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IMPLEMENTATION OF A DECISION SUPPORT SYSTEM FOR NUCLEAR EMERGENCIES

Cyrill von Arx[1]

[1] Swiss Federal Nuclear Safety Inspectorate ENSI, Industriestrasse 19, CH-5201 Brugg, Switzerland

Abstract: We present the continuing development and implementation of a decision support system for ENSI's emergency response organisation to be used in case of emergencies in nuclear installations in Switzerland. In the development step presented here, a tool for the assessment of reactor safety and radiation protection topics was created, which includes the use of atmospheric dispersion model simulations.

Key words: *Decision support system, Nuclear emergency, Emergency preparedness and response, Airborne dispersion and dose modelling.*

INTRODUCTION AND OBJECTIVES

Since many years, ENSI not only possesses means and expertise to assess events in Swiss nuclear installations, but equally strives to improve its means and expertise to evaluate the possible dispersion of radioactivity in the environment and the consequences of such dispersion in case of such an event. Accordingly, Swiss law stipulates as ENSI's task in case of an event in a Swiss nuclear installation to not only inform the Federal Office for Civil Protection's (FOCP) National Emergency Operations Centre (NEOC) about the event but to provide assessments, prognoses, and recommendations to the emergency response partners. In particular, ENSI is tasked with advising FOCP and the Federal Civil Protection Crisis Management Board on the implementation of emergency protective measures for the population (EPM). As part of these official duties, ENSI relies on an airborne dispersion model (ADM) to carry out airborne dispersion and dose simulations (ADDS) which serve as basis for recommendations on EPM.

In case of an emergency, an efficient synthesis of available information is crucial for ENSI's emergency response organisation (ERO) to ensure a timely and situation specific response, including recommendations on EPM. From the perspective of our emergency preparedness and response (EPR) partners, the layout, formulation, and presentation of ENSI's assessments, prognoses, and recommendations is of considerable importance. To address these two objectives, we rely on a software-based decision support system (DSS) for ENSI's ERO's reactor safety and radiation protection groups. The limitations of the DSS currently in operation (for an overview cf. von Arx, 2022) has prompted ENSI to initiate a project to replace the current implementation by a new one, using state-of-the-art programming techniques, improve the overall ergonomics, and add a series of new features.

Here we describe the newly developed DSS for these two ERO groups. In a second step, to be presented later, we will expand the use of the DSS to all ERO groups as well as to ERO staff meetings. As part of the continuous improvement drive for our ERO, this endeavour includes digitisation of the mostly paper-based forms used within the ERO and moving from multiple topic-based reports to one consolidated report for our EPR partners after each ERO staff meeting.

DEVELOPMENT AND IMPLEMENTATION

For the ERO reactor safety group, the new DSS provides basically the same, tried and tested layout and functionalities, albeit in a new overall design.

To aid in answering the questionnaire, a new functionality was implemented enabling the user to show relevant plant parameters as time-dependent measurement curves (time series) in a pop-up window, see Figure 1. Previously, these measurement values were only available in a separate application and the user had to search for the relevant parameters. Within the new DSS, there's a button to open a pop-up window right next to the question, which will directly show the relevant parameters. Moving the cursor over the diagram, the value of every parameter is displayed for the time corresponding to the cursor position. Furthermore, the user can selectively hide one or more of the parameters.

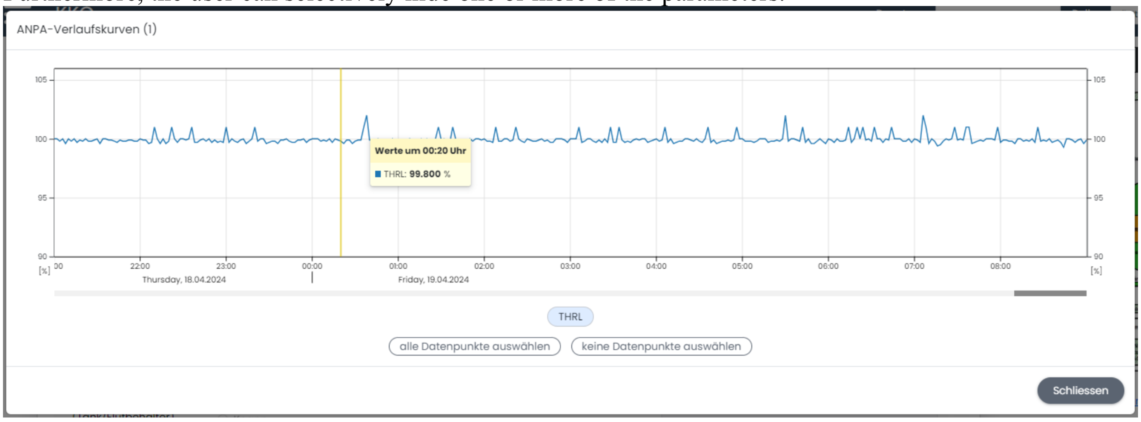


Figure 1: Example of a time series of a plant parameter.

The brief text-based assessment of the event's development since the previous ERO staff meeting has been implemented as a journal with the ability to flag entries containing key information. Concerning information on potential discharges of radioactive substances to the environment, the user interface has been expanded to permit the upload of a source term file created by the operational reactor accident and diagnosis software, which can be read into the ADDS software JRODOS.

As in the currently operational DSS, at the end of each assessment cycle of the reactor safety group, a concise report is generated at the push of a button for the ERO's staff meeting as well as to be uploaded to the national electronic situation overview accessible to all EPR partners.

Regarding ERO's radiation protection group, the new DSS contains a series of changes as well as added functionalities in comparison to the currently operational DSS. The interface for the assessment of results from the ADDS simulation has been redesigned to enable the creation of visualisations of either the areas affected by potential atmospheric radioactive discharges or the EPM recommended by ENSI, both in one place. An example is given in Figure 2. Previously, these two graphics had to be created in separate parts of the DSS. An important new functionality provides the maximum values of the ADDS result displayed in the GIS window within the two emergency planning zones (Precautionary Action Zone PAZ, up to about 5 km from the nuclear installation, and Urgent Protective Action Planning Zone UPZ, up to about 20 km from the nuclear installation), as well as outside the emergency planning zones. Additionally, relevant information of the ADDS, e. g., which weather forecast data or grid configuration was used, is shown via pop-up window. Furthermore, the brief assessment of the weather situation, entered on a different interface, is shown to aid the user in deciding in which areas EPM need to be recommended.

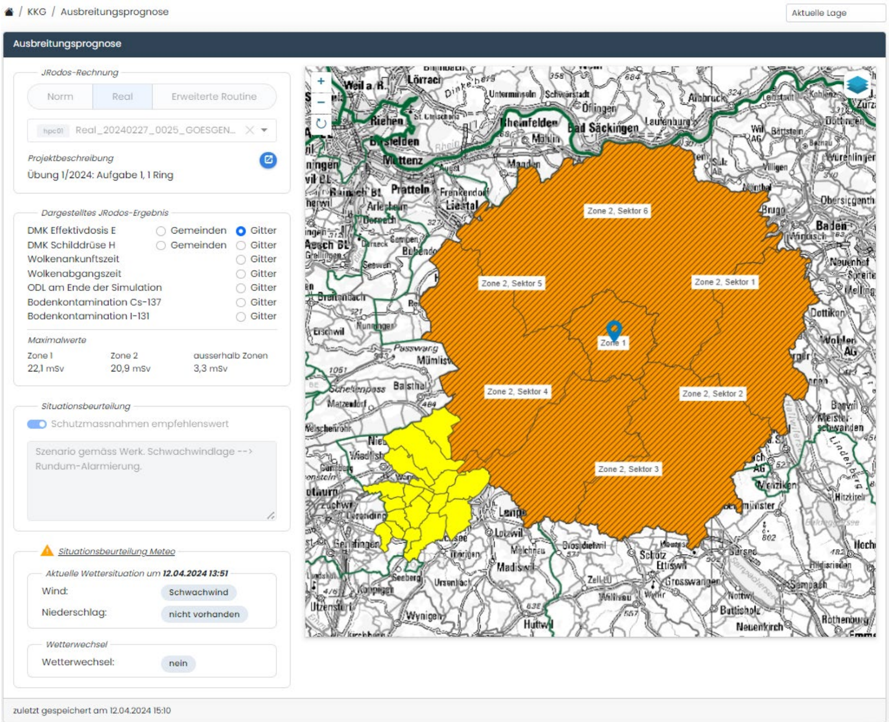
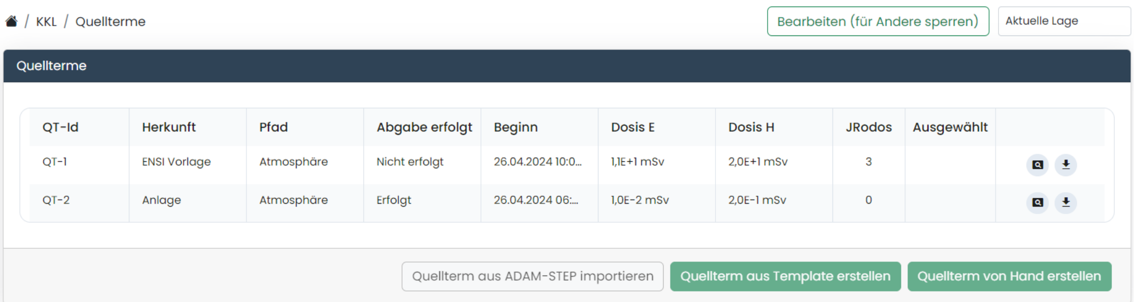


Figure 2: Example of a visualisation of the EPM recommended by ENSI from an exercise.

A new interface has been created for the definition of source terms (ST) and the documentation of instructions regarding ADM simulations. Upon entering relevant ST information, the system provides advice to the user on the kind of ADM simulation(s) to be performed, based on existing guides in the management handbook. This significantly reduces the amount of work currently required to be done all by hand, while still permitting the user to override the system's suggestion. Furthermore, any ST defined in the interface can be downloaded as file to be read into the ADDS software JRODOS, which again reduces the amount of work performed by hand. An example of the ST overview interface is given in Figure 3.



QT-Id	Herkunft	Pfad	Abgabe erfolgt	Beginn	Dosis E	Dosis H	JRodos	Ausgewählt
QT-1	ENSI Vorlage	Atmosphäre	Nicht erfolgt	26.04.2024 10:0...	1,1E+1 mSv	2,0E+1 mSv	3	
QT-2	Anlage	Atmosphäre	Erfolgt	26.04.2024 06:...	1,0E-2 mSv	2,0E-1 mSv	0	

Figure 3: Example of the overview interface for source term documentation.

The visualisation of meteorological parameters relevant for the radiological situation assessment has been redesigned as well, to provide a more easily understandable overview. An example is given in Figure 4. Moving the cursor over the diagram, the value of the meteorological data is displayed for the time corresponding to the cursor position. The new DSS now requires the user to document a brief assessment of the meteorological situation, including information on when to expect the weather to change.

Figure 4: Example of the visualisation of on-site meteorological parameters.

Like the ERO's reactor safety group's functionality for displaying plant parameters detailed above, the ERO's radiation protection group can rely on new functionalities for visualising the emission of radioactive effluents from the site and the values of ENSI's measurement network, both in separate interfaces with similar functionalities.

For the situation assessment performed by the ERO's group on radiation protection, a new interface has been designed, providing the user with the aggregation of relevant information from other parts of the DSS. Apart from a journal functionality, the user has quick access to measurement values relevant for emergency classification. Furthermore, in the event where ADDS have been performed, the user is requested to choose from a list which ST has been used as well as enter an overall situation assessment. In cases where radioactive material has already been discharged and has been documented in the ST interface, the system automatically shows these discharges and provides an overall assessment on whether any site-specific operational limit has been reached. Finally, protective measures for the ERO itself as stipulated by ERO procedures are presented to the user to ensure this aspect is always considered.

Similar to the ERO's reactor safety group, at the push of a button a report is being created, containing all relevant information from the radiological situation assessment as well as an overview of the potentially affected area, recommendations on EPM for the public as well as results from ADDS. This has been completely redesigned and includes all information required in the paper form. Previously, this paper form had to be filled out by hand and the DSS report only provided additional graphics.

Both ERO groups can view each other's current assessments, prognoses, and recommendations inside the DSS, strengthening the internal flow of information and reducing the need for frequent verbal exchanges. This effect cannot be underestimated because stressful situations are prone to lead to misunderstandings. For both ERO groups the DSS further features the ability to go backwards in time during an event, i. e., to load past assessments, prognoses, and recommendations. This feature can be useful during a change in shift personnel or when reviewing the decision-making process after an event.

To provide an overview of the current situation assessment of both ERO groups, a new starting page has been designed, showing relevant information in the form of tiles, where every tile contains the most important information from one interface. An example is given in Figure 5.

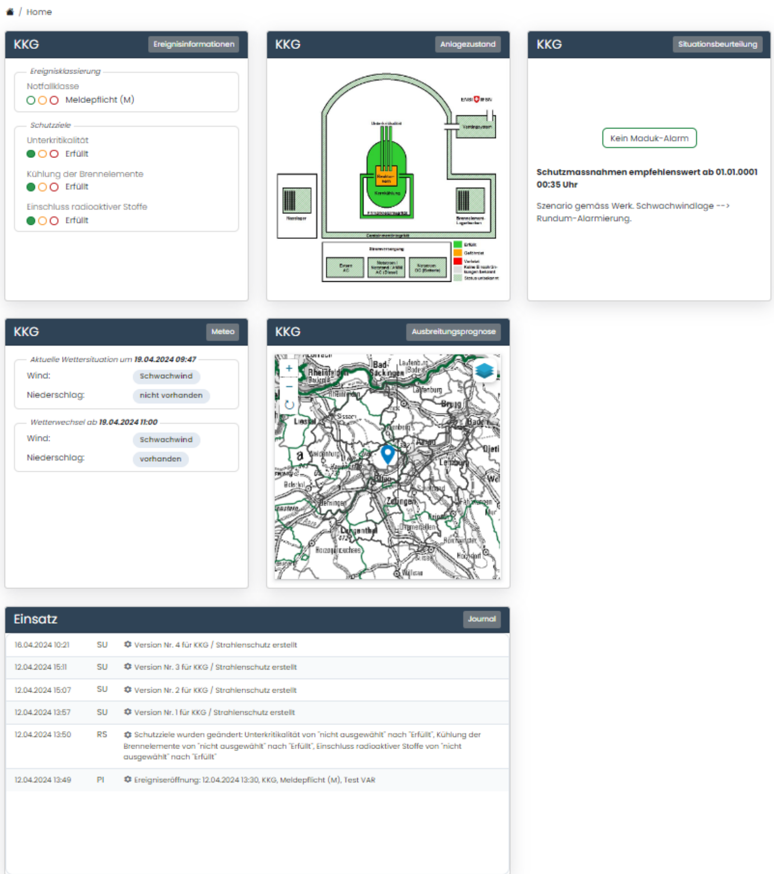


Figure 5: Example of the starting page providing the situation overview.

CONCLUSION AND OUTLOOK

The first deployment of this new DSS will be in the context of exercises planned for autumn 2024. The currently used DSS already had positive effects on both the ENSI ERO's and our external partners' workflow. At the same time, experience gained so far as shown that there is a need for even more extensive automation, semi-automation, and standardisation, parts of which have been followed up on in the new DSS presented here. These aspects will be further considered in the second step, the extension to the entire ERO.

As part of this second step, this digitisation will be extended to all ERO groups as well as to the ERO staff; for redundancy purposes, paper-based forms will be kept in stock. Already pointed out in the introduction, one aspect of this development is the design of a consolidated report published by ENSI's ERO instead of multiple topic-based reports currently produced and published separately by the ERO groups.

As countless nuclear and non-nuclear events in the past have shown, a solid and swift assessment of the situation, a transparent and fact-based decision-making process, and clear and frequent communication in a mutually understandable language are key to an effective emergency response. With ongoing developments presented in this extended abstract, ENSI aims to further strengthen its ERO's assessment, prognosis and decision-making process as well as improve the communication towards our external EPR partners.

REFERENCES

von Arx, C., 2022: Implementation of a decision support system for nuclear emergencies. In *Proceedings of the 21st International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory purposes*, 2022, 221.