

Table 1. Design Safety Factor for Steels, Al, Cu, Ti, Ni and Their Alloys

Conditions			Tensile strength at design temps. σ'_b	Yield limit at design temp. $\sigma'_{0.2}$	Average endurance strength at design temp. (rupture strength at 10^5 hours) σ'_d	Average creep limit at design temp. (with creep rate of 0.01% per 1000 hours) σ'_n
Material						
	Carbon steels, low alloy steels			$n_b \geq 3.0$	$n_s \geq 1.6$	$n_d \geq 1.5$
High alloy steels			$n_b \geq 3.0$	$n_s \geq 1.5$	$n_d \geq 1.5$	$n_n \geq 1.0$
Al, Cu, Ti, Ni and their alloys	Plate, forging, Pipe & bar	Ti	$n_b \geq 3.0$	$n_s \geq 1.5$	$n_d \geq 1.5$	$n_n \geq 1.0$
		Ni	$n_b \geq 3.0$	$n_s \geq 1.5$	$n_d \geq 1.5$	$n_n \geq 1.0$
		Al	$n_b \geq 4.0$	$n_s \geq 1.5$		
		Cu	$n_b \geq 4.0$	$n_s \geq 1.5$		
Cast irons	Grey cast iron		$n_b \geq 10.0$			
	Nodular or malleable cast iron		$n_b \geq 8.0$			
Cast steels	Design temp. $\geq 300^\circ\text{C}$		$n_b \geq 4.0$ / casting factor			
	Design Temp. $< 300^\circ\text{C}$		$n_b \geq 1.5$ / casting factor			
Bolt	Carbon steel		$n_b \geq 5.0$	$n_s \geq 2.7$ (H.R)	$n_d \geq 1.5$	
				$n_s \geq 2.5$ (N)		
	Low alloy steel			$n_s \geq 3.5$ (Q&T)		
	High alloy steel			$n_s \geq 2.7$ (Q&T)		
	Martensite steel			$n_s \geq 3.0$ (Q&T)		
	Austenitic steel		$n_s \geq 1.6$ (S)			
nonferrous metals		$n_b \geq 5.0$	$n_s \geq 4.0$			

Note:

- When the yield strength (or conditional yield strength) at design temperature cannot be determined and the allowable stress is based on the tensile strength of material, the value n_b shall be raised appropriately.
- The casting factors of nonferrous metals shall be determined by the corresponding values for plate, forging, pipe or bar divided by 0.8.
- The casting factor of cast steel shall not exceed 0.9.
- H.R—Hot Rolled, N—Normalized, Q&T—Quenched and Tempered, S—Solution heat- treated.

Table 2 Joint Efficiency of Welded Pressure Vessel

	Full NDE					Spot NDE				
	Steel	Nonferrous metal				Steel	Nonferrous metal			
		Al	Cu	Ni	Ti		Al	Cu	Ni	Ti
Butt joint as attained by double welding or by other means having the same quality as full penetrating double welding	1.0	0.85 / 0.90	0.85 / 0.95	0.85 / 0.95	0.90	0.85	0.80 / 0.85	0.80 / 0.85	0.80 / 0.85	0.85
Single-welded butt joint with backing strip	0.90	0.80 / 0.85	0.80 / 0.85	0.80 / 0.85	0.85	0.80	0.70 / 0.80	0.70 / 0.80	0.70 / 0.85	0.80
Single-welded butt joint without backing strip	/	/	/	/	/	/	/	0.65 / 0.70	0.65 / 0.70	/

Note:

- a. NDE in the Table means RT or UT for steel pressure vessels and RT for non-ferrous metal pressure vessels in principle. Full NDE means 100% RT or UT; and spot NDE means 20% or 50% (for ferrite steel low temperature pressure vessel) RT or UT.
- b. The upper limit of joint efficiencies for nonferrous metal pressure vessel is for welded joint fabricated by metal inert-gas welding, The lower limit is for welded joint fabricated by gas tungsten arc welding.
- c. The words “by other means having the same quality as full penetrating double