USING AN ENGINEERING DATA MANAGEMENT SYSTEM FOR SERIES CAVITY PRODUCTION FOR THE EUROPEAN XFEL

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Abstract

For series production of 800 superconducting cavities for the European XFEL an Engineering Data Management System (EDMS) is in use as a tool for quality control (QC) and quality assurance (QA). DESY is responsible for "in-time" supply of more than 24000 semi-finished products (SFP) of niobium and niobium-titanium alloy. The EDMS as a main repository was set up to fulfil logistic requirements and to guarantee traceability and documentation issues according to the European Pressure Equipment Directive 97/23 EC (PED) [1]. The main aspects consist of complete paperless documentation, fully automated transfer of quality management (QM) documents and data from vendor system to DESY's EDMS, providing to industry an access to relevant documentation and processing of release procedures for acceptance levels and non-conformity reporting. A summary of documentation methods, procedures and first experiences will be presented.

INTRODUCTION

During the negotiation phase for contracting the series fabrication of 800 1.3 GHz superconducting cavities (CAV) for the European XFEL it was decided that DESY has to take over the responsibility of purchasing, QA and "in-time" supply of semi-finished products to the cavity producer according to their manufacturing schedule [2].

The companies RI Research Instruments GmbH (RI) and Ettore Zanon S.p.A. (EZ) were contracted to produce the cavities, each company 400.

Documentation requirements and methods will be described for both fields:

- Semi-finished products.
- Series CAV fabrication.

SEMI-FINISHED PRODUCTS

Requirements on Documentation

For the series CAV fabrication, 12 different types of more than 24000 pieces of SFP (sheets, plates, tubes, and rods) are needed [3]. SFP can be divided into two groups:

- SFP to be used for the production of pressure bearing parts of the CAV (fig. 1) according to the PED. For this type of SFP, the rules according to PED (e.g. full traceability from raw material to the finished CAV as part of pressure equipment) must be guaranteed. It has to be ensured that the cavities' physical requirements will be fulfilled. The use of the EDMS has been qualified successfully by the notified body (TUEV Nord Systems GmbH) according to PED.
- SFP to be used for the production of CAV parts that are not connected to the pressure loaded area of the CAV (fig. 1). For these types of parts, adequate documentation methods have been developed that the requirements of its purchase are fulfilled and the quality of the parts in terms of their functional use of the completed CAV can be guaranteed.

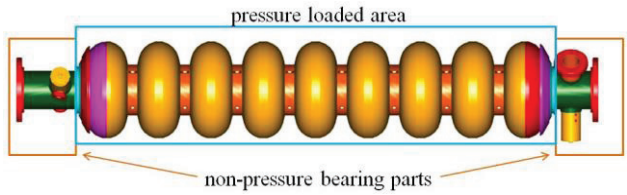

Figure 1: CAV with pressure bearing/non-pressure bearing parts.

The high number of SFP and the strong difference of amount per type of SFP require individual documentation according to the QA procedures, logistic tasks and full process control supported by the EDMS.

Documentation Methods

Three different methods are in use:

- full process control supported by the EDMS for 2.8 mm niobium sheets due to the high number of sheets and the extremely high requirement to quality.
- upload tool for SFP types with amount > 100 up to 2000 parts.
- "by hand" documentation for SFP types with amount < 100 parts.

Fully Process Controlled Documentation

More than 15000 niobium sheets for cell fabrication have been ordered at industry and delivered to DESY.

Due to the high amount and the most complex QA and QC procedure, DESY's IPP group has developed a fully EDMS controlled process (fig. 2) in close collaboration with the QC team to guarantee that all requirements according to PED, QA and logistics issues can be fulfilled.

The process is connected to the EDMS at three work team stations:

- Team "Labelling" for incoming inspection, certificate examination and sheet labelling
- Team "Scanning" for visual examination and eddy current scanning
- Team "Stamping" for permanent marking of the sheets and preparation for its supply to the CAV producer.

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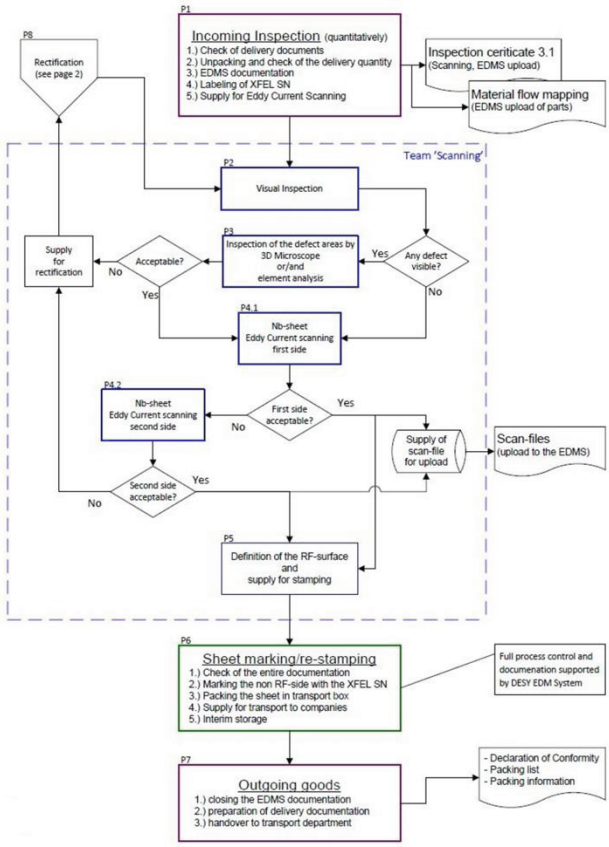

Figure 2: Work flow and QC process of Nb sheets for cell fabrication.

The whole work flow is automatically processed by the EDMS; it is possible to trace the history of any sheet at any time. The work status as well as the location of the sheet can be checked for each single sheet.

SERIES CAV FABRICATION

Requirements on Documentation

Due to the fact that the cavity for XFEL is part pressure equipment according to PED, specific formalities regarding documentation must be fulfilled. Main requirement is to ensure traceability of the finished cavity through following the whole fabrication history back to the raw material and its inspection certificates.

It was decided that DESY wants to perform an external QC procedure in addition to the QA processes that must be performed by the cavity manufactures internally. That requires:

- a fast flow of QM documents to DESY.
- structured and well organized repository of documents.
- an acceptance procedure for checking the quality and releasing the CAV for treatment processes after fabrication.

The EDMS was set up to fulfil all named requirements and was qualified by TUEV Nord Systems GmbH as notified body according to PED.

Quality Management Documents during Series Fabrication

A dedicated selection of QC criteria was defined in the Technical Specification, part XFEL/012 [4]. Test results on dimensional checks, RF-tests, RF-shape accuracy, leak tightness test and visual examination have to be handed over to DESY and data has to be transferred via EDMS to the European XFEL database for QC and statistical analysis.

Automated Document Transfer from CAV Manufacturer to DESY

Due to the high number of reports (table 1) that have to be handed over to DESY during series CAV fabrication, an automated and completely paperless transfer of these QM documents has been developed and implemented.

Table 1: Type of Test Reports per CAV

Test object	Dim. check	RF-test	shape test	leak test	visual test
Normal half cell	X	X	X		
Long half cell	X	X	X		
Short half cell	X	X	X		
Dumb-bell	X	X	X		
End group long	X	X	X	X	
End group short	X	X	X	X	
Cavity	X	X	X	X	X

Both XFEL cavity manufacturers are connected with their internal Enterprise-Resource-Planning (ERP) system directly to the EDMS by using web services created by DESY. That guarantees a fast and continuous flow of documents and data that follows “in time” the fabrication progress. On that way the base requirement to be in position to perform the external QC is fulfilled successfully.

For those QM documents that have to transfer native data to the XFEL database, the use of MS-Excel templates created by DESY was decided. The templates are filled with defined information and data at the manufactures’ site and sent to the EDMS (fig. 3). The EDMS automatically transfers internally relevant documents to the XFEL database.

Other formats e.g. MS Word, PDF are in use and are supported by the EDMS, too.

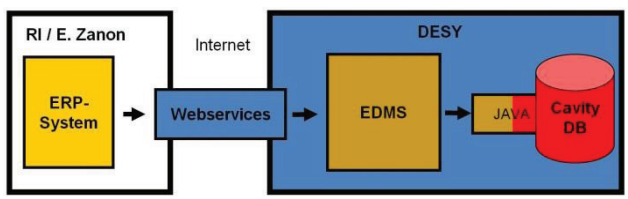

Figure 3: Schema of document transfer.

Cavity Document Structure in the EDMS

The product breakdown structure (PBS) (fig. 4) of the cavity for XFEL is the leading representation for each part of the cavity and the cavity itself in the EDMS [5] [6].

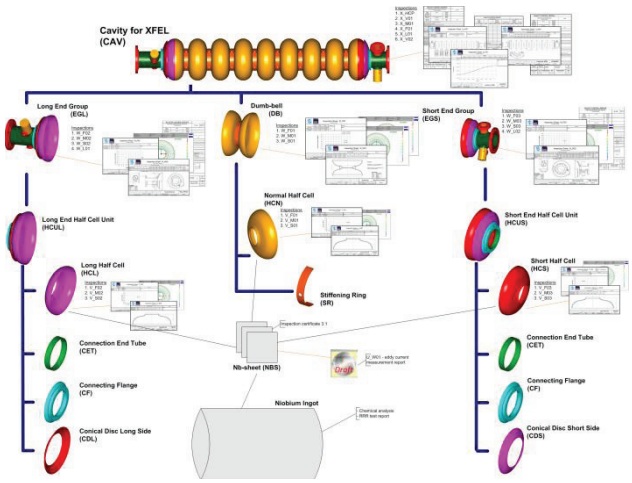

Figure 4: PBS of the cavity for XFEL.

So-called "physical parts" (a data type that in the EDMS represents a part existing in the real world) hierarchically building the complete CAV structure for each existing cavity.

With the receipt of QM documents from the cavity supplier in the EDMS:

- physical parts will be created automatically and the complete structure of each cavity will be built step by step following the fabrication progress
- QM documents will be created and linked automatically and directly to the related physical part.

Acceptance Procedure after CAV Fabrication

Once the cavity manufactures completed a CAV, a contractual hold point is reached and DESY will perform an acceptance release procedure (fig. 5). Without DESY acceptance, a CAV should not be surface treated.

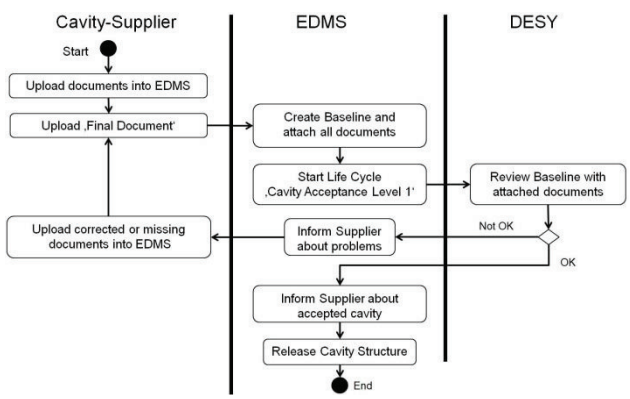

Figure 5: Acceptance release procedure.

The procedure is completely supported and processed by using the EDMS. Based on the uploaded QM documents the cavity manufactures ask for release by sending the so-called "final document" which is starting a life cycle in the EDMS. All documents required for the inspection by the QC team at DESY are collected in a baseline, an EDMS data type that summarizes a set of documents.

This set will be provided by the EDMS to the QC team for inspection. An inspection report will be created and the cavity supplier will be informed about the result afterwards.

EXPERIENCES AND CONLUSION

The EDMS is successfully used since more than one year for the documentation of the semi-finished products and the cavity fabrication for the European XFEL. Thousands of QM documents were transferred from the cavity supplier; about 230 CAV structures have been created and more than 150 CAV have passed the acceptance procedure in the EDMS until today.

The experiences show that the usage of an EDM System for a series cavity production is worthwhile to manage the complex documentation on a reliable way. It guarantees a fast, paperless and well structured storage of documents and supports traceable processes to regulate the QC procedures. It is an indispensable tool for Quality Control and Quality Assurance.

ACKNOWLEDGMENT

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