specified by the authorities ensures that the CASTOR® conforms with all applicable conditions. These include extensive tests on the material and structure plus integrity verifications by ultra-sound, for example.

In the assembly process in the GNS (Gesellschaft für Nuklear-Service mbH) building in Mülheim the cask body, assembly basket, moderator rods, trunnions, lids and a diversity of other small parts are put together to form the total product.

In the overload test the diverse screw fittings and load impact points are tested with 1.5 times the load of the maximum permissable cask weight.

In the leakage test all the cask’s seal barriers are fully tested.

Adding together all the stages involved in production (including the preparation time for the mold production, molding etc.), the total time required for each project is about 1 year or even longer. This excludes the time involved for permissions, reports and safety tests, which can be particularly time consuming where new types of casks are introduced or major design modifications made.

When the cask is finally put into use at the nuclear power station a lengthy project path with many highly complex individual stages comes to an end. The precondition for trouble-free production - and this should be mentioned here too - is not only a high level of technical competence on the part of all the institutions involved but a committed and responsible team effort between them all.

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The CASTOR® is the most widely used transport and storage container for spent fuel rods in the world and provides a necessary and at the same time safe means of disposal. Not only is the production process for making the cask extremely complex, it also involves an extensive network of quality assurance measures.

1. The CASTOR® family

In connection with the disposal of waste from German nuclear power stations a total of some 900 CASTOR® (Cask for Storage and Transport Of Radioactive material) transport and storage containers have been developed, tested, certified and manufactured since the early 1980s. Nearly all of the containers in this series have a cask body made of ductile cast iron. A double lid system seals the inside and the contents are sealed long-term by metal seals.

In accordance with the latest requirements and wishes of the German utilities operating nuclear power stations, the following versions of this model of cask are currently used for interim storage at the power stations or in the cask storage facilities:

- **The CASTOR V cask**: Developed to hold spent pressurized water reactor or boiling-water reactor fuel rods from German power stations with a decay time after loading of 100 years. These casks are made of ductile cast iron and have a double lid system, which together form a sealed enclosure and provide the shield against radiation. The neutron shield which is also generated in nuclear fission, allows the casks to be fitted with so-called moderator rods made of polyethylene, and panels of the same material are also fitted to the floor and underside of the secondary lid. In addition, the shell of the container has a pair of trunnions fitted on both the floor and lid side to enable handling equipment to be attached.

- **The CASTOR HAW 20/28 CG cask**: Developed and given approval for returning HAW glass canisters (HAW = High Active Waste) with vitrified, highly radioactive waste from the reprocessing of spent fuel rods in France and Great Britain. The CASTOR HAW 20/28 CG cask, which holds either 20 or 28 canisters, is approx. 105 Mg; when loaded the total weight is approx. 125 Mg.

2. The material

The CASTOR® is a cask which has to meet requirements in respect of both transportation and storage. The material used must therefore conform with special qualification characteristics, all of which can be met by nodular cast iron.

A key advantage for the CASTOR® as a system as a whole is the monolithic structure of the cask body, which under the principle of “all from a single cast” meets the requirements for completely safe and reliable enclosure and the shielding function without any additional seams. The suitability of the material must be proved in a series of highly involved tests and the specifications for the design include the transportation accident conditions set out by the IAEA (e.g. a drop from 9 m onto an inflexible ground surface, a 1 m drop onto a spike and a subsequent heating test).

3. The production process

Extensive experience has been gathered in planning, production and operational use. Nevertheless, the CASTOR® is not actually a serial product in the normal sense of the word. Each cask is a high-tech system which is manufactured in small piece numbers for each order with all the rigour required to achieve assured quality.

With its 160 Mg or thereabouts of molten iron in the pouring process required as a consequence of the necessarily thick shield wall, the cask body is also one of the largest cast parts to be produced in the world, only capable of being made to high quality standards by hand mold casting by just a few manufacturers such as Siempelkamp.

The production process begins with the raw cast of the cask body at a casting temperature of approx. 1320°C at the Siempelkamp foundry in Krefeld. Some 2 days after casting the molds are stripped as the outer cast structure, and after a further week in the pit for further cooling the cast part is then brought to the blasting shop. In mechanical machining on the large lathe, which takes place in the Siempelkamp Nuclear Technology production center in Mülheim, approx. 50 mm of the wall of the cask bodies is then turned off to ensure that any unavoidable surface defects caused during the casting process are removed. The cooling fins are then machined in a later phase of work.

In deep hole machining, up to 100 lengthwise holes are made in the cask wall to a depth of approx. 5,500 mm for fitting the neutron moderator rods. A large boring machine is used mainly for the holes for the screw fittings for the lids and the trunnions.

The main purpose of the galvanized nickel plating on the inside of the cavity and the lid holders is to provide protection against corrosion during later loading underwater in the nuclear power station. A comprehensive and stringent quality assurance system involving predefined test instructions and special qualifications is applied.