

ICS 13.300
CCS F 73



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 41024-2021

**Load combination and design criteria for structural analysis of
spent fuel transport cask**

乏燃料运输容器结构分析的载荷组合和设计准则

(English Translation)

Issued on: November 1, 2021

Implemented on: December 1, 2021

Issued by: State Administration for Market Regulation

Table of Contents

- Foreword
- 1 Scope
- 2 Normative references
- 3 Terms and Definitions
- 4 Load combinations
- 5 Design Guidelines

1 Scope of application

This standard specifies load combinations and design criteria for structural analysis of spent fuel transport vessels.

This standard applies to the structural analysis of spent fuel transport containers, the total activity of radioactive contents is greater than 3000A1 (special radioactive materials), Greater than 3000A2 or 1×10^4 the radioactive material transport container of Bq can be implemented by reference.

2 Normative references

This standard refers to the following documents or clauses thereof. For dated references, only the dated version applies to this standard.

For undated references, the latest edition (including all amendments) applies to this standard.

GB 11806-2019 Regulations for Safe Transport of Radioactive Materials

3 Terms and Definitions

The following terms and definitions apply to this standard.

3.1 Terminology

3.1.1

stress intensity

The combined stress is based on the equivalent strength of the third strength theory and is specified as 2 times the maximum shear stress at the given point, i.e. the algebraically maximum at the given point the difference between the principal stress and the algebraic

minimum principal stress (positive for tensile stress and negative for compressive stress).

3.1.2

primary stress

Any normal or shear stress resulting from the applied load, which is necessary to satisfy the law of equilibrium of external or internal forces and moments.

The fundamental property of primary stress is that it is not self-limiting, and when the primary stress greatly exceeds the yield strength, it can cause failure or at least general deformation.

shape.

3.1.3

secondary stress

Normal or shear stress due to constraints of adjacent materials or due to constraints of the structure itself. The basic properties of secondary stress are Self-limiting, localized yielding and minor deformations can satisfy conditions to induce stress, a single action of which will not produce the expected failure.

3.1.4

primary membrane stress Average primary normal stress over the thickness of the solid section.

3.1.5

primary bending stress the primary normal stress component distributed linearly along the thickness of the solid section.

3.1.6

alternating stress intensity the alternating stress intensity σ_a is defined as the intensity of the alternating stress at all possible stress states (i and j), One-half of the largest absolute value in the sum.

3.1.7

fatigue

Local and permanent damage increment process occurs at a certain point of the structure under cyclic loading conditions, after sufficient stress or strain cycles, the accumulation of damage can cause cracks in the material, or the cracks can further propagate to complete failure.

3.1.8

stability shakedown

There is no continuous cycle of plastic deformation. When the deformation stabilizes after several load cycles and the subsequent structural response is elastic, the structure will settle down.

3.1.9

containment boundary the assembly of packaging components used to contain the radioactive material is a physical barrier to prevent the loss or dispersion of the radioactive material during transportation barrier.

Note: The metal part of the containment boundary of the spent fuel transport container generally includes. inner cylinder, primary sealing cover, penetration sealing cover and connecting bolts, etc.

3.1.10

criticality safety components Parts other than the containment boundary that may affect the criticality safety of the container during transport.

3.1.11

other safety components all structural parts that perform other safety-related functions of the transport container, with the exception of containment boundaries and criticality safety-related parts.

Note: Secondary sealing structure and its bolts, lifting device (lifting trunnion), etc.

3.1.12

packaging

One or more containers and any other components or materials within the container required for containment and other safety functions.

3.1.13

package

The package submitted for transport and its radioactive contents collectively.

3.2 Symbols

Salt--alternating stress strength, MPa;

Sa--allowable amplitude of alternating stress intensity component, MPa;

Sm--design stress strength, take the smaller of $1/3 S_u$ and $2/3 S_y$, MPa;

Sn--primary plus secondary stress strength, MPa;

Sy--the yield strength of the material at the corresponding temperature, MPa;

Su--the tensile strength of the material at the corresponding temperature, MPa;

A1, A2--Radionuclide limits (according to the regulations in GB 11806-2019).

4.1 Basic regulations

In this standard, the loads that need to be considered for structural analysis under different conditions required by GB 11806-2019 are superimposed according to the most unfavorable situation.

The load combinations of the containers under initial conditions, normal transport conditions and transport accident conditions are given, see Table 1 for details.

4.2.1 General requirements

Loads at initial conditions shall be the basis for normal transport conditions and transport accident conditions, which shall be compared to normal transport conditions and transport incident conditions, respectively.

The loads under these conditions are combined for structural evaluation of the vessel.

4.2.2 Initial temperature

The initial temperature distribution of the container should be in a steady state. The initial temperature of normal transport conditions and transport accident conditions should consider the ambient temperature -40 °C no sun exposure and ambient temperature 38 °C with sun exposure. Sun exposure should meet the requirements of GB 11806-2019. If the most Low temperature lower than -40°C or maximum temperature higher than 38°C should be considered separately. The heat resistance test conditions in the transport accident conditions do not need to consider the low temperature initial condition.

4.2.3 Decay heat

The initial conditions should also take into account the decay heat of spent fuel assemblies. The maximum decay heat should normally be superimposed at higher ambient temperatures and should be considered. Considering the solar exposure requirements in GB 11806-2019, the decay heat can usually not be considered in the case of low temperature.

4.2.4 Internal pressure

4.2.4.1

The internal pressure of the vessel mainly depends on the following factors. the pressure of the inert gas refilled in the vessel, the temperature change of the vessel and the spent fuel Leakage of all gases within the cladding. The internal pressure of the vessel should be