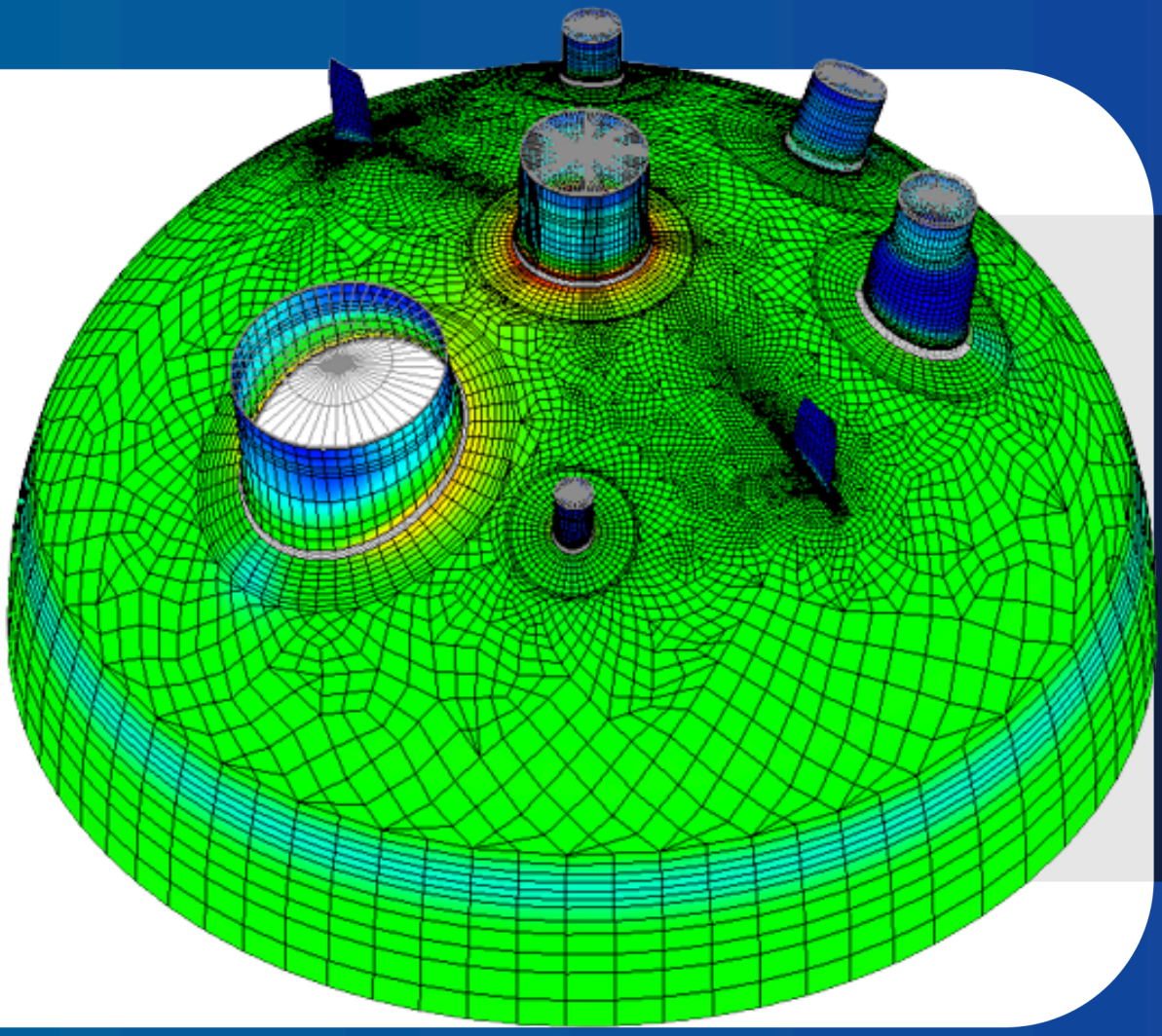
FEA Validation and Reporting

NozzlePRO™

Advanced FEA for Pressure Vessels, Nozzles, Attachments & Multi-Nozzle Systems



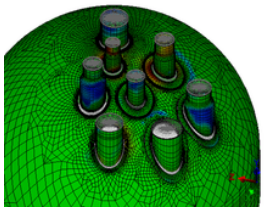
PRG
PAULIN
Research Group
www.paulin.com
Sales: 281-920-9775

NozzlePRO™

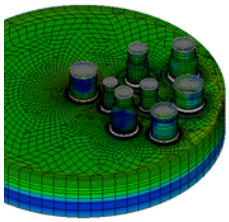
What is NozzlePRO?

NozzlePRO is a standalone solution that enables users to quickly and easily perform **finite element analysis.**

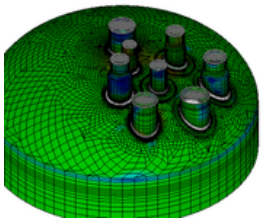
It's a **Design By Analysis** program that enables engineers to perform advanced finite element analysis of pressure vessels, **multi-nozzle geometries**, supports, structural attachments, and multiple interacting nozzle systems without requiring extensive FEA expertise. The software automates model creation, validation, stress categorization, and ASME VIII-2 compliance reporting to significantly reduce analysis time while improving confidence in complex designs.



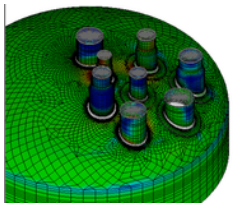
Hemispherical Heads



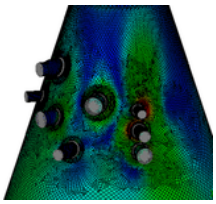
Flat Heads



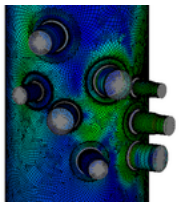
Elliptical Heads



Dished/Torisherical Heads



Conical Heads



Cylinders

What can you analyze with NozzlePRO?

NozzlePRO Software Capabilities

NozzlePRO is designed to quickly and easily **evaluate nozzles, saddles*, pipe shoes* and clips** on a variety of head types including **spherical, elliptical, ASME, dished, cylindrical and conical.** Within minutes you'll be able to generate the following:

- Single nozzle FEA+
- Multi-nozzle FEA
- Clustered nozzle analysis with pressure and external loads
- Structural attachments, clips, lugs and support interactions*
- Straight, pad-reinforced and heavy barrel nozzles+
- Cylindrical, conical, flat, hemispherical, elliptical and dished head geometries*
- Saddle supports and pipe shoe evaluations*
- Steady-state and transient thermal analysis*
- Automatic ASME VIII-2 Part 5 stress categorization and code compliance reporting
- Linear, nonlinear and elastic-plastic analysis capabilities

*Those in asterisks * are included in **NozzlePRO Legacy**. Those with + are included in both NozzlePRO and NozzlePRO Legacy. All NozzlePRO subscriptions include access to NozzlePRO Legacy.* ***For more information about NozzlePRO Legacy, contact sales@paulin.com.***

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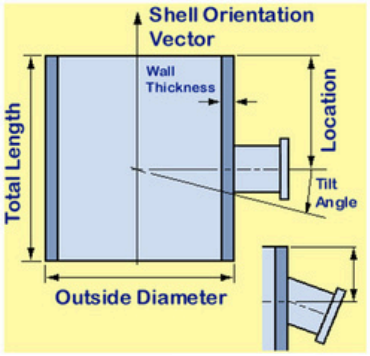
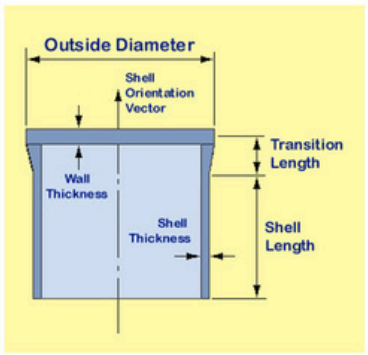
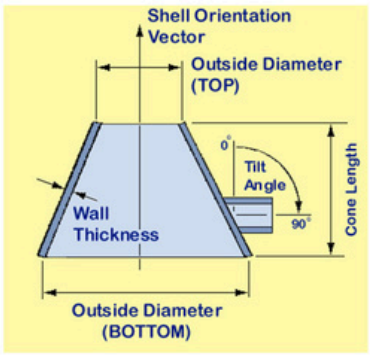
Base/Shell Geometries Supported in NozzlePRO



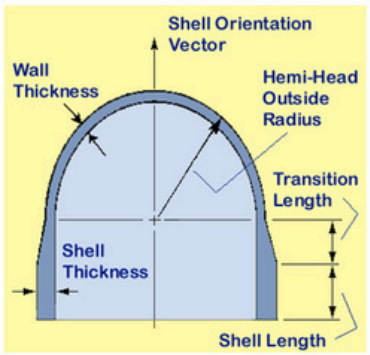
Cylinder / Pipe (Cylinderical Shell)



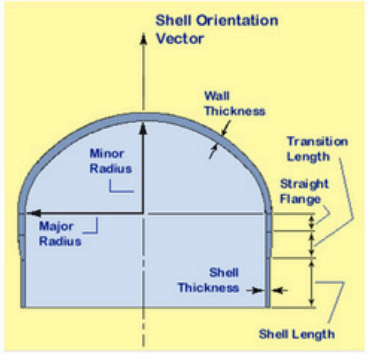
Flat Head



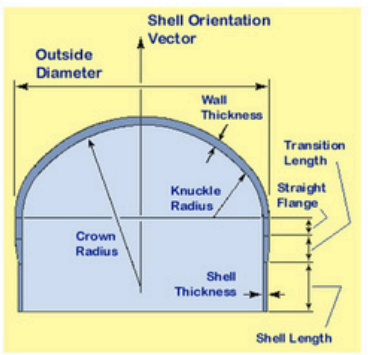
Conical Head / Reducer



Hemispherical Head

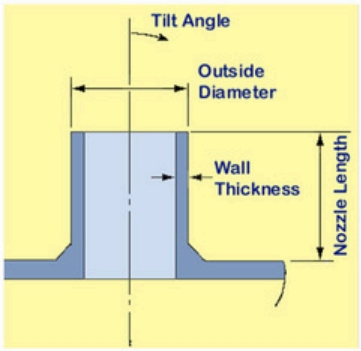


Elliptical Head

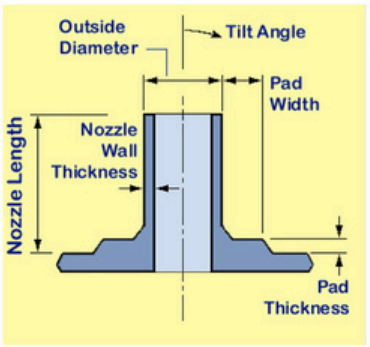


Dished Head

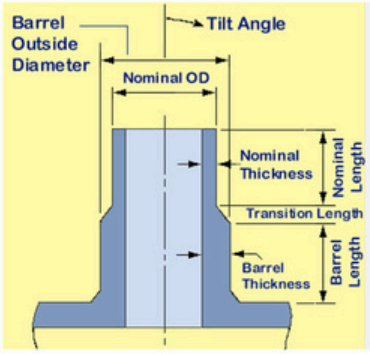
Nozzle/Attachment Geometries Supported in NozzlePRO



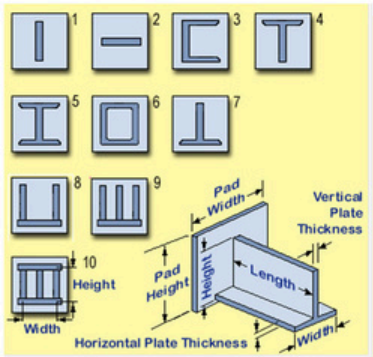
Straight Nozzle



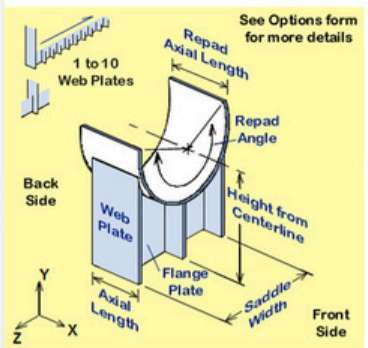
Pad-Reinforced Nozzle



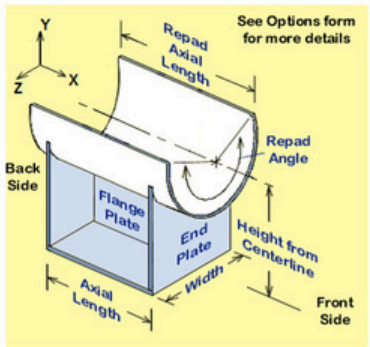
Barrel Nozzle



Lug / Structural Attachments



Saddle (on pipe or tank)



Pipe Shoe

Features in NozzlePRO

PRG's standalone FEA solution aims to support easy and accurate **Design By Analysis** functionalities, including:

Analysis

- Validates models against **ASME Section VIII Division 2 Part 5** requirements with automated stress categorization and reporting
- Evaluates single nozzles, **multiple interacting nozzles** and clustered nozzle configurations
- Simultaneously accounts for pressure, thermal and external piping loads
- Analyzes **buckling, collapse loads** and structural stability using linear, elastic-plastic FEA
- Evaluates flaws and cracks in pressurized or loaded components using Level 3 **fitness-for-service** methods

Design

- Supports cylindrical, conical, flat, hemispherical, elliptical and dished head geometries
- Models straight, pad-reinforced and heavy barrel nozzles in a single **Design By Analysis** workflow
- Evaluates structural attachments, clips, lugs, saddles and pipe shoes alongside nozzle designs
- Handles **multiple load cases simultaneously** across complex pressure equipment configurations
- Provides automatic Stress Intensity Factors (SIFs), Sustained Stress Indices (SSIs) and **flexibility factors** for nozzles and branch connections

Integration

- Integrates with CEI's **DesignCalcs** and **Finglow** workflows, allowing FEA to be performed on pressure vessel components alongside **PD5500, EN13445 and ASME Section VIII Division 1 and Division** 2 design calculations
- **Uses VesselLink** to generate FEA models from supported pressure vessel design software and perform **component-level evaluations within NozzlePRO**

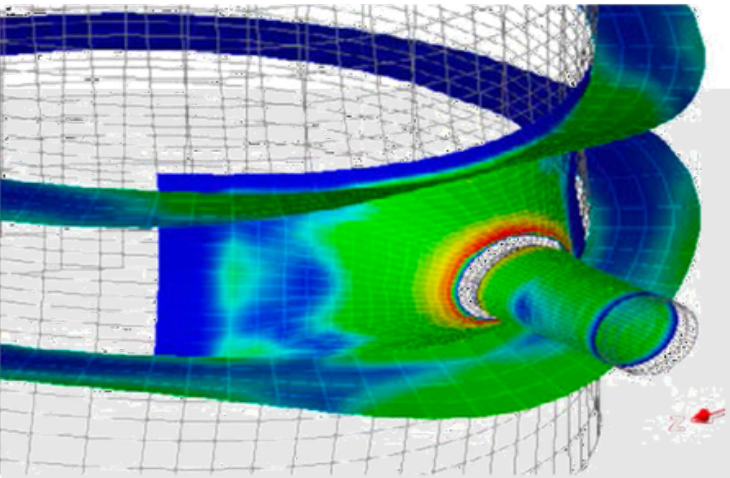
Software like Hexagon and Codeware no longer support PRG software products. If you have any questions regarding NozzlePRO or FEATools licenses purchased through Hexagon or Codeware, please contact our sales group at sales@paulin.com.

Programs in NozzlePRO

Along with a variety of features, NozzlePRO utilizes several programs to provide the ultimate FEA solution for pressure equipment designs. A few include:

- The **Saddle Wizard** is a step-by-step interactive modeler that allows the user to design their horizontal vessel and saddle for any loading conditions.
- The **Pipe Shoe Wizard** creates an FEA model of a pipe shoe on a cylinder to calculate local stress.
- **Vessel Link** allows the user to import models **of any file type** from **DesignCalcs, Finglow, Codeware Compress** and other pressure vessel design software to perform FEA.
- **FE107 replaces WRC 107** as a calculation tool that can be applied when **WRC 107 or WRC 297 calculations or assumptions are limited.** ASME Section VIII Div 2 allowables are printed along with flexibilities and allowable loads for forces, moments, and pressure.

[Optional Upgrade] The Drawing Tools allow the user to add gussets, rings, clips and other attachments to an existing model. NozzlePRO uses the Drawing Tools feature to provide an interactive CAD feature to edit the model or apply local thinning and cracks.



Additional Programs

Program	Program Summary
MatPRO	MatPRO is PRG's materials database that includes high temperature curves, allowable stress plots, NH reporting, creep-fatigue interaction diagrams, elastic-plastic stress strain curves and fatigue curves generated as a funtion of creep temperature.
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.

Additional Programs (continued)

Program	Program Summary
High Frequency	Provides **AIV calculation predictions** of pressure levels from the surface of the vessel. This program is mainly used to: • Determine virtually any number of natural frequencies and their respective shell mode shapes • Perform high frequency vibration tests to confirm surface integration and prediction of damaging SPL levels • Generate the predicted SPL spectrum by using methods in **IEC 60534-8-3 for gas flows** • Scale stresses in high frequency modes to match defined spectrum responses and predict expected cycle lives
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.
Nonlinear Analysis **[Optional Upgrade]**	Computes **burst pressures, sustained stress indices, twice elastic slope load levels** b, and a variety of load and unload conditions.
Degree of Conservatism	This tool aids in determining the **degree of conservatism** on models.
FESIF	Calculates **SIFs and k-factors for standard B31** branch connection geometries.
FETee	Along with performing **FEA of contoured tees per user input, B16.9, or EN10253,** this program mainly: • Defines EN10253 types A and B tees • Determinees thickness profiles • Constructs appropriate finite element models • Automatically generates elastic models to produce SIFs and k-factors, along with nonlinear calculations (with or without pressure) for SSIs and loads thru the branch or run • Defines local thin tees, the crotch radius, and/or the thickness profile around the branch to run penetration line

Why Choose NozzlePRO?

Pressure equipment designs are becoming increasingly complex, requiring engineers to evaluate interacting nozzles, supports, attachments and loading conditions while maintaining compliance with industry codes.

NozzlePRO combines advanced finite element analysis with automated Design By Analysis workflows to help engineers evaluate everything from individual nozzle connections to complex multi-nozzle pressure vessel configurations in a single platform.

With automated model generation, stress categorization and ASME VIII-2 reporting, **NozzlePRO reduces analysis time** while providing the confidence needed for critical design decisions.

When to Use NozzlePRO

- When **multiple nozzles interact and traditional calculation methods** become overly conservative or insufficient
- When **clustered nozzles, structural attachments** or support details must be evaluated together
- When **pressure and external piping loads** must be considered simultaneously
- When **WRC methods** exceed their limitations or assumptions
- When **thermal gradients** and operating loads affect local stresses
- When **nonlinear behavior**, collapse loads or fatigue life must be evaluated
- When supports, saddles, pipe shoes or vessel attachments influence **local stresses**
- When **ASME VIII-2 Design By Analysis** compliance is required or WRC methods exceed their assumptions
- When engineers need **rapid model creation** and automated reporting
- When complex pressure equipment geometries require more than **Design By Rule methods** can provide

NozzlePRO accounts for **thermal, weight, operating, occasional, pressure, wind and earthquake loads** so that compliance requirement needs in the **O&G, Chemical, Pharma** and many other industries can be easily determined and met.

With any DBA program, **NozzlePRO is highly configurable and can be tailored to fit almost any need.** Want to learn more? **Schedule a discovery call with us today by emailing** sales@paulin.com or visitng our webiste.

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