

IMPROVING SSAC CAPABILITY THROUGH THE APPLICATION OF AN APPROPRIATE NMAC SOFTWARE: EXPERIENCE OF THE CZECH REPUBLIC

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Abstract

The core objective of this paper lies in introduction and demonstration of detailed technical features and capabilities of the “SFG - Safeguards application for managing the SSAC”, the software used in the Czech Republic for maintaining the SSAC at both State and operator level. The application, which was created in the early 1990’s and updated several times, has been effectively used by the SRA to manage NMAC and reporting functions, as well as utilizing its capability in support of overall safeguards implementation (with regard to all IAEA, Euratom and national obligations). The paper explains the benefits provided by using the SFG in streamlining of day-to-day SRA regulatory operations in the area of NMAC; controlling export and import of other specified items; and submittal of required declarations to the IAEA. Preparation of supporting documents for IAEA verification activities and national inspections in the context of this application is also touched upon. Structurally, the history and purpose of the application is fully explained, then its scope and coverage are addressed, followed by monitoring of exempted, terminated and pre-34(c) nuclear material and finally its compatibility and security aspects are examined. The key functionalities of the SFG will be demonstrated during an ESPACE presentation.

1. INTRODUCTION AND HISTORY

Historically, the Czech Republic has a long tradition in safeguards implementation and nuclear material accountancy and control (NMA/C) dating back to the accession to the Treaty on the Non-Proliferation of Nuclear Weapons on the 1st July 1968 and conclusion of the first Safeguards agreement with the IAEA on 1st March 1972.¹ With the onset of information technology era and better availability of computer hardware in the early 90s, the decision was made by the State Office for Nuclear Safety² (SONS) to develop a dedicated state-level software for the purposes of maximizing the effectivity of maintaining the State System of Accounting for and Control of Nuclear Material (SSAC). Since the beginning, the system was developed with the specifics of

¹ Both documents were signed by Czechoslovakia, the predecessor State of the Czech Republic.

² SONS is the State Regulatory Authority in the Czech Republic responsible for the implementation of safeguards.

the Czech Nuclear Fuel Cycle kept in mind. This meant especially focus on processing data from the first Czech Nuclear Power Plant Dukovany, dealing with various types of nuclear material (bulk and discrete items) from the Nuclear Research Institute in Řež and the Czech specificity of significant number of Locations Outside Facilities (LOFs) with large amount of exempted material and traditional production of pre-34(c) material. The first programme was developed by the company BIOS, as a stand-alone application running on a single computer which also contained the SSAC database. Regular back-ups had to be made manually and were stored on a secure location. Soon, it became clear that in order to fully maximize the potential of computer technology available at that time and the benefits of dedicated NMAC application called SFG – Software for Accountancy and Control of Nuclear Material (SFG for short), the software had to be network based, with central database hosted on a server accessible from designated workstations (client/server concept). This evolution of the SFG, carried out again by the same company, allowed for simultaneous work with the safeguards data while increasing its security and availability through better processing power. Further evolution of the software focused on adding new functions in the form of independent modules. The most prominent are modules featuring SSAC reporting module, Additional Protocol agenda or register of license holders. This modular concept was based on Code 10 accountancy requirements and supports IAEA labelled format. This allowed SFG to be tailored to specific needs of both the State Regulatory Authority (SRA) and operators. Therefore the software became suitable for use on the State level and facility level, as well.

2. SFG PURPOSE AND APPLICATIONS

Before proceeding with in-depth examination of particular features of the SFG application, the basic structure should be introduced:

- The core of the SFG consists of the interface for data input of inventory change operations and records on results of physical inventory taking.
- Editing and review interface for the entered data prior to their transfer to separate validated data.
- Largely customizable data query allowing for various searches and filters to be applied to the SSAC database.
- Section dedicated to the preparation of various reports (ICR, PIL, MBR and CN) with export to the IAEA labelled XML format.
- Internal logic based on Code 10³ containing various checks and conditions assuring validity of the NMA data in all situations.

The SFG was being developed from the beginning to reflect the reporting requirements outlined in Code 10 of the Subsidiary Arrangements, which describe the format, contents and structure of nuclear material accounting reports to be submitted to the IAEA. The internal logic of the SFG reflects the above mentioned requirements, as well as a set of specific conditions defined by the SONS for the Material Balance Areas (MBA) in the Czech Republic. This allows for various cross-checks of imported, processed or exported data. Among the most useful features of the SFG belongs manual data entry from LOFs, which send their data in a paper-based form to SONS. In connection to this, the SONS has developed a special IC code RZ for nuclear material movements between the LOFs within the same MBA. As a consequence, each batch can be followed up not only among MBAs, but also within the MBA for LOFs. Another important feature is the automatic import option which loads into the database accountancy reports delivered in agreed format (XML usually, but also binary form can be supported) supplied by the operators from other MBAs. For the reason of maintaining data integrity of the SSAC, all data is manually entered or imported first into a working interface where manual editing and review of the data is possible. Only after the completion of this step, the data can be transferred as validated to the separate database table. This procedure includes various verification and cross-checks (checks of allowed IC codes and material description codes, batch names, cross-checks of received and sent batches – warning and errors are produced) validating also the integrity of the data. Only then the database is updated.

During the process of importing data from operators, the format and internal structure the imported XML files are verified. Among the checks that are performed before the imported or manually inserted data is

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³ For the Euratom Safeguards Module the logic was later modified to support Euratom reporting requirements.

transferred to the SSAC database belong the verification of shipping/receiving MBA properties and inventory change type based on conditions specified in Code 10 and Facility Attachments for each relevant MBA. For example, for inventory change codes as NP, DU, DQ, GA, RF, RD⁴ target MBA has to be specified. For the following inventory change codes: TU, LD, LN, LA, GA, TW, FW, RS, RN, SN, DI, EU, an explanatory comment must be included in the form of Concise Note (CN). When rebatching operations are applied, the total sum of RPs for element and isotope weights are checked and have to correspond with respective RMs. Furthermore, upon the agreements of SONS with several partner SRAs from a States with significant amounts of nuclear material regularly supplied to the Czech Republic, a special option of cross-checks for international transfers has been developed. Subjects of this control procedure are ordinary RFs reported by Czech operators in ordinary ICRs on one side and copies of reports sent to the IAEA by those partner SRAs on the other side. This control tool has been used quite successfully and upon relevant agreement with a specific SRA can be used for any international transfers. Finally a comprehensive database cross-check is performed verifying that all SD and RD operations within the input files are paired correctly with appropriate domestic inventory change operations already contained in the database (for efficiency purposes only, all inventory change lines added after the last Physical Inventory Listing are checked).

The screenshot shows a software window titled "Data input ICR [CZ-Z 1]". It contains several input fields and sections:

- Date:** 03.08.2018
- MBA from:** CZ-F
- MBA to:** CZ-Z
- Inventory change:** RD
- Batch ID:** SAMPLE-U308
- Batch ID from/to:** (empty)
- Items:** 5
- Material description:** PHFF
- Element weights:** A table with columns for element symbol, weight, and isotope.

P		g		
		g	Isotope	
N		g		
D	20 000,000	g		
T		g		
- Location:** C12X
- Location from/to:** (empty)
- Measurement:** N
- Correcting report/line:** (empty)
- Comment:** Concise Note comes here
- Some errors occurred during data validation!** (empty text area)
- Buttons:** OK, Back
- Edit** button in the bottom right corner.

FIG. 1. Window for manual entering of inventory change operations.

3. SCOPE

Aside of all obligatory accounting and reporting functions related to nuclear material, as defined in INFCIRC/153, the SONS has requested to incorporate into the SFG structure also some specific functions relevant to pre-34(c) material. With this regard, several specific accountability areas were created for uranium ore concentrate (UOC) “special national MBAs” where upon the conditions of licence only three types of operations were allowed; UOC production, shipments and receipts. Based on this, SFG can easily indicate whenever someone wants carry out any unauthorized action in connection to this type of material. On the other hand, SFG can quickly calculate the overall production or transfers of such material within the defined period related to specific “MBA” or in general for the whole country.

Another “special national MBA” defined in SFG is that one for exempted material. Each batch of nuclear material when exempted (EU, EQ) in any standard MBA is automatically administratively transferred into that “MBA” and in opposite upon re-application of safeguards (DU, DQ) removed from this “MBA” and transferred back to the relevant standard one. Internal structure of this “MBA” is created in line with standard MBAs and

⁴ All inventory change codes used in this article refer to Code 10 of the Subsidiary Arrangements, General Part.

KMPs/LOFs from MBA for LOFs, depending on relevant conditions of licences. In addition, the above mentioned procedure of RZ can be applied for any internal shipments/receipts of exempted material within that “MBA”. Based on such traceability functions, the SONS can easily control both the whole inventory and movements of exempted material.

Another area where the SFG proves to be very useful is streamlining safeguards implementation and regulatory control through license validity and conditions verification. The SFG contains a module where all information about issued licences for possession of nuclear materials and their respective conditions can be entered. Among these conditions belong the licence expiration date, list of permitted inventory changes (based on in the relevant Facility Attachments and licence), types of nuclear material for which the license is valid and their maximum total weights. When processing a report, all inventory changes are cross-checked against these conditions and the nuclear material inventory for the given license holder is computed from the SSAC database and compared with licence conditions.

The SFG capabilities are also leveraged to increase regulatory capacity through the option to display and print (or export to PDF) several types of pre-defined nuclear material accountancy documents. Among the most frequently used ones belong inventory change report, physical inventory listing, book inventory listing (including comparison of both), different ledgers and running balance for any specified MBA. Since these documents may not cover all possible situations and scenarios, the SFG also supports widely customizable data query in order not to limit the user to the pre-defined document options. The broad set of options and conditions allows the user to formulate highly specific queries which are then applied to the SSAC database (for example user can search for all accidental gains within selected MBAs/location where only specified nuclear material type was involved). This has proven to be of a great use when tracking specific items, batches, their movements or possible reporting problems. Because of this capability, the SFG represents an effective tool in preparing for SSAC/national safeguards inspections. It is a routine protocol for Czech safeguards inspectors to use this application during the preparatory stage of SSAC safeguards infield inspections. Then, it is obligatory to generate up-to-date Book Inventory Lists (BIL), General Ledgers (GL) and other supporting documentation.

The Additional Protocol (AP) module was developed after the Czech Republic signed the AP on 28th September 1999 with the purpose of streamlining the process of submitting Article 2.a.(ix) declarations. The greatest advantage of this module is that it keeps track of all issued import and export licences, their expiration dates, entities involved, quantity and type of imported and exported items (equipment and non-nuclear material). This module contains also several conditions and dependencies which help to eliminate any possible mistakes created during the manual data input. Another useful feature subtracts the number of exported (or imported) items from the total number for which the licence was issued (shipments can be divided into several batches) and provides the assurance that the total number is not exceeded.

When the Czech Republic acceded to Trilateral Agreement with the IAEA and Euratom⁵ on 22nd January 2009, it became clear that given the amount of different reporting requirements a new version of the SFG had to be developed. This new version brought the Czech SSAC in line with the requirements laid down in Commission Regulation No 302/2005 on the application of Euratom safeguards and the Treaty establishing the European Atomic Energy Community. To summarize this, it can be stated, that SFG is now available in two versions – with Code 10 to serve for States with INFCIRC/153 type and with Euratom reporting scheme for states with INFCIRC/193.

⁵ As contained in INFCIRC/193.

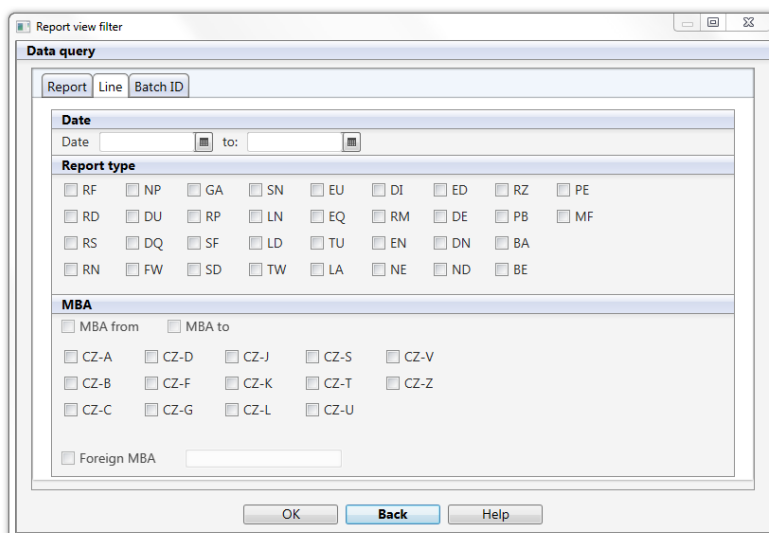


FIG. 2. One of several windows for customizable data query.

4. SECURITY ASPECTS AND SYSTEM ARCHITECTURE

SFG is password protected and each user has an individual account. It supports three basic levels of authorization. The lowest level allows the user only to browse and review the data or to print various documents, but it does not offer any possibility to change or edit the data in any way. Second level gives the user the possibility to manually enter or import accountancy data and make certain edits to it. Only the third (highest) level of authorization offers full control of the SFG, including creating new MBAs and modification of facility attachment conditions. Only this level actually allows the user to export and send relevant NMA reports to the IAEA.⁶

It is worth noting that as a precaution not even the third level of authorization can edit the event log, which records all operations made by any user in the SFG. Concerning SFG system architecture and network security aspects, SFG was originally built as single user application based on development system called Clipper. This system was designated to handle with XBase files but it is faster than the original dBase or FoxBase application systems. Based on further application and networking development during mid-nineties, SFG was being redesigned to client/server architecture.

The Oracle Database Server was chosen for its security, stability and scalability features. Current version of SFG uses Oracle Database Server 12c. Depending on the amount of stored data, there is also a possibility of using the Oracle XE Server (cost free version of Oracle Database Server). Database server is used not only as a storage of the application data, but also for the application of logic procedures and functions stored in the database and for enforcing of the security mechanism. Client side is built on the JavaFX platform, actually based on Java 8. This solution brings the capability of running the SFG application on nearly every device with Java Runtime Environment. This means typical PC with MS Windows (actually tested on Windows 7 and Windows 10), any Linux running device or Mac OS X devices. Client side stores almost no data in the hosting device except temporary files (generated PDF files etc.). All data are stored in the database server exclusively.

SFG is delivered in automatized software package, which cares completely of installation and distribution of updates. Therefore, the maintenance of SFG is very easy.

There are several layers which make SFG a product meeting high security standards. Network communication between clients and the server is encrypted, using the SSL protocol. This encrypted communication is initiated by the first attempt from the client side which guarantees that all transferred data are encrypted, including the username and password of the user who is logging in. User authorization and authentication is provided by the Oracle Database Server itself. This server uses system of explicit grants to use

⁶ The authorization to export and send relevant NMA reports to the IAEA is reserved for the highest authorization level because of legal implications of such action. Once the report is sent, the data is then sealed and must remain unchanged, as required by the Safeguards Agreement.

objects stored in the database (tables, views, procedures, functions). These grants are based on user rules granted to all individual users by the administrator of the SFG. These roles are controlled by the Oracle Database Server and they protect the data against the abuse not only when using the application, but also when using any database client tool.

Typical configuration of the data storage uses plain data stored in tables in the Oracle Database Server. If there is a need to encrypt this data due to some administrative reasons, it is possible to use the Oracle Advanced Security Feature to encrypt requested data directly in database. By the result neither during the network communication nor in the database, the plain data are available. Since SFG is highly customizable, the overall architecture strongly depends on the user needs. Typical installation consists of the separate database server and a flight of connected client's devices. The easiest way for the single user usage, is to include the database server and the client application at the same device, for example a notebook PC. In this case the database server can be installed directly to the operating system of such device⁷ or, for better management, to the virtual server running at this device.

5. CONCLUSIONS

The decision originally taken in the early stage of the SFG development in the 1990's to opt for a modular structure rather than monolithic one proved to be invaluable. This allowed SONS to react quickly to new safeguards and accountancy requirements which in some cases could not even be contemplated when the SFG had been originally developed. For SONS, the SFG is a great instrument in streamlining day to day safeguards operations based on the Czech Republic's integrated safeguards status, including preparation of supporting documentation for national inspections or submitting of accountancy reports. In almost thirty years of existence, the SFG graduated to an asset of strategic national importance. It enables the Czech Republic to fulfil its national obligations in the area of safeguards implementation and nuclear non-proliferation in an efficient and effective way. Furthermore, it gives the State a powerful instrument for maintaining the SSAC with capability going in several areas beyond Agency and Euratom requirements.

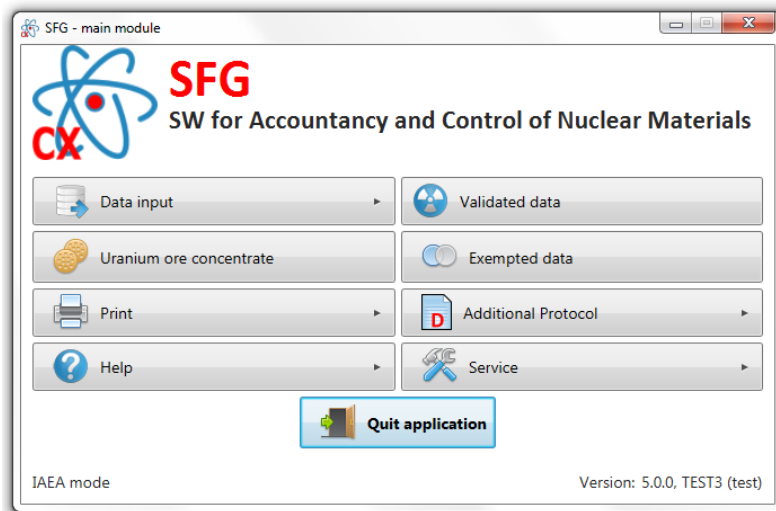


FIG. 3. Main window of the SFG application.

⁷ See the Oracle Database Server compatibility matrix.

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