RELEASE PROCESSES AND DOCUMENTATION METHODS DURING SERIES TREATMENT OF SRF CAVITIES FOR THE EUROPEAN XFEL BY USING AN ENGINEERING DATA MANAGEMENT SYSTEM

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Abstract

For the European XFEL more than 800 superconducting cavities need to be treated. At least 65 quality documents per cavity have to be emitted and transferred to DESY by the vendor; two acceptance levels must be passed successfully to release a cavity for transportation to DESY. All quality documents, non-conformity reports and acceptance levels are automatically processed by using DESY's Engineering Data Management System (EDMS).

We summarize documentation methods, document transfer procedures, review and release processes; we describe the exchange of process information between customer and vendor; and report about experiences.

INTRODUCTION

Two companies, RI Research Instruments GmbH (RI) and Ettore Zanon S.p.A. (EZ) were contracted to fabricate and treat 800 1.3GHz superconducting cavities which are needed for the European XFEL Linac. Company EZ decided to apply the so-called "BCP Flash Scheme" for the 400 cavities contracted, while the company RI has chosen the "Final EP Scheme" to treat 400 cavities in accordance to DESY's Technical Specification for series surface and acceptance test preparation [1].

Due to the fact that such a huge amount of cavities never have been treated by the industry before in the history of SRF, DESY experts decided to implement an intensive Quality Management (QM) concept to ensure that all cavities will fulfil their requirements as specified.

REQUIREMENTS ON DOCUMENTATION

According to European Pressure Equipment Directive (PED) [2] the cavities for XFEL are pressure equipment and therefore specific formalities regarding documentation must be fulfilled. Main requirement is to ensure traceability of the delivered products, the cavity full equipped, through its complete fabrication and treatment 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 as contracted by EZ and RI internally. That requires:

- structured and well organized repository of documents.
- a fast flow of QM documents to DESY.
- an acceptance procedure for checking the quality and releasing the cavities for AL1 [3], AL2 and AL3.

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

QUALITY MANAGEMENT DOCUMENTS DURING SERIES TREATMENT

A dedicated selection of QC criteria for both process schemes was defined for each treatment sequences "BCP Flash" and "Final EP".

Technically all QM documents to be transferred to DESY's EDMS can be separated in two different kinds.

- Templates created by DESY using MS Excel and provided to the cavity supplier.
  Inspection sheets created based on these templates include data of test results on dimensional checks, RF-tests, etc. They are transferred by this type of documents into EDMS and forwarded to the European XFEL database for QC and statistical analysis.
- Company internal templates like leak tightness test reports, visual test reports, conformity certificates, etc.
  Documents created from these templates are accepted with its original file format or scanned to PDF and transferred into DESY's EDMS.

Depending on the treatment process scheme 63 or 65 QM documents for each single cavity had to be created and transferred into EDMS. At the end of the production the total number of QM documents will be higher than 51,000.

AUTOMATED DOCUMENT TRANSFER FROM CAVITY SUPPLIER TO DESY

Due to the high number of reports that have to be handed over to DESY during series treatment of cavities, an automated and complete paperless transfer of these QM documents was developed and implemented.

Both cavity suppliers are directly connected with their own Enterprise-Resource-Planning (ERP) system to the EDMS by using web services created by DESY (Fig. 1). That guarantees a fast and continuous flow of documents and data that follow "just in time" the treatment progress. On that way the base requirement to perform the external QC is fulfilled successfully.

A precise naming convention was created for all files which had to be transferred to DESY and for all QM documents which were created in the EDMS by the incoming files. The naming convention is the result of an

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intensive common work and agreement with both cavity manufacturers.

Upload scripts for each type of document were programed by DESY experts. The scripts hold following basic functions:

- they are creating QM documents in the EDMS by using specified names, descriptions and abbreviations from the convention list
- the files, transferred by the cavity supplier to the EDMS will be connected to the QM document
- the QM documents are connected to the parts structure

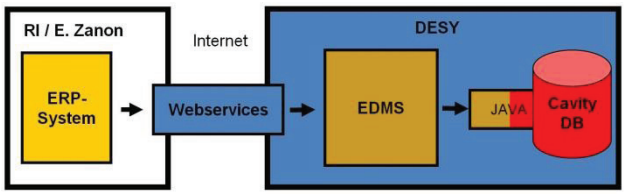

Figure 1: Scheme of document and data transfer.

Product Breakdown Structure and Relation to Documents

The product breakdown structure (PBS) is the leading representation in the EDMS [4, 5] for each part of the cavity up to the delivery product which is the cavity full equipped.

The PBS for the documentation of treatment steps is consisting of four cavity types:

- Cavity for XFEL (CAV), cavity without helium tank (HT) parts.
- Cavity with ring end bellow (CAV_RB), cavity with transition rings for HT connection.
- Cavity in helium tank (CAV_HT), cavity after HT integration, mechanically finished.
- Cavity full equipped (CAV_FE), cavity equipped with accessories, treated ready for the vertical acceptance test at 2 K at DESY.

These so-called "physical parts" (a data type that in the EDMS which represents a part existing in the real world) complete the PBS for each cavity manufactured.

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

- physical parts will be created automatically
- QM documents will be created and linked automatically and directly to the related physical part.

By this way of document handling a structured repository of all incoming documents is realized.

ACCEPTANCE LEVEL RELEASE PROCESS

Acceptance Levels

Three Acceptance Levels (AL) have been defined and the specified as contractual hold point.

- AL1 is releasing the cavities for the surface treatment after the fabrication without HT parts is finished.
- AL2 is releasing the cavities after the cavity is dressed with a HT and all requirements regarding to the PED are fulfilled.
- With AL3 the XFEL expert team is releasing the cavities for transportation to DESY for the vertical test after all treatment steps have been performed successfully.

Review Teams and Reviewing Duration

Five review teams were established; each team consists of at least two experts to perform QA checks for different fields by reviewing QM documents related to "treatment", "RF", "vacuum", "PED/HT" and "conformity". Four review teams are working for AL2 and for AL3 too.

In order not to break the continuous production flow and to keep the delivery schedule, the reviewing duration was limited to 2 working days in common agreement with the cavity suppliers. When the review could not be finished within this duration an automatic release of each AL took place.

Release Processes

Once the cavity suppliers finished the treatment up to AL2 or AL3, a contractual hold point is reached and DESY perform an acceptance release procedure (Fig. 2). Contractually it's not allowed to proceed working on cavities without AL2 or AL3 acceptance.

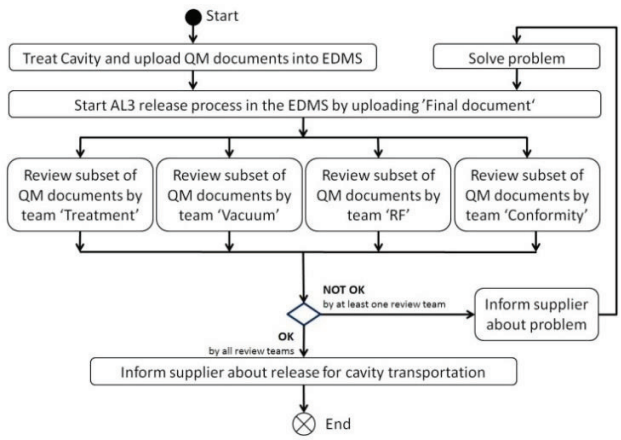

Figure 2: AL3 release process exemplary.

The procedure is completely supported and processed by using the EDMS. Based on the QM documents which were transferred to the EDMS, the cavity suppliers ask for AL2 or AL3 release by sending the so-called "final document" which is starting an AL life-cycle. All documents required for the inspection by the QC team are collected in "baselines", an EDMS data type that summarizes a set of documents.

Such a set is provided by the EDMS to the review teams for inspection. An inspection report is created and the cavity supplier is informed about the result via e-mail by the EDMS automatically and immediately.

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A rejection by one review team leads to a full rejection of the AL. The cavity suppliers are informed immediately and the treatment on the affected cavity has to be stopped. The problem needs to be analyzed, solved and the review process has to be repeated.

CAVITY NON-CONFORMITY HANDLING

Non-conformity Reporting

According to the technical specification, a non-conformity report (NCR) has to be emitted by the cavity supplier to DESY if required (individual) properties couldn't be reached. Any deviation from the specification has to be reported by such a document. The report needs to include a unique report number, the serial number of the affected part and a detailed description of the non-conformity as well as a proposal for its corrective action.

NCR Life-cycle Description

Cavity suppliers are using their own template to create a single NCR. This report is uploaded to the EDMS by a simple upload tool which is provided by DESY.

An upload script is creating an NCR-type document in the EDMS and connects the uploaded file to the NCR-type document which additionally is connected the cavity parts structure. Finally the script starts the Cavity non-conformity life-cycle (Fig. 3).

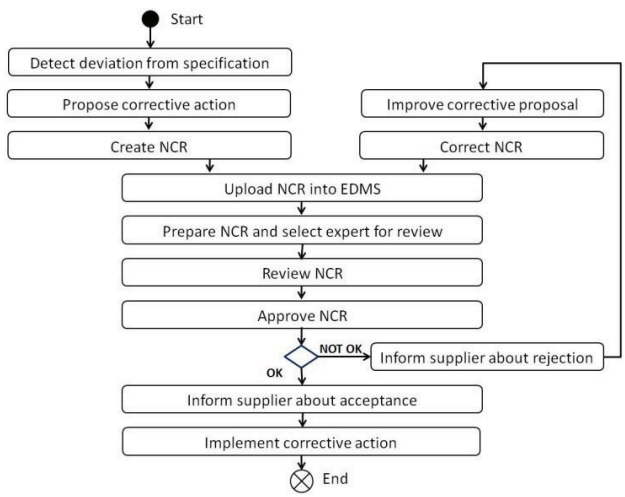

Figure 3: Cavity non-conformity life-cycle.

Three levels of document check at DESY are passed until the decision about the proposed corrective action is transferred back to the cavity suppliers.

1. Prepare NCR by distributor
   The NCR document is provided by the EDMS to the distributor who evaluates the non-conformity and decides which expert has to review the NCR depending on the area of expertise. A review of the non-conformity is not done by the distributor.
   After the preparation and the assignment of the NCR document by the distributor, the EDMS transfers the document to the reviewer chosen by the distributor.
2. Review NCR
   The reviewer is evaluating the non-conformity and proposes a decision to the proposed corrective action. After his assignment, the EDMS transfers the document to the approver.
3. NCR approval
   The approver is taking the final decision after evaluating the non-conformity and takes into consideration the proposal of the reviewer.

Immediately after the assignment by the approver, the information of the result is sent out to the cavity suppliers by the EDMS via e-mail.

The run-time of the Cavity non-conformity life-cycle is limited to 5 working days.

EXPERIENCES AND CONCLUSION

The described documentation methods, acceptance release processes and NCR life-cycle are successfully used since more than two years for the cavity fabrication and treatment for the European XFEL. Based on that, thousands of QM documents of treatment steps were transferred from the cavity supplier to DESY and more than 700 cavities passed the acceptance procedures until today.

The experiences show that for a series cavity production, the usage of such processes supported by the EDMS is worthwhile to manage the complex documentation in a reliable way. It guarantees a fast, paperless and well structured storage of documents and supports traceable processes to manage the QC procedures. It is indispensable for Quality Control and Quality Assurance for a series cavity production, especially when the rules of PED regarding traceability have to be followed.

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