FEPipe v15.0

Released January 2021

FEPipe v15.0 has been designed to meet the specific needs of the pressure vessel and piping industries.

The ability to rapidly construct PV&P geometries and automatically produce ASME stress reports sets us apart. Results are presented in terms of ASME requirements instead of generalized stress results.

FEPipe's use of the parametric approach allows novice finite element analysts to construct accurate models using only dimensional input. FEPipe automatically creates the model geometry, element mesh, applied loads and boundary conditions based on standard dimensions. The user retains the ability to further edit the model via the Drawing Tools editor.

FEPipe v15.0 New Features

New FEPipe Startup Interface

ASME 2019 Code Compliance

Multiple Load Cases in Load Case Editor

Nonlinear Panel & Capability Expanded to All FEPipe Shell Elements

AxiPRO Plasticity Solver Upgrades for Deformation of Flange Loading

Pipe Shoe Design Wizard - PIP Shoe Library Added

Automated Nonlinear SSI and Collapse Calculations for Bends, Heads, Branches or Saddles

Updated Nonlinear Material Large Rotation / Large Strain Solver

Combination Loads Through Run

B31.3 319.2.2 Overload Calculation

ASME Code Classification Update

Updated Bends with Trunnion Models

Collapse Load Model Perturbation and Buckling for Heads, Cylinders, Bends & Branch Connections

WRC 107/537 Update Guidance for Spheres, Elliptical and Dished Heads

Recommended SCF for Pressure Stress on Welds

Interactive Local Thin Area Drawing & Analysis

+Y Simple Nonlinear Supports for Saddles, Pipe Shoes & Similar Geometries

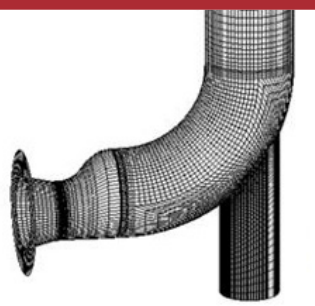
Eccentric and Concentric Reducer Model

Bar Supports & Local Thin Areas

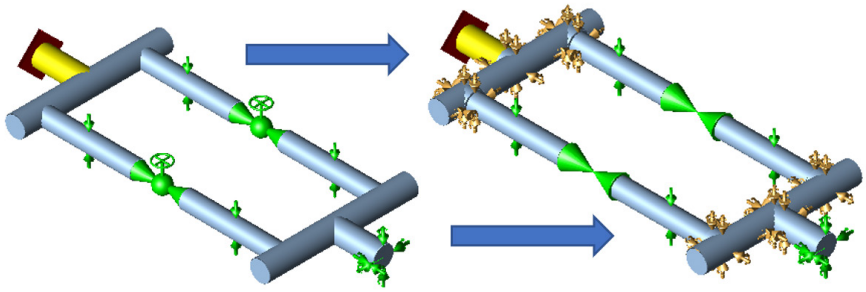
Flange Automated Evaluation Wizard (Condense)

Leak-Before-Break Linear and Nonlinear Pressure Fatigue on Thick Nozzles & Olets

Acoustic Induced Vibration (AIV) Update



FEATools v15.0 is now included with FEPipe v15.0

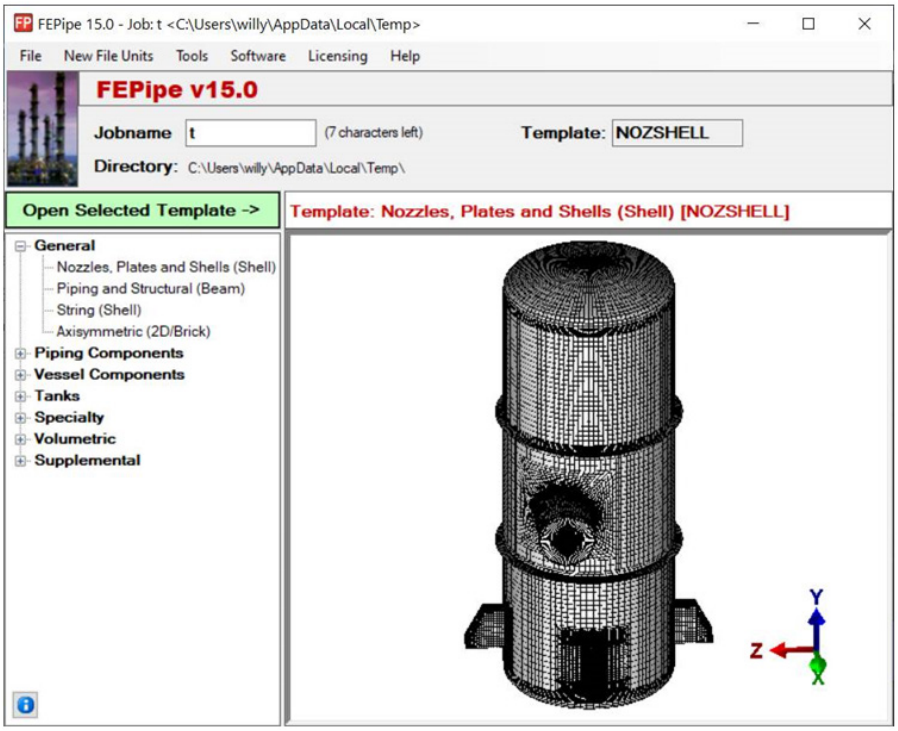


STEP 1 Run the piping model file (CAESAR II or PCL-Gold) thru FEATools to generate FEA-based SIFs, SSIs & k-factors.

STEP 2 Re-run your piping model file (CAESAR II or PCL-Gold) analysis to get more accurate stresses, loads, displacements and life cycles.

NEW Interface for FEPipe v15.0

The new interface makes it easier to find templates and navigate the options available through FEPipe.



PAULIN RESEARCH GROUP

11211 Richmond Ave., Suite B109 • Houston, TX 77082 • U.S.A. voice 281.920.9775 • sales@paulin.com • www.PAULIN.com

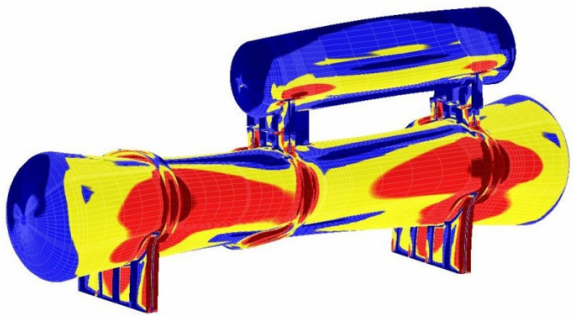
FEPipe v15.0

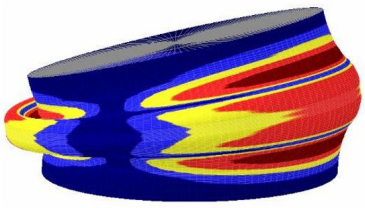
SHELL MODELS

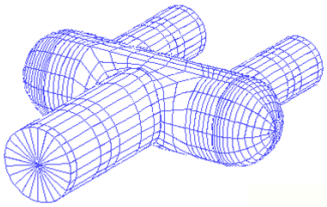
- Unreinforced Fabricated Tee
- Pad Reinforced Fabricated Tee
- Hillside Tee
- Welding Tee
- Y-Fitting Tee
- Bend with Trunnion
- Tank Settlement
- Low Tank Nozzle
- Tangential Nozzle
- Shell-To-Head Nozzle
- Pipe Supports
- String Modeler: string together a series of geometries to create mitered bends, annual plates, conical sections, etc.
- Nozzles/Plates/Shells: build complex geometries such as multiple nozzles on heads, stacked vessels, saddles, skirted vessels with lifting lugs and other supports.

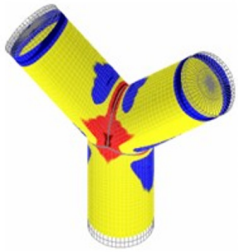
BRICK MODELS

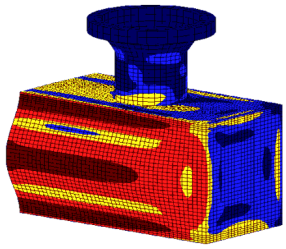
- Unreinforced Fabricated Tee
- Pad Reinforced Fabricated Tee
- Olet Intersection
- Axisymmetric Flange Modeler











LOAD ANALYSIS

- Weight, Operating, Occasional, Thermal & Pressure
- Internal or external pressure
- Applied point or surface loadings
- Piping loads applied to nozzles
- Wind
- Acceleration due to ship motion or transportation
- Seismic
- Fluid Head

SOLUTION CAPABILITIES

- Element library (beam, shell, axisymmetric & brick)
- Linear elastic analysis
- Non-Linear analysis (plasticity)
- Dynamic/modal analysis
- Dynamic harmonic analysis
- Automatic SIF and allow loads
- Eigenvalue buckling
- Steady state and transient thermal analysis
- Stress stiffening (large displacement)
- Refractory
- 2019 Edition of ASME Section VIII-2
- Fatigue Analysis

PCL-GOLD PIPE STRESS MODULE

- Auto fatigue damage calcs for multiple load cases
- Path dependent / convergent friction algorithm
- Refractory lined pipe / Gas lined pipe
- Hinged expansion joints with friction
- FEA i-factor and k-factor modeling
- Pressure fatigue
- i-factors/k-factors for flat, conical, elliptical, spherical and dished heads
- SuperElement results
- Links to FEATools v15.0

PAULIN RESEARCH GROUP

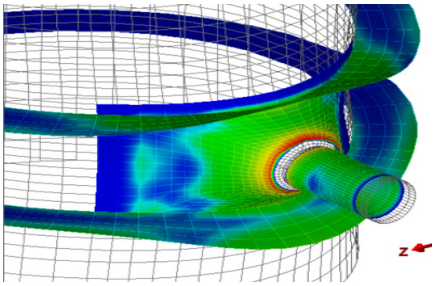
11211 Richmond Ave., Suite B109 • Houston, TX 77082 • U.S.A. voice 281.920.9775 • sales@paulin.com • www.PAULIN.com

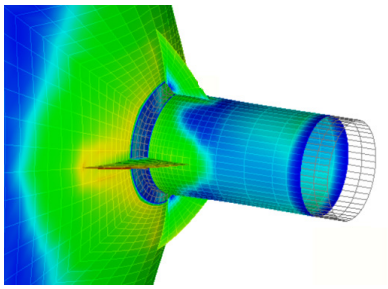
FEPipe v15.0 includes the following Programs...

NozzlePRO	NozzlePRO is a standalone solution that enables users to quickly and easily perform Finite Element Analysis (FEA) of individual pressure vessel and piping components.
MatPRO	PRG's materials database includes high temperature curves, allowable stress plots, NH reporting, creep-fatigue interaction diagrams, elastic-plastic stress strain curves and fatigue curves generated as a function of creep temperature.
AxiPRO	FEA of flanged joints and other axisymmetric geometries. 3D, nonlinear finite element models of gaskets, bolts and flanges are used to calculate stresses, displacements and leakage in and around the flanged joint. Code evaluations of the joint are performed in accordance with ASME Section VIII-1 Appendix 2, ASME BFJ and EN13445 Annex G.
661PRO	661PRO analyzes header box nozzles for air-cooled heat exchangers. It performs tube load analysis for multiple nozzle loads per ASME Section VIII-1 Appendix A. All nozzle loads are applied to the perforated tubesheet and analyzed per ASME 2004-Div. 2 Art 4-9.
FE107	FE107 replaces WRC 107 as a calculation tool that can be applied when WRC 107 or WRC 297 correlations or assumptions are limited. ASME Section VIII Division 2 allowables are printed along with flexibilities and allowable loads for forces, moments and pressure.
FESIF	Calculates SIFs and k-factors for standard B31 branch connection geometries.
FETee	FEA of contoured tees per user input, B16.9 or EN10253 is conducted. EN10253 types A and B tees can be defined and thickness profiles determined and appropriate finite element models constructed. Elastic models to produce SIFs and k-factors are generated automatically, along with nonlinear calculations (with or without pressure) for SSIs and loads thru the branch or run. Users may locally thin tees, define the crotch radius and/or the thickness profile around the branch to run penetration line.
FEBend	FEA calculation of the local stress and SIFs, SSIs and k-factors for 90 deg. elbows with and without supports. Supports include round stanchion as well as structural attachments.
PCL-Gold Pipe Stress	For piping systems in which there are well-known weaknesses in Code approaches, PCL-Gold provides an alternative method for determining whether or not the weakness can cause a potential problem.
Pipe Shoe Design Wizard	Compares CAESAR II or PCL-Gold selected nodes' restraint loads at shoe support locations with the allowable loads from a library of FEA shoe supports for every load case in the piping model. The comparison provides shoe design capabilities as well as validation that existing shoes are appropriately designed.
High Frequency	Acoustic Induced Vibration calculation includes prediction of sound pressure levels measurable away from the surface of the vessel. Used mainly to estimate strength of branch connections and elbows with trunnions when compared to straight pipe. PRG performs high frequency vibration tests to confirm surface integration and prediction of damaging SPL levels. Methods in IEC 60534-8-3 for gas flows are used to generate predicted SPL spectrum. Stresses in high frequency modes are scaled to match defined spectrum responses and predict expected cycle lives.
Cumulative Damage	Performs fatigue analysis and cycle counting for piping systems that were built using CAESAR II or PCL-Gold. This tool should be used whenever cycles are outside limits; fatigue should be considered in the piping system; known fluid loading produces high cycle forces; cracks or local thin areas are present; multiple significant thermal and/or pressure cycle is present.
BOS B31	The fluid-structure interaction using frequency domain analysis of piping systems is used to comply with the B31.3 loading requirements in Para. 301.5.
Flange Evaluation Wizard	CONDENSE - CAESAR II or PCL-Gold models are read in and users can then either specify flange locations or allow the program to pick all possible flange locations for evaluation. In the results below – flange locations in between axial support points are showing high stresses when bolt up tolerances are evaluated. The program simulates the load on the flange due to bolt up with default or specified tolerances.
SIF / SSI / k (PRGik)	Compares SIFs and k-factors from B31 and other codes for branch connections and elbows. Hyper Degree of Freedom (HyperDOF) calculations can be performed for elbows with and without supports with refractory.
Flaw Detection	Predicts crack growth for given stress states in components to know when the crack will reach half wall and/or thru wall for leaks. This is a quick calculation based on observed crack growth in tested low carbon steel components.
MimOut Point Clouds	Plant scan data (point cloud data) processing is combined with 3D modeling utilities to compare computer model estimates of what is in the field to what physically exists. Both high- and low-resolution editing is provided.
Drawing Tools	Available through FETee and FEBend, the Drawing Tools provide hundreds of small functions to modify, evaluate and document the model created.
Nonlinear Analysis	This capability computes burst pressures, sustained stress indices, twice elastic slope load levels, and a variety of load and unload conditions.
Fitness for Service	Perform level 1, level 2 and level 3 (through the drawing tools) Fitness for Service calculations. Local thin areas and cracks can be added into the model for level 3 calculations. API 579/ASME FFS-1 allows the use of ASME Section VIII Division 2 Part 5 for Elastic, Elastic-Perfectly Plastic and Elastic-Plastic FEA analysis.
FEATools v15.0	Transform your piping model (CAESAR II and PCL-Gold) by including upgraded branch connections (with the addition of rigid elements and restraints) to better simulate real-world displacement and forces. The FEA-based calculations provide the necessary k-factors, SSIs and SIFs that will be added to every branch connection. Now available with FEPipe v15.0

Drawing Tools

The Drawing Tools allow for graphical “CAD-like” modification of existing shell model details and the addition of secondary model components such as rings, gussets, clips, etc. Add or delete elements. Add restraints and change elemental thicknesses.

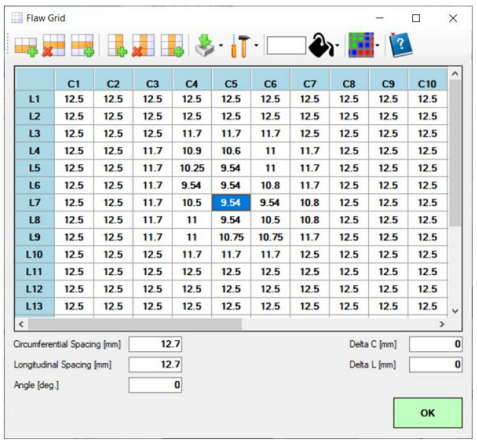


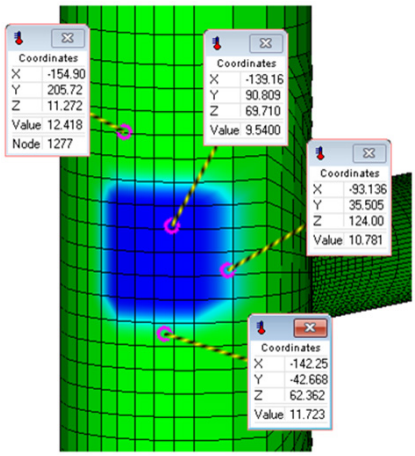


For a demonstration with one of our developers on how FEPipe can help you with your PV&P design and analysis please contact sales@paulin.com.

API 579 Fitness for Service

The FFS program allows for the direct entry of know flaw/corrosion details. Enter the flaw dimensions directly (into the Critical Flaw Dimensions section), or the dimensions can be entered in a spreadsheet grid and the Critical Flaw Dimensions section will be automatically calculated (image of left). The user can also define the defect on the model graphically by drawing the defect on the model (image on right).



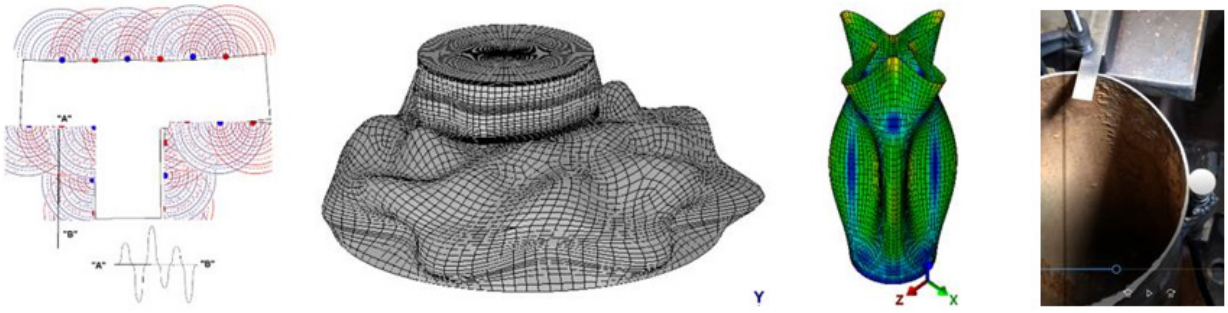


Add Local Thin Areas (LTA) and crack-like flaws using FEPipe, NozzlePRO or the Drawing Tools to perform API 579/ASME FFS-1 Level 3 type analysis. Level 3 allows the use of ASME Section VIII Division 2 Part 5 – Design by Analysis – when the LTA or crack-like flaws are included in the shell or brick models. Perform code compliance using Linear Elastic, Elastic-Perfectly Plastic and Elastic-Plastic analysis as allowed by the ASME code.

Results Verification

Element formulations and related output have been compared against classical hand calculations and benchmarked against other general FEA software tools.

In addition, PAULIN Research Group regularly conducts experimental work in the PRG laboratory. This work includes strain gauge measurements, burst tests, fatigue tests, cryogenic work, heat transfer experiments as well as acoustic vibration tests as shown below.



Acoustic Induced Vibration and Minion Mode Sound Pressure Level Calculations
Test on the right performed at the PRG lab in Houston.

PAULIN RESEARCH GROUP

11211 Richmond Ave., Suite B109 • Houston, TX 77082 • U.S.A. voice 281.920.9775 • sales@paulin.com • www.PAULIN.com