

Evaluate stresses from Ansys®, CAESAR II® or any other program for fatigue, high temperature or fitness-for-service

This article discusses how to convert CAESAR II® or general purpose FEA results into values that can be used in MatPRO to perform fatigue, high temperature or fitness for service (FFS) calculations. Use MatPRO effectively in pressure vessel and piping analysis.

Using CAESAR Results

Item	Load Case	Conversion	Result	Summary
S _L	Sustained stress	S _L	P _L	P _L = S _L
S	Operating stress	(2/1.35)(S)	P _L +P _B +Q	P _L +P _B +Q = (2/1.35)(S)

Using Ansys (or other FEA Program Results)

Load Case	Operation	Result
Primary Loads - Typically Weight + Pressure	Integrate stresses through thickness at critical section	P _L
Operating Loads - Including Weights and Pressure	Linearize S _x , S _y , S _z , T _{xy} , T _{yz} , T _{zx} through thickness at critical section and compute stress intensity from result	P _L +P _B +Q

The above values for P_L and P_L+P_B+Q can be used in MatPRO to evaluate any given stress state.

The MatPRO P_L and P_L+P_B+Q text cells are shown below.

PL - psi	<input type="text" value="0.00"/>	...for WRC 474 Method
PL+Pb+Q - psi	<input type="text" value="23000"/>	...for API, BS, EN, WRC

MatPRO supports a B31.3 and ASME Section II Part D data base along with "condition calculators" that evaluate calculated stress states in welds, base metal, or flawed pipes and vessels.

The MatPRO "condition calculator" determines:

- How close you are to failure,
- If creep-fatigue interaction is a concern, and
- Whether a crack, corroded, or eroded area satisfies API 579 Fitness for Service Rules.

MatPRO is a program no pressure vessel or piping engineer should be without!

The more you know about MatPRO – the more you learn.

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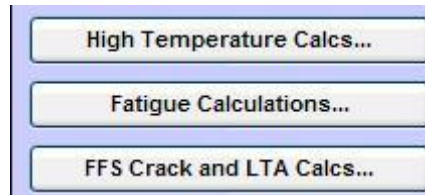
Phone: 281.920.9775

Website: www.paulin.com

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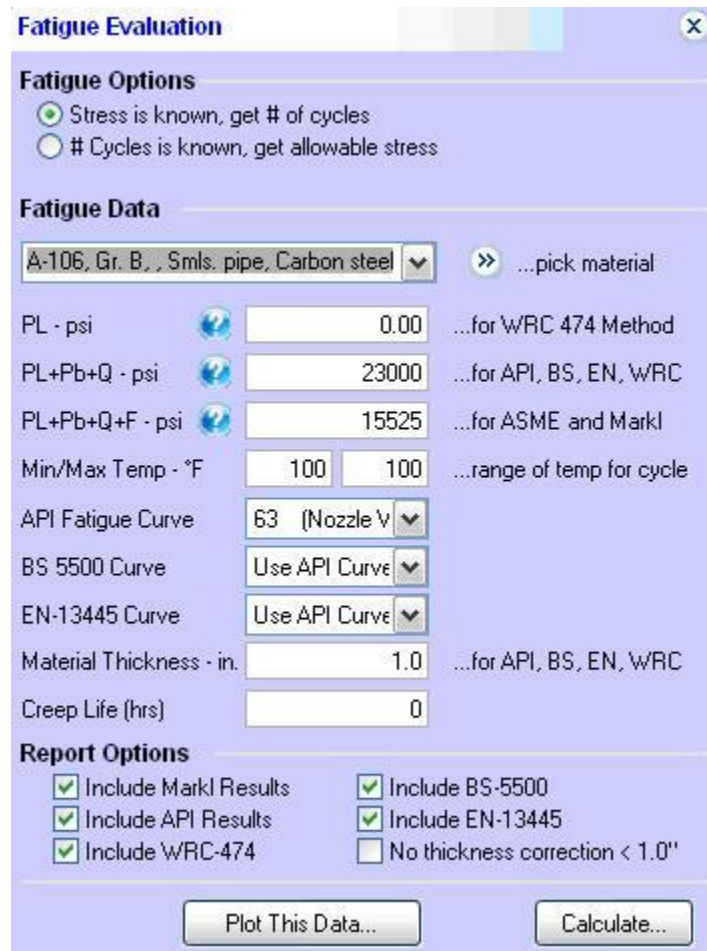
The "condition calculator" is invoked by specifying the material, e.g. SA 106 Grade B, the temperature, and the stress state. The stress state is retrieved automatically from NozzlePRO or FE/Pipe, and can be easily entered with results from Ansys or CAESAR II.

The major "condition" buttons are shown below.



To perform a fatigue analysis using a computed stress from FE/Pipe, NozzlePRO, CAESAR or Ansys, the MatPRO you would click on the "Fatigue Calculations" button shown in the figure below.

The Fatigue input screen is shown below.

The screenshot shows a software dialog box titled "Fatigue Evaluation". It has a close button (X) in the top right corner. The dialog is divided into several sections: "Fatigue Options" with two radio buttons for "Stress is known, get # of cycles" (selected) and "# Cycles is known, get allowable stress"; "Fatigue Data" with a material dropdown menu set to "A-106, Gr. B, Smls. pipe, Carbon steel" and a "...pick material" button; input fields for "PL - psi" (0.00), "PL+Pb+Q - psi" (23000), "PL+Pb+Q+F - psi" (15525), "Min/Max Temp - °F" (100, 100), "API Fatigue Curve" (63), "BS 5500 Curve" (Use API Curve), "EN-13445 Curve" (Use API Curve), "Material Thickness - in." (1.0), and "Creep Life (hrs)" (0); and "Report Options" with checkboxes for "Include MarkI Results", "Include API Results", "Include WRC-474", "Include BS-5500", "Include EN-13445", and "No thickness correction < 1.0\"/>

Fatigue Evaluation MatPRO Input Screen

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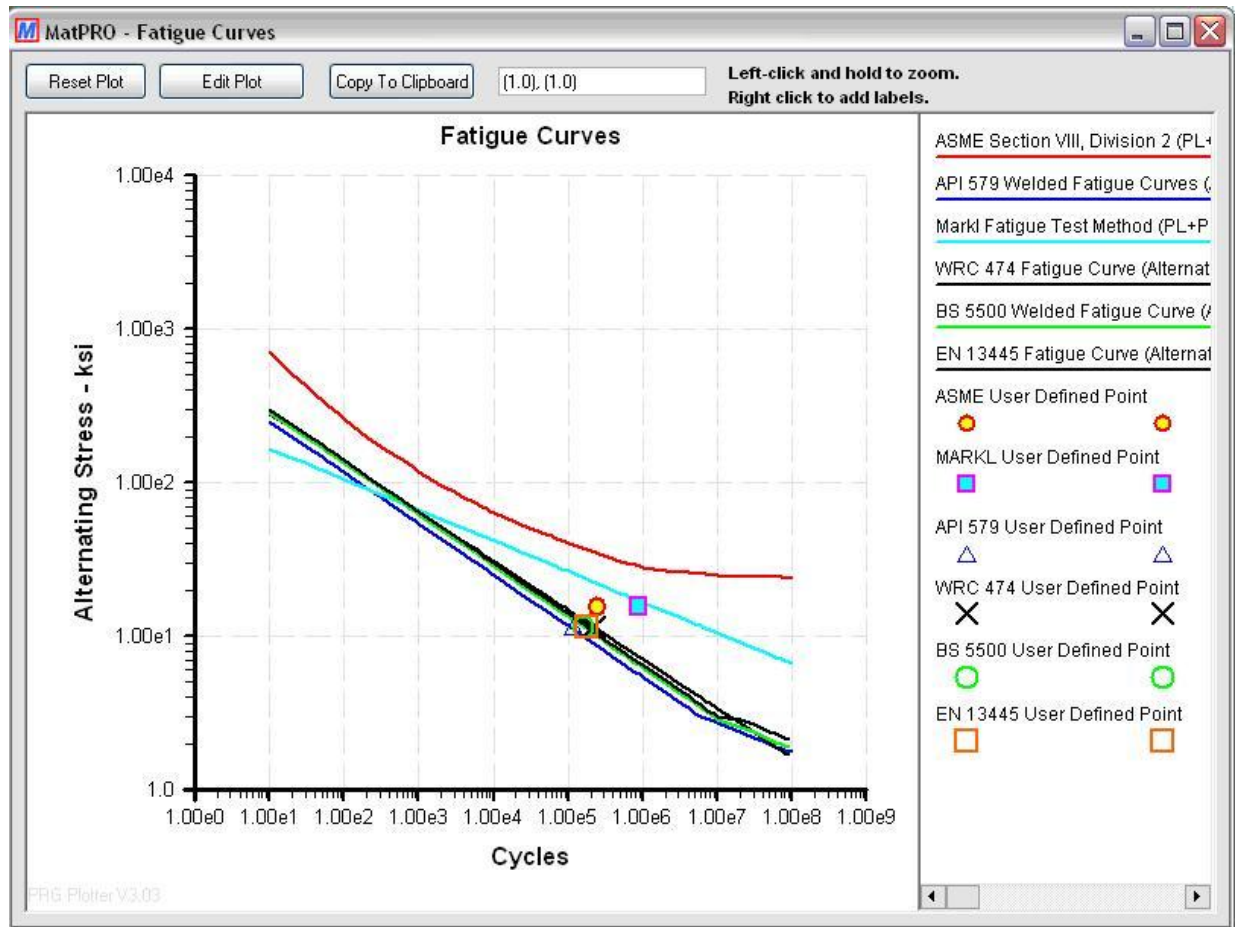
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Note that time, temperature and thickness may all influence creep life.

Output includes detailed text reports and plots of fatigue curves using allowable limits prescribed by Markl, API579, BS 5500, the MasterCurve, ASME and EN13445.



MatPRO Fatigue Curve Comparisons

Generate Material Property Plots

MatPRO also produces material property plots for all combinations of yield, tensile, allowable stress, creep rupture properties, etc.

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The plot below shows the allowable stress, tensile strength and yield stress for an SB-409 plate material at 300,000 hours. Note how the drop in tensile strength at about 1100F affects the allowable stress, while the yield strength remains high!



MatPRO – The more you use it – the more you learn. No engineering desktop should be without it.