Stresses and Deformations in Outer & Inner Shielding Vessels

Bob Weggel, M.O.R.E., LLC
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Fig. 1: Cross section of resistive coils, superconducting coils, shielding vessels and shielding. Vessels start at −3 m up and end at +3 m. Outer vessel: \( r_{\text{max}} = 1.14 \) m; \( r_{\text{min}} = 0.60 \) m; inner vessel: \( r_{\text{max}} \approx 0.56 \) m; \( r_{\text{min}} = 0.076 \) m. Thickness of vessel walls: 4 cm (outer walls) and 2 cm (inner walls). Water pressure = \((100 - y)\) kPa. Density of water-buoyed shielding = 9 g/cm\(^3\).

Fig. 2: Isometric view of resistive coils, SC coils and shielding vessels. Shielding omitted for clarity.
Fig. 3: Sag of coaxial-tube beam of 1.14-m $r_{\text{max}}$ & 0.60-m $r_{\text{min}}$. Tubes = 7.85 g/cm$^3$; annulus = 10 g/cm$^3$.

Fig. 4: Sag of coaxial-tube beam of 0.58-m $r_{\text{max}}$ & 0.16-m $r_{\text{min}}$ point-loaded at $z = (L+3)/2$. 
Fig. 5: Shielding-vessel mesh, mapped (blue) to improve accuracy where stresses change most rapidly.
Fig. 6: Maximum von Mises stress = 33 MPa.
Fig. 7: Maximum deformation = 1.45 mm.

Fig. 8: Inner vessel. Maximum von Mises stress = 27 MPa.

Fig. 9: Inner vessel. Maximum deformation = 2.0 mm
Fig. 10: Outer vessel. Overall length = 6 m. Maximum von Mises stress = 73 MPa.

Fig. 11: Outer vessel. Overall length = 9 m. Maximum deformation = 6.4 mm.