IAEA SAFEGUARDS IMPLEMENTATION IN UKRAINE. CURRENT STATE, PROBLEMS, PROSPECTS.

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Abstracts

For six years the Safeguards Agreement with IAEA has been implemented in Ukraine. The national SSAC is mainly created, but the process of its perfection is going on. This is bounded with developing of Nuclear Power Sector and with an extension of signed international obligations range such as the Protocol Additional. This dynamics implies respective changes of MBA, KMP structure as well as issue of new laws and subordinate legislation.

The annual volume of nuclear fuel consumption of all units in Ukraine is more than 20 tons. Ukraine ships out spent fuel from WWER reactors. Spent fuel of RBMK reactors is stored in the Chernobyl dry storage facility. The burnup credit and the changes of the initial isotope content of uranium dioxide mass inside spent fuel rods are usually determined by calculated methods. After the commissioning the first stage of new Interim Dry Spent Fuel Storage Facility spent assembly will be tested with FDET or SFAT instruments.

1. INTRODUCTION

Fuel and energy sector of Ukraine has highly developed infrastructure and powerful industry. Among its branches the nuclear power sector plays one of the most important role. It consists of the Nuclear Power Plants, Uranium Ore Mining, Dressing and Processing Companies, Zirconium and Hafnium Plants, scientific research and industry Institutes, support Companies on technical equipment fabrication and procurement.

In these circumstances an irreproachable implementation of adopted international obligations on the safeguards demands well-organized work of all executive links of the State system of accounting for and control (SSAC) of nuclear materials. Currently in Ukraine this system has been acting for some only years but the certain positive experience has already been gained.

During short period Ukraine’s Ministry of Fuel and Energy along with other authorized state bodies had been created, developed and entered into force new State Nuclear Legislation. It was extremely important because only one decade ago in the former state system the necessary legislative basis concerned the nuclear power field was almost absent. For some years a lot of state laws and sublegislative acts for regulating peaceful nuclear activity had been issued in Ukraine. They allowed implementing all signed international obligations and specifically requirements and recommendations connected with the IAEA Safeguards.

The State Department of the Nuclear Energy affiliated to Ministry of Fuel and Energy is the responsible authority for the performance of the SSAC on the executive level.

The creation of SSAC in Ukraine had some features, which also take place in its present performance and further development. The full completion of SSAC is not yet reached so far. The process of its perfection is under way. The reason for this is not only short term of implementation of the safeguards system but also by the advancement of the safeguards relationship between IAEA and Ukraine.

Some problems of practical implementations of the safeguards in Ukraine are discussed in this paper.

2. SHORT CHRONOLOGY OF THE UKRAINE SSAC CREATION.

The current state of the safeguards implementation in Ukraine perhaps more than somewhere is bounded with its antecedents. The history of the IAEA safeguards application in Ukraine doesn't exceed six years term in the aggregate. As former part of the former Soviet Union Ukraine had a nuclear weapon on its territory. The State Declaration of the non-nuclear status demanded subsequent practical actions, significant efforts and joint operations as well as took a long time. Complicated technical problems on conversion, problems of the state legislation revision and reorganization of management structure for nuclear power sector has been solved and decisions made in the relatively short term. In 1994 according to historical Trilateral Treaty signed by Presidents of USA, Russia and Ukraine all nuclear weapons were shipped out from Ukraine's territory to Russia. Since then all nuclear activities in Ukraine were directed to the exclusively peaceful goals.

The first version of the Agreement on the Safeguards application based on the document INFCIRC 66 between IAEA and Ukraine was signed in 1994. (see Table 1).

The next steps were made in 1995 by affiliation of Ukraine to the Non-Proliferation Treaty and in 1998 by signing the upgraded "Agreement Between Ukraine and the IAEA for the Application of Safeguards in Connection with the Treaty on Non-Proliferation of Nuclear Weapons (INFCIRC 550 based on the model document INFCIRC 153). The Agreement was entered into force by the ratification of the Ukraine Parliament in 1997.

Then inasmuch as the obsolete previous legislation did not meet the accepted international standards we were forced to provide and develop a new legislative basis for unhampered fulfilment of all entered engagements. This work was carried out on the different state levels, including constitutional framework.

First of all, responsibility of State for the ecology safety, overcoming the Chernobyl accident consequences was fixed under the Ukraine's Constitution. Then after adoption of the Conception of State Regulation and State Management for Nuclear Power branch two important State Laws were issued in Ukraine. There were "The Law of Ukraine on the Use of Nuclear Energy and Radiation Safety"(1995) and "The Law on Radioactive Waste management" (1995). Both of them laid the foundation of new nuclear legislation. The first became the basic and practically covered almost all aspects of the country nuclear activity. Besides in this Law allocation of responsibilities and authorities between respective state bodies was fixed as well.

In parallel with legislation development the administrative structure of nuclear power sector was also subjected to reform. The optimal organization management form was selected. But it is necessary to note that concept of optimal is been varying in time depending on different factors so organizational structure now and then changes on as well. For example, the role of operating body at the very beginning belonged to the Nuclear Power Plants directly but later it was transmitted to organized united energy generating Company.

By the next important decision was begun creation of State System of Accounting or and Control of nuclear materials in Ukraine. In the main components this work had been completing in four years.

As a result all initial physical inventory nuclear material was declared, design information was sent to IAEA and first necessary instructions and rules on accounting for and control were developed and entered for operators. All nuclear materials locations were divided into material balance areas and then the regular IAEA inspections of Ukraine facilities were started. They all are classified as ad hoc inspections until Subsidiary Arrangements and Facility Attachments enter into force in accordance to Article 39 of the Safeguards Agreement (INFCIRC 550).

3. CURRENT STATUS OF THE SAFEGUARDS IMPLEMENTATION

3.1. Organization Chart of Management and Regulation

Currently in organizational aspect the management of Ukraine Nuclear Power branch has a complicated structure. Authorities, rights and responsibilities for nuclear activities were distributed among the following official state bodies:

- Ukraine Cabinet of Ministers is the Supreme State Body. It determines and confirms the basis of the state policy in the Nuclear Power Sector.

- Ministry of Fuel and Energy is the State Management Body of electric power industry in the field of generation, distribution and use of electricity. Ministry of Fuel and Energy consists of some separate Departments, including Department on Nuclear Energy.

- State Department on Nuclear Energy is the State Management Body in the nuclear power generation and use. It is the state owner of nuclear materials and nuclear facilities. Department is responsible for the safeguards implementation at the executive level in Ukraine.

- National Nuclear Energy Generating Company (Energoatom) is official operating company. Being in the hierarchical scale under the Nuclear Energy Department Energoatom integrates all Ukraine's NPPs and is responsible for the fresh fuel buying up and supplying to the NPPs as well as for the spent fuel shipment out. Company controls practical safeguards implementation by operators.

- State Committee of Nuclear Regulation is the competent state body on control and regulation. Now it is the separate state unit that is responsible for the implementation of SSAC. There are confirmations of requirements and standards on the nuclear and radiation safety, fulfilment of legal evaluation of nuclear facilities safety and radiation sources, issue of necessary permissions and licenses in the field of its competence. As one of the units the State Committee of Nuclear Regulation there is the State Inspection that also controls the technical conditions of safeguards implementation at the facility directly.

- Facilities. The lower executive level of the safeguards system in Ukraine is basically represented with the Nuclear Power Plants and Research Institutes having research reactors. At each of them according to the director's injunction the staff of the Nuclear Safety Sections includes the special Safeguards Groups appointed to carry out all necessary routine Safeguards procedures. They compile data and report the current Safeguards situation over each Material Balance Area to responsible state bodies and IAEA. All facilities are provided with physical protection means and security guards keep round-the-clock watch.

The separate Ministry also appointed to solve problems of the shutdown Chernobyl NPP and consequences of the Chernobyl accident.

In much the same the special State Service in Ukraine is responsible for the import/export of nuclear and radioactive meterials and equipment.

3.2. Material Balance Areas

As a result all nuclear material locations in Ukraine were divided into 24 material balance areas (MBA) (see Table 2). 21 of them belong to the State Department of Nuclear Energy, one to the Science Academy, one to the Ministry of Education and Science and one relates to radiation sources and has different owners.

In particular, there are:

(a) Facilities with operated power reactors of the Nuclear Power plants

- Zaporizhya NPP. There are 6 Units with WWER-1000 reactors;

- South Ukraine NPP. There are 3 WWER-1000 Units;
- Khmelnitska NPP. There is 1 WWER-1000 Unit;
- Rivne NPP. There are 1 WWER-1000 Unit and 2 WWER-440 Units;

(b) Facilities with research reactors of the Scientific Research Institutes
- Sevastopol Institute of Nuclear Energy and Industry (SINEI). There is research IR-100 reactor;
- Kiev Nuclear Research Institute. There is research WWR-M reactor;

(c) Fresh fuel storage facilities at the NPPs;

(d) Spent fuel storage facilities;

(e) Kharkiv Physical and Technical Institute (Nuclear materials in bulk form);

(f) Other locations (Radiation Sources).

State Department of Nuclear Energy has 13 Units in operation and 2 Units are under construction. Technically two of them are based on the WWER-440 light water-cooled reactors and eleven other are on WWER-1000. Beside commercial there are also two research reactors operated by scientific research Institutes. One of them IR-100 research reactor is located in Sevastopol Nuclear Energy and Industry Institute affiliated to the Nuclear Energy State Department. The other one (WWR-M, 10 Mw) is located at Kiev Nuclear Research Institute reports to Ukraine Academy of Science.

Every change of nuclear materials inventory accounting inside each MBA is precisely fixed by operators and renewed reports is sent to the regulatory body and IAEA. In different cases operator makes up Physical Inventory Listings (PIL), Inventory Change Reports (ICR), Material Balance Report (MBR), etc. IAEA inspectors periodically verified the obtained data. At the key points IAEA applies the containment/surveillance measures (installation of video cameras and different kinds of seals, including electronic VACOSS).

3.3. Fresh Fuel Using

The majority of the inventory nuclear materials are contained inside nuclear fuel. The single supplier of the fresh nuclear fuel for the Ukraine Nuclear Power Plants is Russian "Concern TVEL". The average annual total volume of nuclear fuel consumption adds up to 20 tons. The shutdown of the Chernobyl NPP in the year 2000 subtracts from this fuel mass the nuclear fuel for RBMK reactors. But in the nearest future after the commissioning of two new WWER units at Rivne and Khmelnytskiy NPPs a fuel consumption will increase again. [2], [3].

All WWER reactors are reloaded annually. In the course of reloading one third of fuel assemblies in the reactor core is changed. Using of fresh fuel in Ukraine reactors has some characteristic [1]. Firstly, initial conditions of the project fuel operation were changed. According to the original design of the WWER-1000 reactors it was intended to operate fuel assemblies for two load fuel cycles during 7000 hours in total. Fuel assemblies consisted of 2.0–3.3 % ^{235}U-enriched fuel rods with 429.5-kg uranium mass. The burnup credit originally was limited by 38MW·day/kgU. However later the search of maximum effective ways of fuel using resulted in changing of this condition. The reactor core with fuel assemblies of 1.6%, 3.0%, (3.6+4.4)% and 4.4% ^{235}U-enriched rods used during 3 fuel cycles was substantiated and calculated. These calculations were implemented in the units of B-338 and B-320 design with 61 RCCA in the reactor core. Then the fuel of (3.6+4.4)% and 3.6%-enrichment was used in the unit B-302 with 49 control rods in the Unit 1 of South Ukraine NPP. Since 1996 assemblies with 3.6%-enrichment have been used in Units 2 and 3 at South Ukraine NPP. A rated limit of average burnup was increased up to 49 MW·day/kgU whereas a summary exposure time inside the reactor core was shortened.

Further research showed that the higher burnup might be reached by using of some part of loaded fuel assemblies for fourth operating year. In 1997 the Main Designer of the WWER-1000 nuclear fuel developed the respective substantiation and prepared the technical decision for the project conditions and operational limits change. The permitted number of fuel assemblies left in reactor core for fourth year use was determined as 36 [1].

Table 3 shows burnup distribution in the unloaded assemblies. The average value of the fuel burnup reached at Ukraine NPPs with VVER-1000 is 4-10 % higher than at the same reactor types in other countries.

The second feature was using of the nuclear fuel with improved performance attributes. The substitution of the steel for zirconium alloy-110 in guide tubes and spacer grids as well as using of the UO_2-Gd_2O_3 pellets in fuel rods (Integrated Burnable Absorber Fuel, - IFBA) instead of fuel with the Separated Burnable Absorber allowed improving of the fuel efficiency by 2.4%. Fuel Assemblies with 3.3% and (3.6+4.0)% of ^{235}U-enrichment, contained the UO_2-Gd_2O_3 pellets (5%-Gd_2O_3), have been used at Rivne and Zaporizhye NPPs.

IR-100 is the heterogeneous research reactor on thermal neutrons. It uses the Ual_3 nuclear fuel with 36% of ^{235}U-enrichment. The fresh fuel is in two kinds as the separate fuel rods, which may be put together in fuel assembly, and as fuel assembly. Each fuel assembly consists of 7 fuel rods. Uranium mass of fuel rod is 26,0 g and mass of ^{235}U is 9,5 g. About 45-57 fuel assemblies can be loaded in the reactor core depending on the required reactivity margin at the experiment. The distilled water is used as coolant and moderator in the IR-100.

In addition to IR-100 reactor at the SINEI the nuclear fuel also used by the research subcritical installation where nuclear fuel rods with UO_2 pellets of 10% ^{235}U-enrichment are applied. Uranium mass in such kind of fuel rod is 81,18 g with 8,1 g of ^{235}U-enrichment mass. Both the IR-100 research reactor as well as the subcritical installation is not used at present.

3.4. Spent fuel accounting and calculations

Spent fuel management in Ukraine develops according to the Nuclear Energy Program. Not having the industrial plant capacities to reprocess the spent fuel Ukraine is forced to ship out the significant amount of spent assemblies to the Russian Federation. In addition, taking into account the stable tendency to shortening of unoccupied capacity in at-reactor storage pools by the Nuclear Energy Program in Ukraine it's planned to build away-from-reactor interim spent fuel storage facilities for storage of spent fuel for a period of more than 50 years [3].

At present spent fuel after unloading from reactor is put into at-reactor cooling pool for three years at least. After exposure in the pool VVER-440 spent fuel is shipped out to the RT-1 reprocessing plant ("Mayak").

VVER-1000 spent fuel is transported to the RT-2 plant (Krasnoyarsk-26) for long-term technological storage in the cooling pools. [2], [3].

Spent Fuel Assemblies of RBMK reactors were placed into the wet away-from-reactor storage facility located near the Chernobyl NPP area. PBMK spent fuel is not planned to reprocess in principal. Too low chemical content of fissile nuclides such as ^{235}U (0.4%) and ^{239}Pu+^{241}Pu (0.25%) in RBMK spent fuel assemblies made its reprocessing economically unjustified. (see Table 4).

The calculations on optimal fuel using in the reactor core and determination of burnup credit and isotopic content in spent fuel assemblies after reloading operations are made with neutron-physical codes. The initial data for standard Russian codes (BIPR-7, ALBOM, etc.) usually are attached to nuclear fuel batches delivered by the supplier.

At present some of scientific and technical centres on engineering support for Nuclear Power development program in Ukraine are developing the design additional calculation techniques to be able to provide evaluation for changed core pattern (non-standard) or for case of new type of nuclear fuel using in the rector core. Besides, centres develop the measurement techniques and instrumental base for spent fuel testing and verifications. However all these works need to be further continued and certified.

In the framework of international program of nuclear safety INSP some codes of neutron-physical calculations such as WIMS, NESTLE, RELAP5-3D and access to them were obtained by some centres. It enables them to make up the comparative analysis of different codes and to train the personnel.

At the turn of August 2001 the Interim Spent Fuel Storage Facility (ISFSF) at Zaporizhya NPP had been commissioned. This project is implemented with the assistance of Duke Engineering & Services Company to perform the design of the storage containers for the WWER-1000 spent fuel and to guide the design of the ISFSF.

Putting into operation of the first stage of the ISFSF enables to curtail the quantity of out-bound spent fuel. The first three casks were been loaded in August-September with 66 WWER-1000 Spent Fuel Assemblies.

So, when the nuclear materials contained in the WWER spent fuel were completely shipped out of Ukraine, the calculated results of burnup credit and isotopic content were entirely acceptable for the Agency (excepting cases with opaque water for Cherenkov indicators in pools where inspectors propose to apply SFAT instruments). After the commissioning of the ISFSF at Zaporizhya NPP and before initial loading of the first containers IAEA made the decision on verification of spent assemblies by testing with Fork Detector instruments. [6], [7]. In consideration that Ukraine has not own reliability instrumental basis for non-destructive analysis for control of spent fuel we also expected to obtain good independent method for testing of spent fuel assemblies. We also expected to present results of that testing in this paper.

Really, the measurements had been done and shown good results and coincidence with calculations especially for spent assemblies with two or three years of cooling time. However because of two months delay of ISFSF putting into operation and design constraints of Fork Detector for WWER Assemblies testing the measurement data organisation, unfortunately, not ready now so cannot be shown here. But IAEA inspectors, which made measurement, have all results.

3.5. Physical Protection

Speaking about continued development process of legislative basis in Ukraine it should noted that at the beginning of this year very important law “The Law on Physical Protection of Nuclear Material and Facilities” was issued. It essentially supplemented the National Nuclear Legislation having determined the main goals of the physical protection as ensuring security of national interests and supporting of international non-proliferation regime. This law is great significance for security and control for nuclear and radioactive materials as well as for the prevention of them illicit trafficking and for struggle against potential terrorism.

In addition some documents of subordinate legislation currently are regulated such questions as nuclear and radioactive materials transportation including interstate conditions of transit convey and guarding.

Certainly, the reliability and effectiveness of physical protection depends not only of instructions. So supporting the necessary level of security demands the corresponding funding for required techniques. But financial problem is one of the most vital difficulties in Ukraine and it is not always solved sufficiently.

3.6. Current problems

In spite of the fact that the SSAC in Ukraine is mainly created some kind of difficulties still occur at the facilities. As faults and its causes are eliminated experience increases and difficulties weaken.

The first cause of the problems was bounded, as stated above, with incompleteness of instructions and standards, which met the demands of the safeguards. Therefore we have been constantly developing the regulatory basis, correcting currently acts and filling up the gaps. Last year we entered into force "Rules on Carrying on the Account and Control of Nuclear Materials", "The Instruction on Safeguards Implementations at the Facility for Operator".

The forthcoming of the new nuclear material location (ISFSF at Zaporizha NPP) is a new Material Balance Area so respective changes in the MBA structure chart are being made currently. Also there are new necessary regulatory documents “Rules on Nuclear and Radiation Safety of the Spent Fuel Management in the Interim Storage Facilities” being developed now by the Regulatory and Management State bodies. This document provides also for every necessary procedure on the safeguards implementation, i.e., an order of accounting, verification, etc.

In August 1998 the Agency entered into force the Subsidiary Arrangements for Ukraine. This document is entered into force the Article 39 of the Agreement. Before this event all IAEA inspections to Ukraine are classifying as ad hoc. So during two last years all Ukraine’s facilities together with the state authorities have been preparing the Facility Attachments for every Material Balance Area. Now this work is approached to completion.

The second cause of SSAC difficulties in Ukraine is bad computer software providing for nuclear material accounting and data processing that the personnel of the Safeguards Groups has. Actually different facilities use different computer software, including the obsolete. Until recently some operators have been supplied by Swedish software “FSS” based on the old Microsoft-DOS code. Now current situation is improving. For two years the old software has been improving by code designer. Beside that the American Argonne National Laboratory grants to aid Ukraine facilities designing the new software “AIMAS” (Automated Inventory Material Accounting System) [5]. AIMAS is a Microsoft Access application that runs under Microsoft Windows 95 or higher versions. Its characteristics include basic physical inventory accounting (item level), transaction logging, basic reporting, support for Material Balance Areas and Key Measurement Points distributed over multiple PCs, multiple item (group) transfers within and between MBA and KMPs, multilevel security, etc. This important work needs to be accomplished but after testing, running and licensing it would be applied in practice.

All current problems and needs as well as reached progress concerning practical safeguards implementation in Ukraine according to verbal understanding between IAEA and Ukraine State bodies are discussed bi-annually in the Safeguards Implementation Work Meetings. There two standing Work Groups were appointed bilaterally [4] for effective solving problems. The Meetings really help to advance a lot of them, so the last held in Vienna in September 2001 included the following questions:

- Changes in the structure of nuclear material locations (organizing of new MBA);
- Design information about new Units in Ukraine;
- Development of the present requirements and standard base for Ukraine SSAC;
- Improving communication between Ukraine facilities, authorities and IAEA (digital instead of satellite), including remote monitoring;
- Improving PC software for SSAC;

- Exchange of the Surveillance Systems, including video-cabling, at facilities for SSAC;
- Coordination of IAEA Inspectors' Test Instrument using and access problems;
- Protocol Additional. Current status.

4. PLANS AND FUTURE PROSPECT

The future of the IAEA safeguards implementations in Ukraine is associated with two directions. First of all it is development of the state nuclear power sector. Within the next few years two new WWER-1000 Units should be completed at Rivne and Khmelnytskiy NPPs. Construction of two units more is included into the Program of the Nuclear Power Sector Development. Program also includes the commissioning of the second Interim Dry Spent Fuel Facility at Chernobyl area and within decade prospective construction starting at the similar facilities for other NPPs. These efforts will correct the present chart of Material Balance Areas, Key Measurement Points, interaction algorithm, accountancy extent, etc.

The current subordinate legislation will be developed as well. It caused, first of all, by entering into force of the Subsidiary Arrangements for Ukraine. So, in the nearest plans on the safeguards implementations is the issue of the Facility Attachments.

The second direction of the further development of the safeguards implementation in Ukraine is connected with extension of the range of signed international obligations.

The Protocol Additional to the Safeguards Agreement (based on document INFCIRC 540) between IAEA and Ukraine was signed in August 2000. The preparation to its ratification is going on now. A lot of State Bodies and interested parties are involved in this activity.

As it was written at the very beginning of my paper, the current status of the Ukraine nuclear power sector is closely connected with its past situation. So, for the last few years Ukraine had been carrying on the preparation to undertaking the Protocol Additional and now the current legislation is being revised according to this document. Protocol Additional covers the uranium, zirconium and hafnium industry, scientific research investigations concerning nuclear fuel cycle topics. Every above sector during short terms should be create and develop the respective intra-branch regulatory and standard basis and perhaps to solve some problems of financial expenditure. Now in conditions of the hard economic situation in Ukraine it is a significant problem. But we expect to solve it.

5. CONCLUSION

The Safeguards Agreement between IAEA and Ukraine has been acting for only six years but significant positive experience has been gained. The Ukraine's SSAC is mainly created but a process of its perfection is going on. The Ukraine's legislation and sublegislative basis for the safeguards implementation are developed constantly according to Ukraine's international obligations. Precise accounting, stringent control for nuclear materials and well-organized physical protection of facilities are the most reliable prevention measure against illicit trafficking and terrorism.

The burnup credit and isotopic content of a spent fuel are determined by the standard calculated codes. But currently the SFAT and Fork Detector instruments are started to apply especially for testing of spent fuel assemblies before loading in Interim Spent Fuel Storage Facility, which was put in operation in august 2001. The first testing gave a good results and coincidence with calculations especially for assemblies with two or three years of cooling time. Unfortunately these data cannot be shown in this paper. IAEA inspectors, which made measurements, have all results.

The commissioning of new facilities in Ukraine will change the present structure of the MBA, KMPs, interaction algorithm, accountancy extent, etc. All current problems are discussed bi-annually in the Safeguards Implementation Work Meetings with participation of standing Work Groups of the IAEA and Ukraine authorities. Such kind of cooperation helps to solve a lot of current problems.

The Protocol Additional to the Safeguards Agreement between IAEA and Ukraine is signed and competent State Bodies with all interested parties prepare its ratification. After this event the great work will be necessary done to further implementation of the strength safeguards.

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TABLE 1. CHRONOLOGY OF ENACTMENTS

1994 Signed	Agreement Between Ukraine and the IAEA for the Application of Safeguards to All Nuclear Materials in All Peaceful Nuclear Activities of Ukraine. (Based on INFCIRC/66).
1995 Entered in force	As a document INFCIRC/462
1995 Signed	The Treaty on the Non-Proliferation of Nuclear Weapons.
1995 Signed	Agreement Between Ukraine and the IAEA for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons. (Based on INFCIRC/153).
1997 Ratified	By the State Low of Ukraine
1998 Entered in force	As a document INFCIRC/550
1998 Entered in force	Subsidiary arrangements (General Part) under the NPT Safeguard Agreement (INFCIRC/550)
2000 Signed	Protocol Additional to the Agreement Between Ukraine and the IAEA for the Application of Safeguards. (Based on INFCIRC/540).

TABLE 2. UKRAINE. MATERIAL BALANCE AREAS.

MBA	FACILITY	Category
RKCS	Chernobyl Storage Facility.	Storage
RKC1	Chernobyl NPP	Power Reactor
RKH0	Fresh Fuel Storage Facility at the Khmelnitsky NPP	Storage
RKH1	Khmelnitsky NPP. Unit 1	Power Reactor
RKH2	Khmelnitsky NPP. Unit 2	Power Reactor
RKK-	Research Reactor WR-M	Research Reactor
RKQ-	Other Locations	Storage off the Facility
RKR0	Fresh Fuel Storage Fasility at the Rivno NPP	Storage
RKR1	Rivno NPP. Unit 1 and 2	Power Reactor
RKR3	Rivno NPP. Unit 3	Power Reactor
RKR4	Rivno NPP. Unit 4	Power Reactor
RKS-	Sevastopol Nuclear Energy & Industry Institute.	Research Reactor
RKU0	Fresh Fuel Storage Facility at the South Ukraine NPP	Storage
RKU1	South Ukraine NPP. Unit 1	Power Reactor
RKU2	South Ukraine NPP. Unit 2	Power Reactor
RKU3	South Ukraine NPP. Unit 3	Power Reactor
RKX-	Kharkov Physical and Technical Institute	Other Locations
RKZ0	Fresh Fuel Storage fasility at the Zaporizhia NPP	Storage
RKZ1	Zaporizhia NPP. Unit 1	Power Reactor
RKZ2	Zaporizhia NPP. Unit 2	Power Reactor
RKZ3	Zaporizhia NPP. Unit 3	Power Reactor
RKZ4	Zaporizhia NPP. Unit 4	Power Reactor
RKZ5	Zaporizhia NPP. Unit 5	Power Reactor
RKZ6	Zaporizhia NPP. Unit 6	Power Reactor

In the nearest some additions of MBA structure will be done.

TABLE 3.

Burnup Distribution of Discharged Ukrainian WWER-1000 FAs (3.6+4.4)%, (3.6+4)%, 4.4% enrichment during time of operation (1988-2000). Number of Fuel cycles was 98, number of FAs was 3202. 1261 of them were used in four Fuel cycles.

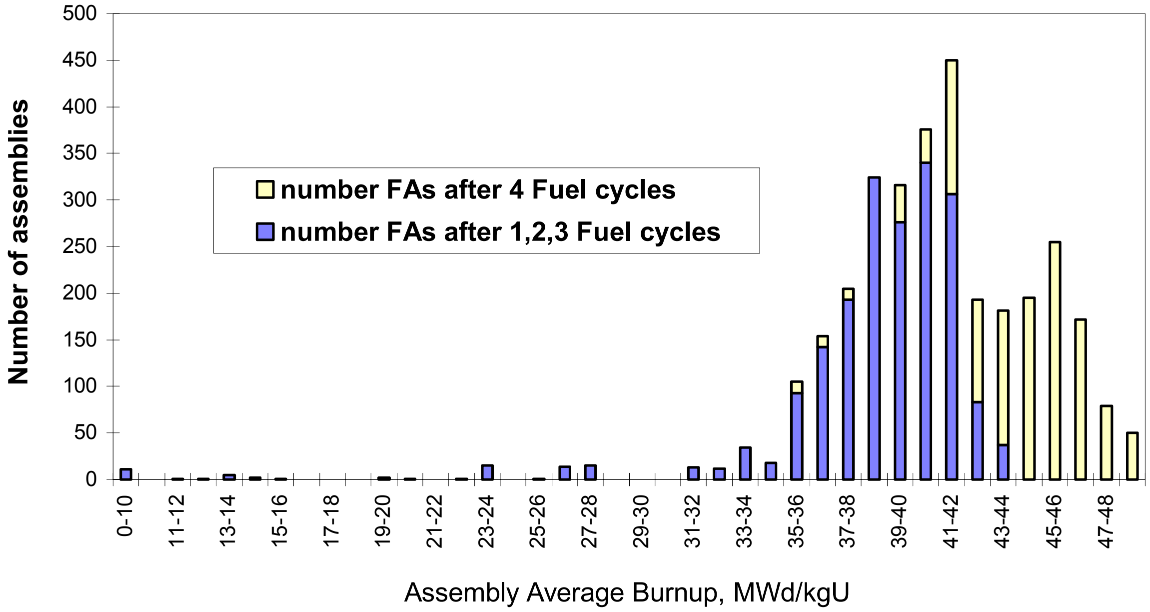

TABLE 4. GENERAL DATA ON BALANCE SPENT FUEL OF UKRAINIAN NPP (as of 2001-04-01)

Spent Fuel	VVER-1000, number SFA/tU	VVER-440, number SFA/tU	RBMK, number SFA/tU	Total tU
Spent fuel generation during the whole period of operation of NPP SFA/(tU)	**6765/2800**	**3848/461.8**	**18899/2173.4**	**5354.68**
Shipped out to reprocessing Plant: - during the whole period of NPP operation	**3635/1461.3**	**2903/348.4**	**-**	**1809,6**
Are in spent fuel pools	**3130/1258.3**	**945/114.4**	**18899/2173.4**	**3546.0**

In August-September there 66 WWER-1000 SFA were shipped out from Zaporizha NPP to the new Interim Spent Fuel Dry Storage Facility