FINAL REPORT
" THE FIRST STAGE OF BFS INTEGRATED SYSTEM FOR NUCLEAR MATERIALS CONTROL AND ACCOUNTING."

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TASK 1. COMPUTERIZED NUCLEAR MATERIAL ACCOUNTING METHODS.

INTRODUCTION

The BFS computerized accounting system is a network-based one. It runs in a client/server mode. The equipment used in the system includes a computer network consisting of:

a. 1 Server computer system, including peripheral hardware. The server is located near the control room of the BFS-2 facility outside of the "stone sack" to ensure access during operation of the critical assemblies.

b. 3 Client computer systems, two of them being located near the assembly tables of the BFS-1 and BFS-2 facilities while the third one being the Fissile Material Storage.

SCOPE

Each fissile material disk as well as each canister and each critical assembly tube is serialized and their serial numbers are used for the identification of these items. It is planned that in future bar-codes will be applied to all disks, canisters and critical assembly tubes. However, by the time of the August demonstration, the bar-code technology for fissile material disks was not available at the BFS. The bar-codes were only applied to tubes, canisters and tamper-indicating devices. To read these bar-codes each client computer of the accounting system is provided with a bar-code reader.

The database of material type and location resides on the server, while the user interface runs on the client. The user interface accesses the server via a network. The computerized accounting system core consists of those functions which provide necessary information requested by the user and which

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manipulate the database to record information about material transactions inside of the BFS Material Balance Area. By the time of the August demonstration an information on two nuclear material types was entered into the data base. The first of these materials is weapon-grade plutonium metal and the second one is 36% enriched uranium dioxide. The total number of the weapon-grade plutonium disks is 12690 and the total number of the uranium dioxide disks is 1700.

Functional requirements for the computerized system are determined by basic objectives of nuclear material accounting:

- providing accurate information on the identity and location of all nuclear material items in the BFS material balance area;
- providing accurate information on location and identity of tamper-indicating devices (TIDs);
- tracking nuclear material inventories;
- issuing periodical reports;
- assisting with the detection of material gains or losses;
- providing a history of nuclear material transactions;
- preventing an unauthorized access to the system and data falsification.

Accordingly, the following software modules are included in the core of the computerized accounting system:

- search a location and passport parameters for any single fissile material item selected for the demonstration in the BFS, including a search of an item with some particular serial number or an item from a random sample;
- tracking an actual movement of fissile material items during all operating procedures including transactions of nuclear materials from/to the storage and to/from the BFS facilities as well as loading and unloading of fuel rods;
- determination of an amount of fissile material in any BFS tube or storage canister, or total amount of fissile material in each of the three key monitoring points in the BFS Material Balance Area;
- search a location and identification of tamper-indicating devices;
- computer generation of a random set of nuclear material items to be taken for inventory verification with indication of location and passport parameters of each item in the sample;
- based on the hypergeometric distribution, computation of a minimum sample size when input parameters are population size, total number of defects in the population (defect rate), maximum allowable number of defects in a sample and confidence level for detecting the given defect rate;
- based on the hypergeometric distribution, computation of point estimates and interval estimates for the total number of defects in the population when input parameters are population size, sample size, number of defects in the sample and confidence interval for the number of defects in the population;

- computation of inventory difference on the basis of measurement results obtained for a random sample of fissile material items and estimation of standard errors of inventory difference on the basis of measurement error variances.

In addition to the working network, the training network was installed in the BFS building. It consists of a server and two clients and is used for development and testing accounting system software in a network environment. One more computer is used for development of software and database and it works in a stand alone mode.

RECOMMENDATIONS

It is recommended that future development of the BFS computerized accounting system should include:

- increase of the data base for the BFS nuclear materials in order to include all the materials available for experiments;
- development of software for tracking sealed containers (canisters and fuel rods) with nuclear materials in addition to tracking individual items;
- establishment of operational and maintenance procedures for the system.

CONCLUSIONS

IPPE, in conjunction with Los Alamos, have reviewed available methods and concepts that be deployed in the near term. This is the BFS Computerized accounting system.LANL have provided information about ... accounting methods. LANL have organized two seminars on

- computation of inventory difference on the basis of measurement results obtained for a random sample of fissile material items and estimation of standard errors of inventory difference on the basis of measurement error variances.

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IPPE, in conjunction with Los Alamos, have selected a range of methods for evaluating and testing.

IPPE, in conjuction with LANL, have developed the test and evaluation plan. In final report on this task there are main optained results of working this System.

IPPE have assembled the necessary equipment, software and some other components available in Russia. LANL have provided equipment, software and some other components to support the evaluation and testing.

System was tested and showed in integrated M&A demonstration exercise.

According to the contract with BNL this System is used for the physical inventory of nuclear material items.

TASK 2. PORTAL MONITORING SYSTEM.

SUMMARY

SNM monitoring system (Portal monitoring system) is the main protection of SNM which are used and stored at the BFS building. This article contains the description of the final real construction of two cabins, the description of the construction of a SNM monitor, some information about experiments, which were made according to the Test and evaluation plan of Task 2, some conclusions about the whole system and the discussion of the some difficulties, which were met, when the system works.

1. DESCRIPTION OF THE FINAL CONSTRUCTION OF SNM MONITORING SYSTEM.

SNM monitoring system (SNMMS) is used to control passages in/from the sensitive ("dirty") zone and to protect SNM in this zone. This system (without SNM monitor) was designed and built by the "TEKHNOCOM" firm and a SNM monitor was designed at the IPPE. The person-trap system (PTS) satisfies the following requirements :

1) the entrance/the exit in/from the cabin-trap is implemented by means of the personal code card;

2) one person may stay in the cabin only;

3) the following executions are implemented in the cabin - the measurement of person weight by means of weight gear, person identification by means of HandKey and radiate monitoring system;

4) the measurements by means of metal detector are made when the person is going out from the sensitive zone;

5) only one door of each cabin may be open simultaneously.

The PTS doors have electrical locks, sensors of close or open state of each door, the equipment for reading code card. Electrical locks have the alarm system for mechanical opening the doors. Each cabin is equipped by the metal detector, the weight gear in the floor of the cabin, radiate monitoring system, HandKey. The doors and the walls of the cabins are made from triple-glass. There is the video system. All systems, sensors and detectors of the cabin are connected with the IBM PC AT/486. There is good service for operator . There are the protocols in the computer memory for all events in the PTS.

Some words about the procedure of the passage throughout the cabin. A person must use the personal card on a block reading if he goes to the sensitive zone. The electrical lock is opened if in this moment in the cabin there is no another person and this person has the admission in the sensitive zone. A person goes in to the cabin. He must close the entrance door. Alarm situation will be take place if he don't close it. In cabin a person must make the test on the HandKey. In this moment the PTS makes the automatic determination of the weight of the person and all information is transferred to the computer. The exit door is opened if all three parameters are coincided (code of card, code of the HandKey and weight). After this a person goes out from the cabin. In this moment he must close the exit door. The alarm situation takes place, if a person doesn't close the door. In the case a person goes out from the sensitive zone , he must also go though the cabin in the same manner. In this case there is the metal control by means of the metal detector.

This system (SNMMS) controls also the entrances in the BFS-1, the BFS-2, the elevator and the storage of SNM by means of the same code cards.

2. TEST AND EVALUATION OF THE WHOLE SYSTEM.

2.1 SNM monitoring system

2.1.1 Determination of the time intervals for counting background.

For the optimization these parameters we made some measurements of the background in the area of the placement of the SNMMS . These measurements were made using the radioactive monitor. Measurements were made for the following situations: a) the BFS-1 isn't in the operation; b) the BFS-1 is in the operation with the power level 100 VA. We used two gamma ray energetic intervals: 50-3000 keV and 50-500 keV. These measurements show that the first scheme of counting background (at the first the background is acquired for 16s, after that the unit continuously takes the counts for 5s and adds the latest counts for 4s to calculate the most recent background count) is suitable. The energetic interval 50-500 keV is better than the whole one.

2.1.2 Procedure for Nuisance Alarm testing.

At present the SNM monitor has two modes - continuous mode and mode with external setting in the operation. At the first we implemented some experiments for the case the monitor was in continuous mode. We watched the running of the monitor, when it was in this mode, and fixed in the protocol the nuisance alarm, when it took place. The probability of nuisance alarm (PNA) per passage was calculated after each experimental series . In first series we had 15 nuisance alarms and PNA was equal 1/420. Sigma value was equal 3, the energetic scale - 50-3000 keV. After this we changed the energetic scale to 50-500 keV and Sigma value - to 5. In second series we had 20 nuisance alarms and PNA was equal 1/800. This number of the measurements is not enough for good statistic (it is need about 100 nuisance alarms). We shall complete these measurements in the process of working SNMMS. We also measured PNA for the case the monitor is operated with external setting. We turned the SNM monitor in the fastcount mode and the monitor was in the operation during 300 sec. In this experimental series the energetic scale was equal 50-500 keV and sigma value - 5. We had 25 nuisance alarms and PNA was equal 1/1050. We are going to have the good statistics in process of working SNMMS. At the first stage we guess that the values of PNA are enough for the running of the whole system.

2.1.3. Procedure for sensitivity testing.

According to the Test and Evaluation Plan of Task 2, at the first we determinated the least sensitive regions of the SNM monitor. These experiments were made step by step. The first - the determination of the least sensitive regions on the height and the width of the cabin (person-trap). The second - the determination of the least sensitive regions on the height and the depth of the cabin. Some words about the first series of the measurements. The cabin has the following geometrical sizes: the height is equal 2160 mm, the width - 1100mm and the depth - 930mm. We made the model of the cabin, which was used in these experiments. We divided all plane of the cabin (on the height and the depth) to the squares 100*100mm by means of the cord. The detectors were installed in this plane according to the select scheme. After this the U-90% test source is moved the cell by the cell and the counts of the monitor are written to the protocol. The measurements were implemented for the both modes of the SNM monitor. Using these measurements we determined the optimal arrangement of the detectors in the height-width plane. After this the second part of the experiments was implemented. We determined the depth of arrangement of the detectors. The procedure was following: we divided the depth of the cabin to the 50mm intervals and done the measurements in the each cell using the U-90% test source. After this series of the experiments we determined the optimal position of the plane of the SNM detectors. It is equal 400mm from the plane of the exit door of the cabin.

After the installation of the SNM detectors in the cabin we repeated these experiments and implemented the experiments with the test source (the U-90% disk) located in the different places of the person body: 1) between the foot and the shoe; 2)between the legs; 3) between the hand and the body. We had 30 passages for the each case in order to check the sensitivity of the SNM monitor. The test-person was in the cabin about 5 seconds. The smallest sensitivity was for the case when the test source was located between the legs. The experiments were implemented for two modes of the monitor. According to the common requirements the detection probability would be 0.5 or more with the 95% confidence interval. In our case in the each series (with 30 passages) the number of the detections must be more than 20. For the second case (the source was located between the legs) the average value of the detection for 10 series was equal 25 (for the case when the monitor was worked in the continuous mode). For the second mode the monitor was started by the electrical lock of the door. The detection probability was equal 22/30 for the second case. For this reason, now the SNM monitor is operated in the continuous mode. It's not good the situation, because in this mode the value of PNA is not good enough. We guess that we can rise the detection probability of the SNM monitor for the mode with the external start. For this we will use the ID sensors. The background count in the monitor memory will not rise, when the person stays near the cabin with the source.

We guess the SNM monitor satisfies to the requirements of the detection probability at present, but we are going to improve its properties in the near future.

2.2 Metal detector.

We did not implement the Test and evaluation procedure in the whole volume, because this detector was designed by "ELERON" and has the certificate. The "TEKHNOCOM" used this detector in SNMMS. We installed only the Alarm threshold in this detector. It is equal 150g metal.

RECOMMENDATIONS

It will be very useful to install IR detectors in portal monitor (two IR detectors in each cabin). In some weeks later we shall install in our portal 4 scintillators (2 in each cabin) which were supplied by the LANL. Also , in future, we shall plan to make like works with door #3 (fire exit) and with transport door. Now, these doors are stamped by means of special stamps and may be open only with guard man.

CONCLUSIONS.

IPPE, conjunction with Los Alamos have reviewed the requirements to the Portal monitoring System to protect SNM at the BFS building.

IPPE with "TECHNOCOM" have designed this System, which satisfies to the requirements on protection of SNM.

IPPE with "TECHNOCOM" have installed this System and tested it. The results of evaluation and test procedures shows, that the Portal Monitoring System satisfies to the requirements on protection of SNM.

Now , the Portal Monitoring System works at the BFS building and designers of this System work to raise the sensitivity of radiate part of the System.

TASK 3 TEST AND EVALUATION OF ITEM CONTROL TECHNOLOGY.

INTRODUCTION

The purpose of this task was to test and evaluate methods for tracking and monitoring the movement of nuclear material items within a nuclear facility and assuring the integrity of the items. According to the subcontract this work was carried out with plutonium and highly enriched uranium. The scope of technical areas includes: the BFS item contol identification, using of the bar code technologies, some activities which are connected with providing nuclear items control and safeguards, automatic physical inventory methods.

SCOPE

The following works were carried out at the BFS building:

1. Methods and concepts of Item Control Technology having in LANL and SNL were examined, review report on the problem was prepared.

2.The BFS plutonium and highly enriched uranium disks in the form of metal and dioxide are nuclear materials accounting items. Total number of such items at the BFS facility is approximately equal to 70.000.

2.1. The BFS item control identification is carried out taking into account following indications:
-mark made on a disk stainless steel cladding;
-individual manufacturer's number made on disk cladding (and disk core);
-reaction of IDEM device identifying nuclear materials type;
-passport weight characteristics (in the KMP's in nuclear materials vault and BFS-1 and BFS-2 facilities electronic balance of PM-600 type are installed, delivered from LANL and user for disks weighing in the case of PIT);
-isotopic composition measurements by U-Pu Inspector (delivered from LANL) and nuclear material NDA mass measurements by Coincidence Counter (delivered from LANL).

2.2.After studying and testing of different methods and technologies of putting marks on nuclear material item dummies (satisfying the requirements of their using in the BFS cores), it was decided, together ith USA Oak Ridge national Laboratory specialist, that such marks will be placed on item cladding axial surface. As marks with information on nuclear material type and manufacturer number, bar codes used after preliminary putting thin layer of aluminum oxide on a mark place. The job of placing bar codes on test batch of 50 items according to the chosen technology is planned to be done by the end of 1995. Further, under condition of getting of positive results it is assumed to build, together with ORNL specialists, automatic line for bar codes placing on all material items.

2.3. To provide nuclear items control and safeguards:
-paper and vinyl seals are used to seal doors, hatches providing access to "stone sack", i.e. to zones of nuclear material storage, transportation and workmanship with, and also to seal transport containers and temporary storage of canisters with nuclear material items in the BFS-1 and BFS-2 facilities rooms;

-by contract with SNL the design of plug-seals was elaborated to seal BFS core tubes and canister with nuclear material disks; tests of small batch were carried out, design was elaborated and test batch of special tools was manufactured for seals of paper (or A-foil) installation on plug-seal, and plungers were manufactured to load plug-seals into core tubes and canisters of chosen depth allowing to carry out opperations on their relocation without seals damage; batch of 230 plug-seal was manufactured with which plutonium BFS-1 core (200 tubes) and canisters with plutonium and "thin" uranium dioxide disks in the nuclear materials vault (30 canisters) were sealed;

-4 TV cameras were installed in one room of the nuclear material vault and 2 more cameras were installed in the BFS-1 facility hall; cabling was made (including fiber optic) from TV cameras to the digital data storage and processing computer; TV system test was carried out on the subject of one canister removal from a row of canister in the nuclear material vault and one BFS-1 core fuel tube removal, which showed the ability of the TV system to detect such events. Task for future is to put under TV system control of 2 more nuclear material vault rooms and the BFS-2 facility hall. Besides, the task is put into agenda to investigate the possibility of using such TV system for recording plug-seals tampering with which are used for core tubes sealing.

2.4. At the BFS facility computerized access control system was put into test run to control personnel access into zones of nuclear material storage, transportation and workmanship with, and also computerized system of TV control of entrance doors into the BFS-1 and BFS-2 facility halls, nuclear material storage and into two cabin traps giving access to the "stone sack".

2.5. For weighing process automation using electronic balance PM-600 and upgrading of weight measurements accuracy, the regime of the balance connection to computers-clirnts in the three KMP's was introduced.

2.6. Preliminary agreement with SNL exits on carrying out of the BFS facility of fiber optics "blanket" test run with the aim of detection of any attempts of canisters or core tubes removal after putting the "blanket" into permanent regime of nuclear material safeguards.

2.7. Number of manufactured by contract AP-9474 with SNL plug-seals (230 seals) is evidently too small to seal all core fuel tubes of the BFS-1 and BFS-2 cores and canisters with nuclear material disks in the storage. We need to have about 3000 such plug-seals, and it calls for an additional contract for their manufacturing.

TASK 4. TEST AND EVALUATION OF RADIATION BASED NUCLEAR MATERIAL MEASUREMENT EQUIPMENT

INTRODUCTION

The physical measurements are the main source of the information for the confirmation of material type and analysis of inventory difference. The test and evaluation plan (TEP) was developed for testing and evaluation of radiation based measurement methods and equipment that could be used to measure isotopics of nuclear material and fissile mass of BFS pellets. This TEP is the part of Measurement Control Program (3.3 Deliverable on Task 2 of the BNL), which determines and describes the technical and administrative elements that are considered to be important in the measurements for special nuclear material accounting. The purpose of Measurement Control Program is to ensure that the measurements of inventory BFS pellets are valid. The TEP included the following radiation based measurement methods and equipment :

- *IFIM - the rapid identification of the kind (strata) of BFS pellets;*
- *modified AWCC for the measurement of Pu and U mass of BFS pellets;*
- *MGAU, MGA and FRAM codes using high resolution Ge detector for measurements of uranium enrichment and plutonium isotopics.*

This report contents the description of measurement principle, standards and calibrations, statistical control, test and evaluation results, and recommendations for selected measurement technique.

SCOPE

The TEP was limited to the realistic simulation of integrated system, software and procedures for nuclear Materials Control and Accounting (MC&A), which was carried out on the BFS facilities in August 1995. During this demonstration two nuclear materials were used. The first of these materials was weapon-grade plutonium metal and the second one was 36% enriched uranium oxide. These materials are kept in small stainless steel containers, and each container with the nuclear material has its serial number so being considered as a separate item.

The BFS personnel have received and assembled the following equipment from the USA:

- modified AWCC for the measurement of Pu and U mass of BFS pellets by the beginning of July. (At present PIT we only use passive mode for Pu measurements because the IPPE has not import licence for AmLi sources. This problem will be solved in the nearly future and we hope to use active mode by next PIT);

- U-PU inspector (with MGAU and MGA codes) and FRAM equipment for the measurement of uranium enrichment and plutonium isotopics by the middle of September. (At present PIT we use MGAU and MGA codes).

Special attention was focused on rapid identification (confirmation) of the kind of nuclear materials (BFS pellets) using new Identification Fissile Material device (IFIM) developed at the IPPE. Two IFIM devices were assembled and special metrological testing of the equipment was implemented.

All three techniques were used for testing and evaluating. The following items are included for each measurement technique:

MEASUREMENT PRINCIPLE;
STANDARDS and CALIBRATIONS;
STATISTICAL CONTROL;
RESULTS;
RECOMMENDATIONS.

1. RAPID IDENTIFICATION OF THE KIND OF BFS PELLETS

1.1. MEASUREMENT PRINCIPLE

The IFIM device consists of detection block (NaI crystal) and logic block. The spectrum registered by NaI detector is divided on seven energy intervals. The counts in each energy interval are normalized on total number of counts in all energy intervals and then are compared with standard value in the memory of the device. This information is processed by the logic chip and the result is given on the monitor. This method is very suitable for rapid verification of the large number of pellets for short time (less than 12 sec). The description of the IFIM was given in "A gamma-ray rapid identification system of nuclear material" (Interim letter report for 3.2. Deliverable on this Task) in detail.

1.2. STANDARDS and CALIBRATIONS

The IFIM device demands no special standards for calibration. The width of the energy groups used (ROI) is constant and wide, that is why it is enough to check the amplitude of the output signal from the amplifier (check the gain coefficient) using the oscillograph and any radioactive source. In the case of Cs-137 source, the signal amplitude must be equal to 662 mV. Such calibration should be performed one time before starting measurements.

1.3. STATISTICAL CONTROL and RESULTS

Before and during the PIT measurements the IFIM logic function was checked using working standards of plutonium and 36% uranium oxide. Every day before measurements the IFIM energy scale calibration was made in according with Procedure 1.2. Working standards measurements shown full correspondence of measurements results to declared fissile material stratum.

1.4. RECOMMENDATIONS

It would be useful to connect IFIM, Bar Code Reader and Scales Balance using additional PC ports to collect all data simultaneously.

2. THE MEASUREMENT OF PU DISKS MASS USING MODIFIED AWCC

2.1. MEASUREMENT PRINCIPLE

The neutron coincidence counting measurement of Pu quantities (equivalent to ^{240}Pu by emitting rate of fission neutrons) uses passive neutron technique. This technique is based on the registration of coincident neutrons that are naturally emitted by materials which contain spontaneously fissile isotopes. In general, neutrons to be detected are slowed by polyethylene and then captured and counted by ^{3}He tubes embedded in the polyethylene. The electronic impulses, produced by neutrons captured in the ^{3}He tubes are amplified and shaped in fast, hybrid preamplifier circuits, then the pulses are sent to the coincidence circuit for processing. The counting circuit determines the total count rate and the coincident count rate. Then the computer analyzes the row data and applies electronic dead time corrections and background subtractions before the mass of nuclear material is calculated. Ideally, the detector parameters, the coincidence count rate and the isotopic composition determine the plutonium content of each pellet.

For measurements of uranium isotopic mass in items is used the thermal mode of active neutron coincidence technique. In difference with passive method in the active one two AmLi sources are used, slowing neutrons of which burn the uranium in items. In other respects this technique is close to passive one.

We used for test and evaluation the third measurement configuration of modified AWCC. Special graphite end plugs were fabricated for passive (no AmLi sources), fast mode (with cadmium) measurements of plutonium disks.

2.2. STANDARDS and CALIBRATIONS

Measurements of fissile isotopic mass in working standards. We have used selected BFS Pu disks as working standards for NDA. Parameters of these disks are in the table 1.

Table 1.
Working standards for NDA.

Disk number	Disk mass g	Core mass g	Pu mass g	Pu-239 %	Pu-240 %	Pu-241 %	Separate date
Pu 589	66.32	53.12	52.27	95.06	4.65	0.29	1973.05
Pu 929	66.08	52.38	51.34	96.23	3.60	0.17	1969.12
Pu 1794	66.54	53.78	52.91	95.21	4.51	0.28	1973.10
Pu 2702	65.22	52.79	51.84	95.22	4.53	0.25	1973.12
Pu 6200	62.33	53.64	52.72	95.06	4.73	0.21	1974.08

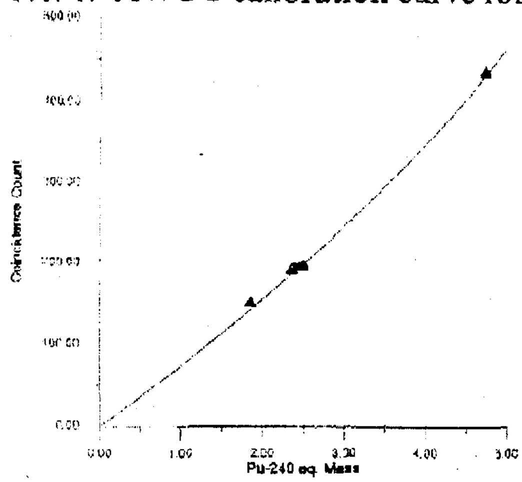
2.3. STATISTICAL CONTROL and RESULTS

For AWCC calibration five working standards of 95%-plutonium disks have been selected. At present these standards are kept separately from other disks which are involved in the PIT. The passport data of plutonium working standards are in the table 1 (see 2.2. item).

The experimental points were approximated by curve $y=ax/(1+bx)$ (see Pic. 1) from the set of possible approximations of NCC software, because of in this case the approximation coefficients have the smallest uncertainty.

For this curve: $a = 69.4 +/- 0.9$; $b = - 0.0505 +/- 0.0028$.

Pic. 1. AWCC calibration curve for Pu metal.



A standard AWCC modified by LANL for nuclear material measurements at the BFS is very suitable and reliable device for measurements of single plutonium disks.

2.5. RECOMMENDATIONS

It will be very useful to modify a standard AWCC for measuring full 50-cm storage tube with HEU and plutonium disks without destroying seals.

3. THE MEASUREMENT OF PLUTONIUM ISOTOPICS AND URANIUM ENRICHMENT USING GE DETECTOR

3.1. MEASUREMENT PRINCIPLE

The measurements of γ- and x-ray spectrum are used for the determination of plutonium isotopic ratio and uranium enrichment. With the purpose of improvement of spectrum peaks separation Ge detector is used. At present we have used for test and evaluation U-PU inspector with MGA and MGAU codes.

3.2. STANDARDS and CALIBRATIONS

MGA and MGAU codes require no standards and calibrations.

3.3. RESULTS

Measurement results are in Tables 2 - 4. In Table 4 there are also results for Pu, which were early obtained for this Pu disk (Pu 550) using ICPM Code by T.Dragnev (IAEA) with time correction by this PIT.

Table 2.
90% Pu metal measurement results using MGA and ICPM Codes.

Isotopics	Passport data %	Measurement Code	
		MGA , %	ICPM , %
Pu-238	-	0.057 +/- 0.004	0.039 +/-0.004
Pu-239	90.25 +/- 0.09	88.67 +/- 0.29	90.15 +/- 0.20
Pu-240	9.44 +/- 0.09	10.93 +/- 0.28	9.45 +/- 0.20
Pu-241	0.31 +/- 0.06	0.280 +/- 0.007	0.28 +/- 0.02
Pu-242	-	0.060 +/- 0.007	0.080
Am-241	0.66 +/- 0.06	0.786 +/- 0.014	0.780 +/- 0.02

Table 3.
90% U metal measurement results using MGAU Code.

Isotopics	Passport data , %	MGAU , %
U-234	-	1.77 +/- 0.18
U-235	89.80 +/- 0.15	94.48 +/- 3.60
U-238	10.20 +/-0.15	3.74 +/- 3.60

Table 4.
Depleted oxide uranium measurement results using MGAU Code.

Isotopics	Passport data , %	MGAU , %
U-234	-	0.004 +/- 0.003
U-235	0.420 +/- 0.02	0.818 +/- 0.049
U-238	99.580 +/-0.02	99.18 +/- 0.08

There are visible differences (more than experimental errors) between passport and measurement data obtained using MGA and MGAU Codes. We gees these codes do not take to account the irradiation of BFS pellets most of them are used for simulation of fast reactors.

3.4. RECOMMENDATIONS

It will be very useful to investigate the operation of MGA, MGAU and FRAM Codes for slightly irradiative pellets for the BFS facility conditions in order to good use these codes for MC&A. Also, in future , for BFS facilities very ueful to have a scaner for rapid identification of the SNM items in whole tube from BFS.

COMMON RECOMMENDATIONS

In September 1995 was completed the first stage of developing system MPC&A at BFS building. In the process of this work were received very valuable results, but we think that it will be very useful to continue these works in following directions:

- extension of the database for computerized system;
- problem of stamping bar codes on BFS items;
- works in developing of methodology and technique of control and accounting BFS items;
- extension of the methodology and technique base for NDA;
- creation of the technology of physical inventory ;
- works with system of Physical protection of the BFS building;
- spreading of experience of the BFS building on another facilities and buildings of IPPE.

- computation of inventory difference on the basis of measurement results obtained for a random sample of fissile material items and estimation of standard errors of inventory difference on the basis of measurement error variances.

In addition to the working network, the training network was installed in the BFS building. It consists of a server and two clients and is used for development and testing accounting system software in a network environment. One more computer is used for development of software and database and it works in a stand alone mode.

RECOMMENDATIONS

It is recommended that future development of the BFS computerized accounting system should include:

- increase of the data base for the BFS nuclear materials in order to include all the materials available for experiments;

- development of software for tracking sealed containers (canisters and fuel rods) with nuclear materials in addition to tracking individual items;

- establishment of operational and maintenance procedures for the system.

CONCLUSIONS

IPPE, in conjunction with Los Alamos, have reviewed available methods and concepts that be deployed in the near term. This is the BFS Computerized accounting system.LANL have provided information about computerized accounting methods. LANL have organized two seminars on software development methods.

IPPE, in conjunction with Los Alamos, have selected a range of methods for evaluating and testing.

IPPE, in conjuction with LANL, have developed the test and evaluation plan. In final report on this task there are main optained results of working this System.

IPPE have assembled the necessary equipment, software and some other components available in Russia. LANL have provided equipment, software and some other components to support the evaluation and testing.

System was tested and showed in integrated M&A demonstration exercise.

According to the contract with BNL this System is used for the physical inventory of nuclear material items.