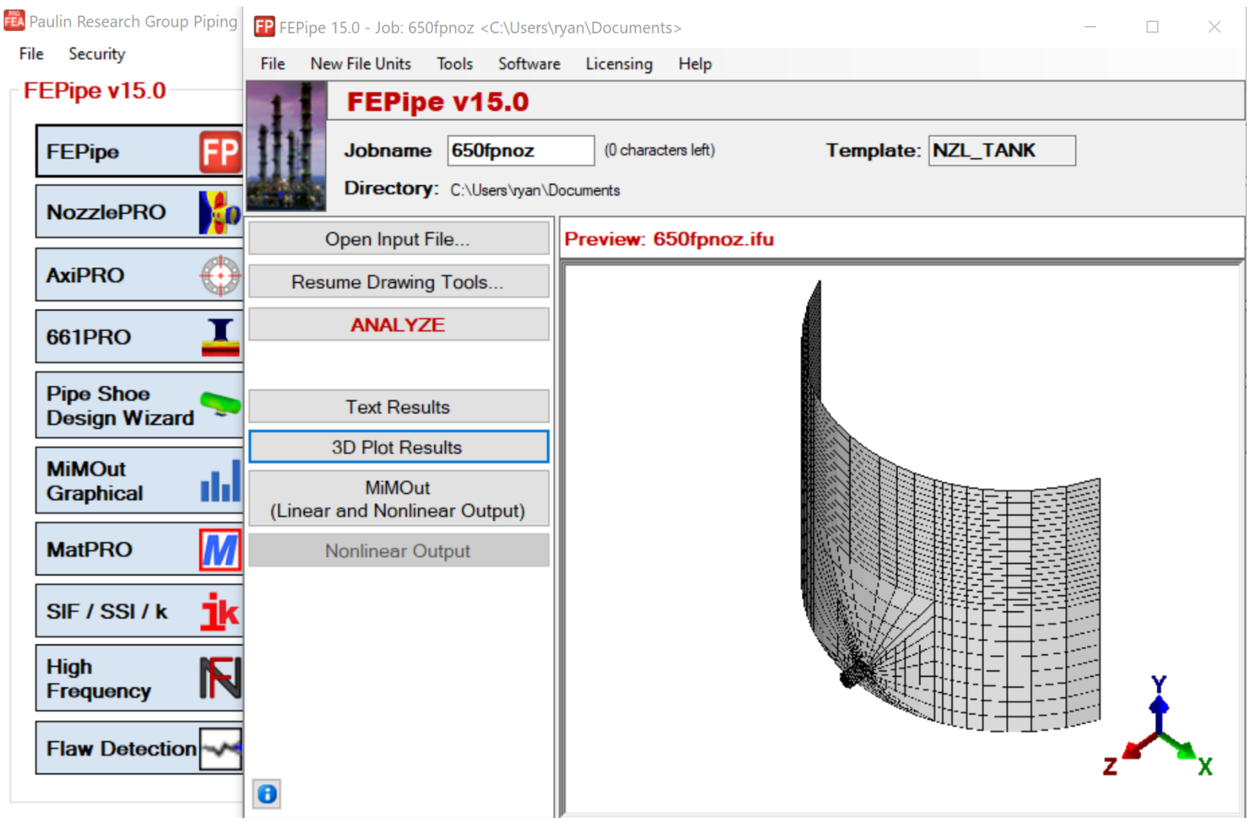
SAMPLE FEPipe Model

With Output And Notes On Currently Supported FEPipe Templates

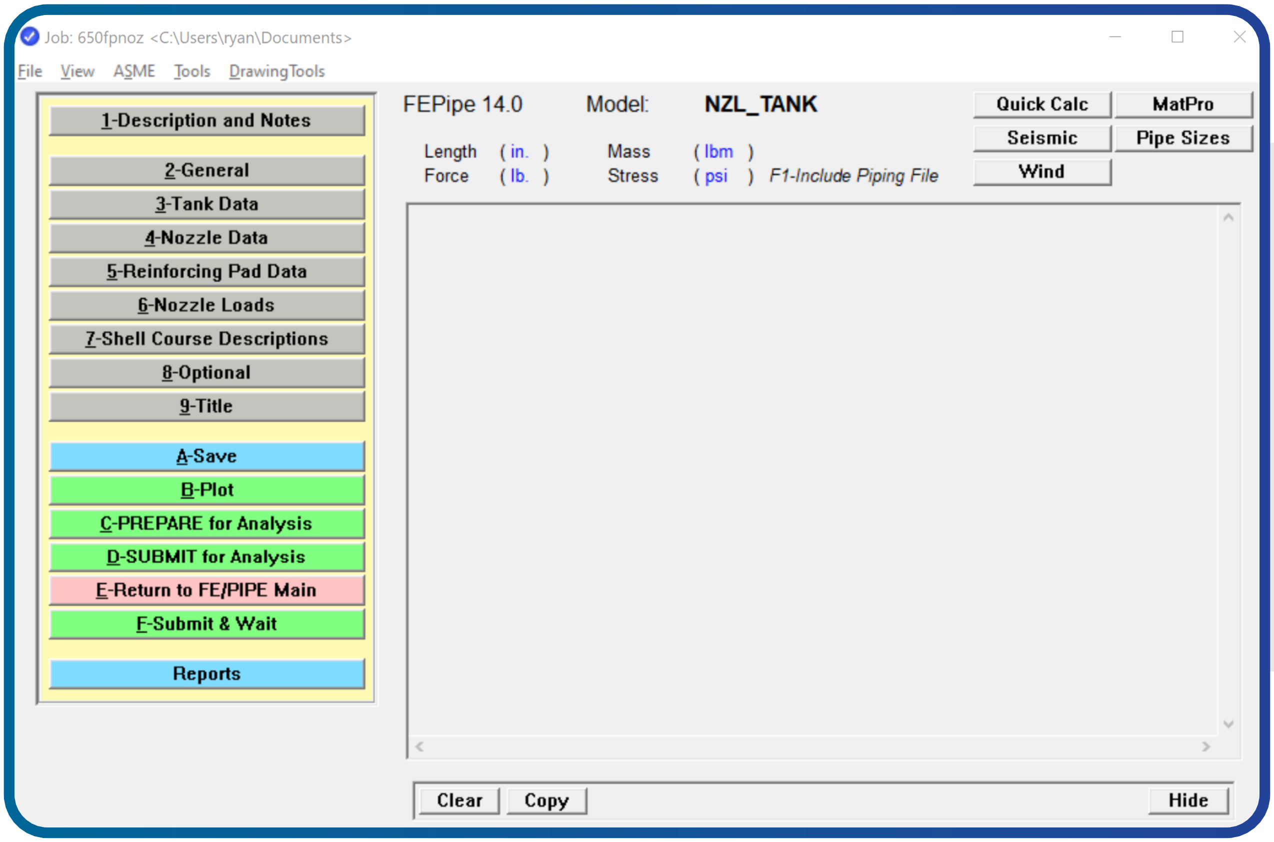
This document provides an example of a model based on FEPipe template. The template for this example is the **“Low Tank Nozzle”** template. The main FEPipe GUI with this model selected/ open is shown below.



At first glance, this may appear like a single nozzle that could have been modeled in NozzlePRO. This template, however, provides the user with a specific set of data input “forms” (dialogs) that allow the user to define many characteristics that are unique to a nozzle located near the bottom of a large oil or other liquid-holding tank.

This template was also built specifically to address needs in the API 650 specificaMons.

The list of data input forms and the main FEPipe GUI for this template is shown below.



The user can define the following for this low tank nozzle:

General

Liquid Height

Liquid Specific Gravity

Tank Data

Tank Data

Tank Diameter
Tank Top (Fixed/Floating)
Tank Bottom Boundary Condition (Fixity/Simple)
Angular portion of tank to include in model

Stress

Design Stress
Yield Stress
Tensile Stress

Material Properties

Elastic Modulus
Density
Poisson's Ratio
Thermal Coefficient

Nozzle Data

Nozzle Data

- Outside Diameter Nozzle
- Thickness of Nozzle
- Elevation on Tank Side

Lengths & Numbers

- Outside Length of Nozzle
- Internal Length of Nozzle (the nozzle can go into the tank some length)
- Nozzle Weld Length
- Tank Weld Length
- X-axis Skew Length
- Nozzle Node Number (to join to other FEPipe model)
- Insert Node Number (to join to other FEPipe model)

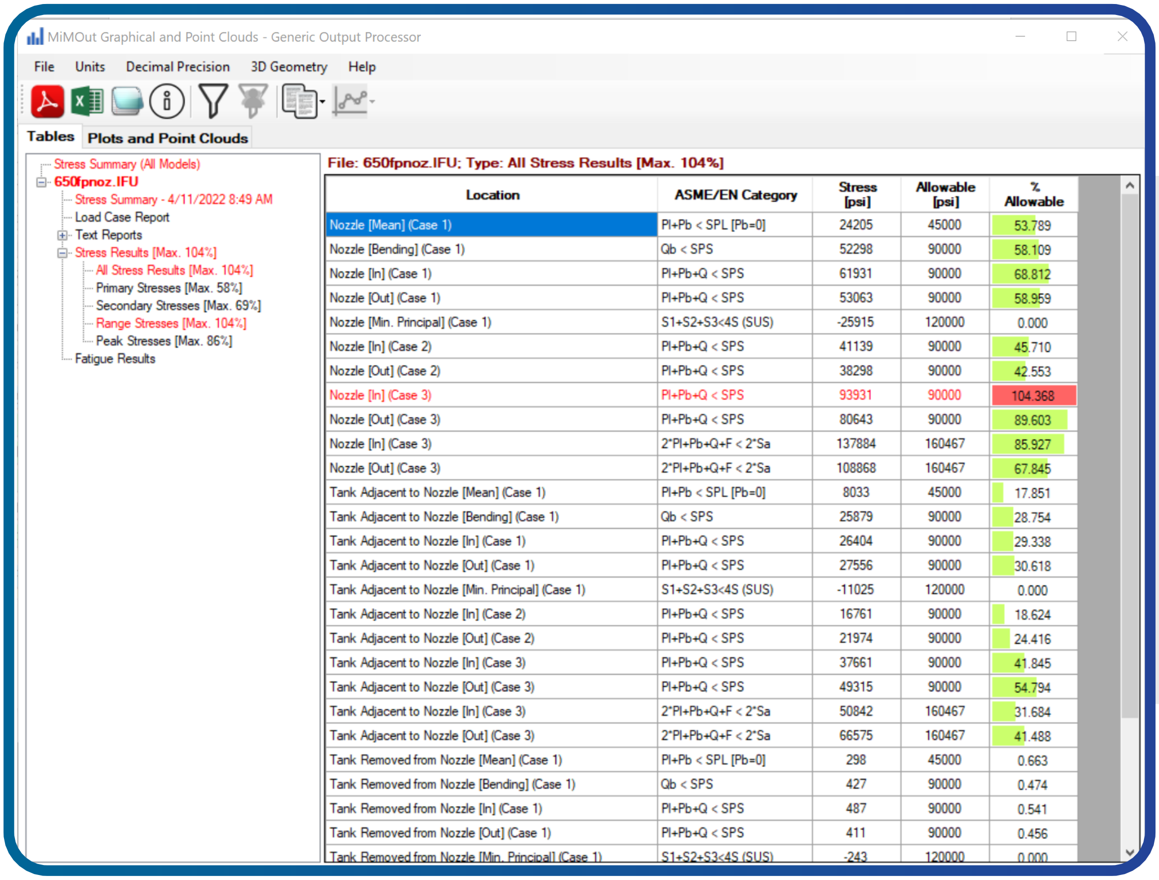
...

In this way, the template **benefits the user by**:

- Letting the user define many aspects of an API 650 Nozzle, with the minimum numbers of data values needed.
- Allowing the user to define a reinforcement pad on the nozzle of several types (Round, Octagonal, Rathole).
- Allowing the user to define the “shell course thickness” if the tank has sections (vertically) that are of different thicknesses.

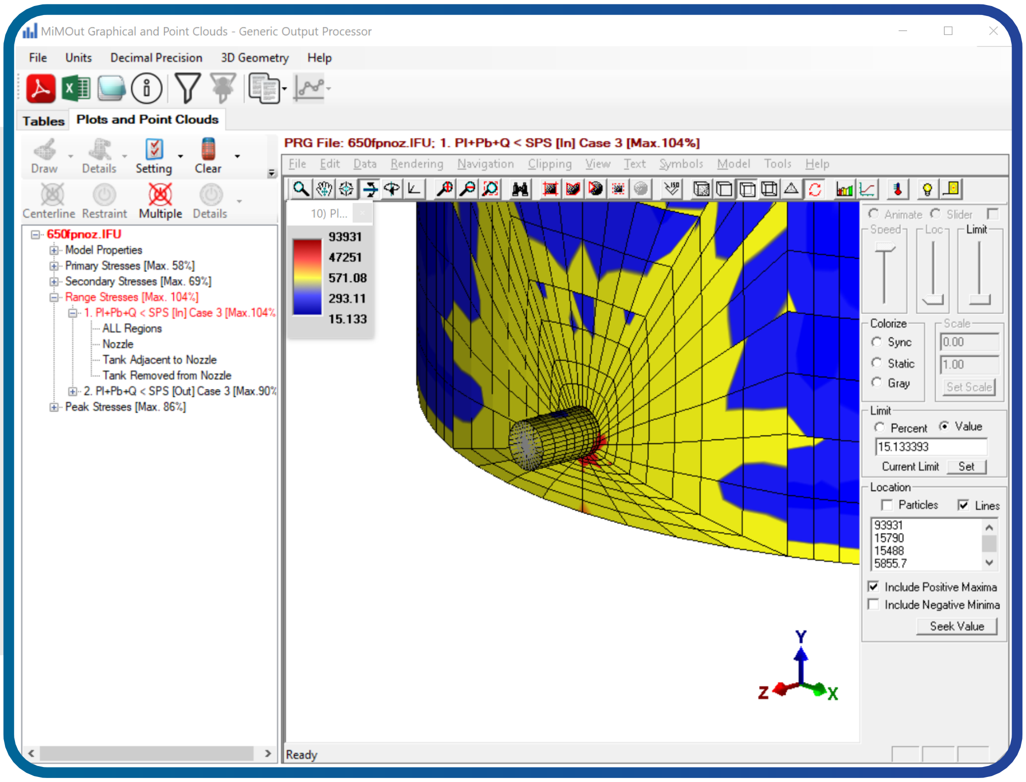
Once the user has defined the model as accurately as they can and used the normal procedures to define loads on the nozzle and the boundary conditions of the tank itself (e.g. Is the tank bottom fixed to the ground or free to move/expand?), then they can do a complete **FEA Analysis** of the tank and the nozzle. Using this, the user can then address tank/nozzle configurations, materials, thickness, or operating conditions that fall outside the limits of the standard code guidelines and industry specifications.

An example of the output from a typical Low Tank Nozzle analysis is shown below.

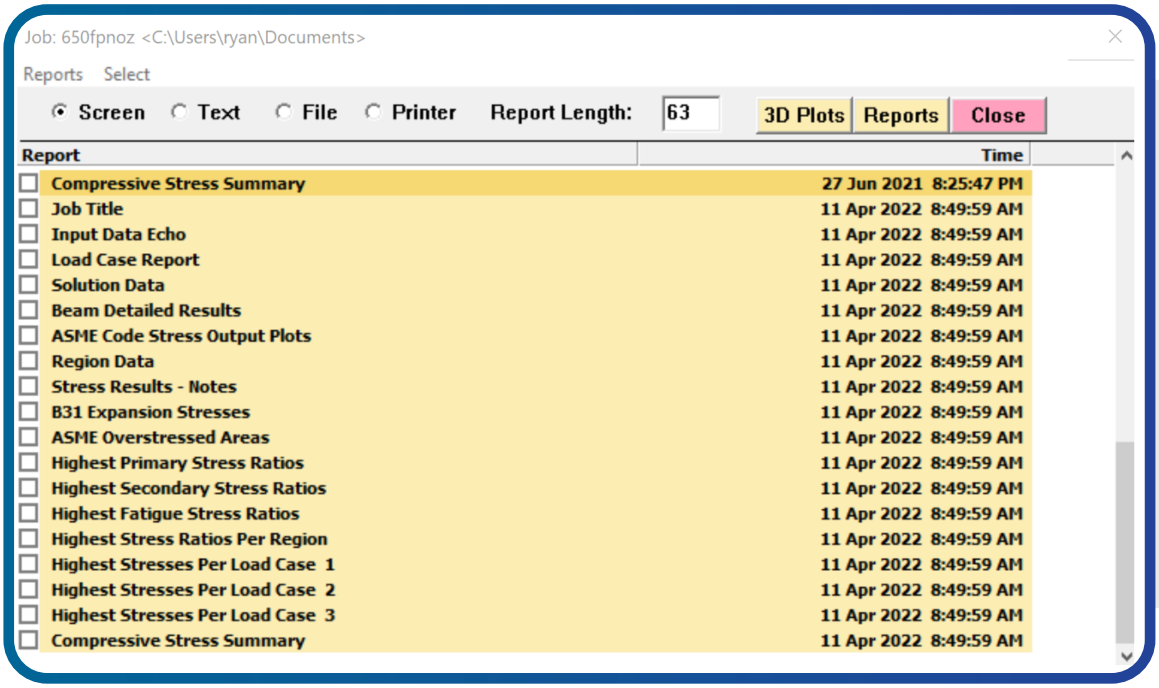


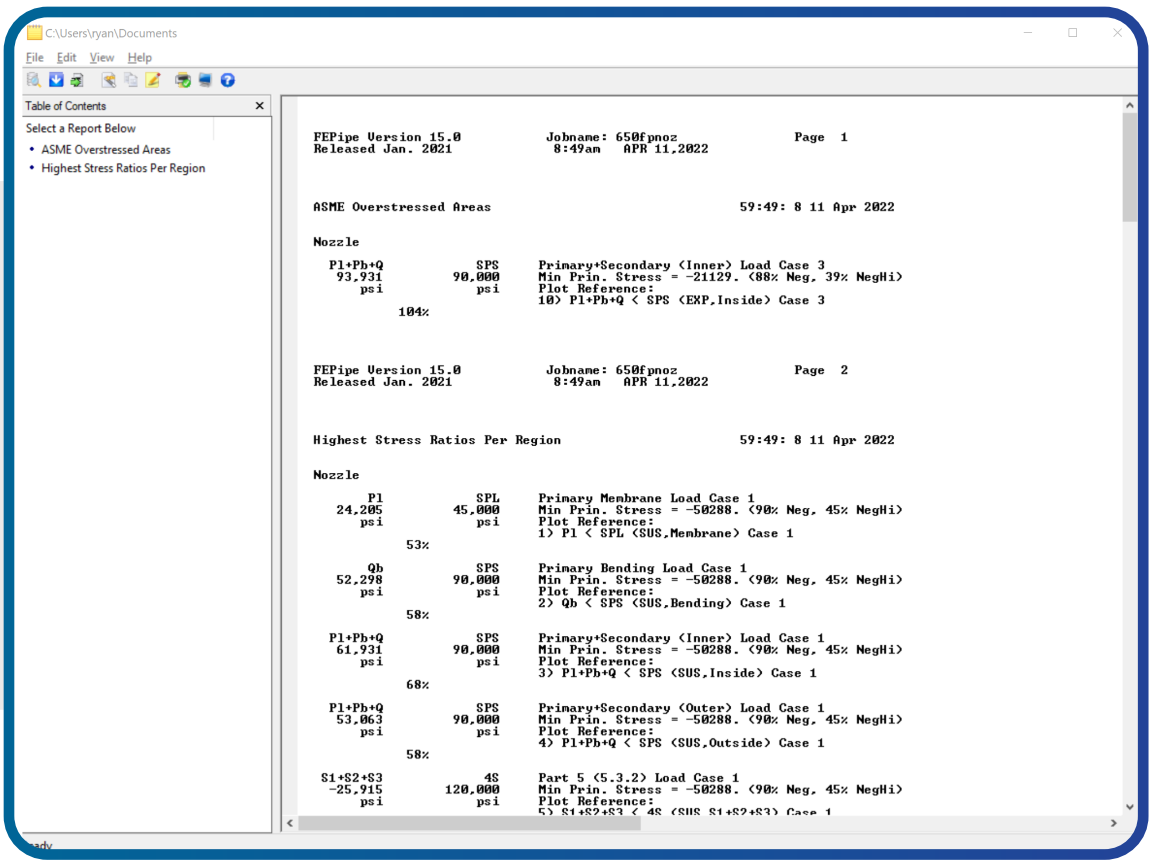
Location	ASME/EN Category	Stress [psi]	Allowable [psi]	% Allowable
Nozzle [Mean] (Case 1)	Pl+Pb < SPL [Pb=0]	24205	45000	53.789
Nozzle [Bending] (Case 1)	Qb < SPS	52298	90000	58.109
Nozzle [In] (Case 1)	Pl+Pb+Q < SPS	61931	90000	68.812
Nozzle [Out] (Case 1)	Pl+Pb+Q < SPS	53063	90000	58.959
Nozzle [Min. Principal] (Case 1)	S1+S2+S3<4S (SUS)	-25915	120000	0.000
Nozzle [In] (Case 2)	Pl+Pb+Q < SPS	41139	90000	45.710
Nozzle [Out] (Case 2)	Pl+Pb+Q < SPS	38298	90000	42.553
Nozzle [In] (Case 3)	Pl+Pb+Q < SPS	93931	90000	104.368
Nozzle [Out] (Case 3)	Pl+Pb+Q < SPS	80643	90000	89.603
Nozzle [In] (Case 3)	2*Pl+Pb+Q+F < 2*Sa	137884	160467	85.927
Nozzle [Out] (Case 3)	2*Pl+Pb+Q+F < 2*Sa	108868	160467	67.845
Tank Adjacent to Nozzle [Mean] (Case 1)	Pl+Pb < SPL [Pb=0]	8033	45000	17.851
Tank Adjacent to Nozzle [Bending] (Case 1)	Qb < SPS	25879	90000	28.754
Tank Adjacent to Nozzle [In] (Case 1)	Pl+Pb+Q < SPS	26404	90000	29.338
Tank Adjacent to Nozzle [Out] (Case 1)	Pl+Pb+Q < SPS	27556	90000	30.618
Tank Adjacent to Nozzle [Min. Principal] (Case 1)	S1+S2+S3<4S (SUS)	-11025	120000	0.000
Tank Adjacent to Nozzle [In] (Case 2)	Pl+Pb+Q < SPS	16761	90000	18.624
Tank Adjacent to Nozzle [Out] (Case 2)	Pl+Pb+Q < SPS	21974	90000	24.416
Tank Adjacent to Nozzle [In] (Case 3)	Pl+Pb+Q < SPS	37661	90000	41.845
Tank Adjacent to Nozzle [Out] (Case 3)	Pl+Pb+Q < SPS	49315	90000	54.794
Tank Adjacent to Nozzle [In] (Case 3)	2*Pl+Pb+Q+F < 2*Sa	50842	160467	31.684
Tank Adjacent to Nozzle [Out] (Case 3)	2*Pl+Pb+Q+F < 2*Sa	66575	160467	41.488
Tank Removed from Nozzle [Mean] (Case 1)	Pl+Pb < SPL [Pb=0]	298	45000	0.663
Tank Removed from Nozzle [Bending] (Case 1)	Qb < SPS	427	90000	0.474
Tank Removed from Nozzle [In] (Case 1)	Pl+Pb+Q < SPS	487	90000	0.541
Tank Removed from Nozzle [Out] (Case 1)	Pl+Pb+Q < SPS	411	90000	0.456
Tank Removed from Nozzle [Min. Principal] (Case 1)	S1+S2+S3<4S (SUS)	-243	120000	0.000

Note that PRG offers many of the same output/report options that the user has for a NozzlePRO model. The most flexible and valuable of these is the MiMOUT reporting tool. When this is used for this model's output, the list of areas of the model one can inspect/plot/graph are specific to the Low Tank Nozzle template, so the user does not have to spend a lot of time fishing around for stress results.



Sample Tabular Output:





This template-based approach allows the user to quickly model and fully analyze a large number of complex model types that are commonly found in the PVP industry. And with the ability to join these models together to form larger models, one can systematically model and analyze entire plant processes, within limits.

The standard list of supported FEPipe templates is shown in the diagram below.

General

- Nozzles, Plates and Shells (Shell)
- Piping and Structural (Beam)
- String (Shell)
- Axisymmetric (2D/Brick)

Piping Components

- Piping and Structural (Beam)
- String (Shell)
- Nozzles, Plates and Shells (Shell)
- Unreinforced Fabricated Tee (Shell)
- Reinforced Fabricated Tee (Shell)
- Hillside (Shell)
- Welding Tee (Shell)
- Bend with Staunchion (Shell)
- Wye Fittings (Shell)
- FCC Wye Fittings (Shell)
- Cylinder-Clyinder Intersection (Brick)
- OLET Type (Brick)
- Simple Pipe Supports (Shell)

Vessel Components

- Nozzels, Plates and Shells (Shell)
- Unreinforced Fabricated Tee (Shell)
- Reinforced Fabricated Tee (Shell)
- Hillside (Shell)
- Cylinder-Cylinder Intersection (Brick)
- Shell-To-Head (Shell)
- Tangential Nozzles (Shell)
- Large Nozzles (Shell)

Tanks

- Low Tank Nozzle (Shell)
- Tank Settlement (Shell)

Specialty

- General Head Supports (Shell)
- Plate Heat Exchanger Port (Shell)
- Shell-To-Head (Shell)
- Large Nozzles (Shell)
- Axisymmetric (2D/Brick)

Volumetric

- Axisymmetric (2D/Brick)
- OLET Type (Brick)
- Simple Flange (Axisymmetric)
- Cylinder-Cylinder Intersection (Brick)

Supplemental

- Miscellaneous Calculations
- SAM

Finally, the user can use the new Drawing Tools, or one of the templates that allows the user to literally build a model “plate-by-plate.” There are many custom designs that can be acommodated.