ENGINEERING DOCUMENTATION AND ASSET MANAGEMENT FOR THE EUROPEAN XFEL ACCELERATOR

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Abstract

During the construction of the European XFEL, detailed technical as-built documentation has been generated for the accelerator. It is stored in an Engineering Data Management System, which provides an inventory of major accelerator components and contains documents such as specifications, 3D-CAD models and drawings, work instructions, inspection and repair records, certificates and more. Inventory and documents are of great importance for maintaining the accelerator throughout its life-time. The paper provides an overview of the available engineering documentation, describes methods of using and updating the documentation, and discusses its expected role and benefits in future maintenance processes.

INTRODUCTION

The European XFEL project team has created extensive technical documentation during the design and construction of the accelerator. It is based on a configuration database, the DESY EDMS, which has originally been introduced for the production of the superconducting cavities and the accelerator modules and has then been extended to cover the whole inventory of accelerator components [1] [2]. The configuration database registers components and their used materials, and it tracks the component design, fabrication and installation history. It contains engineering documents and drawings, and work and inspection records. In the construction project, technical documentation has been driving design, fabrication and quality management processes.

In the upcoming operation phase, the role of documentation is changing. The aim to provide reliable and highly available beams poses strong requirements on operation and maintenance. The technical documentation now has to support processes like asset management, condition and status monitoring, maintenance planning and change management.

The configuration database can be accessed through intuitive web interfaces, with dedicated support for mobile devices in the accelerator tunnel by component tags with QR codes. Numerous tools have been developed for automatically uploading and cross-linking documents, thus reducing documentation efforts for the project teams. The configuration database has performed well in the construction project and now serves as a foundation for operation and maintenance activities.

REQUIREMENTS

In the XFEL construction project, engineering documentation was set up as a central service, which was provided as part of the work package “information and process support”. The work package was created in response to increasing demand from project team and management for standardized tools and procedures to cope with technical documentation. Major requirements included enabling distributed and inter-disciplinary engineering collaboration, supporting quality management, complying with legal regulations, and laying foundation for later operation, maintenance and upgrades [3].

The resulting solution covers all requirements and has been successfully operated during the construction project. It now has to be transferred to the operation phase. While the major demand of the construction project was supporting collaborative engineering, the focus of attention now switches to availability and reliability requirements and the expected longevity of accelerator operation.

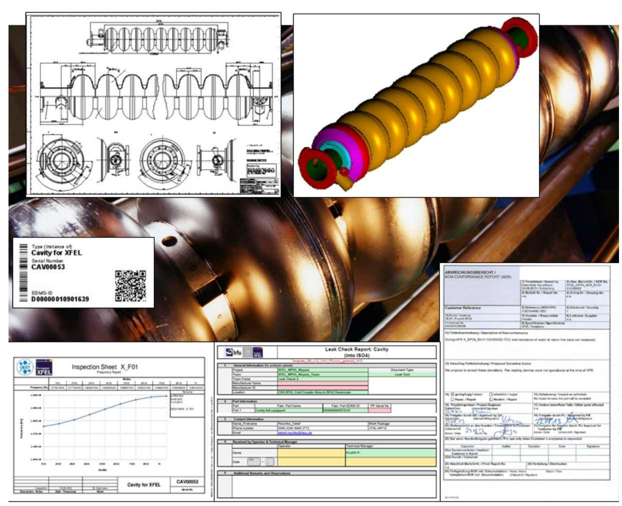

Figure 1: Example for accelerator component documentation, showing design documents (top) and various inspection records (bottom).

Figure 1 shows an example of a well-documented component. Quick and location-independent access to the full accelerator documentation is essential for service (“health”) checks, and maintenance and repair of accelerator components. This is true for both regular maintenance periods and, even more so, for emergency access in

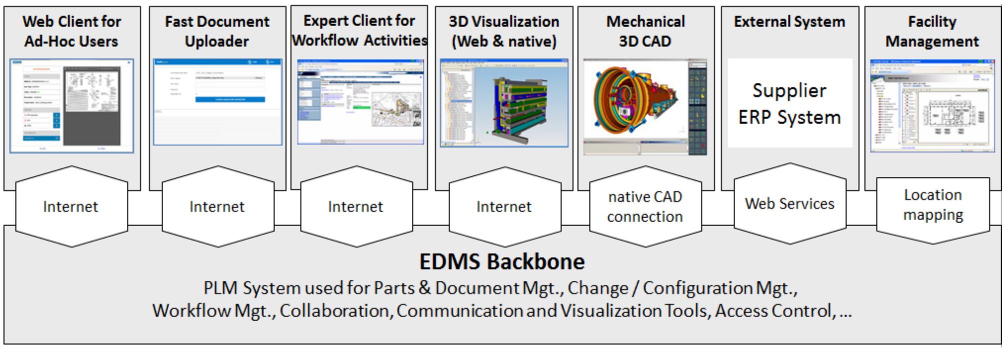

Figure 3: DESY EDMS solution architecture.

case of failure and unexpected downtime. Unavailability of the information in a central online repository may cause longer repair times and as a consequence fewer user hours. The aim is to evolve the technical documentation into a foundation for preventive and predictive maintenance.

Availability of the information over the life-time of the XFEL facility is crucial, including history and change logs. Operations will face staff fluctuations, and the technical documentation should provide enough details and context to enable efficient operation and maintenance work also after more than a decade of operation, which requires keeping the documentation continuously up to date.

SOLUTION OVERVIEW, STATUS AND PERSPECTIVE

A solution for technical documentation based on the DESY EDMS has been provided and successfully operated throughout the construction project. It consists of a configuration database, a number of web-based clients for different user groups, workflows and tools for automating document processing, integration with external databases at partner labs, and data structures and templates for standardizing documentation efforts [4]. Figure 3 highlights the current solution architecture.

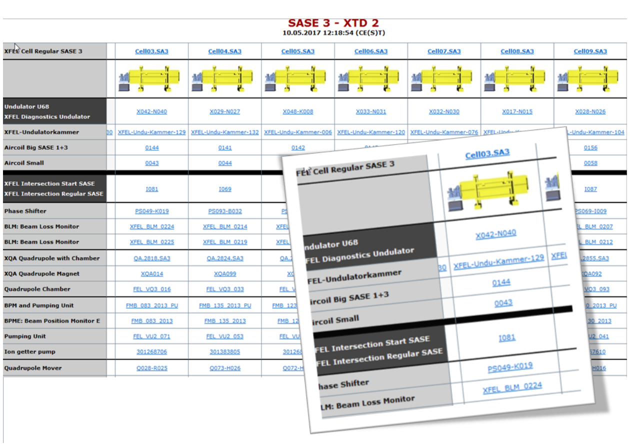

Figure 2: Summary report of XFEL SASE section showing parts inventory with links to further part documentation.

The overall technical documentation coverage of the facility varies. While essential and mission-critical sections and components are usually well documented, the documentation of more conventional components (such as e. g. technical infrastructure) still needs to be post-processed and completed. Figure 2 shows a summary report for quickly accessing inventory and documents of an accelerator section.

The current solution can be directly carried over to the operation phase, but new requirements will need some extensions of the software. Some developments will be within the scope of the current system, such as e.g. additional metadata attributes for capturing component usage information, or for tracking and documenting changes from incidents. Others may require extending the system scope by addressing novel functionality, such as e.g. maintenance planning, but such extensions are already foreseen in the system architecture and will be straight forward to implement with the available concepts.

USING THE DOCUMENTATION

Accessing documentation is the most essential use case for providing required documents whenever and wherever needed. Document access ranges from desktop access by experts, planners or supervisors to fast-response and ad-hoc access by technicians while on the job anywhere in the facility.

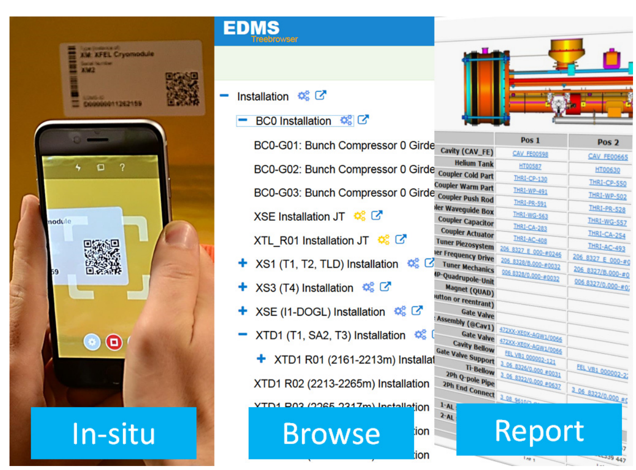

Figure 4: Different methods of accessing technical documentation of the European XFEL.

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Users can access component documentation in-situ by scanning a dedicated QR-code attached to the component. The QR code contains a direct link to the component's EDMS record and its related documentation. Alternative access methods include tree browsers and summary reports of beamline (sub-) sections, and of course a search. All access methods are available for many kinds of mobile and desktop devices and may be used without any user training. Figure 4 illustrates some of the different ad-hoc access methods.

KEEPING THE DOCUMENTATION UP-TO-DATE

Being able to catch any document or information immediately when it occurs is a vital capability for keeping documentation up to date. For this reason, the EDMS offers a variety of easy-to-use input channels.

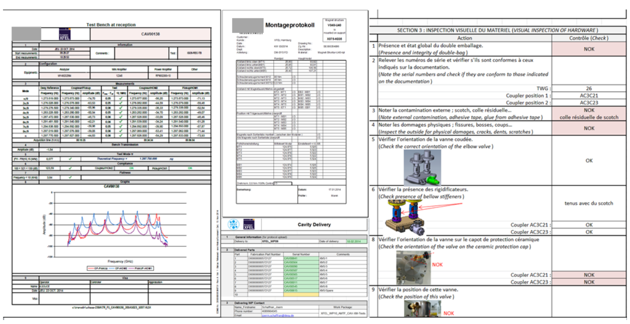

Figure 5: Examples for spreadsheet-based process documentation.

Process users can upload documents through a simple web-page which requires only a file name and user credentials. It works equally well for quality engineers filling spreadsheet-based checklists, or partners providing (scanned) manufacturer certificates, independent of whether they are located on site, at partner labs, or subcontractors in industry. Figure 5 shows different kinds of forms, certificates and vendor documents which were provided during component fabrication.

For even higher throughput, quickly configurable web-services are available for integrating with external databases and information systems. They have been used for example in the series production of the superconducting rf cavities, capturing more than 100,000 documents, an amount which could have no longer been handled without proper automation.

EXPERIENCE

The technical documentation and its supporting systems have evolved into an important ingredient to efficient and effective project work. The most essential applications were using documentation for quick in-process information, leading to better quality of the related work, and using documents to initiate and track workflows.

It is important to provide solutions with immediate practical value and low additional workload for the work packages. Value of documents was typically found in clarifying deliverables, interfaces and responsibilities by agreeing who will provide which information, and thus conduct which activity when; by passing information about incoming components ahead of their delivery; and of course by completeness, reliability and repeatability of document-driven procedures. Low additional workload was achieved by providing central documentation services, including delegating central systems engineers to work packages to help ramping up documentation tasks, and jumping in when additional capacities were needed.

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