

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.

PAULIN RESEARCH GROUP

PAULIN RESEARCH GROUP

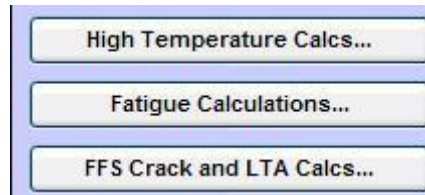
Phone: 281.920.9775

Website: www.paulin.com

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

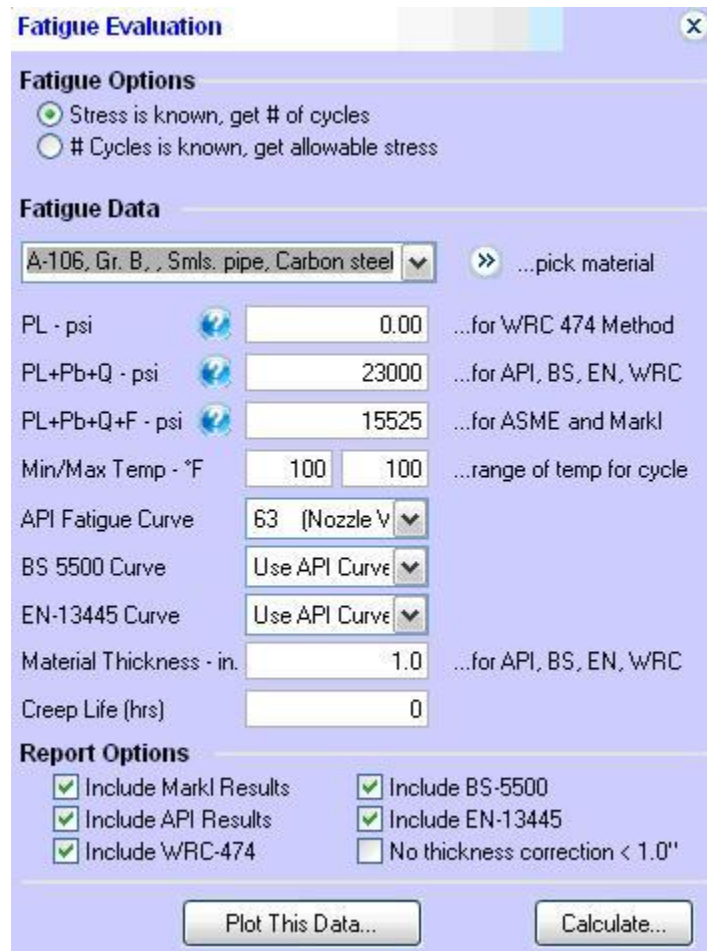
The "condition calculator" is invoked by specifying the material, e.g. SA 106 Grade B, the temperature, and the stress state. The stress state is retrieved automatically from NozzlePRO or FE/Pipe, and can be easily entered with results from Ansys or CAESAR II.

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 window titled "Fatigue Evaluation" with a close button (X) in the top right corner. The window is divided into several sections:

- Fatigue Options:** Two radio buttons. The first is selected: "Stress is known, get # of cycles". The second is " # Cycles is known, get allowable stress".
- Fatigue Data:** A dropdown menu shows "A-106, Gr. B, Smls. pipe, Carbon steel" with a "...pick material" button to its right. Below are several input fields:
 - PL - psi: 0.00 (with a blue globe icon and "...for WRC 474 Method")
 - PL+Pb+Q - psi: 23000 (with a blue globe icon and "...for API, BS, EN, WRC")
 - PL+Pb+Q+F - psi: 15525 (with a blue globe icon and "...for ASME and MarkI")
 - Min/Max Temp - °F: 100 | 100 (with "...range of temp for cycle")
 - API Fatigue Curve: 63 (Nozzle V) (with a dropdown arrow)
 - BS 5500 Curve: Use API Curve (with a dropdown arrow)
 - EN-13445 Curve: Use API Curve (with a dropdown arrow)
 - Material Thickness - in.: 1.0 (with "...for API, BS, EN, WRC")
 - Creep Life (hrs): 0
- Report Options:** Four checked checkboxes: "Include MarkI Results", "Include API Results", "Include WRC-474", and "Include BS-5500". Two unchecked checkboxes: "Include EN-13445" and "No thickness correction < 1.0\"".

At the bottom of the window are two buttons: "Plot This Data..." and "Calculate...".

Fatigue Evaluation MatPRO Input Screen

PAULIN RESEARCH GROUP

PAULIN RESEARCH GROUP

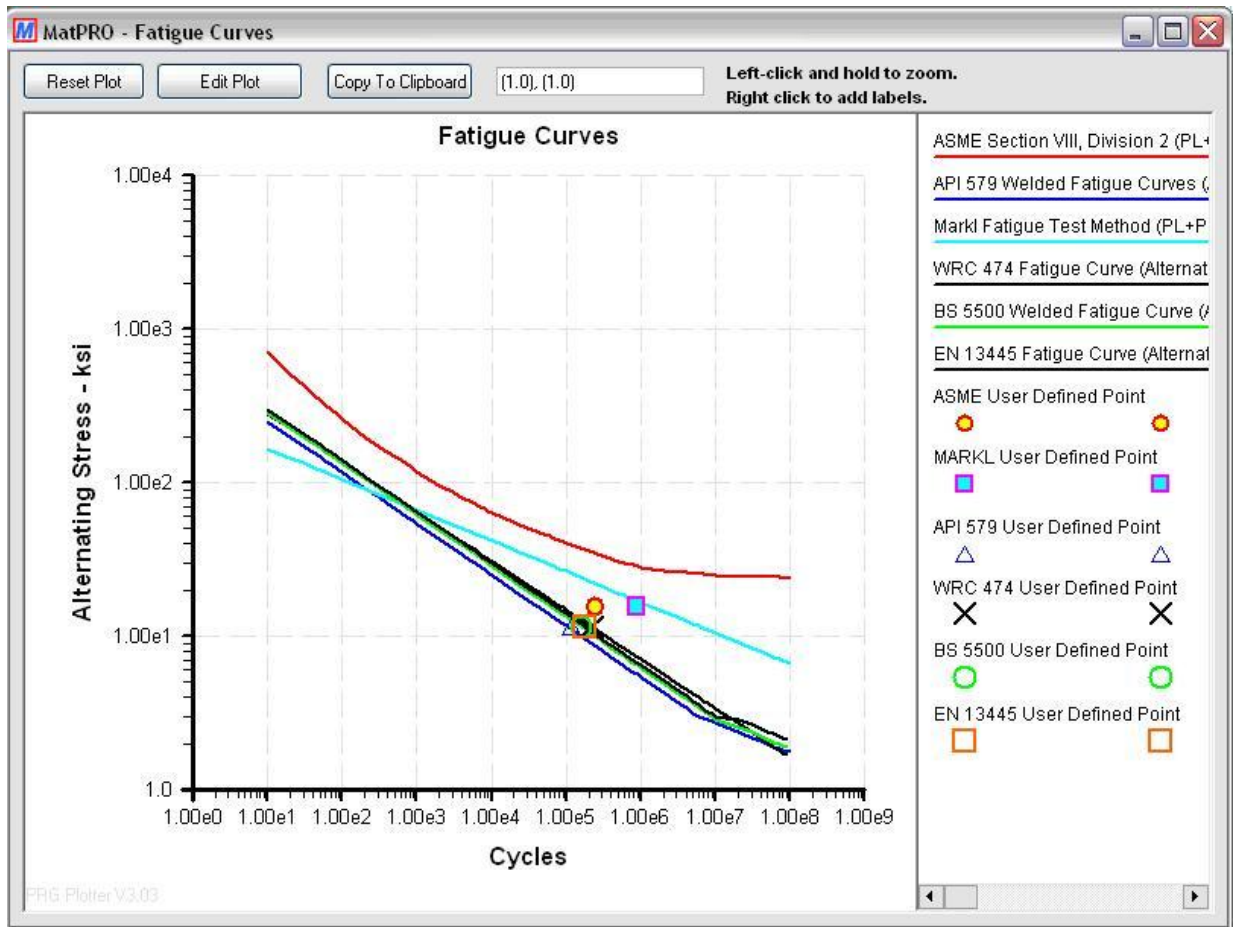
Phone: 281.920.9775

Website: www.paulin.com

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

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.

PAULIN RESEARCH GROUP

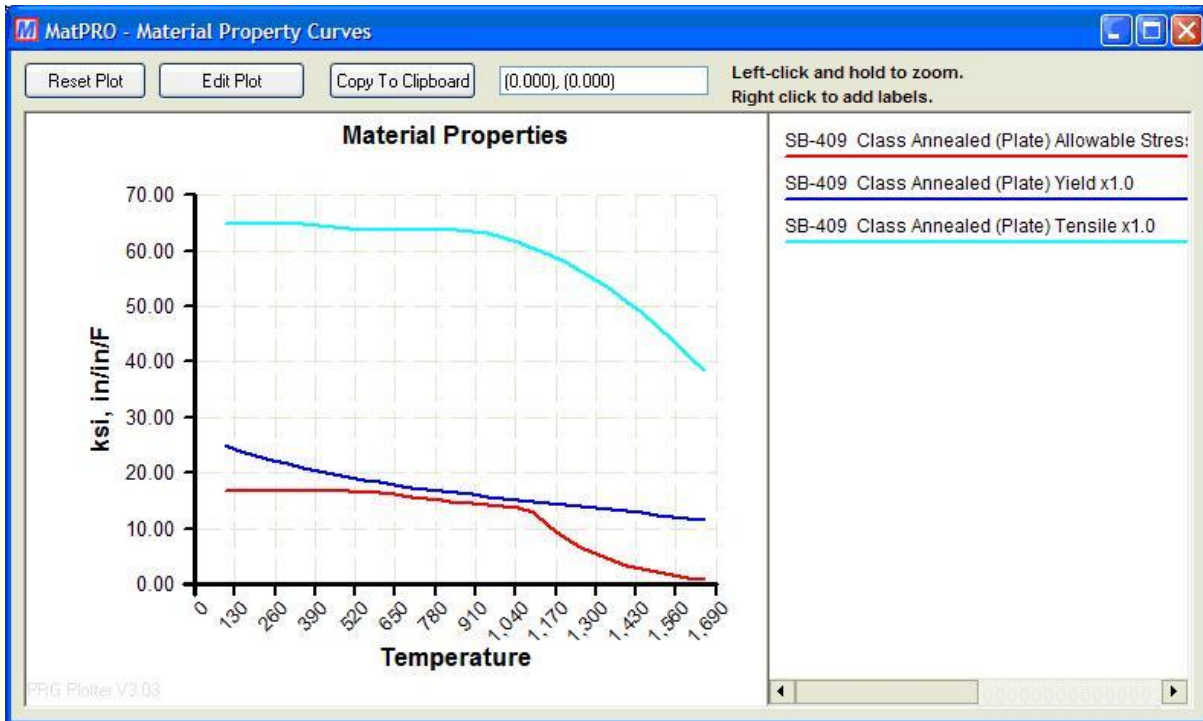
PAULIN RESEARCH GROUP

Phone: 281.920.9775

Website: www.paulin.com

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

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.