agency asked the Iranian authorities to investigate whether there were differences in the manufacturing history of those pieces of equipment.

40. In August 2003, the IAEA was allowed to take swipe samples of imported components stored at Natanz, as well as of some of the newly machined components that had been produced in Iran. At the request of the Agency, Iran provided a list of imported and domestically produced centrifuge components and equipment in October 2003.

41. Agency inspectors were told in early October 2003 that all of the centrifuges from the Kalaye Electric Company had been scrapped, and therefore were not available for inspection, whereas it became clear later that the centrifuges had in fact been stored at another location in Tehran and were finally shown to the inspectors at Natanz on 30–31 October 2003, at which time Agency experts examined the centrifuges and associated equipment, and took environmental samples. All major imported and domestically produced components, as well as various pieces of manufacturing equipment have now been sampled. The results of the sample analyses are not expected to be available before December 2003. The nuclear material held in this equipment will be verified during the forthcoming inspections. The Agency has now also obtained information about the source of the components that Iran claims to have been contaminated.

42. On 25 June 2003, Iran introduced UF_6 into the first centrifuge at PFEP for the purpose of single machine testing. On 19 August 2003, Iran began the testing of a small ten-machine cascade at PFEP with UF_6. As of October 2003, some single machine testing using UF_6 had been carried out at PFEP and the installation of a 164-machine cascade was being finalized. Agency inspectors visited PFEP on 31 October 2003, and observed that no UF_6 gas was being fed into the first centrifuges of the 164-centrifuge machine cascade. However, construction and installation work at the site was continuing.

Kalaye Electric Company

43. In March 2003, during an Agency visit to the workshop at the Kalaye Electric Company, the Iranian authorities refused Agency access to one of the workshop buildings, claiming that the building was used for storage and that no keys to the building were available.

44. During their 9–12 August 2003 visit to Iran, Agency inspectors were permitted to take environmental samples at the Kalaye Electric Company workshop, with a view to assessing the role of that company in Iran's enrichment research and development programme. During that visit, the inspectors noted that there had been considerable modification of the premises since their visits in March and May 2003, which the Iranian authorities attributed to the transformation of the workshop from use as a storage facility to its use as a laboratory for non-destructive analysis. As reflected in the Director General's previous report to the Board, this could impact on the accuracy of the environmental sampling and the Agency's ability to verify Iran's declarations about the types of activities previously carried out there.

45. On 16 September 2003, the Agency informed representatives of Iran of the results of the analysis of the environmental samples taken at the Kalaye Electric Company in August 2003, which had revealed the presence of HEU and LEU particles which were not consistent with the nuclear material in the declared inventory of Iran.

46. In its letter of 21 October 2003, Iran acknowledged that "a limited number of tests, using small amounts of UF_6, [had been] conducted in 1999 and 2002" at the Kalaye Electric Company. The equipment used between 1999 and 2000 at Kalaye Electric Company was suitable for pilot scale uranium isotope separation. As an isotope separation plant is defined in Article 98.I.(a) of the Safeguards Agreement as a facility, the existence of this facility should have been declared to the Agency.

Enrichment research and development activities

47. As indicated in the Director General's previous report, in contrast to the initial information provided about the chronology of the enrichment programme and its indigenous nature, Iran informed the Agency in August 2003 that the decision to launch a centrifuge enrichment programme had actually been taken in 1985, and that Iran had received drawings of the centrifuge through a foreign intermediary around 1987. Iranian officials further described the programme as having consisted of three phases: the first phase, from 1985 until 1997, during which related activities had been located mainly at the AEOI premises in Tehran (with laboratory work at the Plasma Physics Laboratories of TNRC); the second phase, between 1997 and 2002, during which the activities had been relocated and concentrated at the Kalaye Electric Company in Tehran and Iran was able to make all components had some success in mechanically testing centrifuges and decided to construct the enrichment facilities at Natanz; and the third phase, 2002 to the present, when the research and development and assembly activities were moved to Natanz.

48. According to information provided by Iran in August 2003, during the first phase, about 2000 components and some subassemblies had been obtained from abroad through foreign intermediaries or directly by Iranian entities, but no help was received from abroad in the assembly of centrifuges or in training, nor were any completed centrifuges imported. Efforts had been concentrated on achieving an operating centrifuge, but many difficulties were encountered as a result of machine crashes attributed to poor quality components. Iran described the second phase of activities as having involved the assembly and testing of centrifuges, but again without inert (e.g. xenon) or UF_6 gas.

49. In pursuit of its verification of Iran's statement that it had not tested any centrifuges using nuclear material, the Agency's team of centrifuge technology experts inquired of Iran how it had developed the 'enrichment factor'[4] and 'separative output'[5] used in the relevant calculations. The Agency was

[4] The "enrichment factor" of a centrifuge is the ratio of the amount of U-235 in the product to the amount of U-235 in the feed.

told that they had been obtained from an original centrifuge 'sketch', supported by theoretical calculations using open literature, and not from experiments.

50. The Agency's centrifuge technology experts remained of the view that, based on all information available to them, Iran's assertion that no UF_6 or any simulation gas had ever been introduced into a centrifuge machine in Iran was inconsistent with other countries' experience, and they still could not conclude that the then current status of the centrifuges installed at Natanz could have been achieved solely on the basis of open source information and computer simulations without additional confirmation through the use of UF_6 in laboratory testing.

51. No new information was provided by Iran with respect to the issue of testing of centrifuges using nuclear material until October 2003. In its letter of 21 October 2003, Iran acknowledged that, in order to ensure the performance of centrifuge machines, a limited number of tests using small amounts of UF_6 imported in 1991 had been carried out at the Kalaye Electric Company. According to Iran, the first test of the centrifuges was conducted in 1998 using an inert gas (xenon). Series of tests using UF_6 were performed between 1999 and 2002. In the course of the last series of tests, an enrichment level of 1.2% U-235 was achieved.

52. In a meeting with enrichment technology experts held during the 27 October–1 November 2003 visit, Iran provided additional information about its gas centrifuge programme. The authorities explained that the experiments which had been carried out at the Kalaye Electric Company had involved the 1.9 kg of imported UF_6 the absence of which the State authorities had earlier attributed to evaporation due to leaking valves on the cylinders containing the gas. The individual who had been in charge of the actual research and development work during the period 1992–2001 was made available for discussions with the Agency. Although there were no detailed technical or nuclear material accountancy reports available, the individual interviewed by the Agency was able to provide, as supporting documentation, his personal notebooks.

53. On 1 November 2003, the Iranian authorities stated that all nuclear material had been declared to the Agency and that Iran had not enriched uranium beyond 1.2% U-235 using centrifuges, and that, therefore, the contamination could not have arisen as a result of indigenous activities. In the course of these investigations and interviews of individuals involved in the nuclear programme, the Agency has obtained information on the origin of the centrifuge components and equipment which Iran claims to be the source of HEU, LEU and other particle contamination at the Kalaye Electric Company and at PFEP. The Agency will continue to investigate this matter.

54. As a corrective measure, Iran has agreed to submit ICRs for JHL and for PFEP, and to provide updated design information for PFEP.

Laser Enrichment

55. During the Agency's 12 August 2003 visit to the laser laboratory located at Lashkar Ab'ad, the Iranian authorities described the laboratory as originally having been devoted to laser fusion research and laser spectroscopy, but stated that its focus had been changed and the equipment unrelated to the site's current projects, including a large vacuum vessel imported by Iran in 2000, had been moved. The Agency requested that Iran confirm that there had not been in the past any activities related to uranium laser enrichment at this location or at any other location in Iran, and requested permission to take environmental samples at the laboratory.

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[5] The "separative output" of a centrifuge defines the amount of enrichment achieved by the centrifuge. The "separative output" multiplied by the number of centrifuges in an enrichment plant defines the total output achievable by the plant.

56. In response to that request, in its 19 August 2003 letter to the Agency, Iran stated that, in the past, apart from planned co-operation in laser fusion and laser spectroscopy which never materialized, there had been a research thesis on laser spectroscopy of SF_6 prepared by a university student in co-operation with the laser division of AEOI. As indicated in the Director General's previous report to the Board, Iran stated that it had a substantial research and development programme on lasers, but that it currently had no programme for laser isotope separation.

57. During discussions which took place in Iran from 2 to 3 October 2003, the Iranian authorities informed Agency inspectors that Iran had received from a foreign source, in 1992, a laser spectroscopy laboratory intended for the study of laser induced fusion, optogalvanic phenomena and photoionization spectroscopy, and from another foreign source, in 2000, the large vacuum vessel referred to above, but that the equipment had been only for spectroscopic studies. It was agreed that the Agency would be shown the equipment and permitted to take environmental samples, as had been requested by the Agency on 12 August 2003.

58. On 6 October 2003, Agency inspectors were permitted to take environmental samples at Lashkar Ab'ad. The inspectors also visited a warehouse in the Karaj Agricultural and Medical Centre of the AEOI, where a large imported vacuum vessel (approximately 5 m long, 1 m in diameter) with associated hardware were stored. The Iranian authorities stated that it was the equipment which had been imported in 2000, that it had never been used, and that it had now been packed for shipment back to the manufacturer, since the contract related to its supply had been terminated by the foreign partner in 2000. The inspectors were informed that the individuals involved with the projects would be made available for interviews, but that the interviews would take place later in Tehran, where the equipment related to the laboratory imported from another country in 1992 would be made available for examination and environmental sampling. However, these interviews and the presentation of the other equipment were deferred by Iran until the end of October 2003.

59. In its letter dated 21 October 2003, Iran acknowledged that, starting in the 1970s, it had had contracts related to laser enrichment using atomic vapour laser isotope separation (AVLIS) and molecular laser isotope separation (MLIS) techniques with foreign entities from four countries:

(a) 1975 – a contract for the establishment of a laboratory to study the spectroscopic behaviour of uranium metal, which had been abandoned in the 1980s as the laboratory had not functioned properly. The laboratory had also contained two mass spectrometers, purchased from the same source in 1976, which had been used to analyse samples of nuclear material obtained from enrichment experiments at Kalaye Electric Company, TNRC and Lashkar Ab'ad. While the import of the nuclear material used in that project had been reported to the Agency, the laboratory where the laser equipment had been installed (at TNRC) was not. None of these activities involving the nuclear material had been reported to the Agency.

(b) Late 1970s – a contract with a second supplier to study MLIS, under which four 5 μm CO lasers and four vacuum chambers were delivered, but which was ultimately terminated due to the political situation prevailing at that time.

(c) 1991 – a contract with a third supplier for the establishment of a laser laboratory, consisting of two parts: the "Laser Spectroscopy Laboratory" (LSL), for the spectroscopic study of uranium metal; and the "Comprehensive Separation Laboratory" (CSL), at which enrichment would be carried out on a milligram scale. The contract also provided for the supply to Iran of 50 kg of natural uranium metal (which was imported in 1993). The equipment was able to enrich uranium up to the contracted level of 3% U-235, and even slightly beyond, in the course of the

experiments. It was used until October 2002, when the laboratories, and the nuclear material, were moved from TNRC to Lashkar Ab'ad. None of these activities involving nuclear material were reported to the Agency.

(d) 1998 – a contract with a fourth supplier to obtain information related to laser enrichment, and the supply of relevant equipment. However, due to the inability of the supplier to secure export licences, only some of the equipment was delivered (to Lashkar Ab'ad).

60. The equipment imported in connection with the above mentioned AVLIS and MLIS projects was presented to the Agency inspectors in October 2003, and the inspectors were able to discuss the projects with individuals who had been involved with them and to take environmental samples. Final assessment must await evaluation of the recently available information and the environmental sampling results.

61. In October 2003, Iran provided more information on Lashkar Ab'ad, and acknowledged that it had in fact contained a pilot plant for laser enrichment using AVLIS techniques, which had been established in 2000 pursuant to a project involving the fourth country. As indicated above, this contract was not fully implemented, since export licences were not obtained for all of the equipment. The project had consisted of several contracts covering not only the supply of information, as indicated in Iran's letter of 21 October 2003 to the Agency, but also delivery of more powerful copper vapour lasers (CVLs) up to 150 kW. Since the delivery of the CVLs was blocked due to the lack of export licences, the equipment at LSL and CSL was moved to Lashkar Ab'ad in October 2002, and, taking advantage of the CVL and dye lasers from these laboratories and the large vacuum chamber and associated equipment imported in 2000 and already located there, experiments were conducted from October 2002 through January 2003 using 22 kg of the 50 kg of imported natural uranium metal. According to Iranian authorities, the uranium metal was located at Lashkar Ab'ad from December 2002 through May 2003. The equipment was dismantled in May 2003 and transferred together with uranium metal to Karaj, where they were presented to Agency inspectors on 28 October 2003. The Agency took environmental samples from the equipment and nuclear material presented to it.

62. In its letter of 21 October 2003, Iran also informed the Agency that it had used for separation experiments at LSL and CSL at TNRC 8 kg of the 50 kg of natural uranium metal imported in 1993.

63. The equipment received in 1992 and 1999 was suitable for pilot plant scale operations of uranium isotope separation using AVLIS. As an isotope separation plant is defined in Article 98.I.(a) of the Safeguards Agreement as a facility, the existence of these facilities should have been declared to the Agency, and information provided on an as-built basis at Lashkar Ab'ad, and its subsequent transfer to Karaj.

64. Iran had failed to report the receipt and use of uranium metal and to provide design information for LSL, CSL and Lashkar Ab'ad. In the meeting of 1 November 2003, Iran agreed, as a corrective measure, to submit the relevant ICRs concerning the use of the uranium metal, which will be presented for Agency verification during the inspection scheduled for 8–15 November 2003. Iran also agreed to submit design information for a new storage facility at Karaj, where the waste from the laser enrichment programme is being stored along with the dismantled equipment, and to amend the design information for JHL to cover the mass spectrometer and laser laboratories as well as some waste tanks containing nuclear material.

65. Final assessment is pending evaluation of the new information, the verification results from the November 2003 inspection and the results of environmental and other sample taking.

Heavy Water Reactor Programme

66. In response to Agency enquiries in September 2002, Iran confirmed in February 2003 its construction of a Heavy Water Production Plant at Arak. In explaining the need for such a plant, Iranian officials said that they had not known whether their uranium enrichment programme would succeed, and that, therefore, they had considered in the 1980s the possibility of constructing a natural uranium nuclear power plant using heavy water as the moderator and coolant. They further explained that, now that the enrichment programme had succeeded, there was no need for heavy water production, and they were not sure whether the plant would be completed. On 26 February 2003, the Agency submitted a number of questions to Iran about its heavy water reactor programme, requesting that it provide further information, in particular on any plans Iran had to build heavy water reactors.

Design and Purpose of the IR-40

67. The Agency was first informed of Iran's construction of a heavy water reactor in a letter from Iran dated 5 May 2003. In that letter, Iran stated that it intended to construct a 40 MW(th) heavy water reactor, the Iran Nuclear Research Reactor (IR-40) at Arak. Enclosed with the letter was only preliminary design information on the reactor, in which the reactor power output of 40 MW(th) was confirmed; it did not include information on the fuel or the reactor design. At the same time, Iran provided preliminary information on a facility intended to manufacture fuel for IR-40, namely the Fuel Manufacturing Plant (FMP) to be built on the Esfahan site.

68. During a technical visit to Iran by the Agency on 10–13 July 2003, the Iranian authorities made a presentation on some of the technical features of the IR-40, and informed the Agency that the construction was planned to start in 2004. According to statements made in the course of this presentation, Iran had decided to replace TRR because, after 35 years of operation, it was reaching the safety limits for which it had been designed and because of its location within what had become the suburbs of the city of Tehran. However, as it had tried, unsuccessfully, on several occasions to import a research reactor suitable for medical, industrial isotope production and for research and development, Iran had decided in the mid-1980s to construct its own reactor. The only alternative was a heavy water reactor which could use UO_2 and zirconium produced in Esfahan. According to the Iranian authorities, to meet its isotope production requirements, such a reactor should have a neutron flux of 10^{13} to 10^{14} n/cm^2/s, based on a power of the order of 30-40 MW(th) when using natural UO_2 fuel.

69. During the presentation, the Iranian authorities informed the Agency that the facility was based on indigenous design, and that it was currently in the detailed design phase and would be built in the Khondab area near Arak. The core fuel assemblies would be made from natural UO_2 and supplied by FMP, the feed for which would be supplied by UCF, currently under construction at Esfahan. The Agency was informed that the construction of FMP would begin in 2003 and be completed in 2006, and that operations were planned to start in 2007. Iran provided updated design information on the IR-40 on 26 July 2003, and preliminary design information on FMP in 2003.

70. In a letter to the Agency dated 19 August 2003, the AEOI provided more information on Iran's heavy water reactor programme, stating that a decision to start the research and development had been made in the early 1980s.

71. As indicated above, Iran previously stated that the IR-40 was of indigenous design. According to the information provided by Iran in its letter of 21 October 2003, however, foreign experts had been consulted in the development of some parts of the design of the reactor. When asked, Iranian

authorities stated that they had conducted extensive reactor core calculations for the fuel management strategies and to control the excess reactivity[6] of the core. In that letter, Iran stated further that the reactor design had been 90% completed by the end of 2002, and the detailed design was expected to be completed by the end of 2005.

72. On 29 October 2003, Iran informed the Agency that the production of both "short lived" and "long lived" isotopes had been considered for this project, and that the exact amount and type of these isotopes would be decided upon during the detailed design stage of the project.

Hot Cells

73. During its July 2003 visit to Tehran, the Agency was provided with drawings of the reactor. Contrary to what would have been expected given the declared radioisotope production purpose of the facility, the drawings contained no references to hot cells. The Agency raised this issue during that visit, particularly in light of open source reports of recent efforts by Iran to acquire from abroad heavy manipulators and leaded windows designed for hot cell applications. The Agency indicated to the Iranian authorities that, given the specifications of the manipulators and windows which were the subject of those reports, a design for hot cells should exist already and that, therefore, the hot cell, or cells, should already have been declared, at least on a preliminary basis, as part of the facility or as a separate installation. On 4 August 2003, the Agency was provided with updated design information on the IR-40 which did not contain any references to hot cells. Later in August, Iran informed the Agency that, as Iran had not been certain about the success of its procurement efforts, the design of the hot cell(s) had not been included in the preliminary drawings of the IR-40 Research Reactor.

74. In its letter of 21 October 2003, Iran acknowledged that two hot cells had been foreseen for this project. However, according to the information provided in that letter, neither the design nor detailed information about the dimensions or the actual layout of the hot cells were available at the present time, since they did not know the characteristics of the manipulators and shielded windows for the hot cells which they could procure. Iran indicated in that letter that manipulators would be needed for: 4 hot cells for the production of medical radioisotopes, 2 hot cells for the production of Co-60 and Ir-192 sources, 3 hot cells for waste processing, and 10 back-up manipulators. The 21 October 2003 letter included a drawing of a building which Iran said would contain hot cells for the production of isotopes. In the meeting on 1 November 2003, upon further Agency inquiry, Iran confirmed that there were tentative plans to construct at the Arak site an additional building with hot cells for the production of radioisotopes. Iran stated that that first building was to contain hot cells for the production of "short lived" isotopes, and that it intended to construct the other building to produce "long lived" radioisotopes. Iran agreed to provide preliminary design information for the second building.

75. Agency experts will examine in detail all of the available information with a view to making a technical assessment of the explanations provided by Iran concerning the prospective use of the hot cells at Arak and the associated equipment and manipulators.

Heavy water production capacity and inventory

76. According to Iranian statements, the estimated annual need for heavy water at the IR-40 is less than 1 t. In a 19 August 2003 letter to the Agency, Iran provided additional information on the amount of heavy water initially needed for the reactor (approximately 80–90 t), and on the design capacity of

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[6] Excess reactivity is the maximum deviation from criticality attainable at any time by adjustment of the reactor's control rods.

the heavy water production plant under construction at Khondab near Arak (8 t of heavy water per year with expansion capabilities to twice its design capacity). According to the information provided in that letter, Iran plans to start the production of heavy water in 2004. In that letter, Iran stated further that laboratory scale experiments to produce heavy water had been conducted in Esfahan in the 1980s using electrolysis techniques.

77. In a meeting held on 29 October 2003, Iran confirmed that the construction of a second production line, with a production capacity of 8 t, had been started. It was further stated that the Khondab facility was actually a pilot plant, and that no laboratory or other experiments using the Girdler-Sulphide method (to be used at the Arak facility) had been carried out in the past in Iran.

LIST OF LOCATIONS RELEVANT TO THE IMPLEMENTATION OF AGENCY SAFEGUARDS

LOCATION	AS OF NOVEMBER 2003	STATUS
TEHRAN NUCLEAR RESEARCH CENTRE	Tehran Research Reactor (TRR)	Operating
	Molybdenum, Iodine and Xenon Radioisotope Production Facility (MIX Facility)	Constructed, but not operating
	*Jabr Ibn Hayan Multipurpose Laboratories (JHL)	Operating
	*Waste Handling Facility (WHF)	Operating
TEHRAN	*Kalaye Electric Company	Dismantled pilot enrichment facility
BUSHEHR	Bushehr Nuclear Power Plant (BNPP)	Under construction
ESFAHAN NUCLEAR TECHNOLOGY CENTRE	Miniature Neutron Source Reactor (MNSR)	Operating
	Light Water Sub-Critical Reactor (LWSCR)	Operating
	Heavy Water Zero Power Reactor (HWSPR)	Operating
	Fuel Fabrication Laboratory (FFL)	Operating
	Uranium Chemistry Laboratory (UCL)	Closed down
	Uranium Conversion Facility (UCF)	Under construction, first process units being commissioned for operation
	Graphite Sub-Critical Reactor (GSCR)	Decommissioned
	*Fuel Manufacturing Plant (FMP)	In detailed design stage, construction to begin in 2004
NATANZ	*Pilot Fuel Enrichment Plant (PFEP)	Operating
	*Fuel Enrichment Plant (FEP)	Under construction

KARAJ	*Radioactive Waste Storage	Under construction, but partially operating
LASHKAR AB'AD	*Pilot Uranium Laser Enrichment Plant	Dismantled
ARAK	*Iran Nuclear Research Reactor (IR-40)	In detailed design phase
	*Hot cell facility for production of radioisotopes	In preliminary design stage
	*Heavy Water Production Plant (HWPP)	Under construction Not subject to Safeguards Agreement
ANARAK	*Waste storage site	Waste to be transferred to JHL

* Locations declared in 2003

MAP OF IRAN


AZERBAIJAN
TURKEY
TURKMENISTAN
Tabriz
CASPIAN SEA
Lashkar Abad
TEHRAN
Mashhad
Karaj
Qom
IRAN
Arak
Kashan
IRAQ
Natanz
Anarak
AFGHANISTAN
Esfahan
Yazd
Ahvaz
Darkhovin
Kerman
Shiraz
KUWAIT
Bushehr
Bandar Abbas
PAKISTAN
SAUDI
ARABIA
THE GULF
BAHRAIN
OMAN
QATAR
UAE
0 km 100 200 300 400
0 miles 100 200

ABBREVIATIONS AND TERMS

AEOI	Atomic Energy Organisation of Iran
AUC	ammonium uranyl carbonate
AVLIS	atomic vapour laser isotope separation
BNPP	Bushehr Nuclear Power Plant, Bushehr
CO	carbon monoxide
CSL	Comprehensive Separation Laboratory, TNRC and Lashkar Ab'ad
CVL	copper vapour laser
DIV	design information verification
ENTC	Esfahan Nuclear Technology Centre
FEP	Fuel Enrichment Plant, Natanz
FFL	Fuel Fabrication Laboratory, ENTC
FMP	Fuel Manufacturing Plant, ENTC
GSCR	Graphite, Sub-Critical Reactor, ENTC
HEU	high enriched uranium
HWPP	Heavy Water Production Plant, Arak
HWSPR	Heavy Water Zero Power Reactor, ENTC
ICR	inventory change report
IR-40	Iran Nuclear Research Reactor, Arak
JHL	Jabr Ibn Hayan Multipurpose Laboratories, TNRC
LEU	low enriched uranium
LSL	Laser Separation Laboratory, TNRC and Lashkar Ab'ad
LWSCR	Light Water Sub-Critical Reactor, ENTC
MBR	material balance report
MIX Facility	Molybdenum, Iodine and Xenon Radioisotope Facility, TNRC
MLIS	molecular laser isotope separation
MNSR	Miniature Neutron Source Reactor, ENTC
PFEP	Pilot Fuel Enrichment Plant, Natanz
PIL	physical inventory listing

SF_6	sulphur hexafluoride
TNRC	Tehran Nuclear Research Centre
TRR	Tehran Research Reactor, Tehran
UCF	Uranium Conversion Facility, ENTC
UCL	Uranium Chemistry Laboratory, ENTC
UF_4	uranium tetrachloride
UF_6	uranium hexafluoride
UO_2	uranium dioxide
UO_3	uranium trioxide
U_3O_8	urano-uranic oxide
UOC	uranium ore concentrate
WHF	Waste Handling Facility, TNRC
WSF	Waste Storage Facility, Karaj