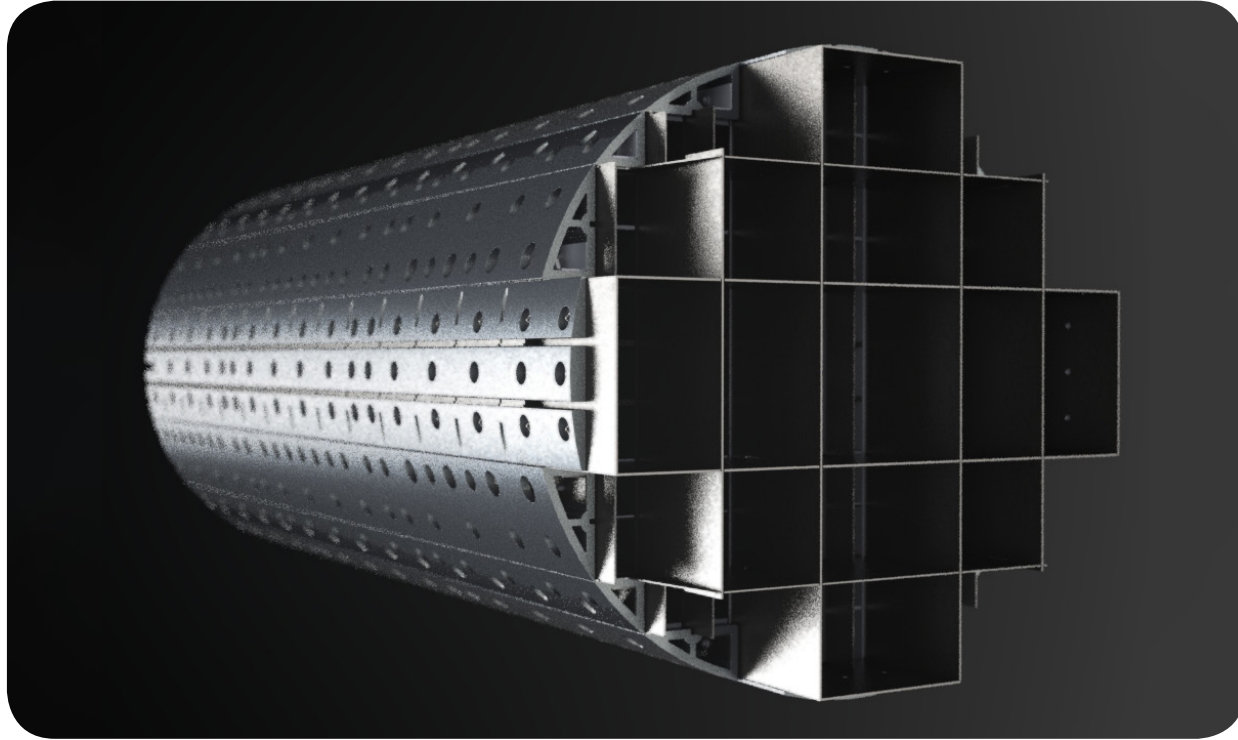


NUHOMS® DPX

Duplex Stainless Steel Canister Option



As issues of used fuel canister aging management and Chloride-Induced Stress Corrosion Cracking (CISCC) dominate the conversation when discussing long-term storage of used fuel at marine environment sites, TN Americas offers an option for materials that will mitigate canister aging issues and simplify aging management plans. TN Americas has determined that Duplex Stainless Steel (Duplex SS) is a strong solution, due primarily to its high resistance to chloride-induced stress corrosion cracking in aggressive marine environments.

A recent analysis revealed that the use of a single layer of Duplex SS in the fabrication of dry shielded canisters will ensure the long-term safety of canister systems, as the two-phase (austenite and ferrite) micro-structure of duplex stainless steel has a number of benefits. In addition, Duplex SS has a combination of alloying contents such as chromium, molybdenum, nitrogen and nickel that offer several advantages including enhanced mechanical properties and greater resistance to chloride-induced stress corrosion cracking, pitting and crevice corrosion.

Duplex SS has superior strength compared to austenitic stainless steels and offers better thermal performance. With Duplex SS there is no need to create

a double wall; having a double wall decreases the safety margin of the canister.

Features and Benefits:

- High resistance to Chloride-Induced Stress Corrosion Cracking in aggressive marine environments
- Enhanced mechanical properties and greater resistance to chloride corrosion including stress corrosion cracking, pitting and crevice corrosion than austenitic stainless steel 304 or 316L canisters
- Ensures the long-term safety of canister systems
- Superior strength compared to austenitic stainless steels
- Contains approximately 22% chromium, which offers a higher resistance to corrosion than 316L grade stainless steel
- Better thermal performance with relatively low thermal expansion and high thermal conductivity
- Eliminates need for a double wall which decreases the safety margin of the canister

TN Americas
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Duplex Stainless Steel is used extensively in corrosive environments where there is exposure to high chloride content and high temperatures, is a crucial component for the shipbuilding industry and is widely utilized in the mining industry and at nuclear plants.

Various industrial sectors such as refinery, chemical, petrochemical, power generation, and oil and gas use advanced stainless steel alloys like Duplex SS as the base material in structural components and equipment exposed to aggressive environments. At Koeberg NPP, located close to the Atlantic Ocean and known for a high incidence of airborne chlorides, Duplex SS 2205 grade has been specified for a replacement of a 59 feet high, 49 feet diameter 304 grade stainless steel water storage tank that developed leaks due to chloride-induced stress corrosion cracking (ESKOM Doc. DSG-310-301).

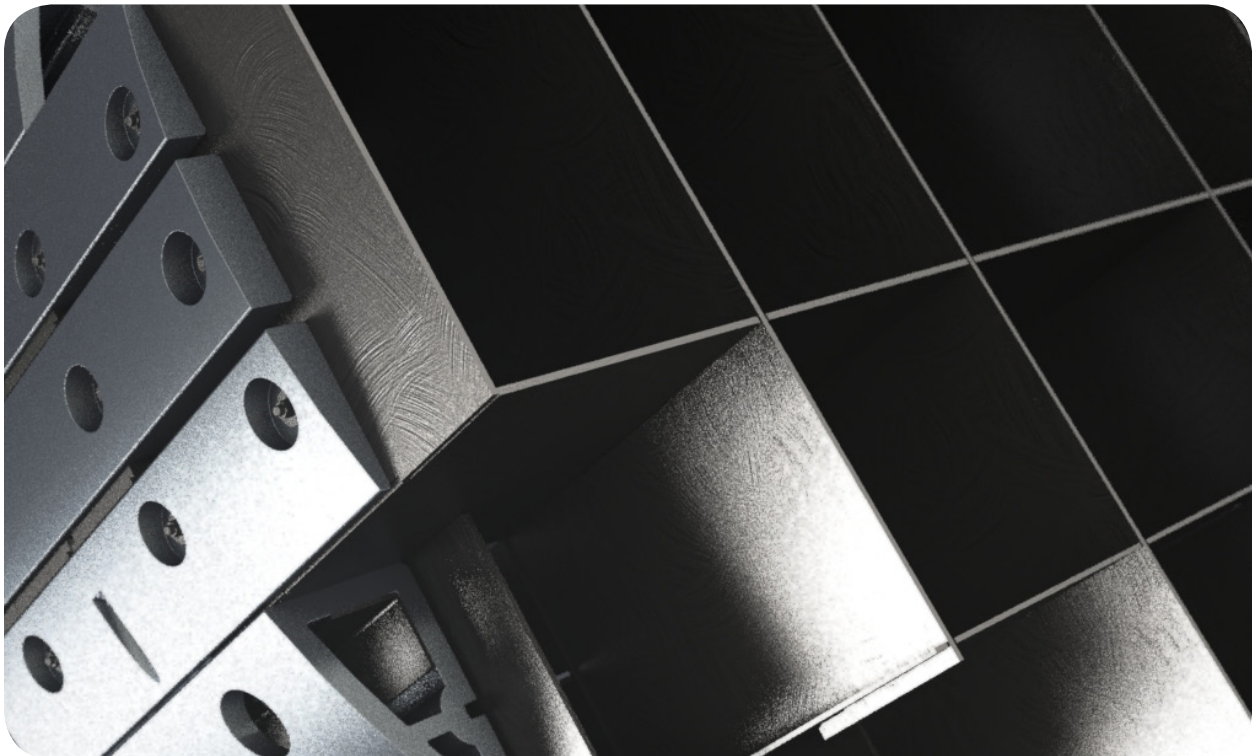
Duplex SS got its name from the two-phase microstructure consisting of roughly 50% ferrite and 50% austenite. The material has been used for more than 80 years since the first wrought duplex stainless steels were produced in Sweden in 1930.

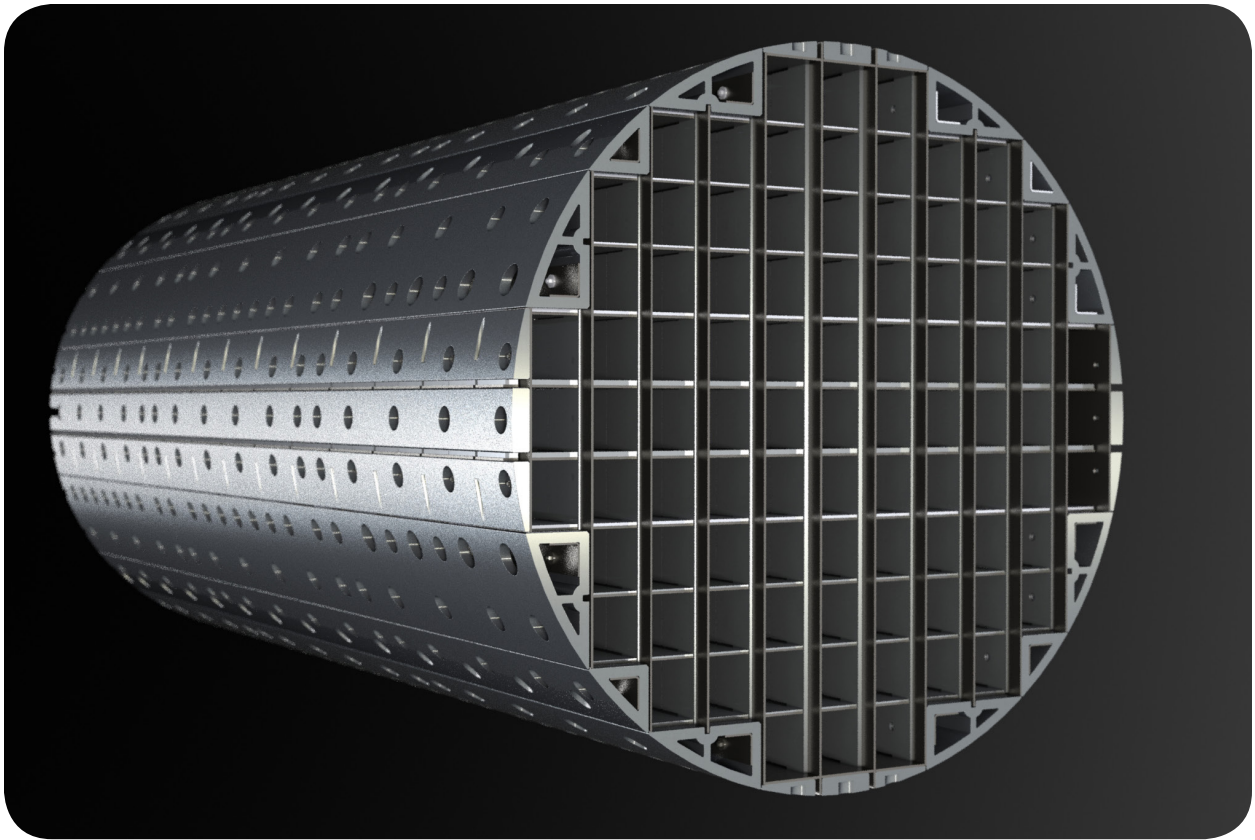
Duplex SS contains approximately 22% chromium, which offers a higher resistance to corrosion than 316L grade stainless steel. For resistance to chloride induced stress corrosion cracking, pitting and crevice corrosion, the contents of chromium, molybdenum, nickel, and nitrogen in the alloy are most important.

For nuclear application, Duplex SS is included in the materials listed in ASME Section II, Part D and allowed for use as the materials for Section III, Division 1 Classes 1, 2, and 3. One advantage of advanced Duplex SS is its superior mechanical strength as compared to conventional stainless steel Types 304 and 316L. With a yield strength of 400-450 MPa, Duplex SS is more than two times higher than the 205 MPa offered by austenitic SS Types 304 and 316L.

Duplex SS has better thermal performance with relatively low thermal expansion and higher thermal conductivity than SS 304 and 316L. The marginally higher thermal conductivity of the Duplex SS material enables the effective removal of the heat emitted by the spent fuel elements from the canister.

Due to superior resistance of Duplex SS to corrosion, Duplex SS is often used in lieu of austenitic SS 304 or 316L in applications where the use of austenitic SS would result in chloride pitting and CISCC. Chloride corrosion resistance is measured in terms of a pitting resistance equivalent number (PREN). The PREN number for Duplex SS is 33-36, compared to 25-28 for SS 316L, thus Duplex stainless steel shows a far superior pitting corrosion resistance.





Proven Operational Experience & Testing

Duplex SS has demonstrated high resistance to chloride corrosion including CISCC based on both operational experience in the field and accelerated laboratory testing with high enough chloride environment. A corrosion map of CISCC susceptibility for various stainless steels presents that Duplex SS grades 2304 and 2205 are not expected to incur CISCC below 100° C, while SS 304/316L will experience CISCC when prerequisites of susceptible material, surface stress, and a corrosive environment with high enough chloride content are met [F. King, "Corrosion Resistance of Austenitic and Duplex Stainless Steels in Environments Related to UK Geological Disposal" QRS-1384C-R1, Report to NDA RWMD, April 2009]

Duplex SS is already used in the fabrication of other TN nuclear waste packages that are licensed and in service including TRUPACT-III, a transport cask used to ship transuranic waste, NUPAC Enviroalloy High Integrity Container (HIC) for disposal of Class B and C low level nuclear waste, which requires a 300 year design life, and TN's FS-47 and FS-65 transport casks for MOX fuel.



About TN Americas

TN Americas is a leader in the American nuclear market offering innovative total systems solutions for used fuel and radioactive waste management and transportation. More than 50 percent of American nuclear plant operators use TN's used fuel storage or transport solutions, irradiated waste removal and processing, and pool to pad services.

TN Americas' track record of providing safe storage and transportation of used fuel is driven by state-of-the-art products and services, innovative engineering solutions, and integrity in meeting customer expectations for low-dose and error-free campaigns. TN Americas customers include utilities, reactor operators, research reactors and the U.S. government.

TN Americas' products are marked by the highest standard of safety, uncompromising commitment to quality and operational dependability, and "as promised" service integrity.



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