ТЕХНІКА ТА МЕТОДИ ЕКСПЕРИМЕНТУ
ENGINEERING AND METHODS OF EXPERIMENT

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BELARUSIAN SOFTWARE FOR NUCLEAR MATERIAL ACCOUNTING AT THE LEVEL OF THE REGULATORY BODY

A review of the information system for nuclear material accounting and control at the level of the Belarusian regulatory body in the field of nuclear and radiation safety is presented. This system is developed in accordance with International Atomic Energy Agency (IAEA) requirements depicted in Code 10 of the State subsidiary arrangements. The system provides automatic generation of the following accounting reports: physical inventory listing, inventory change report, material balance report, and textual report for each material balance area as well as the corresponding General Ledger. It provides all necessary calculations and pre-calculations, based on input data, to produce accurate accounting reports. The system implements the import/export of data to/from the system using Code 10 (labelled and fixed formats), as well as making adjustments to accounting documents in accordance with IAEA rules. There are two possibilities of nuclear material accounting in the system. The first consists of importing into the system of all reporting documents from the material balance areas of facilities and the subsequent possibility of checking the received data using an independent recalculation tool in the system. The second one includes the registration of all necessary information on nuclear material batches at locations outside facilities and their movement in the material balance area and then automatic generation of all required reports and General Ledger.

Keywords: nuclear material, accounting of nuclear material, information system, Code 10, free software.

1. Introduction

According to the comprehensive safeguards agreement with the IAEA [1], the State system of accounting for and control of nuclear material (SSAC) of the Republic of Belarus, accounts for all batches of nuclear material (NM) subject to IAEA safeguards: plutonium, uranium (depleted, enriched, natural) and thorium. These elements are widely used not only in various nuclear installations and reactors, such as the Belarusian Nuclear Power Plant (NPP), the Joint Institute for Power and Nuclear Research - Sosny of the National Academy of Sciences of Belarus ("JIPNR-Sosny") but also in small quantities in various medical devices, transport containers, different control and measuring equipment, radioisotope smoke detectors, etc., used at enterprises and organizations in the country. All such nuclear material is situated in locations outside facilities (LOFs). All Belarusian LOFs form a separate Material Balance Area (MBA).

In Belarus, the Department of Nuclear and Radiation Safety of the Ministry for Emergency Situations of the Republic of Belarus (Gosatomnadzor) implements the functions of a nuclear regulatory body in the fields of nuclear and radiation safety. The Belarusian SSAC is defined by the Resolution of the Council of Ministers of the Republic of Belarus dated March 17, 2014, No. 224 "Regulations on the procedure for maintaining the state system of accounting for and control of nuclear materials of the Republic of Belarus". In Belarus, all NM accounting for LOFs is implemented by Gosatomnadzor based on information from enterprises and organizations using NM in their work. This is the nuclear material accounting and control (NMAC) program.

According to IAEA requirements, the NMAC information system of facilities should provide information support for the processes of NM movement at all stages of the material and facility life cycles and provide for:

accounting for nuclear material in all facilities and MBAs;

taking into account the location of each NM batch at all stages of its use, as well as a prompt indication of its location;

developing NM storage cartograms;

justifying nuclear fuel burnup estimation;

automating the preparation of work schedules for nuclear core fuel reload;

preparing, registering, and maintaining accounting and reporting documents;

submitting reporting documents to regulatory authorities in accordance with the established procedure.

For LOFs, the composition of the information system functions should contain fewer options, ensuring NM accounting in the organization, the location of each item in every batch or nuclear material at all stages of its use, as well as maintaining accounting and reporting documents, submitting them in the prescribed manner to regulatory authorities.

A good analysis of the difference and common sides between SSAC and NMAC programs is given in [2]. Considering the above, it is clear that the information system of Gosatomnadzor should be developed for the realization of all functions of the SSAC and the functions of NMAC.

At present, there are many different software and information systems for realizing SSAC and NMAC functions [3, 4], as well specialized software for calculating the nuclear fuel burnup estimation (e. g. [5]).

The functions are often referred to as information and analytical systems or automated information systems for accounting and control. Any of these systems include an operating system (OS), a database management system (DBMS), databases (DB), and application software. System specifications for such a system are depicted in [6] following IAEA requirements [7].

It is important to understand the role played by Code 10. The Code number represents a part (code) in the Subsidiary Arrangements for a State, and there are 10 codes. Procedures and prescribed forms of the documents are in codes 1 through 9 and are depicted in [8]. Code 10 specifies each format of nuclear material accounting reports that are provided in an electronic format. There are three formats of Code 10: the fixed format in a hard copy format with fixed field sizes, such as 8 symbols for the name or number of the batch. The labelled one is in a format using label identifiers for fields without size restrictions and one in an XML format, which closely resembles the labelled format. The XML format of Code 10 can be implemented in the Belarusian NMAC information system in the future. A full description of the format of reports in the labelled Code 10 is given [9]. In this case, if a country changes from fixed to labelled format in IAEA reports, like Belarus, its information system should support both formats. All Code 10 formats provide the necessary information to the IAEA for the implementation of safeguards.

2. Belarusian regulatory body software

Let us present an Intellectual Information System (eLab-Control) to ensure control (supervision) in the field of nuclear and radiation safety, developed in 2016 - 2020 and successfully implemented in Gosatomnadzor [10 - 12]. The system is based on free software and was developed by researchers of the Institute for Nuclear Problems of Belarusian State University. Some basic block diagrams of the system and the main principles of its functioning can be found in [11].

The system architecture is presented in Fig. 1. eLab-Control is an isolated system operating in the Gosatomnadzor Intranet. Communicating with the staff outside of the main building is carried out via VPN. eLab-Control is based on free software: Debian GNU/Linux, Web-server Apache, the Firebird database server, PHP application server. The system runs under Windows and Linux. The system is designed for intranet usage with concurrent multiuser access. User authentication is performed by the Active directory Kerberos server (network mode) or local user database (in standalone mode). Access level is determined by user group membership (Active Directory groups) which are defined per-module.

The choice of original Belarusian software in such a sensible area as NM accounting and control was justified by the need and the possibility of strict control over domestic developers. It is also important to have the possibility of quick implementation or prompt revision and further development of software based on requests of Gosatomnadzor employees.

At present, eLab-Control system includes some modules, realizing control and supervision over safety during the construction and commissioning of the Belarusian NPP, over radiation safety of sources of ionizing radiation as well as for accounting and control of nuclear materials, radioactive waste, and spent nuclear material. The last module (NMAC) is Module No. 3 of the system. It is installed additionally on a separate computer outside the Gosatomnadzor Intranet. eLab-Control allows this possibility.

Data from the old databases of Gosatomnadzor on accounting for radiation sources and nuclear materials were loaded into (eLab-Control) with the help of special scripts. The system is connected to the Unified Register of Licenses and the database of the Ministry of Taxes and Duties of the Republic of Belarus.

At present, the filing, updating, and storing of databases in the State system of accounting and control of nuclear materials and the Unified state system of accounting and control of sources of ionizing radiation as well as supervision of Belarusian NPP construction are provided by eLab-Control.

So, Module No. 3 provides information support to Gosatomnadzor for the implementation of accounting, control, and supervision functions in accordance with the international obligations of the Republic of Belarus for NM circulation, data on radioactive waste (RW) and spent nuclear fuel (SNF), licensing, as wells as NMAC at LOFs.

The following algorithms have been developed in the system. An in-depth specification of the kernel code and system databases was developed to provide a general systematic approach to retrieving and editing data in the database. A user-specific system of interface controls, including dedicated buttons,

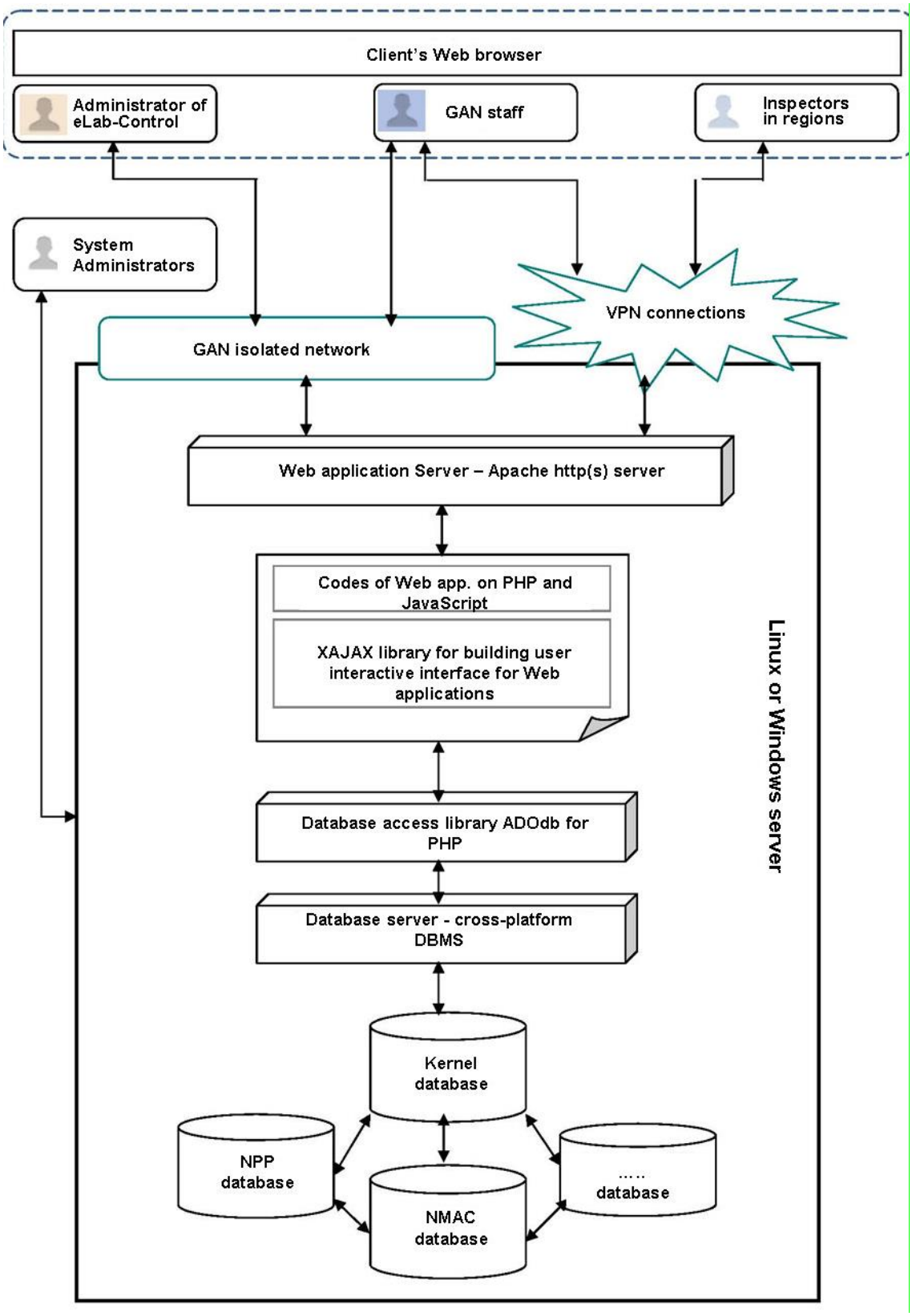


Fig. 1. The architecture of eLab-Control.

(e.g. for sending emails and checking data in the State Internet registries) were implemented. eLab-Control provides several levels of record sorting and filtering including different aggregative complex database search queries. A declarative markup language with special labels and coordinates for dynamic and static data was developed for importing data from Excel and text files. The system provides the formation of final documents according to established templates. Users can make changes to such templates. Various "statistical" reports, a system of notifications, and different changelogs are imple-

mented. Full-text search in documents allows to index textual (not scanned) documents.

An original "Enterprise tree" tool is implemented, allowing work with the hierarchical data structure within the relational database.

Below, we will use the term "journal" for database logs that are sets of DB records of the same structure of data.

The principle workflow components in the system are as follows:

Step 1. Complete all reference-books, that are small journals referenced from the main data journals.

Step 2. Customize the system interface to fit user needs.

Step 3. Create, complete and save a new entry in the data journal.

Step 4. Load files into this record, if necessary.

Step 5. Create and fill in the entries of auxiliary journals, information from which is accumulated and displayed in the main journal using "view".

Step 6. If there are additional data files, import data from them into the journal.

Step 7. Generate a reporting document using the available report templates.

Step 8. Sort and search the records and data, if needed.

Step 9. If necessary, create an additional report template, create a record for it and upload it to the system.

Step 10. Export data to files, if necessary, and print data.

3. NM accounting using eLab-Control

The functions of Module No. 3 provide information support for Gosatomnadzor employees. Such support is based on accepted methods of collecting, recording, storing, and analyzing information on NM circulation and use, as well as operating time, defects, damages, failures, and violations in the field of nuclear and radiation safety. Module No. 3 provides the formation of all necessary reporting documents at the State level according to the IAEA forms [7, 9]. So, the main documents generated here are: nuclear material inventory change report (ICR), material balance report (MBR), physical inventory listing (PIL), and textual report (TR).

There are two possibilities of nuclear material accounting activities in the system. The first consists of importing to the system all reporting documents from the facility's MBAs and the subsequent checking of the received data using an independent verification tool in the system. The second one includes the registration of all necessary information about batches at a LOF and their movement in the material balance area and then automatic generation of all required nuclear material accounting reports and General Ledger.

In any case, one can perform a preliminary calculation of data for the PIL and MBR at the current date, carry out correcting an entry under IAEA regulations as well as import/export from/to the system of all types of reports in formats of fixed and labelled Code 10.

The system contains reference books with all the necessary information about NM according to [6, 7, 9], including "Element code", "NM characteristics", "Isotope code", "NM inventory change codes", "Material description codes (physical form, chemical form, containment, irradiation status, and quality)", "Storage containers classified by volume", "Measurement base", "Countries", "Known MBAs", "Types of accounting reports" and others. These are all well-defined in the Code 10 document for the State.

The following algorithm for generating records in the NM accounting database is implemented in the system.

1. In the journal "Nuclear Material Batches" based on data received from organizations (LOFs), records for each batch should include the following data fields: KMP code (key measurement point), Batch name, Organization, Device numbers, Description of material, Element, Isotope code, Registered, Notes.

The field "Registered" has two values: yes/no. The value "no" is chosen in the case of withdrawal of the party from guarantees or its liquidation. Values in the "List of reports" field are generated automatically based on party references in all ICR, PIL, MBR reports. The system warns about accidental non-selection of one or more values at the appropriate positions in the journal entry.

2. In order to facilitate the tracking of the batch history, an auxiliary non-editable journal "Information on NM batches" was created. It contains the following fields generated in the journal "NM Batch": KMP code, Batch name, Organization, Device numbers, Material description, Element, Isotope code, Registered, List of reports, Notes.

3. In the journal "Changes in NM inventory" data is generated on the change in inventory based on fields, which correspond to the fields of reports [7]. To speed up data entry, the editor contains some preset values that are more than 50 % likely to be correct for a particular record. There are drop-down lists in many data fields in the record editors in the system.

4. In the journal "Inventory change report" the data are generated for all required fields of the ICR [7]. This journal can be automatically generated based on the journal "Change of NM inventory". Another possibility is to import data from a file or create it in the record editor.

5. After the ICR is created, all data are automatically transferred to the archive – the journal "Data of reports on changes in NM inventory". In the future, these data are not subject to change and can only be corrected following IAEA procedures.

6. The journal "General information about accounting reports" must be filled in for each new report that is created in the system, with the following fields: Material balance area, Report type, Report number, Reporting period, Name of the originator, Number of pages, Date submissions, Concise note, Notes. This is the "header" information for the report, data that is common to all entries in the report.

When importing all types of reports in the format of fixed or labelled Code 10, the system automatically creates "headers" (records) of reports in the "General information on accounting reports" journals. The "IAEA approved (yes/no)" field, if set to yes, closes the report for editing.

7. Records of the journal "Physical inventory listing" contain all necessary data accordingly to [7]. They can be imported from a file or created in the record editor.

8. The journal "Material balance report" contains all the necessary fields for entering the material balance report according to [7]. They can be imported from a file or created in the record editor.

9. The journal "General Ledger" (Fig. 2) for each element is automatically calculated based on ICR, PIL, MBR reports, giving data in the following fields: Report number, Line, Date, References, Type of NM inventory change – IC code, Units of measurement (kg, g), Element, Number of item, Increases; Decreases, Inventory (current balance), Increases, Decreases, Fissile isotope mass (only for uranium), Total: Number of items.

1.5.5. General Ledger

Report number: -1000

Element: T

Report number	Line	Date	References	IC code	Measurement units (kg, g)	Element	N of items	Increases	Decreases	Inventory	Isotope inventory	N of items
-1000						T	1			0.000	0.000	1
-1000	2	150409	ICR 123	RF	g	T	1	0.000		0.000	0.000	1
-1000	3	150508	ICR 123	EQ	g	T	1		0.000	0.000	0.000	0
-1000	4	150518	ICR 123	DU	g	T	1	0.000		0.000	0.000	1
-1000	1	150101	PIL		g	T	0			0.000	0.000	0

Fig. 2. Journal "General Ledger".

The last line in the journal contains the totals. Above the journal, there is a drop-down list allowing to filter data for a specific element.

10. The system has a "Textual report" journal with the following fields: Record number, Material balance area, Link type, Report reference, Record reference, Text (no more than 2000 characters of the Latin alphabet). An explanatory note (CN – Concise Note) can also be generated in accordance with the fixed-format Code 10, containing no more than 68 characters of information in each line (a record). The textual report, as well as Concise Note, can be imported from a file or created in the record editor.

11. A preliminary calculation of a PIL can be carried out using the corresponding journal, in which data for the current date is automatically generated based on the data of the ICR and previous PIL. When saving a preliminary PIL, it became a regular PIL in an appropriate journal.

12. A preliminary calculation of the MBR is automatically generated based on corresponding journals on the data for two consecutive PILs and the ICRs that are dated after the first PIL through the date of the second PIL. When saving a preliminary MBR, it becomes a completed MBR in an appropriate journal.

13. Journal "Operational Journal. NM in the Organization" provides the ability to determine at any time the available amount of NM in their locations, including NM not currently under safeguards (e.g. exempted material). Also, the journal "Nuclear material batches not under IAEA safeguards" displays additionally such batches for each organization.

14. The process of correcting a record is implemented in accordance with IAEA rules in Code 10. The entry that will be affected by the adjustment is highlighted in bold on the screen.

In most of the above journals there are drop-down lists in which, for user convenience and for

reducing the amount of data on the screen, one can select the necessary parameters. In all such drop-down lists, only reports related to the current MBA are offered for selection.

The system contains a "DB change journal" with all the changes made by the user.

For Belarusian NPP and "JIPNR - Sosny" MBAs data processing consists of importing appropriate journals in steps 4, 7, 8, 10 and the possibility of checking them through steps 11, 12, and 9.

For LOFs the procedure contains the following points: 1, 2, 3, 6, 4, 5, 10, 11, 12, and 9.

4. Input/output NM data in eLab-Control

Import with a special setting of the dataset is provided by special commands in the system .ini files. This instrument allows processing data from Excel or a labelled Code 10 format file with the .text10 extension. It can split one cell of spreadsheets into several database fields. It allows comparing the entered values with reference values from reference books. If no search result is found, a blank value is inserted in the corresponding DB field. That is why, before importing, it is necessary to carefully fill in all reference books, including, for example, the list of countries and known MBAs.

Developers included all report templates for report generation according to Code 10 (fixed and labelled). The user can add additional report templates to this section. The principles of developing such templates are described in the General User Guide of the system. Report templates are available for selection and generation using the "Run" button in the upper right corner of the system screen.

The system contains the following templates: MBR template in labelled Code 10; MBR template in fixed Code 10; PIL template in labelled Code 10; PIL template in fixed Code 10: ICR template in labelled Code 10; ICR template in fixed Code 10; Textual report template in labelled Code 10; CN template – concise note in fixed Code 10; General Ledger Template; General Ledger Template with Isotopes.

An example of an MBR template labelled Code 10 is given in Fig. 3. The result of the output of an MBR to a file with labelled Code 10 data is shown in Fig. 4. Note that labels with empty values are not displayed. Therefore, a user should carefully fill out the general information about the reports. If, for example, the recorder's name is not specified, then the label 006 will be absent in the generated report.

Examples of an ICR template in fixed Code 10 are given in Figs. 5 and 6 depict the corresponding output result. In Fig. 7 the result of export in Excel-file by way of the General Ledger Template of General Ledger from Fig. 2 is presented.

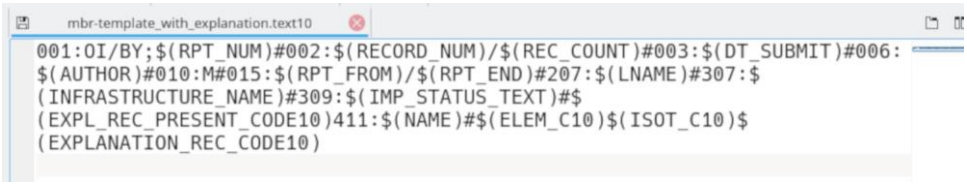


Fig. 3. The file of the template of MBR in labelled Code 10.

Fig. 4. Result of MBR export in labelled Code 10.

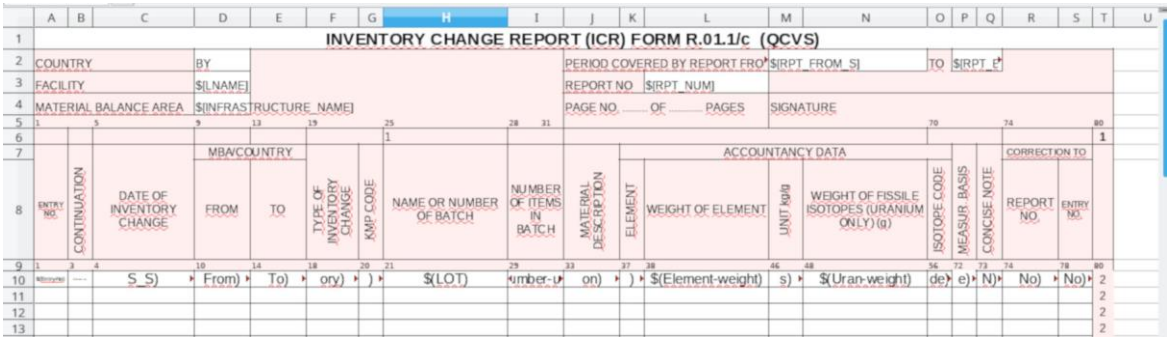
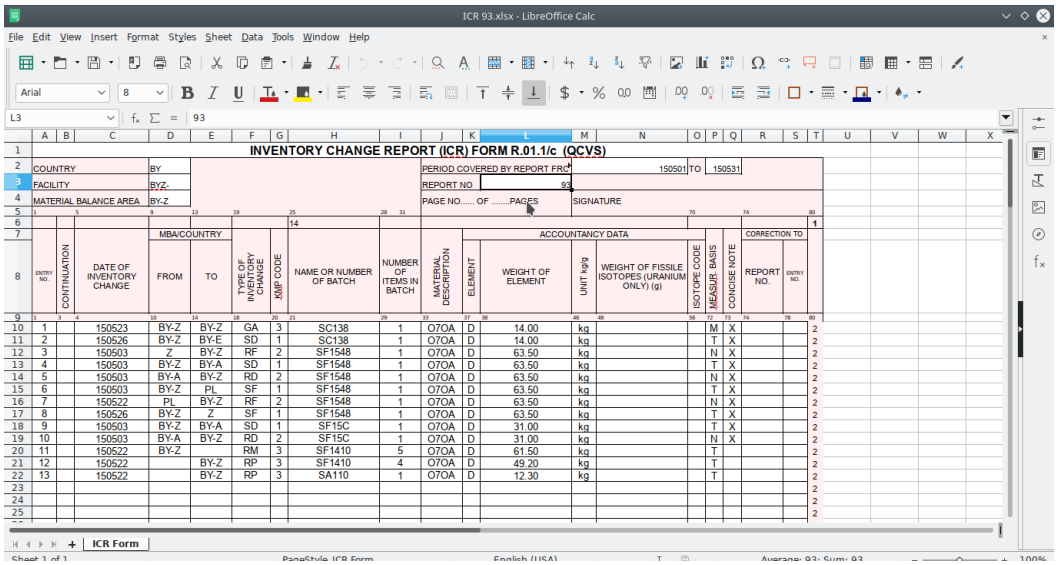


Fig. 5. Excel file of template of ICR in fixed Code 10.

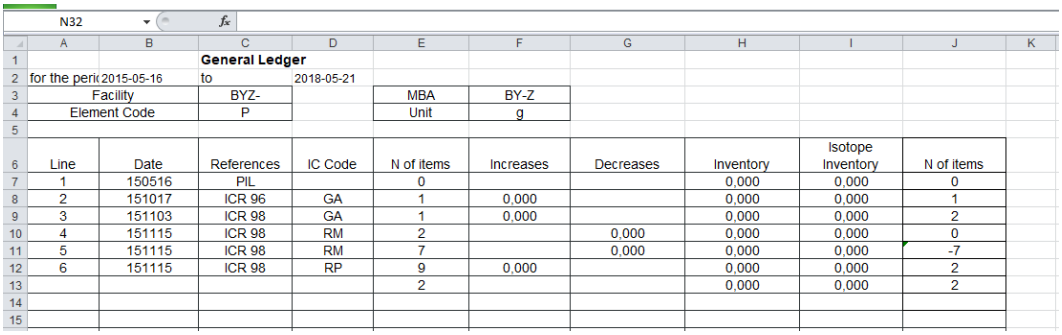


INVENTORY CHANGE REPORT (ICR) FORM R.01.1/c (QCVS)

COUNTRY BY | PERIOD COVERED BY REPORT FRO 150501 TO 150531
FACILITY BYZ- | REPORT NO 93
MATERIAL BALANCE AREA BY-Z | PAGE NO..... OF .....PAGES | SIGNATURE

ENTRY NO.	CONTINUATION	DATE OF INVENTORY CHANGE	MBA/COUNTRY FROM	MBA/COUNTRY TO	TYPE OF INVENTORY CHANGE	KMP CODE	NAME OR NUMBER OF BATCH	NUMBER OF ITEMS IN BATCH	ACCOUNTANCY DATA: MATERIAL DESCRIPTION	ELEMENT	WEIGHT OF ELEMENT	UNIT kg/g	WEIGHT OF FISSILE ISOTOPES (URANIUM ONLY) (g)	ISOTOPE CODE	MEASUR. BASIS	CONCISE NOTE	CORRECTION TO: REPORT NO.	ENTRY NO.
1		150523	BY-Z	BY-Z	GA	3	SC138	1	O7OA	D	14.00	kg			M	X		
2		150526	BY-Z	BY-E	SD	1	SC138	1	O7OA	D	14.00	kg			T	X		
3		150503	Z	BY-Z	RF	2	SF1548	1	O7OA	D	63.50	kg			N	X		
4		150503	BY-Z	BY-A	SD	1	SF1548	1	O7OA	D	63.50	kg			T	X		
5		150503	BY-A	BY-Z	RD	2	SF1548	1	O7OA	D	63.50	kg			N	X		
6		150503	BY-Z	PL	SF	1	SF1548	1	O7OA	D	63.50	kg			T	X		
7		150522	PL	BY-Z	RF	2	SF1548	1	O7OA	D	63.50	kg			N	X		
8		150526	BY-Z	Z	SF	1	SF1548	1	O7OA	D	63.50	kg			T	X		
9		150503	BY-Z	BY-A	SD	1	SF15C	1	O7OA	D	31.00	kg			T	X		
10		150503	BY-A	BY-Z	RD	2	SF15C	1	O7OA	D	31.00	kg			N	X		
11		150522	BY-Z		RM	3	SF1410	5	O7OA	D	61.50	kg			T			
12		150522		BY-Z	RP	3	SF1410	4	O7OA	D	49.20	kg			T			
13		150522		BY-Z	RP	3	SA110	1	O7OA	D	12.30	kg			T			

Fig. 6. Result of ICR export in fixed Code 10.



General Ledger

for the peri 2015-05-16 to 2018-05-21

Facility	BYZ-		MBA	BY-Z
Element Code	P		Unit	g

Line	Date	References	IC Code	N of items	Increases	Decreases	Inventory	Isotope Inventory	N of items
1	150516	PIL		0			0,000	0,000	0
2	151017	ICR 96	GA	1	0,000		0,000	0,000	1
3	151103	ICR 98	GA	1	0,000		0,000	0,000	2
4	151115	ICR 98	RM	2		0,000	0,000	0,000	0
5	151115	ICR 98	RM	7		0,000	0,000	0,000	-7
6	151115	ICR 98	RP	9	0,000		0,000	0,000	2
				2			0,000	0,000	2

Fig. 7. General Ledger export in Excel format.

5. Other features of Module No. 3

The complete Module No. 3 structure consists of the following Submodules:

3.1. NM accounting;

3.2. Organization and results of administrative and supervisory activities;

3.3. Organizations;

3.4. Nuclear materials and spent nuclear fuel;

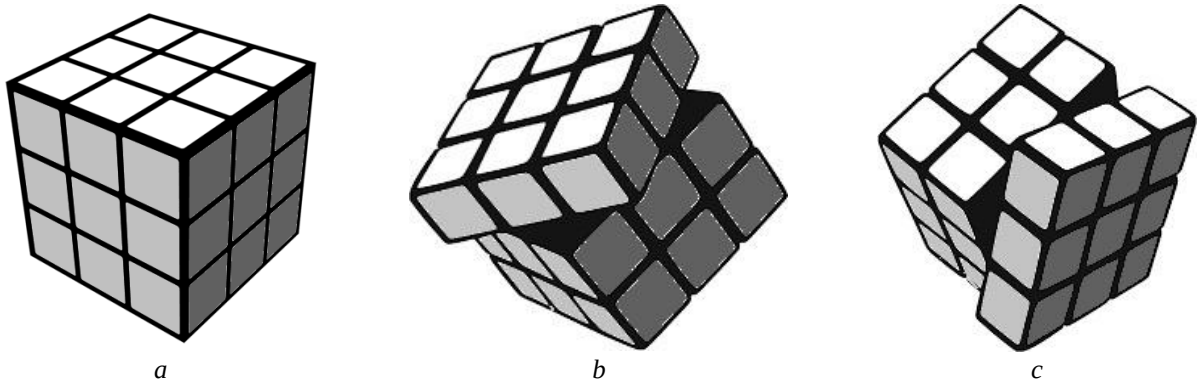
3.5. Radioactive waste;

3.6. Radioactivity calculator;

3.7. General reference books;

3.8. Reference books on NM, RW, SNF.

In Submodule 3.1, the "Tree" tool was used in relation to all existing MBAs. In Submodule 3.4, they are collected in a hierarchical structure with respect to individual journals – ICR, PIL, MBR, General Ledger, etc. Here, one can get information, for example, about PILs for all MBAs at the same time. In other words, Submodules 3.1 and 3.4 represent the same relational database data from two different perspectives (compare pictures of a cube in Fig. 8). Here if each light grey row depicts an individual MBA and white rows correspond to different reports (one row – to ICR, the second one – to PIL, etc.), so the rotated layer in Fig. 3, *b* demonstrates all data for chosen MBA (as in Submodule 3.1). The rotated layer in Fig. 3, *c* shows e. g. all ICRs for all MBAs.



a *b* *c*

Fig. 8. Schematic presentation of the database (*a*) and their perspectives for Submodule 3.1 (*b*) and Submodule 3.4 (*c*).

Submodule 3.2 includes some journals devoted to Gosatomnadzor's administrative and regulatory infrastructure, licensed activity, administrative procedures, supervisory activities, organization of supervision (inspection), violations, sanctions, and abnormalities.

Submodule 3.3 depicts all necessary information about operating facilities and LOFs, including staff for NM accounting and monitoring. Management of objects with NM includes the following fields: object name, MBA type, MBA name, Date of creation, Additional properties, Fuel type, Notes (edit), and Files. An additional sub-journal is next: Nuclear materials in MBA, KMP, KMP buildings, KMP rooms, KMP scaffolding, KMP boxes.

Submodule 3.4 contains additional information – Advance notification of planned transfers of nuclear material from/to MBA, MBA inventory, etc., as well as information about spent nuclear fuel – management infrastructure facilities, their state, and movement.

Submodule 3.5 is devoted to RW accounting in accordance with Belarusian legislation in this field. The information about the infrastructure of RW location and RW disposal in the fields of DB data are: RW name, Volume (m3), Weight (kg), State of aggregation, Total activity (Bq), and Activity measurement date, etc. Submodule 3.6 of the system contains the auxiliary Radioactivity calculator.

Submodules 3.7. and 3.8 includes 58 different general and specialised reference books.

6. Conclusion

The information system eLab-Control and its Module No. 3 implement all the necessary functions of accounting and control of nuclear materials required by the IAEA at the level of the regulatory body. The system allows to automatically recode all types of reports from the fixed Code 10 to the labelled Code 10 and vice versa.

Among the main distinguishing features of eLab-Control that should be noticed are the implementation of several integrated applications with a single interface, and the ability to expand the functionality of the system. The system has open-source code and allows easy translation into other languages.

Since it is an easily adaptable and customizable information system, Module No. 3 can be readily configured to provide NM accounting in facilities and LOFs.

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БІЛОРУСЬКЕ ПРОГРАМНЕ ЗАБЕЗПЕЧЕННЯ ДЛЯ ОБЛІКУ ЯДЕРНОГО МАТЕРІАЛУ НА РІВНІ РЕГУЛЮЮЧОГО ОРГАНУ

Представлено огляд інформаційної системи обліку та контролю ядерних матеріалів на рівні регулюючого органу Республіки Білорусь у галузі ядерної та радіаційної безпеки. Ця система розроблена відповідно до вимог МАГАТЕ, викладених у типовому коді 10. Система забезпечує автоматичне створення таких облікових звітів: звіт про фактично наявну кількість матеріалу (PIL), звіт про зміни інвентарної кількості матеріалів (ICR), матеріально-балансовий звіт (MBR), текстовий звіт (TR), головний журнал обліку (General Ledger). Вона забезпечує всі необхідні розрахунки та пропозиції на основі вихідних даних для отримання повністю узгоджених звітних документів. У системі реалізовано імпорт/експорт даних до/із системи з використанням коду 10 (маркований та фіксований), а також внесення корекцій до звітів відповідно до правил МАГАТЕ. У системі є дві можливості ведення обліку ядерних матеріалів. Перша полягає в імпорті в систему всіх звітних документів із зони балансу матеріалу установки і подальшої можливості перевірки отриманих даних за допомогою незалежного перерахунку їх у системі. Друга включає реєстрацію всієї необхідної інформації про партії на об’єктах поза установками та рух їх у зоні балансу матеріалу, а потім автоматичне створення всіх необхідних звітів і головного журналу обліку.

Ключові слова: ядерний матеріал, облік ядерних матеріалів, інформаційна система, код 10, вільне програмне забезпечення.

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