PROGRESS AND EXPERIENCES OF SERIES PRODUCTION OF HELIUM TANKS WITH DESY AS A SUBCONTRACTOR FOR RI

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Abstract

DESY act as a subcontractor for helium tanks, for one of the cavity manufacturer in charge, for the XFEL cavity production. Here the full responsibility of production, quality and warranty of these parts is at DESY. Therefore on 400 out of the total of 800 helium tanks, DESY has to set up a logistic of incoming inspection, documentation, storage and distribution. Special effort is made to archive a free of doubts interconnection and integration of the cavity into the helium tank. After more than 300 units produced a review and statistic is provided.

INTRODUCTION

For the European XFEL project two companies are in charge to provide 824 superconducting cavities, 412 cavities each [1]. The complete fabrication and surface treated of these cavities is done by industry according to XFEL specification. After finalizing the surface treatment and integration into the helium tank, the resonators are handed out to DESY in the status ready for acceptance test and string assembly. The two companies, contracted for fabrication and surface treatment are E. Zanon S.p.A. in Schio Italy (EZ) and Research Instruments in Bergisch Gladbach Germany (RI).

One step of the cavity production line is the completion of the cavity with the helium tank. E. Zanon was contracted to manufacture also the helium tanks for their own cavity production. For the RI cavity production the helium tanks are provided by DESY.

Basing on a European call for tender; DESY ordered in total 272 helium tanks at the company C.S.C S.p.A. in Schio Italy (CSC) and 146 helium tanks at EZ.

INCOMING INSPECTION

From April 2012 to September 2013, 300 so called helium tank kits (HTkit) consisting of helium tank (HT), bellow unit (BU), reduction ring (RR), sliding collar (SC) and adapter (AD) were manufactured. After delivery the components of the helium tank kit are tested on a special designed control device at DESY. After the incoming inspection the helium tanks are stored or supplied directly to RI.

Due to the complicated measurement, the big amount of captured parameters and a requested production rate of up to 28 units per month, the quality control department of DESY, responsible for all DESY incoming inspections of mechanical products, were not able to cover these additional inspections.

Therefore the workshop of the DESY department MKS-3 carried out the work of receiving, storage, testing and prepare for shipment of helium tanks.

Control Device

To minimize the cost and time for measuring a special control device (CD) (Fig. 1) is developed in cooperation with “Horst Witte Gerätebau Barskamp KG”. The incoming inspection, as designed by DESY, can be done by semi-skilled worker within half an hour. For application of a 3D measuring device people need to be trained very well and approximately 2 hours are needed for this measurement.

The CD fixes the helium tank at the machined diameters at the end of the tank tube and gives the reference for the measurement. Four dial gauges at each bracket measure the correct position. For testing the parallelism and evenness of the bracket the dial gauges can slide back and forth. Errors at the parallelism or evenness result in a movement of the index of the dial gauge.

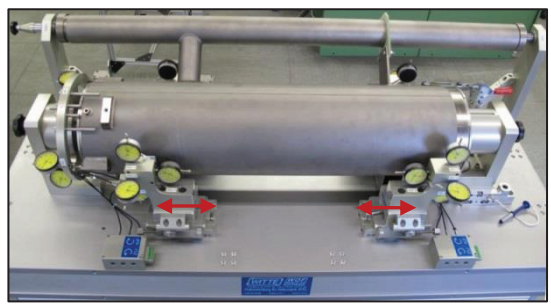

Figure 1: Control device with helium tank on place.

The correct position of projecting edges, ribs and pins can be measured by sliding a wheel with dial gauges and gauging jigs onto the welded attachments of the helium tank (Fig: 2 and 3). If the parts are on correct position the wheel can be moved without stagnating. For parts that are displaced, the jig will stagnate at the wrong position of the attachment. Also for the helium service pipe gauging jigs show if the position is correct or displaced.

Figure 2 and 3: Wheel with dial gauges and gaunging jigs.

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Diameter Gauges

For checking the diameters of the helium tank, bellow unit, reduction ring and sliding collar, hardened steel gauges (Fig.: 4) are designed, were relevant dimensions are defined by incorporated steps. The rings are machined with the minimum respectively maximum allowed tolerance of the part to be tested. The application of gauges guaranties that during assembly of helium tank components to a cavity the parts always fit together perfectly.

Figure 4: Gauges for checking diameters of bellow unit, reduction ring and sliding collar.

Master Piece

A "master helium tank" (Fig. 5) machined with very high precision allows to calibrate the dial gauges at the control device. Whenever needed the master can be set into the control device and re-calibrate the dial gauges and the other gauging elements. This ensures a stable and redundant measurement.

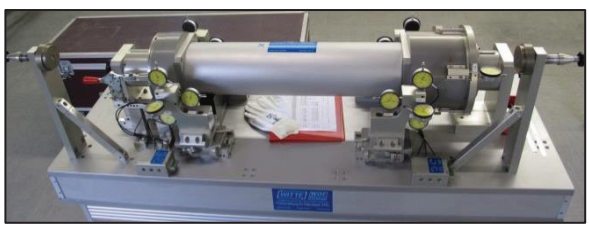

Figure 5: control device with master on place.

Storage

A rack (Fig. 6) was installed for an easy and fast asses to the helium tank components. Also a lifter was setup to obtain an easy handling of helium tanks. A colour code at the positions at the rack shows the status of the inspection.

- Blue: entrance, not tested
- Light green: tested, not approved
- Dark green: approved and ready for shipment
- Yellow: wait, quarantine
- Red: not ok, send back

Figure 6: Storage rack with helium tank and lifter.

STATISTICS

Until September 2013 300 helium tank kits are tested. With the control device and gauges about 62 characteristics are taken for each helium tank kit, resulting in a total of 18.600 characters tested with the control device and gauges so far. 126 non-conformities were detected and the parts were send back to the company for repair (Fig. 7). 90% of these non-conformities are related to the diameter of reduction ring or bellow unit (Fig. 8). 13 non-conformities detected, are related to a wrong position of bracket, dents in the bellow, or other defects (Fig. 9).

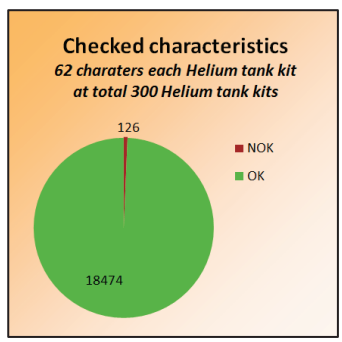

Figure 7: Graph of checked characteristics.

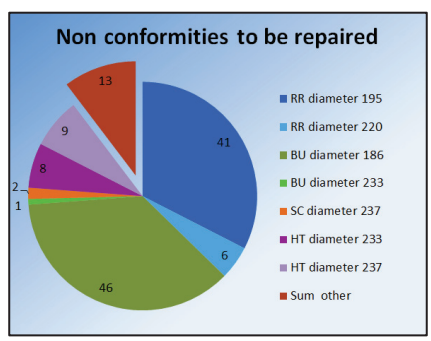

Figure 8: Graph of non-conformities.

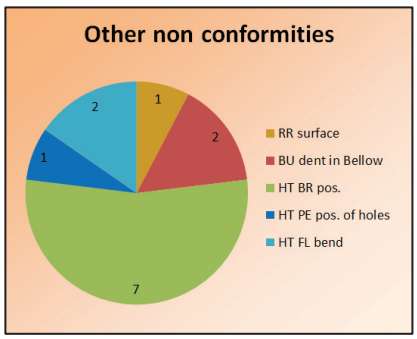

Figure 9: Graph of other non-conformities.

DOCUMENTATION

The DESY "engineering data managements system" (EDMS) is applied for receiving the manufacturers documentation and storage of the incoming inspection reports. A script was written to upload all documents to EDMS and automatically build relations to the individual components.

With the first upload of the manufacturers' documentation, which consists of reports of radiographic testing, leak testing, mechanical measurements, material certificates and other documents, the physical parts are created in the EDMS. In the second step the TUEV reports are attached to the physical parts. At third step the DESY incoming inspection report is uploaded. The report will be also attached to the physical part and changes the status of the physical part from working to released.

A traceability report outlining the information, which helium tank components and their identification numbers are attached to a cavity, is emitted by Research Instruments.

The EDMS automatically identifies the serial numbers of the traceability report and build up the cavity structure. Searching for a cavity number links you to all attached components with all relevant documents and full traceability is assured (Fig. 10).

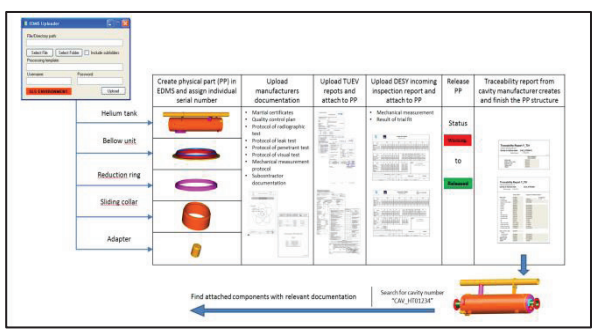

Figure 10: Appling the EDMS for documentation.

PROPOSAL FOR IMPROVEMENTS

As it was expected for the start-up of a series production more non-conformity were detected than in the running production. After a ramp up phase the non-conformities were reduced to zero. In table 1 the critical factors and findings of the production and proposals of improvements for further production are given.

Table 1: Critical Factors and Findings of the Helium Tank Production

Critical factors and findings	Improvements
Diameters for interconnection	check carefully
Axial position of brackets	extend brackets length
Assembling filling line for welding	open slot in mounting plate
Weld connection of filling line to tank tube	re-design connection
Position of service pipe	extend tolerance due flexible position
2mm wall thickness at the end of service pipe	use 2,3mm sheet for service pipe tube
Redundant measurement	agree to procedure
Borehole projection edges	increase diameter to 11mm
Drawing 02L 01	split into two drawings: - welding - final machining review of tolerances
Analysis of minimum penetration depth of all weld	

SUMMARY

DESY act as a subcontractor for helium tank kits for the cavity production at Research Instruments. An order of 418 XFEL helium tank kits is placed to industry and these tanks are provided to RI. Up to now 300 helium tanks have undergone the incoming inspection. The applied control device and gauges give clear and doubtless results and were accepted by the companies as a reference tool. During a ramp up phase the non-conformities could be eliminated. 80 helium tank kits were provided to Research Instruments and the integration of cavities into their helium vessel happens without problems so far.

REFERENCES

[1] W. Singer, at al.: "The Challenge and Realization of the Cavity Production and Treatment in Industry for the European XFEL.", MOIOA03, this conference.

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