

Modernization of the Fuel Assembly Register Software

Sebastian Pleško

Reactor physics department, "Jozef Stefan" Institute
Jamova cesta 39
1000 Ljubljana, Slovenia
sebastian.plesko@ijs.si

Slavko Slavič, Bojan Žefran, Marjan Kromar, Luka Snoj

Reactor physics department, "Jozef Stefan" Institute
Jamova cesta 39
1000 Ljubljana, Slovenia
slavko.slavic@ijs.si, bojan.zefran@ijs.si, marjan.kromar@ijs.si, luka.snoj@ijs.si

ABSTRACT

The Fuel Assembly Register (FAR) software, developed in 1994 at the "Jožef Stefan" Institute, covers all aspects of nuclear material accounting in a nuclear facility. FAR was originally developed for the Krško NPP, but due to the generality of the programming and the modularity of the structure, it can be easily applied to any other nuclear facility. The main purpose of the package is to simplify the control and updating of fuel properties during the NPP lifetime. Automatic data processing reduces the possibility of errors and allows easier implementation of a quality assurance programme.

The software was first created in 1994 as a DOS code in the Clipper programming language using dBase for data storage and later received numerous upgrades, including a rewrite for Windows in Alaska. Now, in 2022, it has been rewritten again in an intranet form, with the interface running in a web browser. The backend of the software is written in the PHP language and uses the SQLite database, while the front end uses HTML/JS/CSS/SVG. It can work on a single computer locally or as an intranet application on the local network. It retains essentially all of the previous functionalities (except for the obsolete ones), but places more emphasis on the graphical interpretation of data, which is welcomed for the better human-computer interaction. Because computers are orders of magnitude faster today than they were decades ago, some tasks, such as calculating isotopic data and decay heat, have been greatly simplified and are now automatic with increased accuracy.

1 INTRODUCTION

This paper describes what the Fuel Assembly Register (FAR) software is, the rationale for the modernization of it, as well as the new features that come with it.

2 QUICK DESCRIPTION OF THE “FAR” SOFTWARE

The Fuel Assembly Register (FAR) software was developed in 1994 for managing the nuclear material accounting needs of the NPP Krško in Slovenia and has been continuously used ever since [1]. At first it was only used to generate IAEA reports (like ICR, PIL, MBR) for the fuel assemblies, but later new functionalities were added, such as:

- an inspection database of fuel assemblies and fuel inserts,
- a database for small nuclear items,
- a database for separate fuel rods,
- EURATOM ENMAS style ICR/PIL reports in XML format,
- SNSA¹ report for spent nuclear fuel's radionuclides,
- direct import of fuel assembly burnup from Beacon format,
- various graphical views,
- support for the spent fuel dry storage,
- connection to SHUFFLE code, to prepare and monitor the fuel loading and unloading sequence into reactor core, forming an integrated eco-system for NPP fuel management [3].

The original software was DOS based, written in Clipper language using a dBase database format. It was later adopted for the Windows by the use of the Alaska language, which is basically a graphical version of Clipper [2].

3 MODERNIZATION

3.1 Rationale

In 2022 it was decided to rewrite the FAR software from scratch and making it an intranet-based web application, so that it can be accessed by multiple users simultaneously. A careful thought has been given to the future maintenance of the software, as it is expected to be used for decades to come. It has been recognized, that Clipper/Alaska language became too clumsy over time and applying more widely used language is essential for continuous technical support in future operations.

The software was also of limited scope at first and somehow organically grew over time. Some options became obsolete, while some were nevertheless retained using clever hacks for backward compatibility. That is why a fresh rewrite with all this in mind is a good idea.

¹ Slovenia's nuclear regulator, Urad Republike Slovenije za Jedrsko Varnost

We must emphasize though, that the old version of the software will be used at least until the next refuelling of the NPP Krško, because all of the planned features have not yet been fully implemented, tested and verified.

3.2 Choice of the programming language

The first choice of the programming language for the rewrite was PHP as it is the most popular backend web development language [4]. It is also very mature and stable language, since it is still possible to run two decades old PHP scripts on modern PHP interpreters with minimal changes or none [5]. PHP is also platform blind and it can run on non-Windows, non-x86 based systems [6]. Therefore, if there will be any switch in platforms in the future, the rewrite of FAR in PHP will most likely handle it with ease.

Newer PHP interpreter versions also feature just-in-time (JIT) compilation, making it also very quick [6].

With the switch from Clipper/Alaska to PHP it was also natural to change the type of the database from XBase to SQL based SQLite.

For the front end, the use of HTML/JS/CSS/SVG technologies was a first choice. There is no need of any javascript libraries, maximizing the future compatibility, minimizing any incompatibilities from libraries' updates and minimize any potential security risk from software updates.

3.3 New features

The main new features are:

- a more intuitive approach of the software, resembling expected behaviour to other programs that handle spreadsheets, like Excel (see Figure 1),
- increased use of right-click context menus to give further choices (see Figure 2),
- increased use of graphical representation of data, like graphs or maps,
- fast generation of graphics that can be generated for the state on any arbitrary date, coloured by various parameters, like burnup, enrichment, etc. (see Figure 3),
- multi-user/multi-computer intranet access,
- seamless one-click integration of Origen to generate SNSA radionuclide reports of spent nuclear fuel.

	Batch	Region	ANSI	IFBA	Obl.	MTU ▼	SNF
1	HH12	8A	LMOLMF	Ø	A	Ø,416992	2007-12-31
2	G17	7A	LMOJND	Ø	A	Ø,416981	2007-12-31
3	HH07	8A	LMOLML	Ø	A	Ø,416792	2007-12-31
4	G20	7A	LMOJNG	Ø	A	Ø,416453	2007-12-31
5	G07	7A	LMOJN2	Ø	A	Ø,416430	2007-12-31
6	G21	7A	LMOJNH	Ø	A	Ø,416401	2007-12-31

Figure 1: Sorting is achieved with one-click.

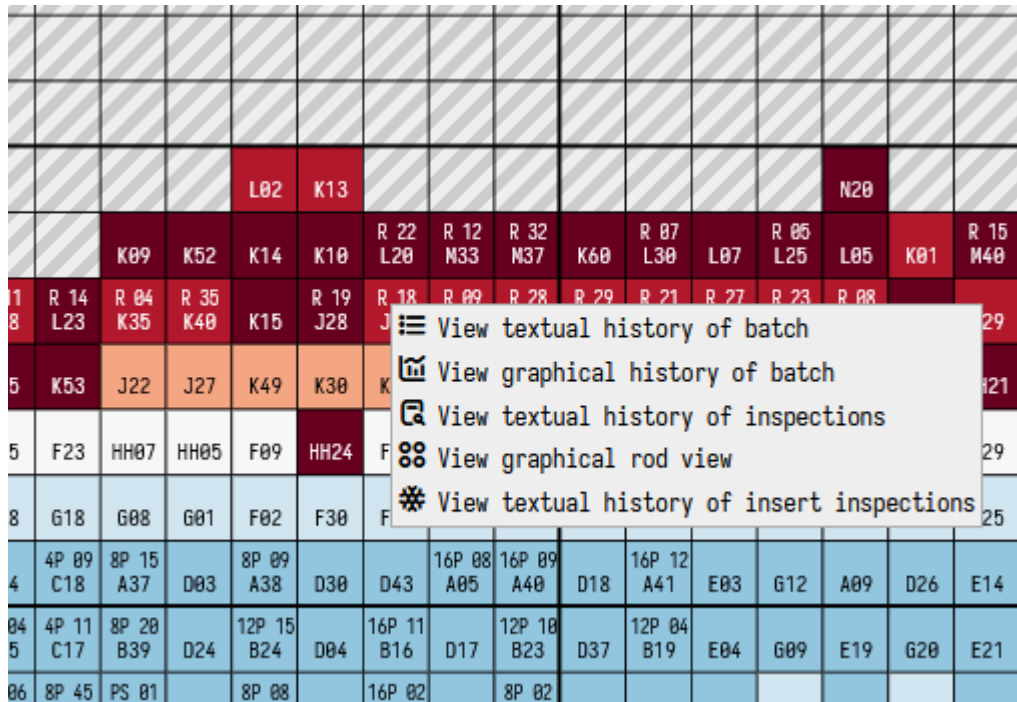


Figure 2: An example of a right-click context menu.

Batches History Inspections Inserts Insp. Small items Rods Cycles Maps ENMAS reports

View core by date

Date: 04 / 11 / 2016

Cycle: 29 start

Color by: Burnup

Location: CORE View

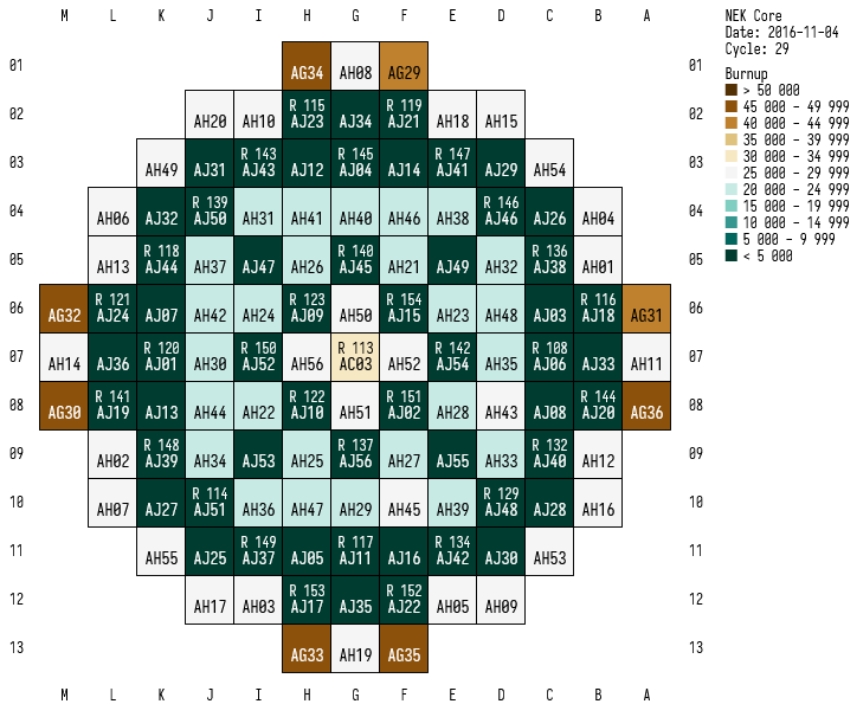


Figure 3: Core burnup view of an arbitrary date.

3.4 Obsolete features

It was decided to delete the support for TOTE input data, since only Beacon data are currently used. Preparation of the IAEA nuclear reports is also removed, since only EURATOM ENMAS style XML reports are needed.

3.5 Future work

After the rewriting of the FAR code, it is planned to renew and modernize also other software in the same software eco-system, like SHUFFLE and combine it into a seamless software package.

Of course before that the new version of the FAR will need to undergo extensive testing and verification to become approved software package of the NPP Krško.

ACKNOWLEDGMENTS

We acknowledge the fruitful discussions and input of the personnel from the NPP Krško Fuel department.

REFERENCES

- [1] S.Slavič, M.Kromar, FAR Software Package for the Nuclear Material Accounting, Annual Meeting of the Nuclear Society of Slovenia, Rogaška Slatina, Slovenia, 18.-21. September 1994
- [2] S.Slavič, M.Kromar, B. Žefran Latest Extensions of the FAR - Software Package for the Nuclear Material Accounting, Nuclear Energy for New Europe 2010, Portorož, Slovenia, 6.-9. September 2010
- [3] S.Slavič, B.Žefran, A.Trkov, M.Ravnik, Program Package SHUFFLE, Regional Meeting: Nuclear Energy in Central Europe, Present and Perspectives, Portorož, SLOVENIA, 13.-16. June 1993
- [4] Usage statistics of server-side programming languages for websites, retrieved at 2022-08-31, https://w3techs.com/technologies/overview/programming_language
- [5] PHP Manual Appendices, sections on Backward Incompatibilities, <https://www.php.net/manual/en/appendices.php>
- [6] PHP 8.0: JIT, retrieved at 2022-08-31, <https://php.watch/versions/8.0/JIT>
- [7] Data Visualization for Human Perception, The Encyclopedia of Human-Computer Interaction, 2nd Ed., Interaction Design Foundation