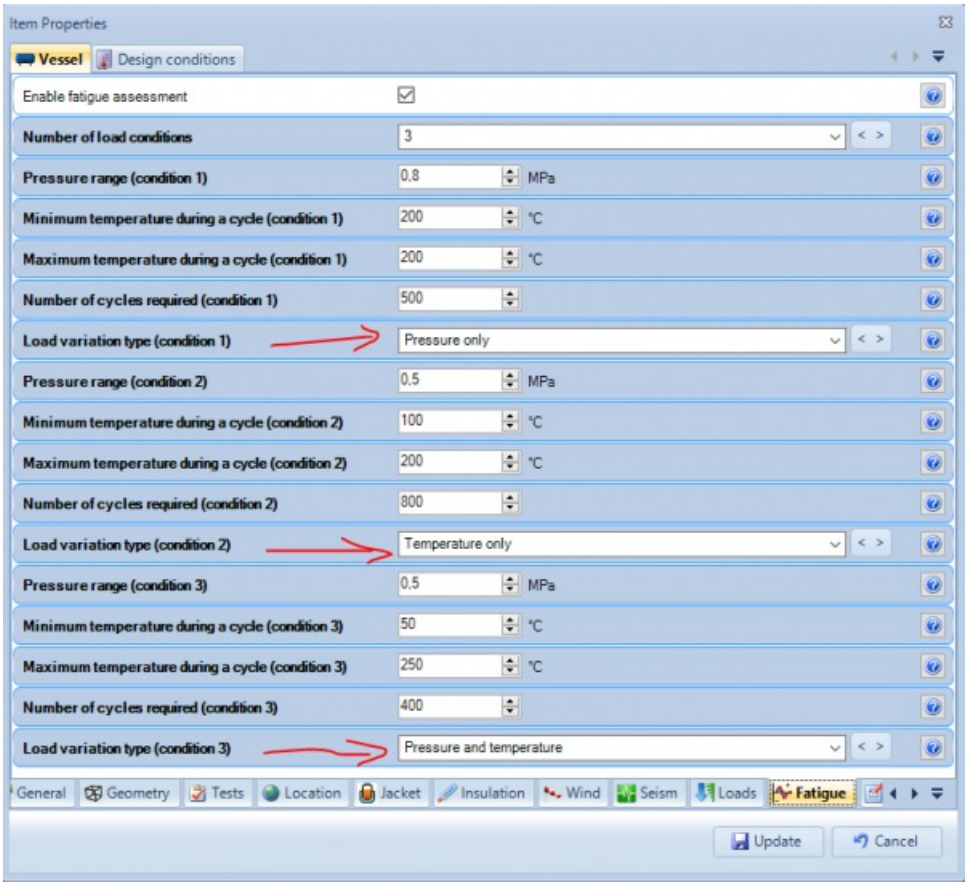
Updates to simplified fatigue assessment in Clause 17 according to EN 13445-3 2014, Amendment 5

An overview of the fatigue calculation changes introduced in Amendment 5 to EN 13445-3 2014 Edition.
Online version: *https://nextgen.sant-ambrogio.it/KB706633*
Latest update: 29 ott 2019

Amendment 5 to EN 13445-3 introduces important changes regarding the simplified fatigue calculation, performed according to Clause 17. Essentially, these changes concern new ways to consider thermal stresses in fatigue calculation. Load cases can now have pressure variation only, temperature variation only or a combination of both.

In the general settings for fatigue cases (File> Item Properties> Fatigue) a new option is now available for each fatigue case, allowing you to choose which type of stress corresponds to each case.



When a fatigue detail is set (welded or unwelded) under Fatigue category for a component, new values are requested only for those cases involving temperature variations. This values are the local range of temperature variation ΔT_{diff} and the coincident thermal stress factor κ. This value can be set according to Table 17-2.

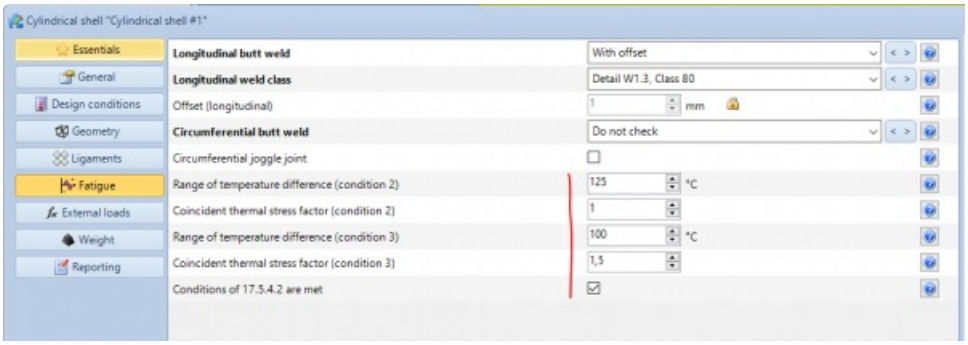


Table 17-2 — Value of the thermal stress factor κ for different thermal gradient types

Thermal gradient type	κ
Linear gradient through thickness or Linear gradient along surface direction in shell	0,75
Linear gradient along surface direction in flat end	1
Thermal shock	1,5

From now on, when NextGen runs the fatigue calculation, it'll use new equations for the determination of both number of equivalent full pressure cycles and allowable fatigue cycles, since conditions of 17.5.4.2 are set as met.

Simplified fatigue assessment according to EN13445-3 Clause 17

Load condition 1, load details			
Design pressure	P	=	1.00 MPa
Pressure range	ΔP	=	0.80 MPa
Minimum operating temperature during cycle	Tmin	=	200.00 °C
Maximum operating temperature during cycle	Tmax	=	200.00 °C
Design temperature	T	=	200.00 °C
Number of required fatigue cycles	Nreq	=	500
Highest allowable stress between involved materials contributing to Pmax	f	=	150.00 MPa
Ultimate tensile strength at room temperature	Rm	=	483.00 MPa
Yield strength at design temperature	Rp0.2/T	=	225.00 MPa
Load condition 1, Longitudinal butt weld			
Maximum allowable pressure (component)	Pmax	=	5.01 MPa
Nominal thickness	en	=	9.53 mm
Joint efficiency	z	=	1.00
Offset	δo	=	1.00 mm
Partial stress factor	η1=(3·δo)/en	=	0.31480
Stress factor	η=(1+η1)·z	=	1.31480
Pseudo-elastic stress range	Δσ=(ΔP/Pmax)·η·f	=	31.51 MPa
Thickness correction factor	Ce	=	1.00000
Assumed mean cycle temperature	T*=0.75·Tmax+0.25·Tmin	=	200.00 °C
Temperature correction factor	CT=1.03-1.5E-4·T*-1.5E-6·T*²	=	0.94000
Equivalent number of full pressure cycles according to 17.5-3	$\sum_i n_{Pi}\cdot(\frac{\Delta P_i}{P_{max}})^3+\sum_j n_{Tj}\cdot(\frac{E\cdot\alpha\cdot\kappa_j\cdot\Delta T_{diff,j}}{\eta_{max}\cdot f})^3+\sum_k n_{PTk}(\frac{\Delta P_k}{P_{max}}+\frac{E\cdot\alpha\cdot\kappa_k\cdot\Delta T_{diff,k}}{\eta_{max}\cdot f})^3$	=	5942
Conditions of 17.5.4.2 are met:			Yes
Allowable number of full pressure cycles according to 17.5-2	$N_{eq}=2\cdot10^6[\frac{C_{min}\cdot C_e\cdot C_T}{\eta_{max}\cdot f}]^3$	=	110875
Weld class	C	=	80
Endurance limit	ΔσD	=	58.96 MPa
Cut-off limit	Δσcut	=	32.40 MPa
Fictitious stress range for insertion into the fatigue design curves	Δσ*=[Δσ/Ce·CT]	=	33.52 MPa
Number of allowable fatigue cycles	N=5e+6·(0.737·C/Δσ*)^5	=	84126391
Partial fatigue damage index	D=Nreq/N	=	0.00001
			neq ≤ Neq (5942 ≤ 110875.40755): Ok

Of course, for cases of simple pressure oscillation everything remains as before: if in the general settings of the fatigue calculation one or more combinations are present and all are set to "pressure only" as the type of variation, the calculation is carried out according pre-Amendment 5 rules.