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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 development and implementation of a decision support system (DSS) for ENSI's emergency response organisation (ERO) to be used for emergencies in nuclear installations in Switzerland. In a first step detailed here, a tool for the assessment of reactor safety and radiation protection was created; in a second step, a DSS for ENSI's entire ERO shall be established.

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 features means and expertise to assess events in Swiss nuclear installations, but equally strives to improve its means and expertise to evaluate developments of such events regarding consequences for the protection of the population. 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. Assessments are focused on the measures implemented by the operator, their effect on the installation and the event's development, and their suitability for mitigating any off-site impact. Prognoses have to be provided on the development of the event at the installation, the potential discharge of radioactive substances to the environment as well as the consequences of such discharges, including potential doses to the public. In particular, ENSI is tasked with advising FOCP and the Federal Staff for Civil Protection (FSCP) on the implementation of emergency protective measures for the population (EPM). As part of these official duties, ENSI carries 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, as a first step, we developed and implemented a software-based decision support system (DSS) for ENSI ERO's reactor safety and radiation protection groups. In a second step, to be presented later, we will expand this DSS to include all ERO groups as well as 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

Inspired by the IAEA IEC's Reactor Assessment Tool (RAT) with questionnaire and simplified plant graphic, the ERO developed its own questionnaires for the different types of nuclear installations in Switzerland (pressurised water reactors in operation, boiling water reactors both in operation and in the process of dismantling, research reactors, interim storage facilities, etc.). These questionnaires focus on functions and components vital for plant control and the mitigation of an event's impact on the environment.

As such, they permit the ERO's reactor safety group a quick and complete overview and assessment of the current situation. In addition to the questionnaires, simplified plant schemata were developed for each of the different types of nuclear installations, visualising the questionnaire's functions and components as parts of the nuclear installation. By filling in the questionnaire in the digital DSS, the corresponding parts of the plant schema are colourised automatically with signal colours, indicating their condition. An example is presented in Figure 1.

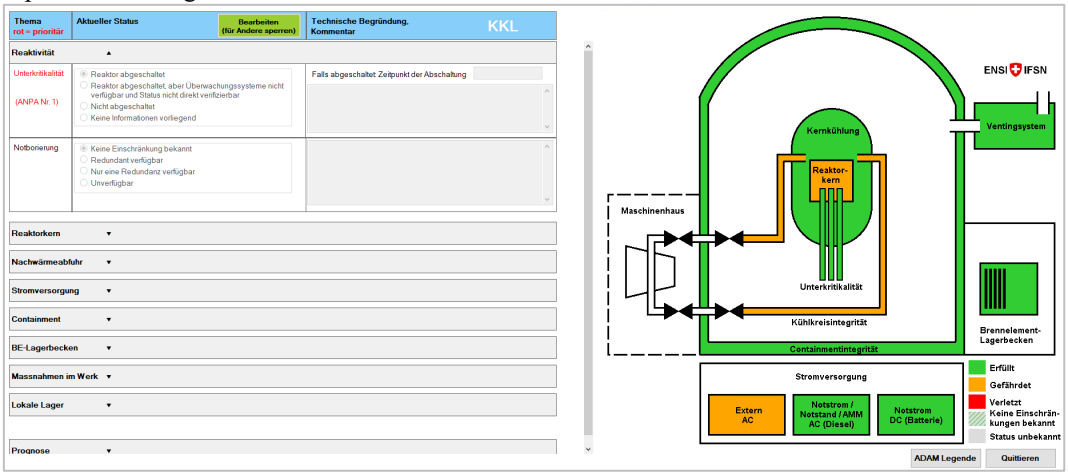
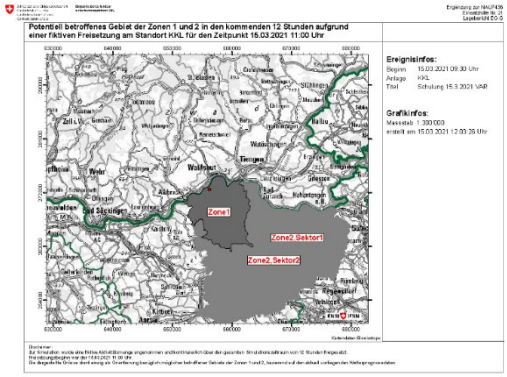


Figure 1: Questionnaire and simplified plant schema for a boiling water reactor.

These simplified plant schemata can then be used to give a concise overview of the plant's condition and they're designed to be readily understood even by non-experts. As such, they form the basis of situation reports during ERO's periodic staff meetings and they're included in the reports provided to ENSI's EPR partners nationally and internationally. During ENSI ERO's assessment and prognosis cycle, the ERO reactor safety group fills in and reviews the questionnaire periodically. Additional parts of the DSS for the ERO reactor safety group accommodate the event category (based on emergency action levels) and the safety objectives as well as a brief text-based assessment of the event's development since the previous ERO staff meeting and information on potential discharges of radioactive substances to the environment. At the end of each reactor safety assessment cycle, 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. With this procedure, ERO has shifted the work mode within the reactor safety group from a paper-based to a digital work mode; paper-based forms identical to the ones generated automatically are stocked to serve as redundancy in case of IT systems failure.

Regarding ERO's radiation protection group, until recently, all products of ENSI's ERO containing results from ADDS had to be created manually in a rather cumbersome process; with the DSS presented here, they can all be created in a standardised format at the push of a button. This greatly reduces the amount of time spent on producing these products and at the same time reduces the probability for human errors. Furthermore, ERO's radiation protection group personnel now have the possibility to create easily understandable graphic visualisations of the areas affected by potential atmospheric radioactive discharges and for EPM recommended by ENSI, both based on ADDS results. For both features, the DSS utilises geographic information system (GIS) plugins to permit a dynamic and ergonomic work process. Examples of such products are given in Figure 2.



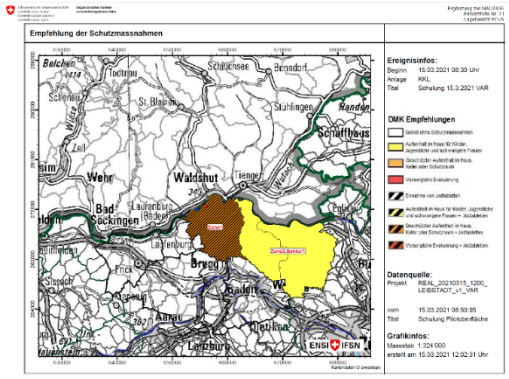


Figure 2: Examples of the products containing the areas affected by potential radioactive discharges (left) and the recommendation on EPM as visualised by colouring the affected areas (right).

In addition, the DSS visualises meteorological parameters relevant for the radiological situation assessment. Similar to the ERO's reactor safety group, at the push of a button a report is being created, containing pertinent meteorological information, an overview of potentially affected area, recommendations on EPM for the public as well as the aforementioned results from ADDS. Even though the ERO's radiation protection group still uses paper-based forms for their presentation during ERO staff meetings, this new report created via DSS is added as appendix to the paper-based form and strongly enhances the communication both internally and externally.

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 verbal exchanges. This effect cannot be underestimated, because these are prone to misunderstandings in stressful situations. 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.

CONCLUSION AND FURTHER DEVELOPMENTS

First applications of this new DSS in the context of exercises have confirmed its positive effects both inside ENSI's ERO and for our external partners. At the same time, they have demonstrated the need for even more extensive automation, semi-automation and standardisation. These aspects will be considered in the second step, the development of the DSS for the entire ERO.

As part of this second step, ENSI envisions the design of a questionnaire and shifting to a fully digitized work process for ERO's radiation protection group. This digitisation shall be extended to all the other 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 situation assessment, a transparent and fact-based decision-making process, and clear and frequent communication in mutually understandable language are the cornerstones of any emergency response chain of command. With the continuation of the developments presented in this extended abstract, ENSI aims to further strengthen ENSI ERO's assessment, prognosis and decision-making process as well as improve the communication towards our external EPR partners.