



## **Surveillance of quality assurance in the manufacture of spent fuel and HLW transport and storage casks**

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### **Abstract**

The purpose of quality assurance measures in the manufacture of packagings for radioactive materials is to ensure that the series sample conforms to the design that was authorised in the design approval certificate, and fulfils all the required qualities.

In Germany, the basis of this process is the TRV 006 (Technical Rules Traffic). This describes the requirements on the manufacturer and a system of supervision for the production process.

Packaging components are divided into 3 classification levels according to their importance for safety. Compliance with the requirements of the highest classification level is supervised directly by the Federal Institute for Materials Research and Testing (BAM) as German competent authority or consulted experts to a high extent.

In the lecture, an example will be given for the qualification of a foundry for the production of cask bodies made of ductile cast iron. The results will be presented.

Production based on the parts list and drawings stated in the design approval certificate for the package is supervised and documented by a quality assurance program. This is pre-checked and released by BAM. For all non-conformances in manufacturing, non-conformance reports have to be issued by the manufacturer and evaluated by BAM. These are itemised in the acceptance certificate, which certifies the conformity of the series sample with the approved design.

Details of this supervision system, experience of several hundred manufactured casks and results will be presented.

### **Introduction**

The production of transport and storage casks is performed on the basis of the design approval certificate of the Federal Office for Radiation Protection (BfS). The approved design is described entirely by drawings and parts lists as well as applicable specifications.

The Technical Rule concerning measures for quality assurance and quality control for packaging for the transport of radioactive materials (TRV 006) defines requirements for production. Employees of TÜV Rheinland are entrusted with supervision of compliance of the measures as consulted experts of BAM. In the case of transport and storage casks for spent fuel and HLW, cask components are generally manufactured by sub-suppliers of the approval holder.

The essential elements of quality assurance are

- the quality management system of the manufacturer and
- a quality assurance programme adapted to the scope of production.

The essential responsibility for quality assurance and the execution of packages in accordance with the approval are the responsibility of the manufacturer.

The extent of external supervision depends on the safety importance of the components.

This is divided into 3 classification levels:

Class 1: Components that have a direct influence on integrity / leak tightness of cask, subcriticality and shielding.

- first qualification and monitoring of the manufacturer and also sub-suppliers by BAM in relation to the QM system and the manufacturing processes on the basis of specifications,
- manufacture and documentation on the basis of manufacturing and test plans (MTPs),
- checking and approval of all relevant documents by BAM,
- non-conformance reports have to be accepted by BAM (and BfS for subcriticality/shielding).

Class 2: Components that have an indirect influence on integrity / leak tightness of cask, subcriticality and shielding

- as class 1 components, but without monitoring by BAM (except non-conformances).

Class 3: All other components

- self-regulation by manufacturer.

## **Qualification and Supervision of Manufacturers and Sub-suppliers**

TRV 006 requires the manufacturer to employ a quality assurance system that is adapted to the requirements of packages for radioactive materials. Certified quality management systems according to ISO 9001 are now the general rule. A specific quality assurance programme for the production and testing of the product is still required depending on the production scope of the manufacturer – complete packages or components thereof.

The qualification of manufacturers of packages and components of classification level 1 is monitored by BAM in the form of audits. In the case of sub-suppliers, auditing is carried out in conjunction with the buyer. A period of 2 years is presently defined by BAM for the supervision of the manufacturer's qualification.

These audits focus on the quality management system and the general circumstances at the manufacturer and especially on:

- human resources and infrastructure
- product realisation
- measurement, analysis and improvement.

Monitoring of the quality assurance programme is geared towards the requirements of the production scope. It must contain written specifications for all quality-relevant stages. In the case of sub-suppliers, the interfaces to the system of the buyer must be taken into account.

In the case of particularly technically complex products with high relevance for the safety of packages, the manufacturer must provide evidence that the production process is safely under control.

In the following, an example is given based on the qualification of the production process for bodies for transport and storage casks of type Castor HAW 20/28 CG of ductile cast iron as cask components of classification level 1.

In the case of the sub-supplier of the approval holder, the production of the cask body was partially relocated to another production facility. Relocation involved the use of different smelting and casting technology. Accordingly, new evidence had to be provided that the required properties as described by the material specification were reliably guaranteed in the entire casting.

The first three castings produced with defined, described technology were subjected to considerably more intensive examination than the acceptance tests in series production provide for.

From the cask bodies were taken 4 hollow drill samples in the longitudinal axis at the position of the holes for the moderator material and 2 coupon samples on the bottom.

From the 3 casks, a total of 39 chemical test samples, 39 microstructure test samples and 384 tensile test specimens were analysed in the accredited test laboratories of the manufacturer as well as of TÜV.

Chemical analysis and microstructure met the requirements of the underlying material specification without reservation and yielded no irregularities.

The results of the tensile tests are shown in summarised form in figs. 1 to 3. Tensile strength, yield strength and elongation are well above the specified requirements and reveal good regularity of the mechanical properties over the cask body. None of the test specimens failed.

Process capability analyses carried out by the manufacturer showed that the process capability in respect of mechanical properties is guaranteed, with process performance indices lying between 1.37 for elongation and 5.35 for tensile strength.

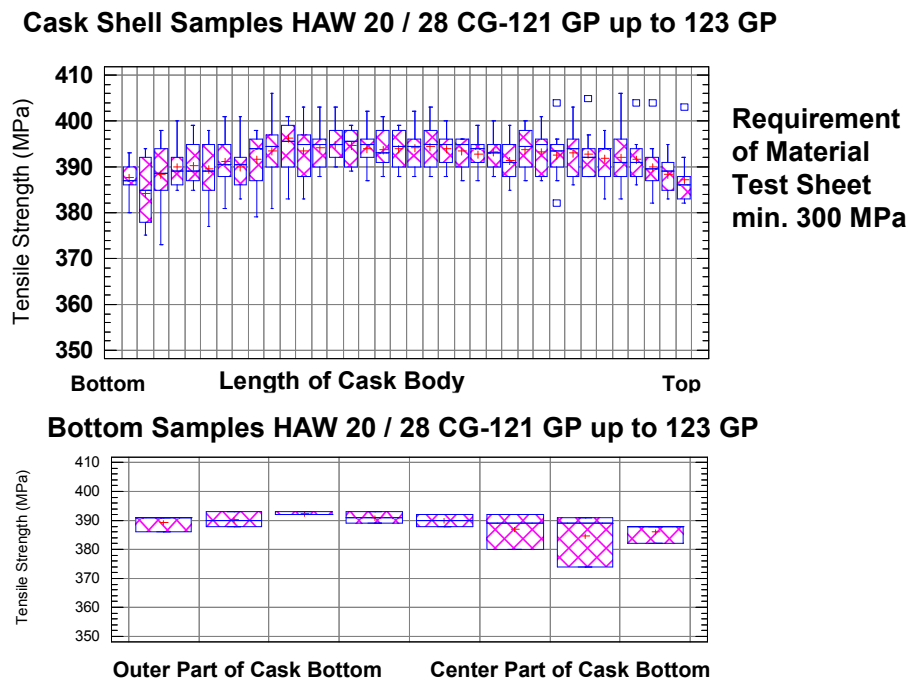
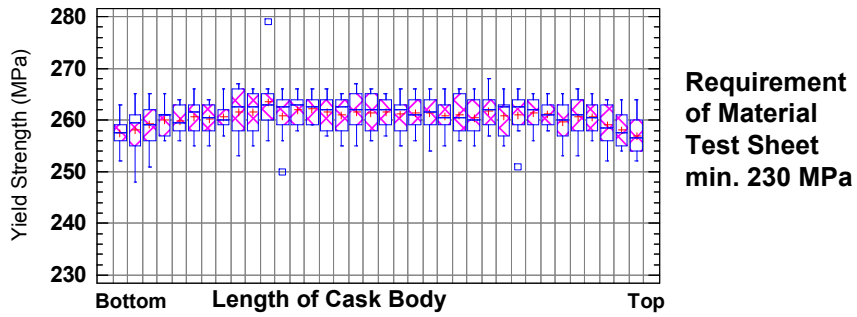


Fig. 1, Tensile Strength of shell and bottom samples

**Cask Shell Samples HAW 20 / 28 CG-121 GP up to 123 GP**



**Bottom Samples HAW 20 / 28 CG-121 GP up to 123 GP**

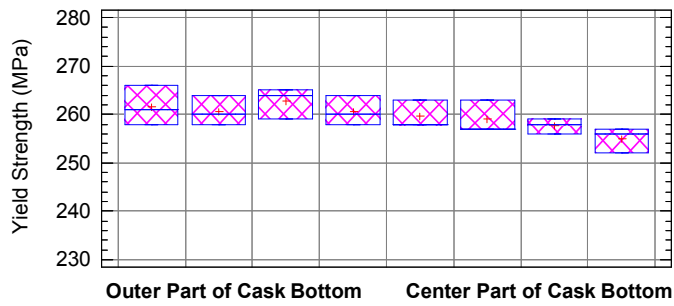
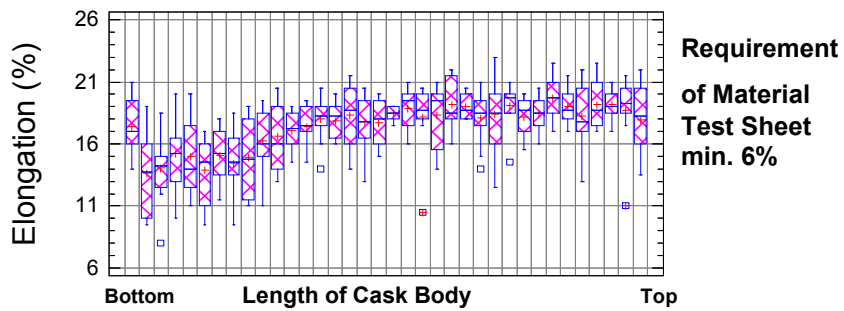


Fig. 2, Yield Strength of shell and bottom samples

**Cask Shell Samples HAW 20 / 28 CG-121 GP up to 123 GP**



**Bottom Samples HAW 20 / 28 CG-121 GP up to 123 GP**

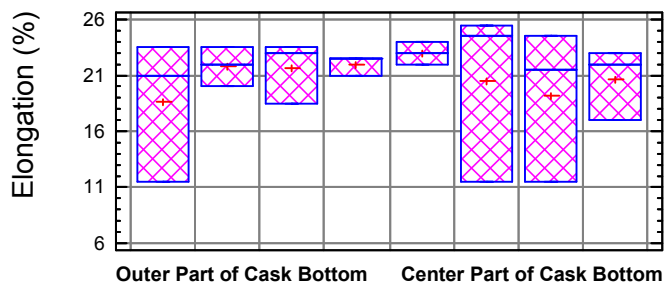


Fig. 3, Elongation of shell and bottom samples

To summarise, the analyses on the first 3 castings of cask bodies with changed technology showed that

- the requirements of the material specification on the component were safely met,
- there was good regularity of the chemical composition, microstructure and mechanical properties,
- the defined production process of the manufacturer is safely under control and adequate production reliability is guaranteed.

On successful conclusion of the qualification process, the testing scope for subsequent castings was reduced to the scope of series testing with 3 chemical and microstructure test specimens as well as 10 tensile test specimens from one hollow drill sample and the random testing of a bottom coupon sample. The production of so far 11 further bodies for casks of type Castor HAW 20/28 CG in the evaluated production facilities has taken place with no cases of non-conformance.

## **Quality assurance programme**

The central document for the production of components of classification levels 1 and 2 as well as the assembly of packages is the manufacturing and test plan (MTP). All relevant documents are defined in this together with revision status.

The MTP contains in detail:

- drawings and material specifications
- specifications for manufacture, assembly and testing
- the sequence of the production and test stages and test participation.

MTPs prepared by the manufacturer are examined and released by the approval holder and finally by BAM. The inspection by BAM relates, in particular, to a check that the quoted documents conform to the definitions of the approval and that the necessary tests are carried out according to the latest specifications with the test participation required under TRV 006.

BAM also inspects and releases the specifications for all tests and currently for production stages on components of classification level 1 and on assembly of the packages.

The external tests that accompany production are largely performed by the local expert of TÜV. BAM takes part in essential tests such as ultrasonic testing of cask bodies and in tests before commissioning such as leak tightness testing and overload testing of load attachment points.

An important aspect of production monitoring is that non-conformances are reliably detected. Non-conformance reports must be prepared for all cases of non-conformance arising during production on components of classification levels 1 and 2. The manufacturer has no discretionary powers whatsoever in this, every case of non-conformance from the approved design of a component must be recorded. The non-conformance reports have to be prepared by the approval holder and submitted to BAM (and BfS) for acceptance.

They must contain information on the following items:

- Definition of the component or components in question
- Description of the non-conformance
- Causer and cause
- Assessment of the effect of the non-conformance
- Measures for correction of the non-conformance where possible or necessary
- Preventive measures against recurrence of the non-conformance.

The introduction and control of the effectiveness of measures to prevent the recurrence of non-conformances is an essential point for the regular monitoring of the manufacturer's qualification.

An assessment of the number of non-conformance reports for, in each case, 10 casks of the types Castor HAW 20/28 CG and Castor V/19 manufactured in succession during series production clearly shows a reduction in the number of cases of non-conformance:

- For the production period 1998, between 7 and 25 non-conformance reports per cask, average 15.
- For the production period Nov. 2003 to June 2004, between 3 and 9 non-conformance reports per cask, average 5.

Where wanted changes are introduced in production, resulting in a partial non-conformance of the series sample to the approved design, the bearer of approval must obtain a release from BAM and an approval from BfS. Modifications are documented in the form of modification certificates. This rule applies to components of all classification levels.

The production documentation is produced by the approval holder and manufacturer, generally on the basis of the MTP. Essential components are materials documentation, production and testing of the components, assembly and the tests before commissioning. In addition, non-conformance reports and modification certificates, where they exist, become part of the documentation.

Following the internal test, BAM carries out the final check for compliance with the test requirements, completeness and correctness. Conformity of the series sample with the approved design is confirmed in the acceptance certificate. The type plate of the packaging is provided with the date of the next recurrent inspection and BAM's acceptance stamp.

## Summary

The application of quality-assurance measures defined by TRV 006 in the manufacture of transport and storage casks for spent fuel and HLW ensure that the series samples of packages conform to the design approval certificate.

The system of quality assurance is based on the responsibility of the approval holders and manufacturers themselves, and supplemented with monitoring by BAM. The scope of external supervision is graded according to the safety importance of the package components.

Supervision focuses on:

- Qualification of the manufacturer
- Pre-examination of production and test specifications
- Participation in production and acceptance tests
- Checking of documentation.

Cases of non-conformance are detected, documented and assessed to see whether they can be accepted by BAM (and BfS). Through further development of quality assurance and supervising in collaboration with applicants, manufacturers and BAM, a reduction in the need for acceptance of non-conformances has been achieved.

## References

Technische Richtlinie über Maßnahmen zur Qualitätssicherung (QM) und -überwachung (QÜ) für Verpackungen zur Beförderung radioaktiver Stoffe - TRV 006 – Verkehrsblatt (Amtlicher Teil), Heft 4 – 1991 S. 231

