PASS/EQUIP Overview Webinar

Comprehensive Software for Structural Pressure Vessels Analysis

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PASS

PIPING AND EQUIPMENT ANALYSIS & SIZING SUITE

Webinar Agenda

- About PASS Suite
- What is PASS/EQUIP
- PASS/EQUIP Configurations
- Supported codes and standards
- PASS/EQUIP Material Database
- 3D Model Export
- Reports generation
- What's new in PASS/EQUIP 3.02
- Live demonstration of PASS/EQUIP
- Q & A session

PASS
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ANALYSIS & SIZING SUITE

PASS Suite

PASS Suite provides smart simulation & sizing tools for every piping and equipment engineer and designer

PIPING AND EQUIPMENT ANALYSIS & SIZING SUITE

Company Overview

- > 50 years history
- > 3,000 active users worldwide
- Best in class modern methods, algorithms and software libraries
- Embedded knowledge and support/training from industry experts
- User-friendly interface and flexible CAD integration
- Affordable price and flexible licensing

PASS/EQUIP

Pressure vessel strength and stability analysis for horizontal and vertical vessels, columns, storage tanks, heat exchangers, and finite element analysis of arbitrary vessel nozzles

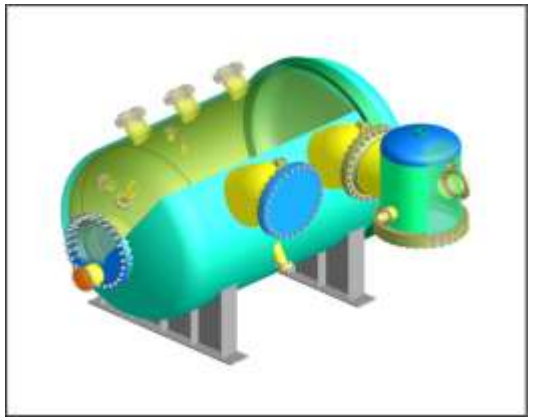
PASS PIPING AND EQUIPMENT ANALYSIS & SIZING SUITE

Pressure Vessel Stress Analysis

- Broad Applicability
- Unsurpassed Usability
- Powerful Capabilities
- Flexible Configurations
- Widely Used

PASS/EQUIP | Broad Applicability

- Power
- Oil Refining
- Chemical
- Petrochemical
- Natural Gas



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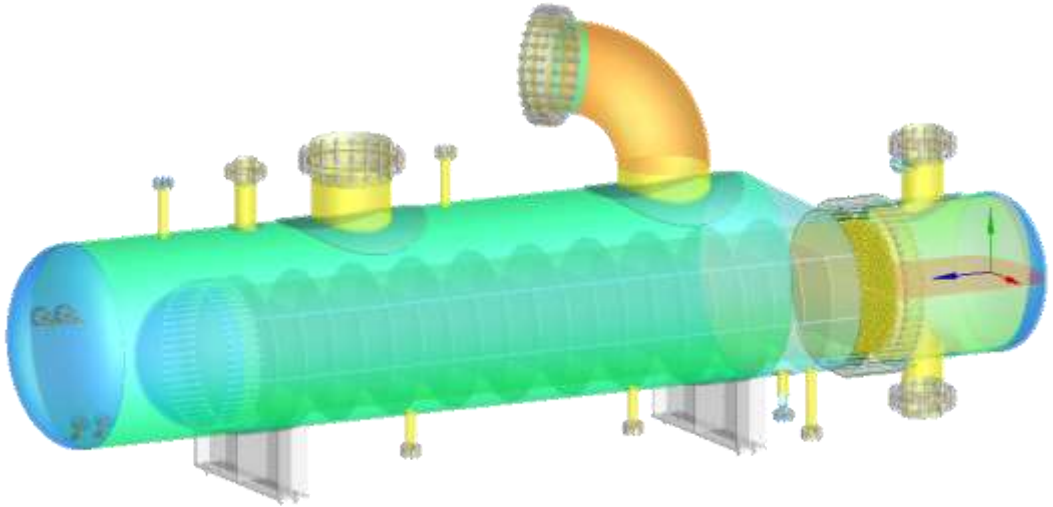
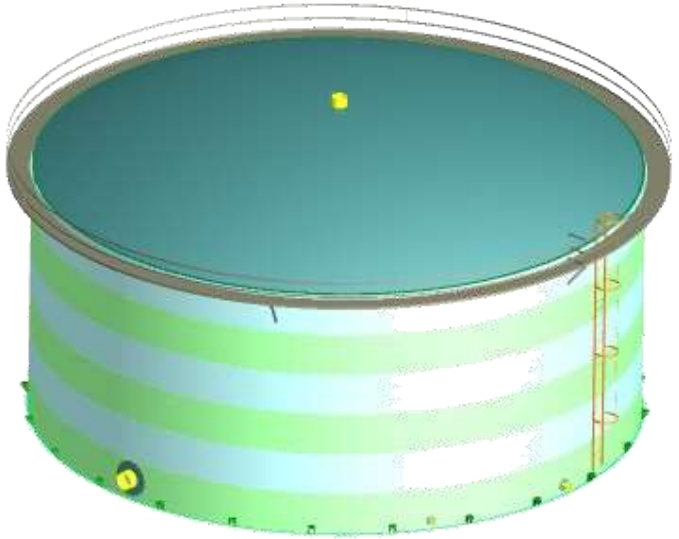
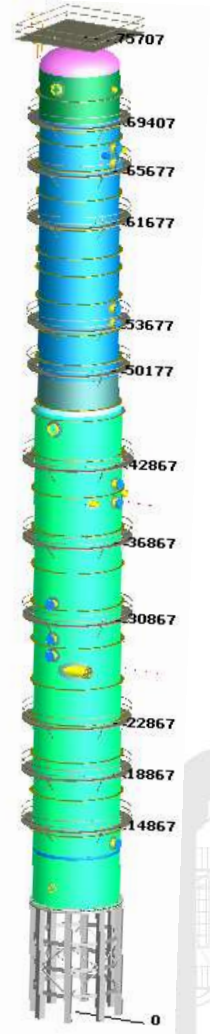
PASS/EQUIP

Configurations

- Horizontal and vertical vessels
- Columns
- Heat Exchangers
  - shell-and-tube
  - air–cooled
- Tanks







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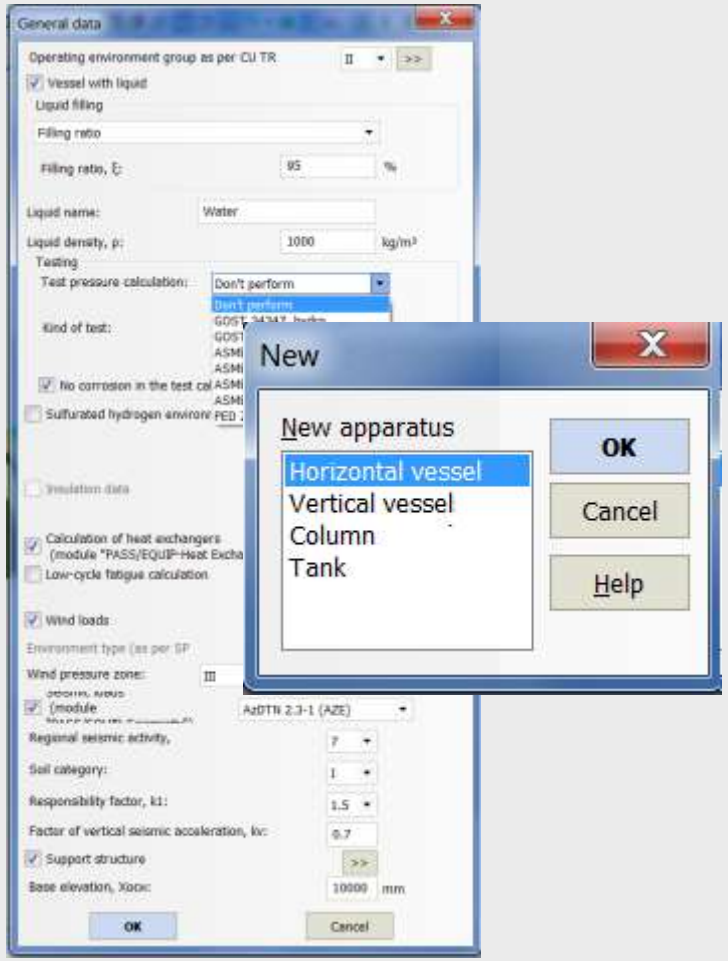
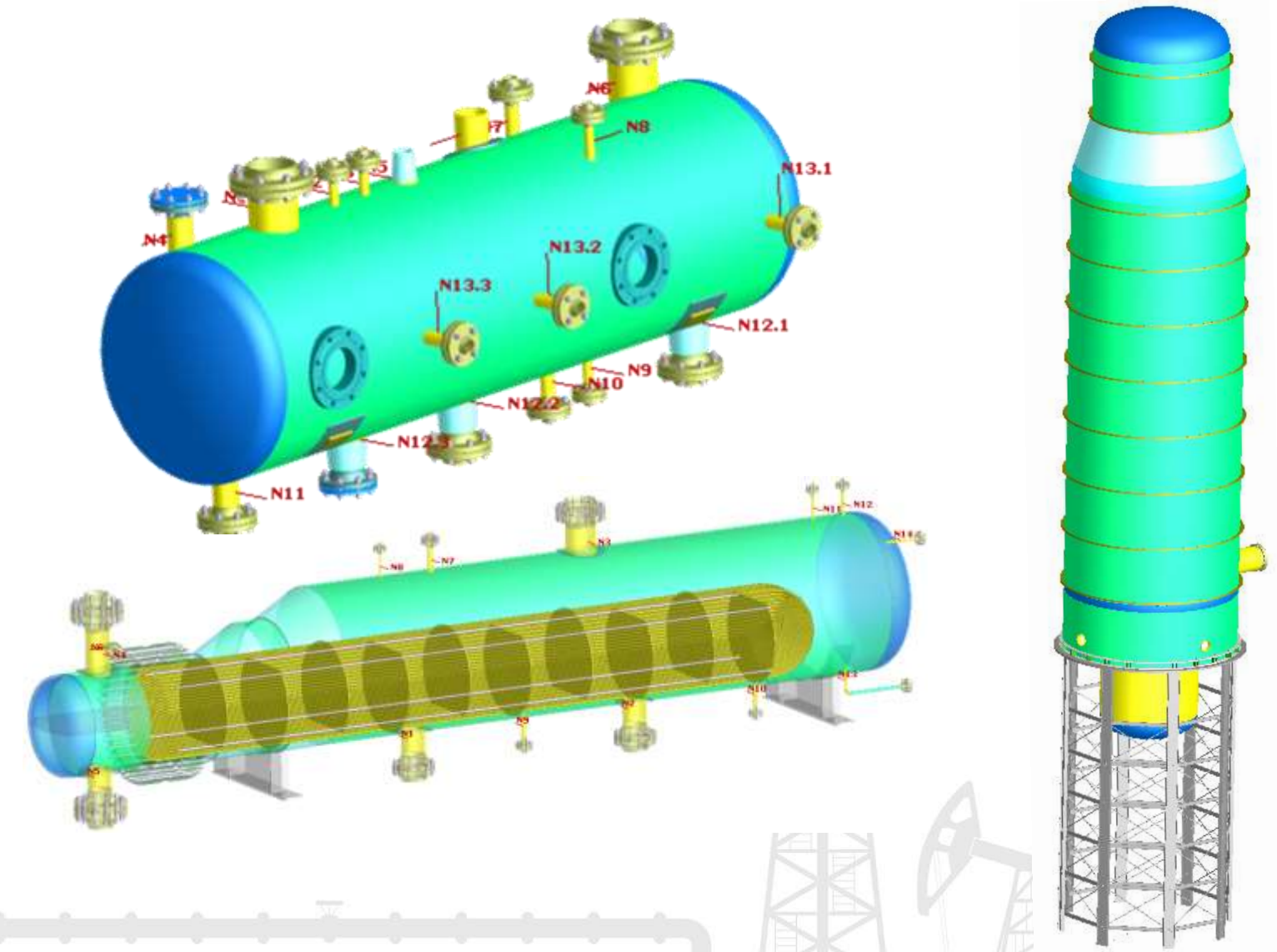
PASS/EQUIP

General Data





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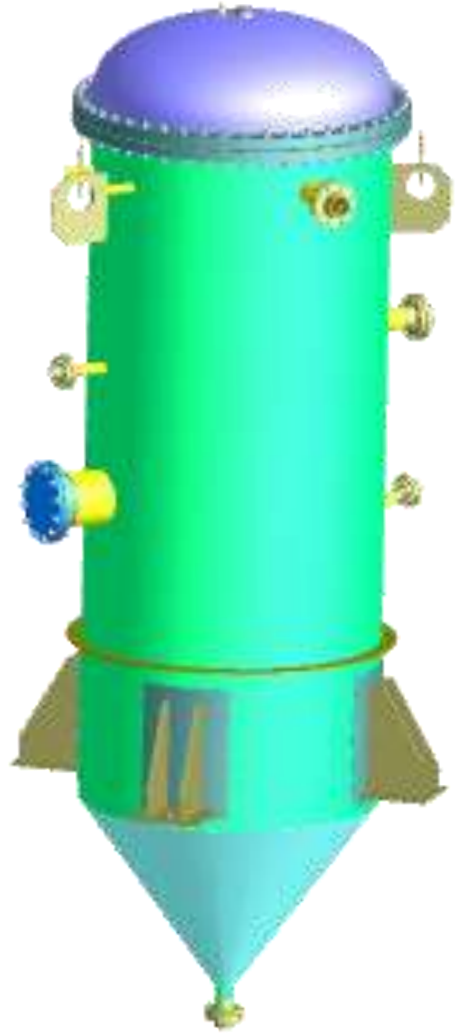
PASS/EQUIP Features

- **Codes:**
  ASME sec VII div. 1 and div.2, EN 13445, WRC and Russian GOST
- **Nozzle-shell connection:**
  The stresses per WRC 537(107)/297 and GOST 34233.3-2017 codes
- **Materials and Elements Database:**
  ASME, EN, GOST, JB etc., shells, heads, flanges gaskets, saddle supports, supporting legs, cylindrical and conical supports, nozzles, cross-sections of ribs, reinforcing rings, beam elements of support structure
- **Input data analysis**
  Error and warning messages
- **Input of additional weight loads**
  Forces and moments
- **Thickness calculation**
  (Including for external pressure) and calculation of allowable pressure, forces and moments



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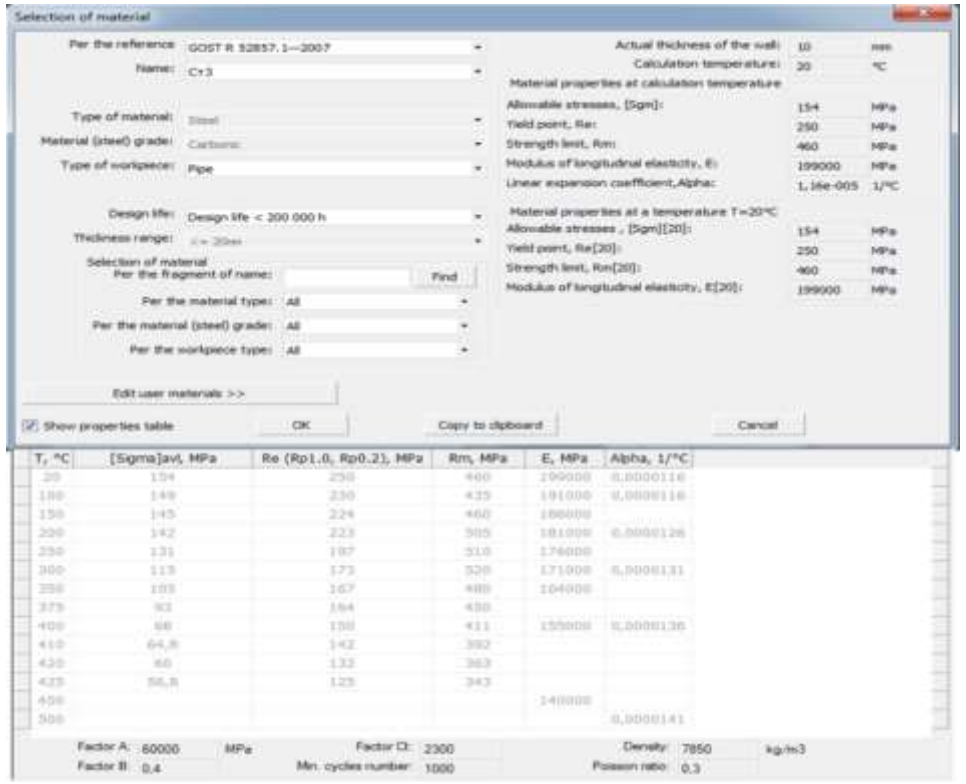
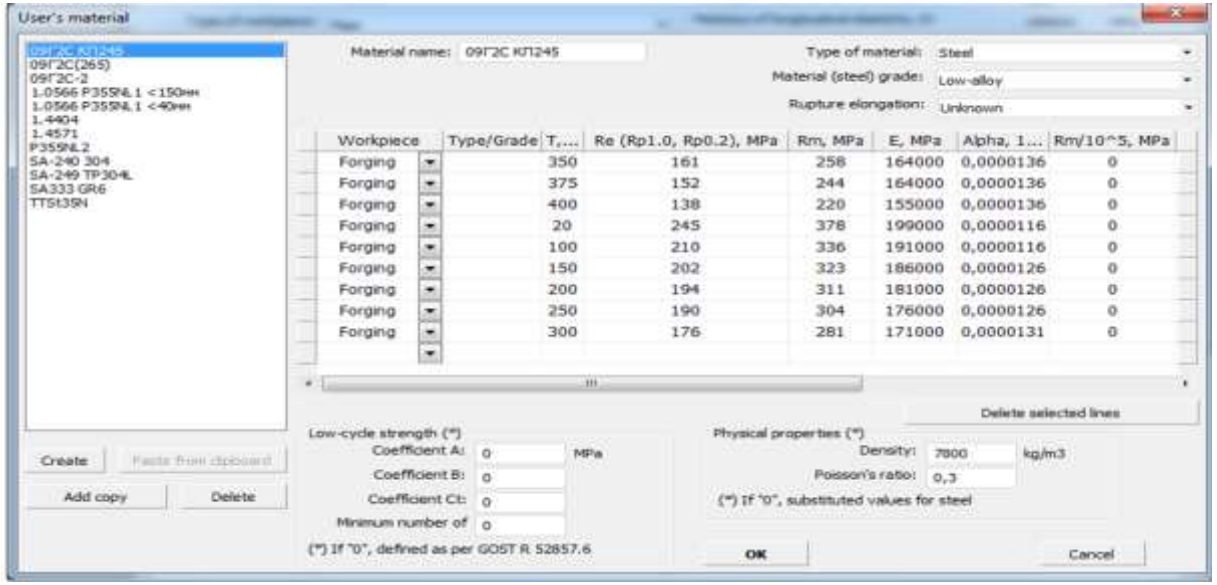
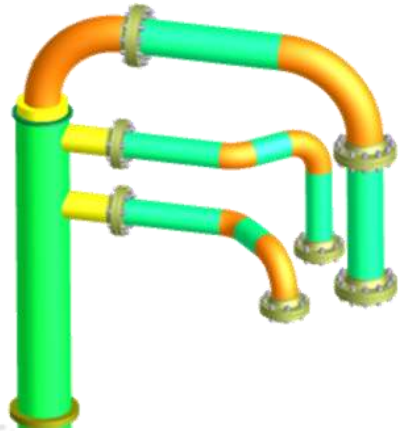
PASS/EQUIP | Material Database

- Selected from database (ASME II Part D, EN, GOST 34233.1, PNAE G-7-002-86, GOST R 54522-2011 etc.)
- User-defined materials







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PASS/EQUIP

- Representation of model structure as a structure tree.
- 3D graphic display: the color of selected elements and the entire model to be customized.
- “Wire-frame" and "transparent" view which allows internal elements to be seen.

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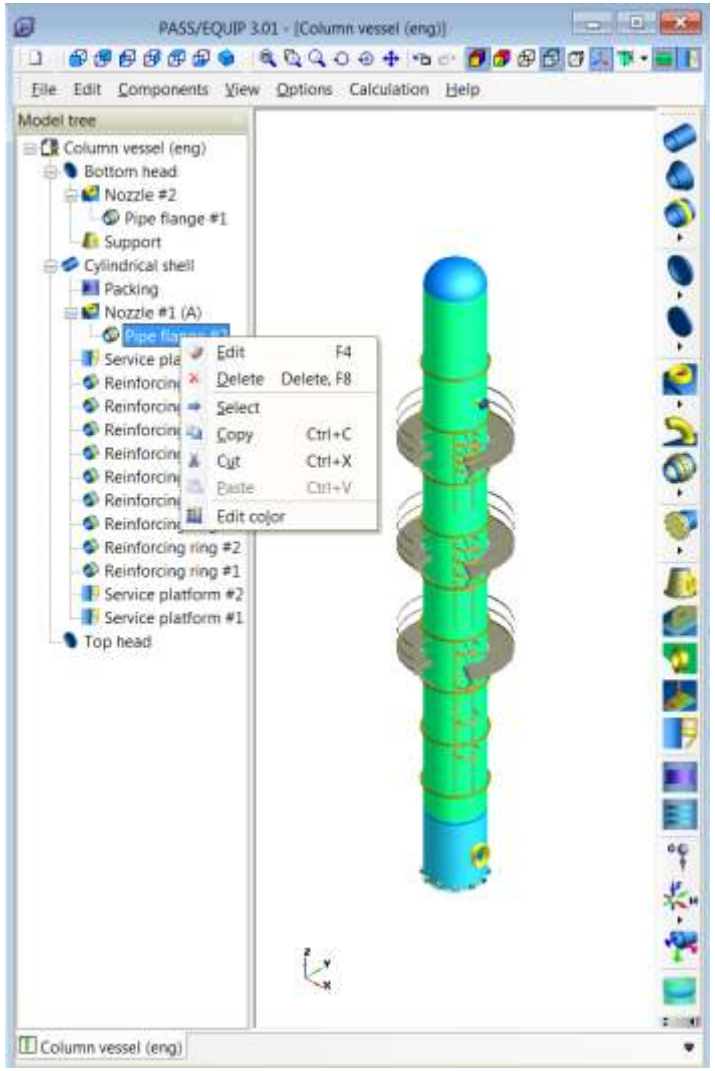
Features



PASS/EQUIP

Automatic calculation of:

- weight
- length
- reinforcing ring properties (in both cylindrical shells and saddle supports)
- liquid volume, fill height, filling ratio and hydrostatic pressure

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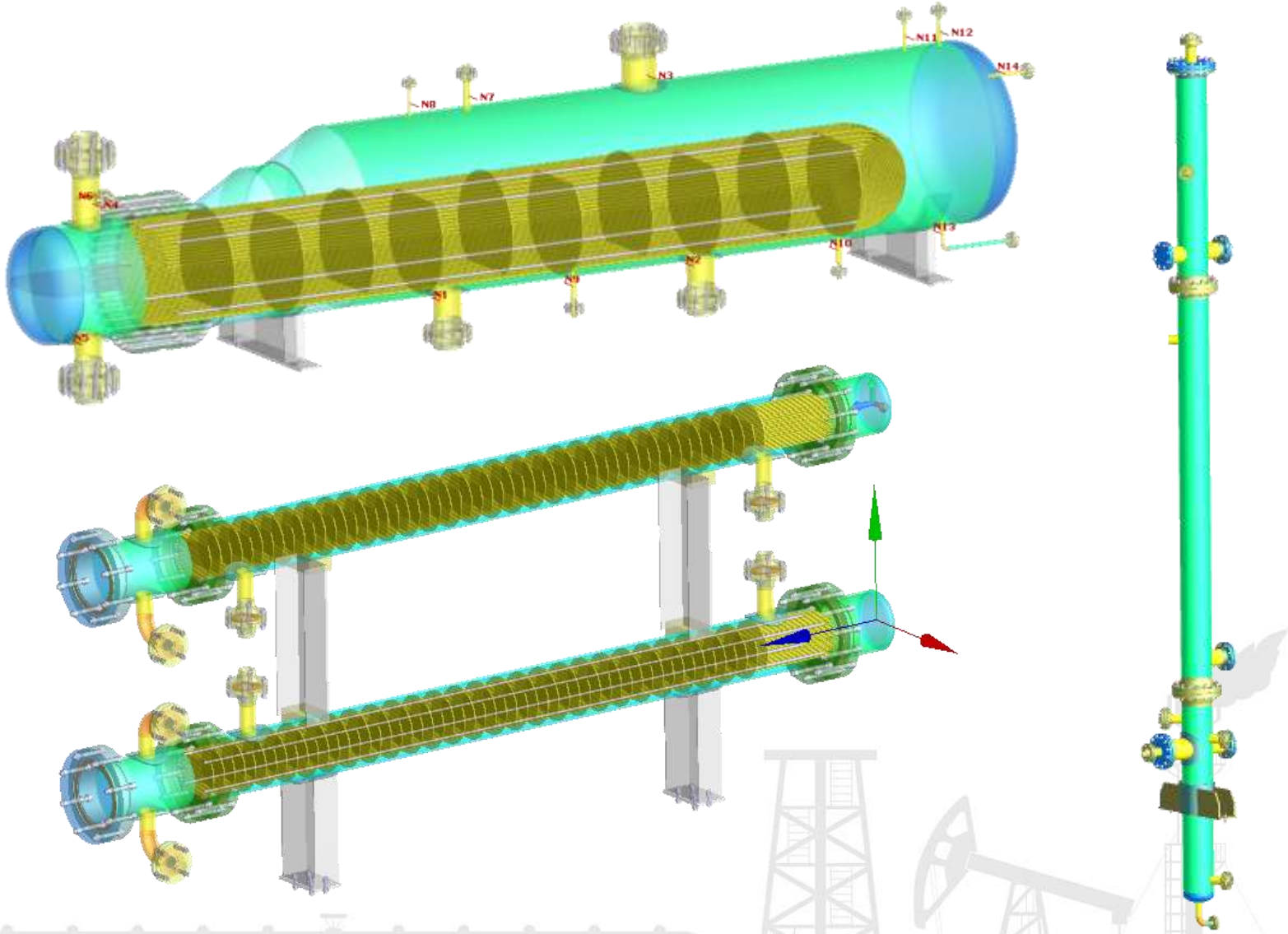
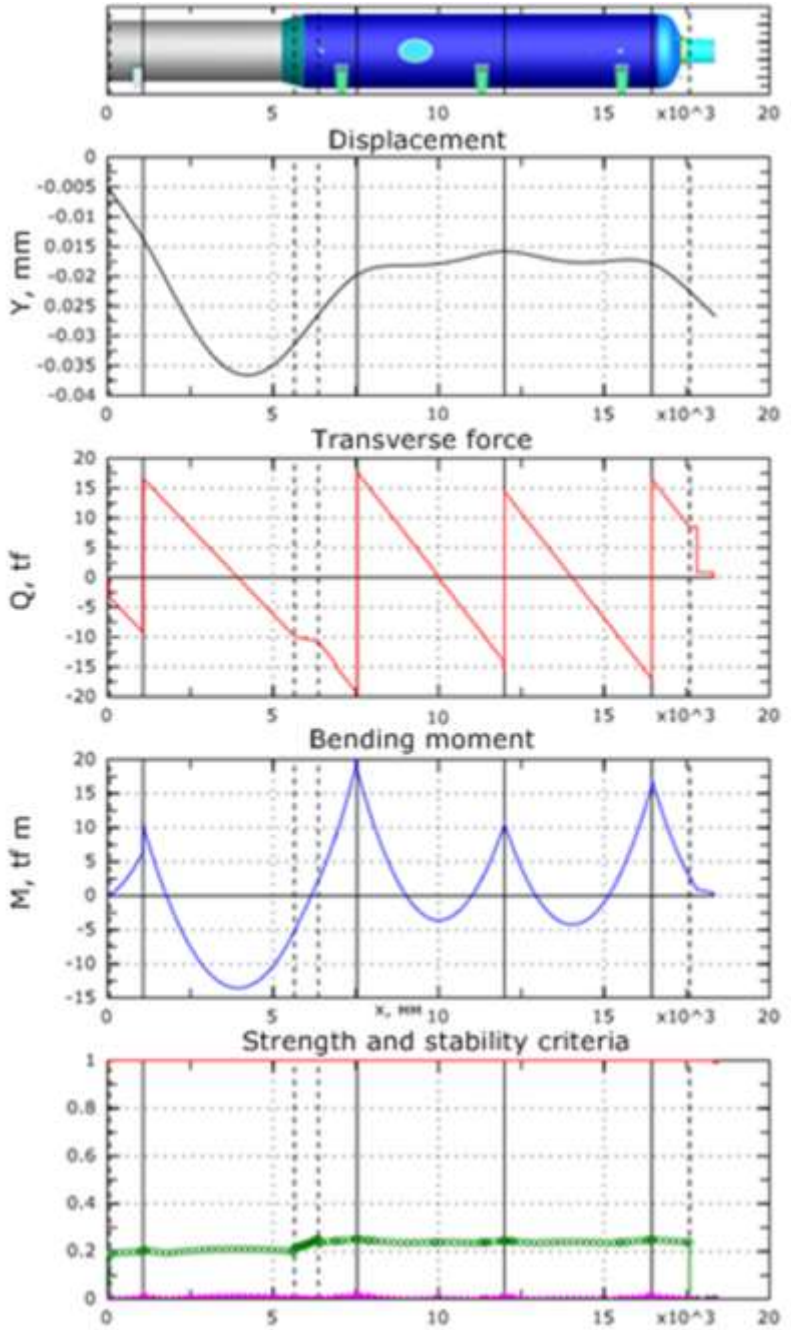
Features



PASS/EQUIP Features

- Dependency between elements
  when one element changes, other linked elements change automatically
- Precise 3D solid model representation
- Units selection (US, SI, MKS)
- Analysis of horizontal vessel shells with any number (more than 2) and position of saddle supports
- Output of diagrams
  for deformation, bending moments, transverse forces and strength and stability allowances
- Export of the model
  to popular solid modelling formats, i.e. ACIS, IGES, Parasolid, STEP



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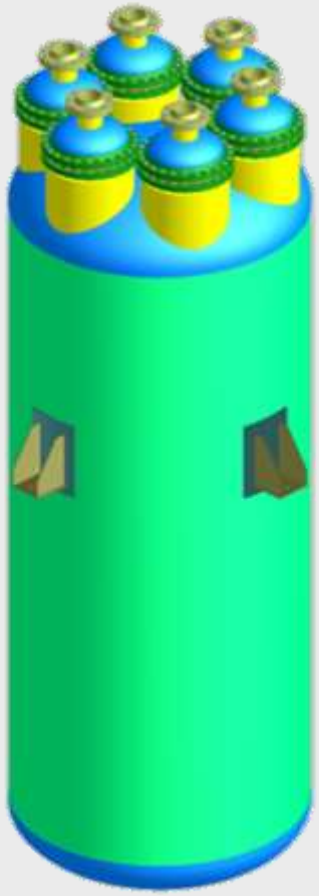
PASS/EQUIP



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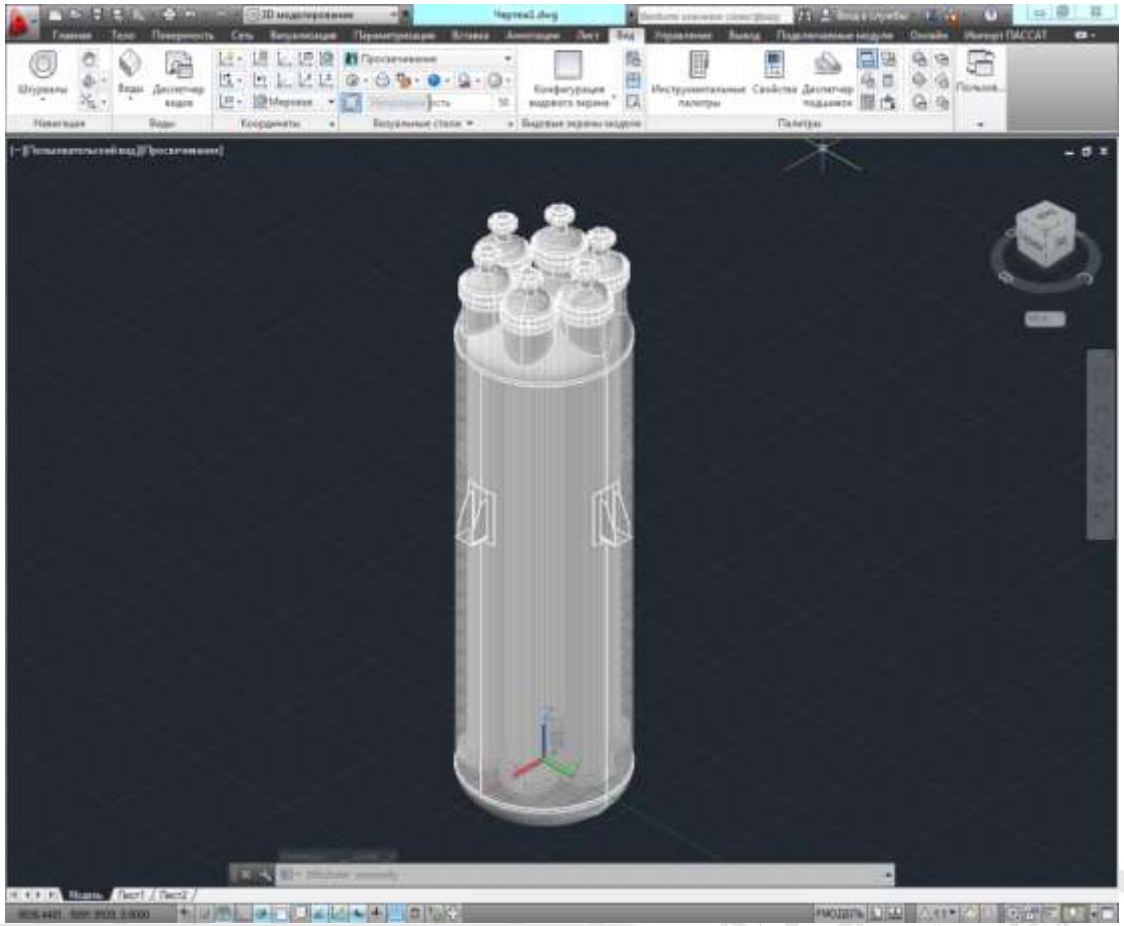
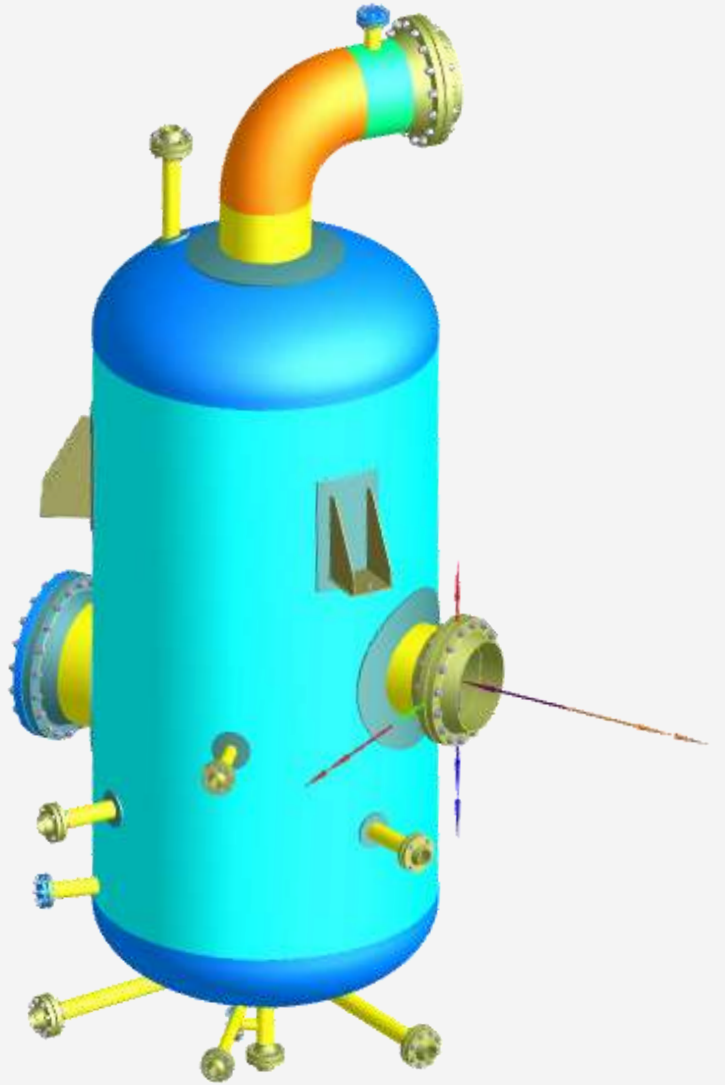
3D Model Export

Export to AutoCAD and other popular CAD systems and finite element analysis software via formats IGES, STEP, ACIS, ParaSolid



PASS/EQUIP Features

- Analysis of bolted caps
  (with flange joints) as a combined analysis of flange and heads
- Calculation of low-cycle fatigue of vessel elements
- Strength analysis of shells and heads
  considering displacement of weld joint edges, angularity and out-of-roundness of the shells
- Full (with intermediate analysis results) or Short reports of analysis
- Export of nozzles to PASS/EQUIP Nozzle FEM files (*.nzl)



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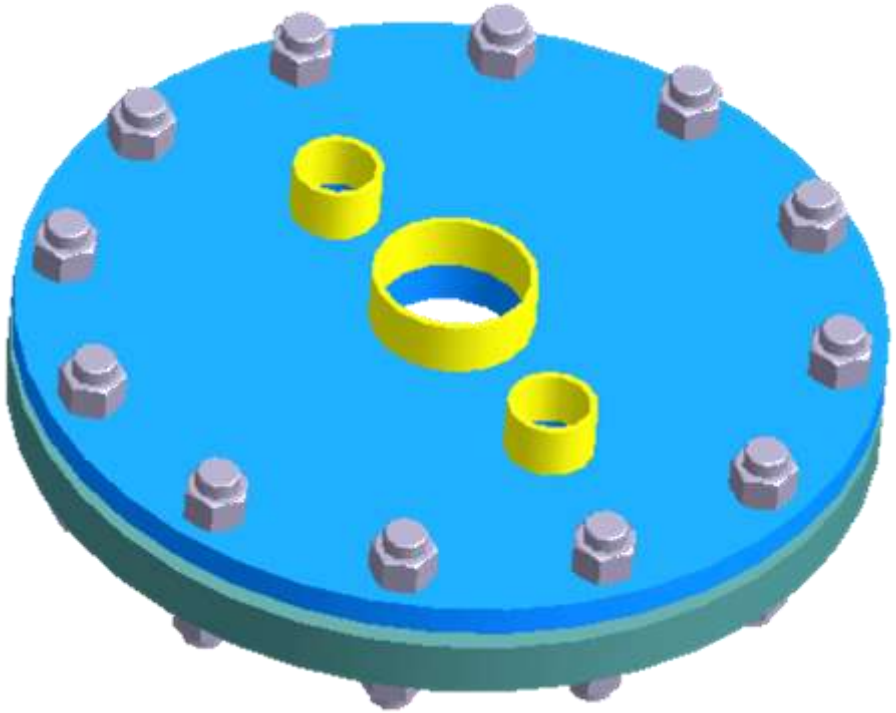
PASS/EQUIP | Report

FLAT COVER WITH HOLES



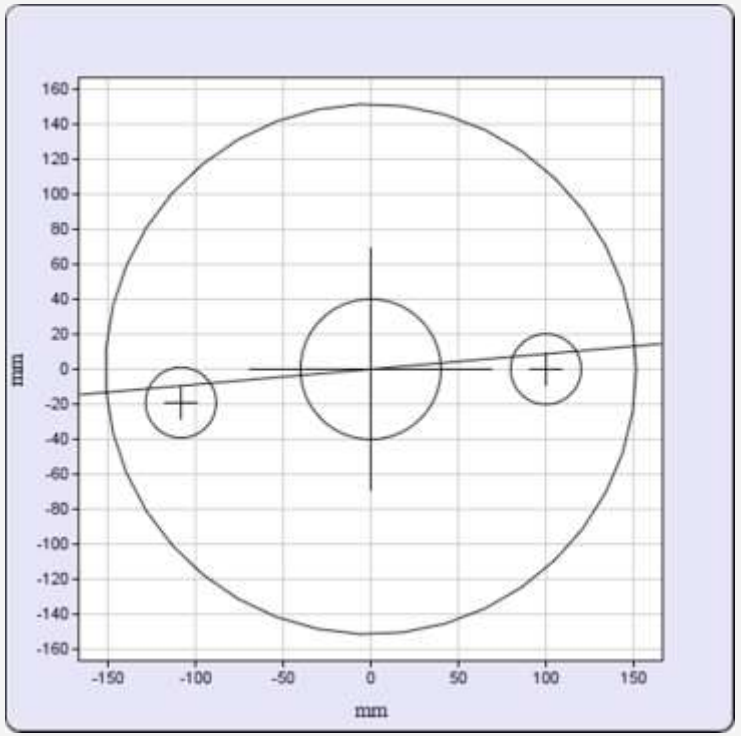
Nozzle number, i	Nozzle name	Chord, d_i, mm
1	Nozzle 1	80.3
2	Nozzle №2	36.34
3	Nozzle №3	35.45

Reduction factor for bottoms with holes (number of holes: 3) :

$$K_0 = \sqrt{\frac{1-\left(\frac{\sum d_i}{D_p}\right)^3}{1-\left(\frac{\sum d_i}{D_p}\right)}} = 1.274$$

Position of the most hazardous section:

Angle of the most hazardous section, ϑ: 5 °



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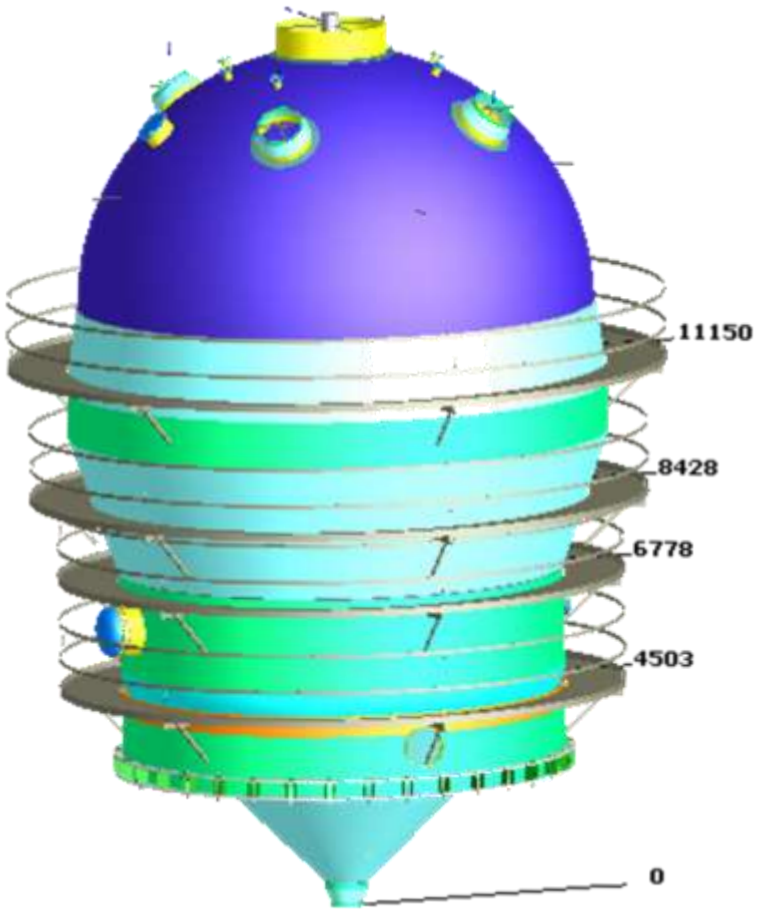
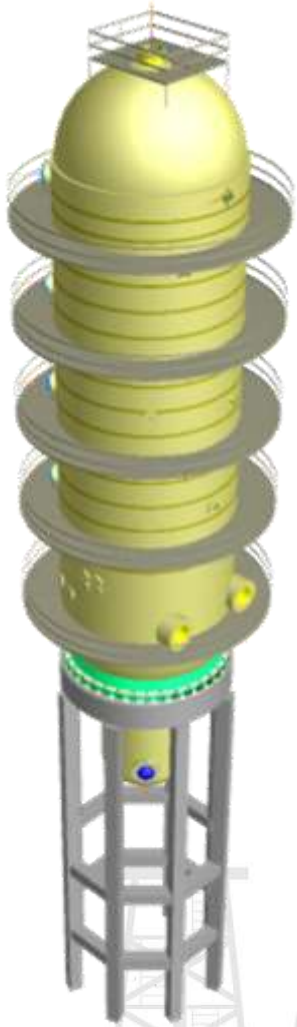
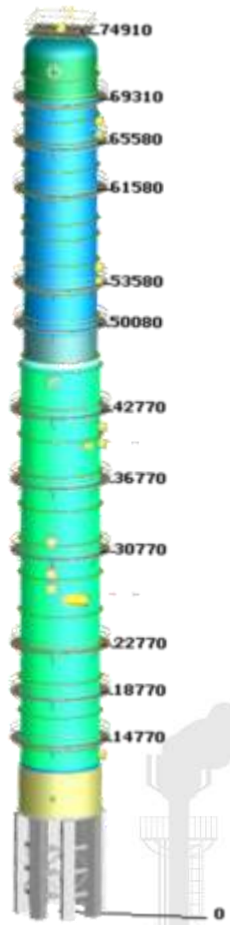
PASS/EQUIP

Columns

- Lowest vibration frequency.
- Forces under wind loads (including resonance vortex excitation) and seismic loads.
- Strength and stability analysis of column elements.







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PASS/EQUIP

- Analysis of “cylinder + cone” support skirt with the option of including a transitional shell.
- Automatic determination of position and properties of most unsafe cross-section of supporting shell.
- Calculation of loads on basement and support structure.

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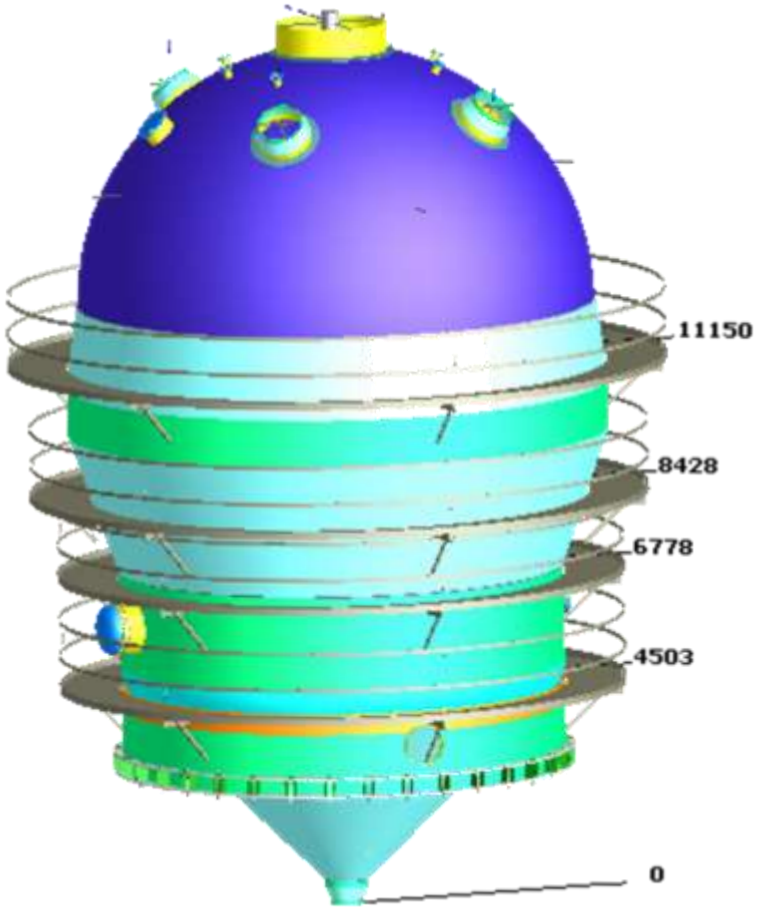
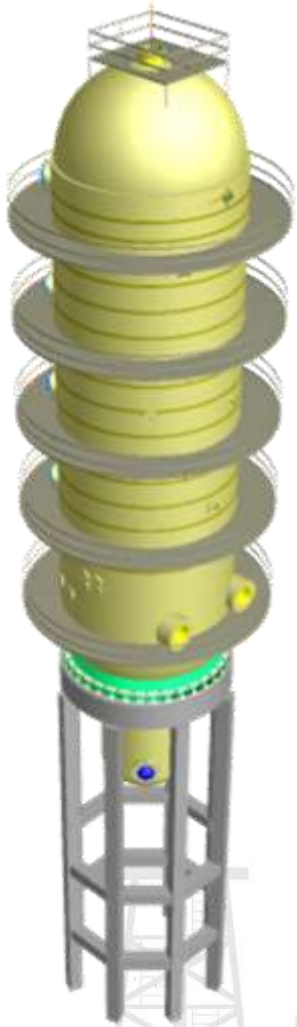
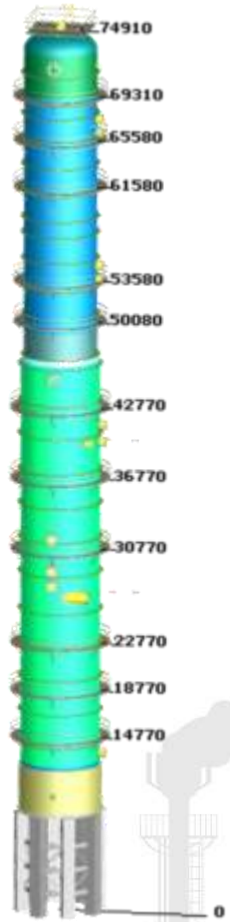
Columns

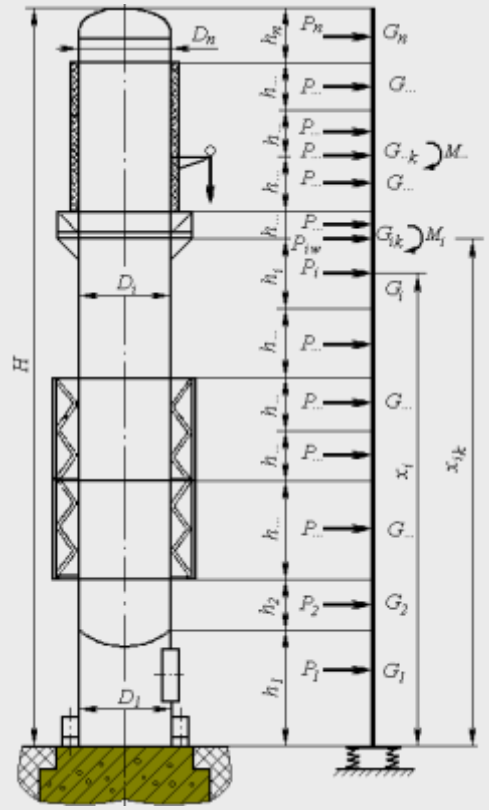






PASS/EQUIP

$$T = 2\pi \sqrt{\frac{\sum\left(G_i y_i^2 + G_{ik} y_{ik}^2\right)}{g\sum\left(G_i y_i + G_{ik} y_{ik}\right)}}$$



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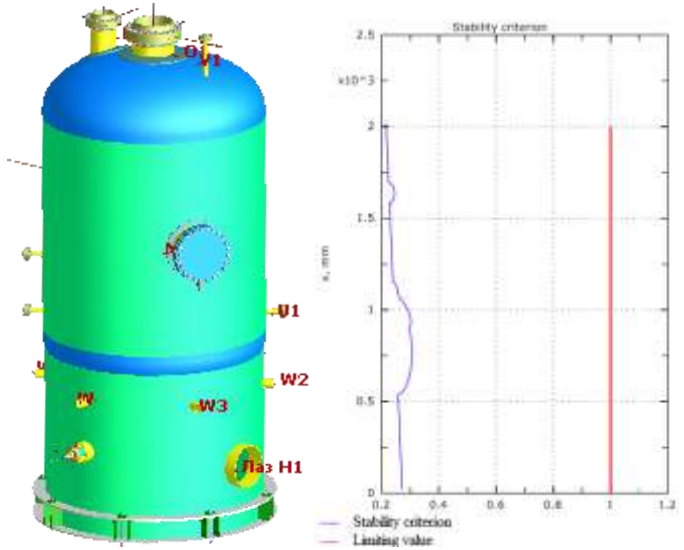
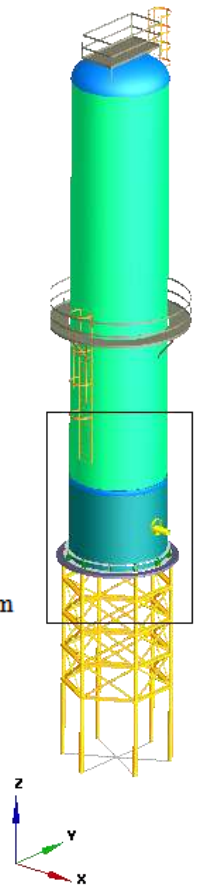
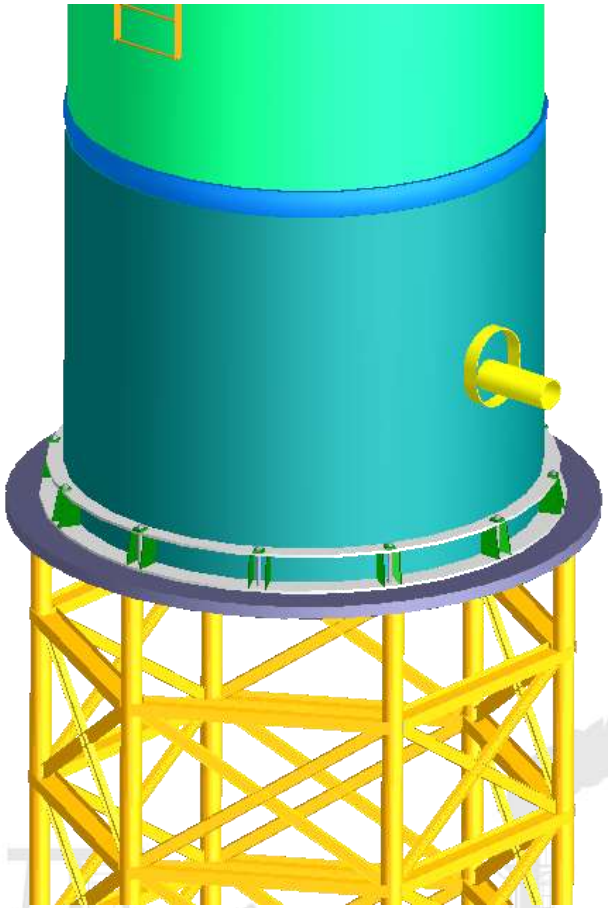
Columns

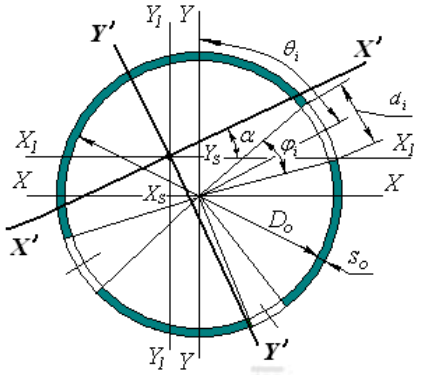






Parameters of hazardous section

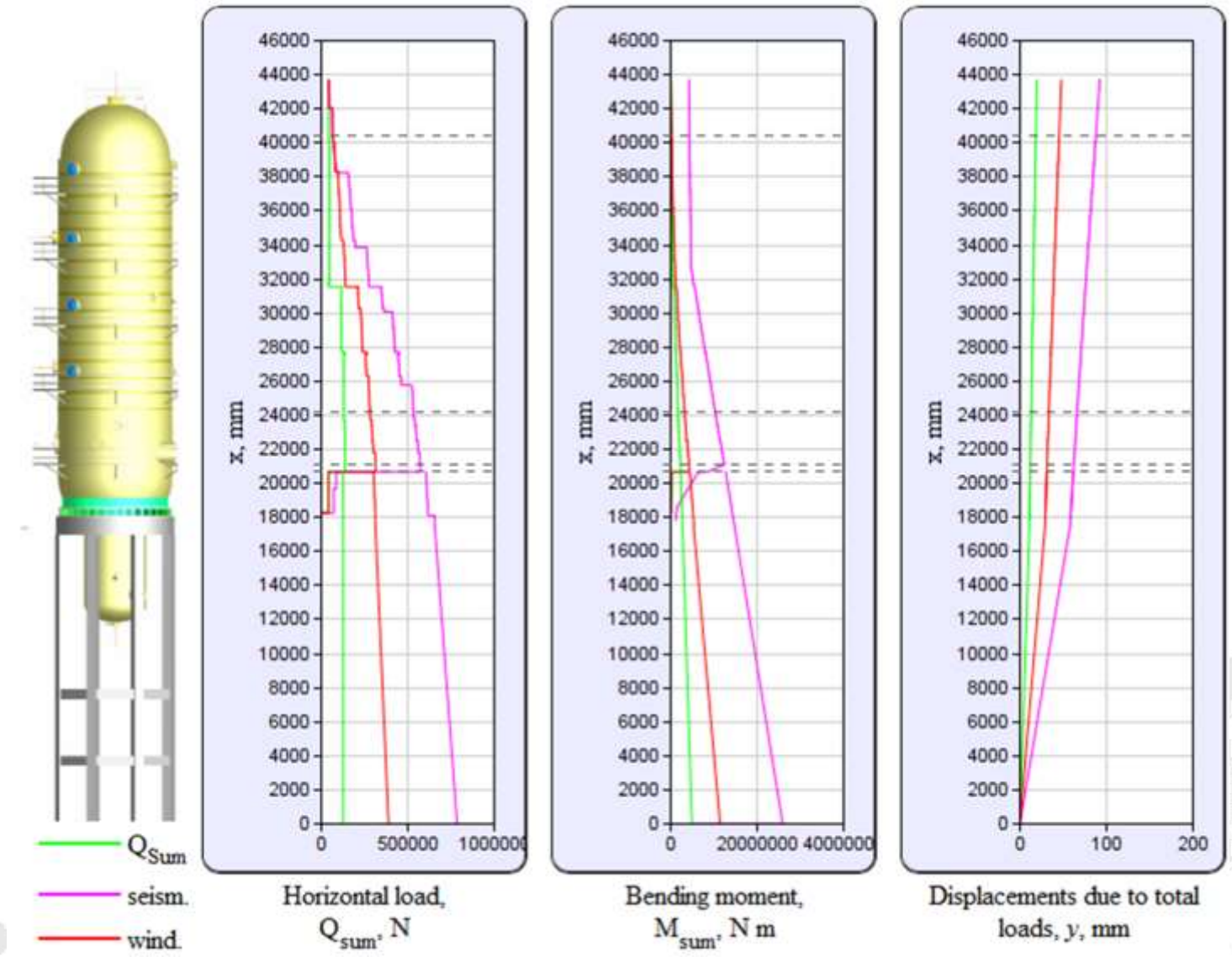
Section coordinate (from the lower point of base): x = 768.6 mm
Diameter in the critical cross-section: D_2 = 2600 mm



PASS/EQUIP

Columns

Automatic Determination of Loads, Plotting



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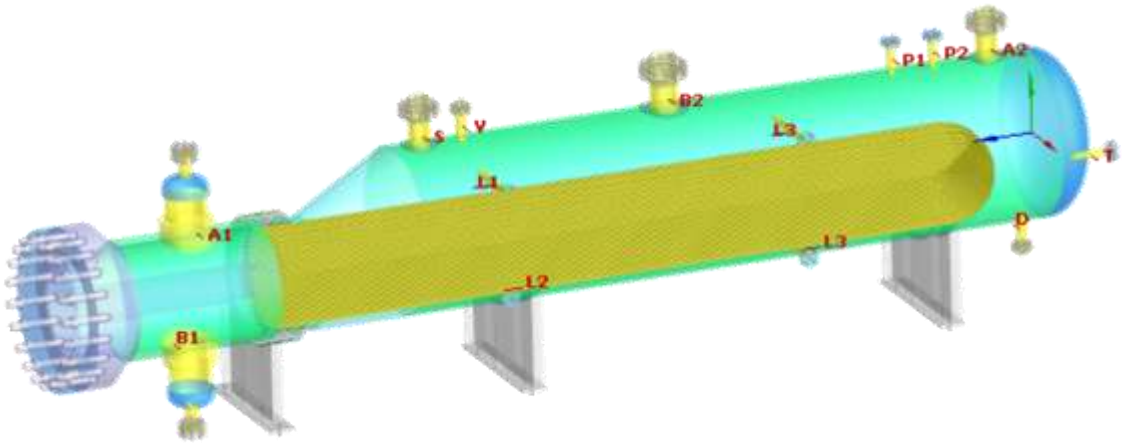
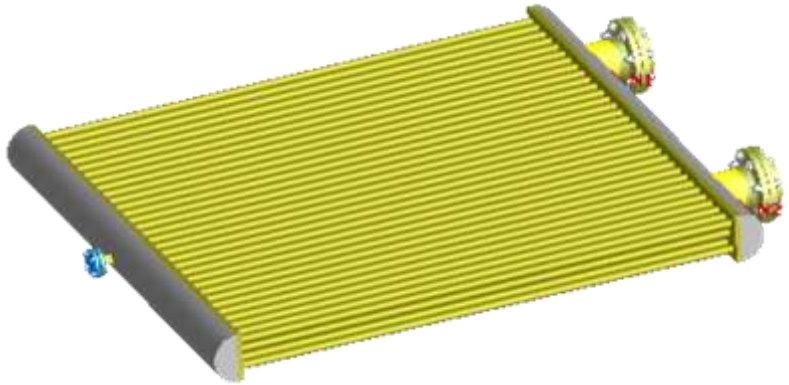
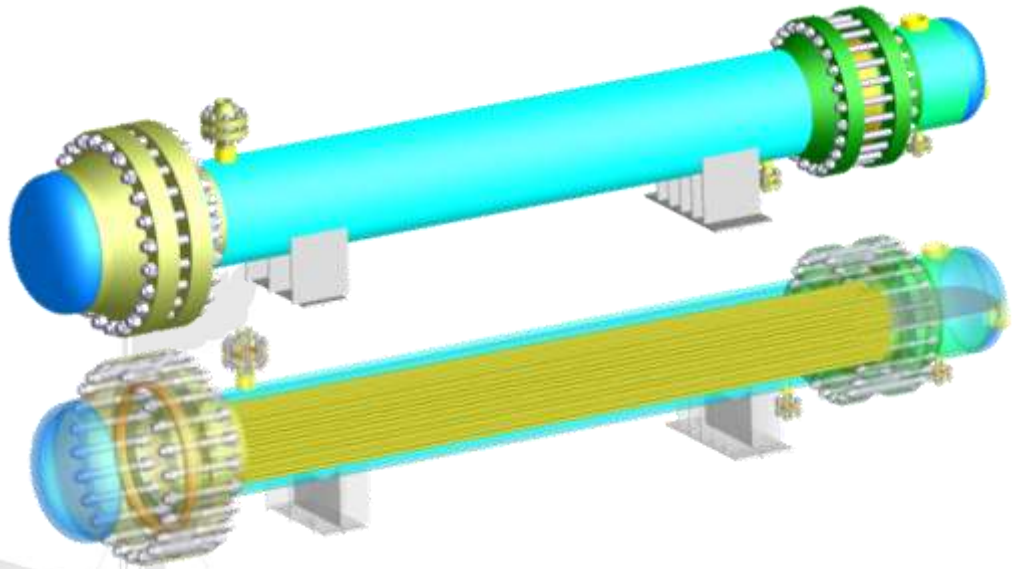
PASS/EQUIP | Heat Exchangers

- ASME UHX and GOST 34233.7 heat exchanger mechanical design;
- Input of heat-exchange element properties within a single multi-window interface;
- Calculation of forces in tube plates, casing and tubes;
- Analysis of tube plates, casing, tubes, expansion joint, expansion vessel, floating head;
- Air cooling exchanger.







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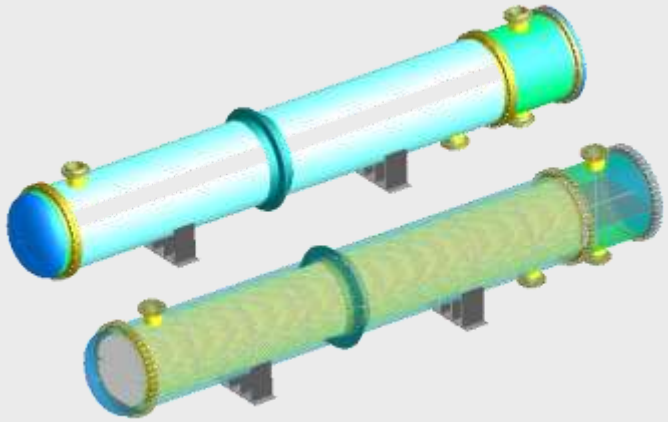
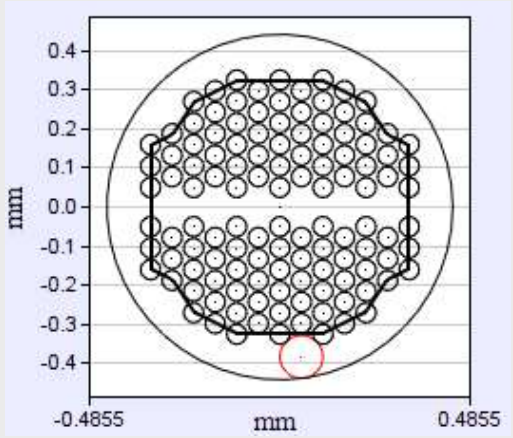
PASS/EQUIP

Heat Exchanger





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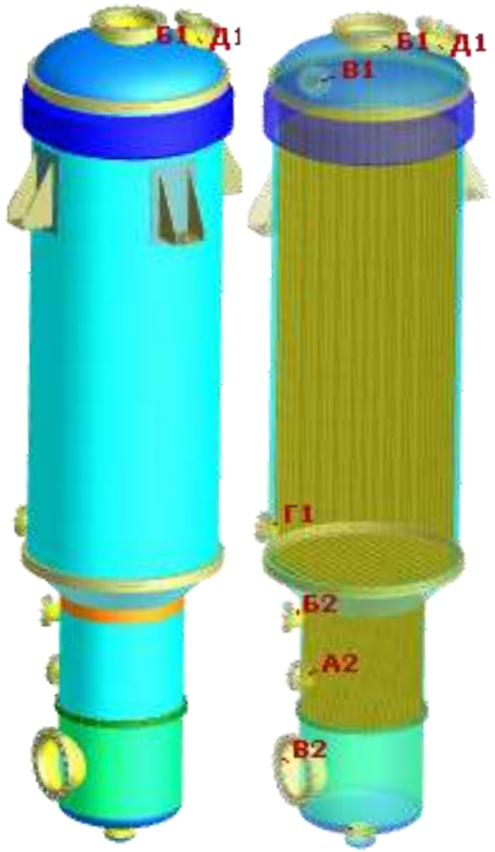
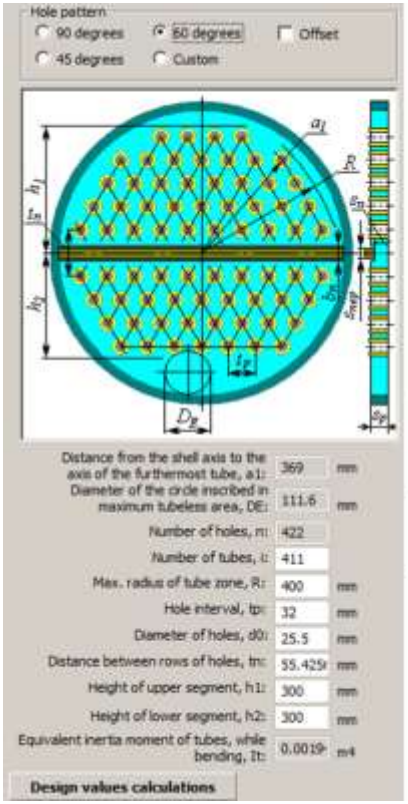
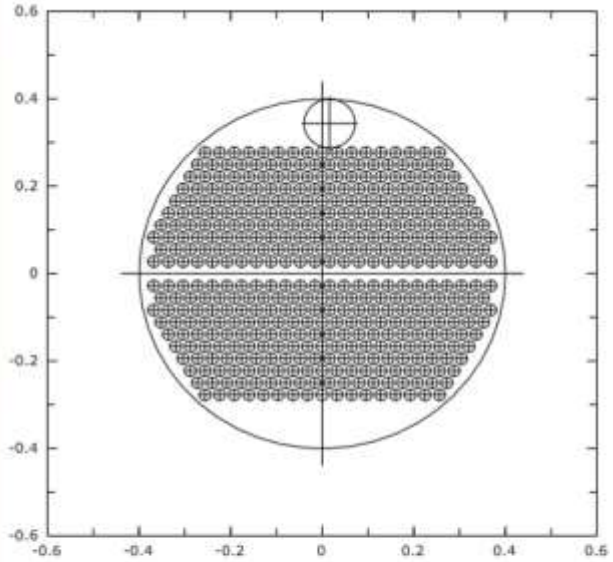
Automatic determination of tube sheet design parameters



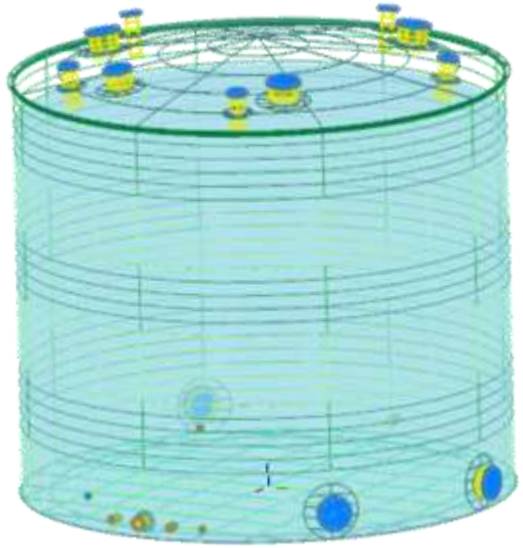


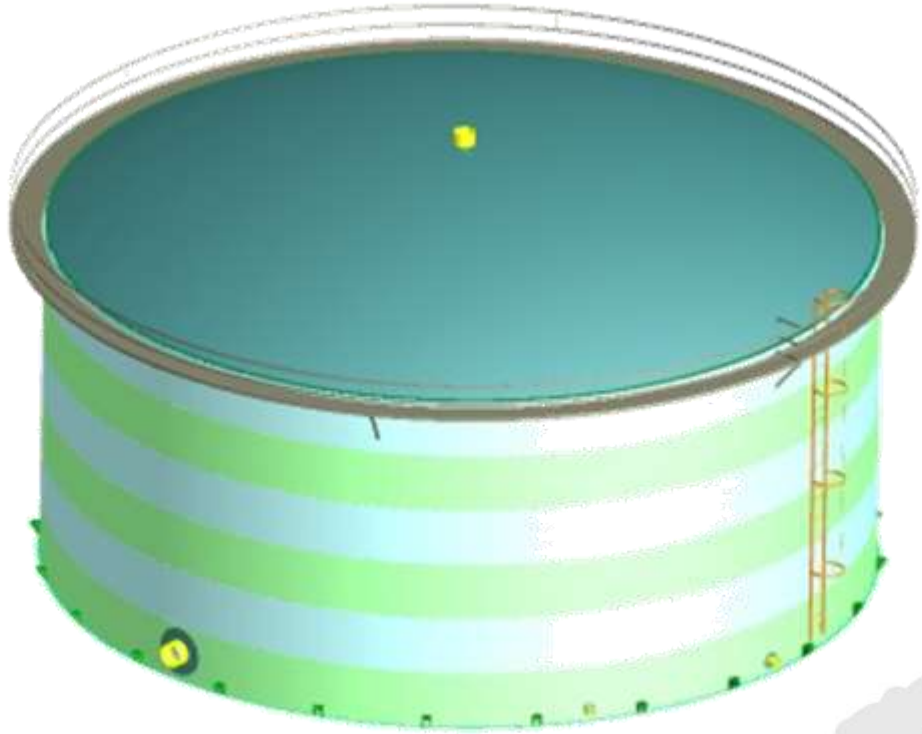


PASS/EQUIP

Tanks

- Automatic weight measurement.
- Strength and stability analysis of the wall, stationary frameless roof and tank head, including wind, snow and seismic loads.
- Wall anchorage calculation.
- Calculation of loads on basement.
- Estimation of allowable stresses on the nozzles of cut-ins in the tank wall.





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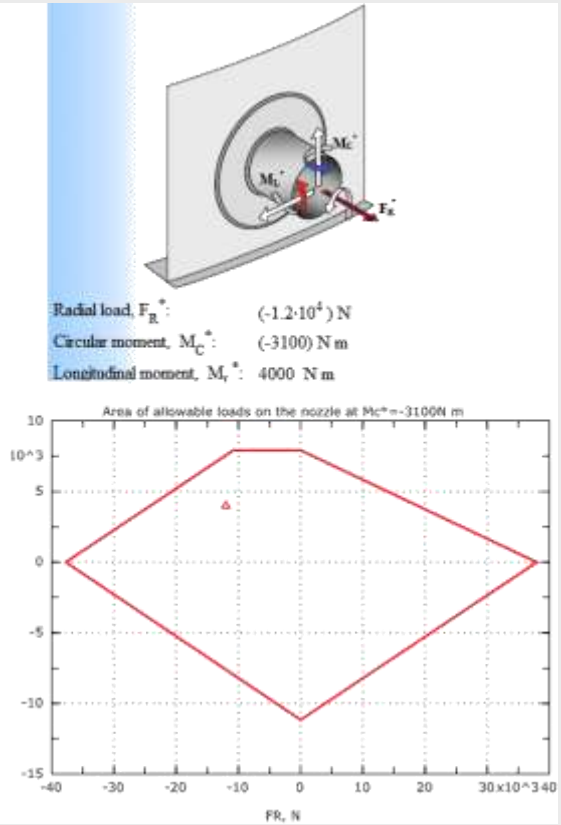
PASS/EQUIP

Area of allowable nozzle loads



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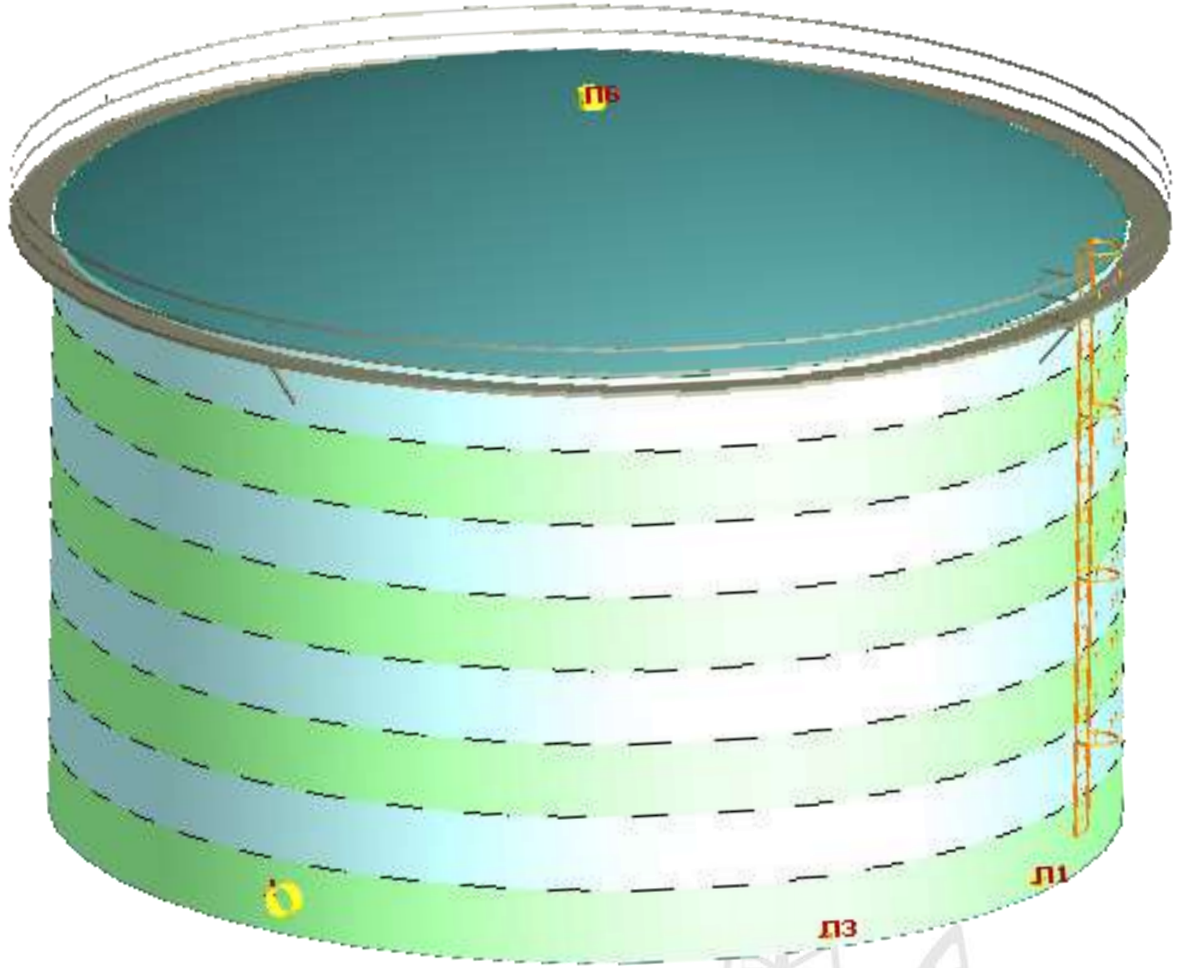
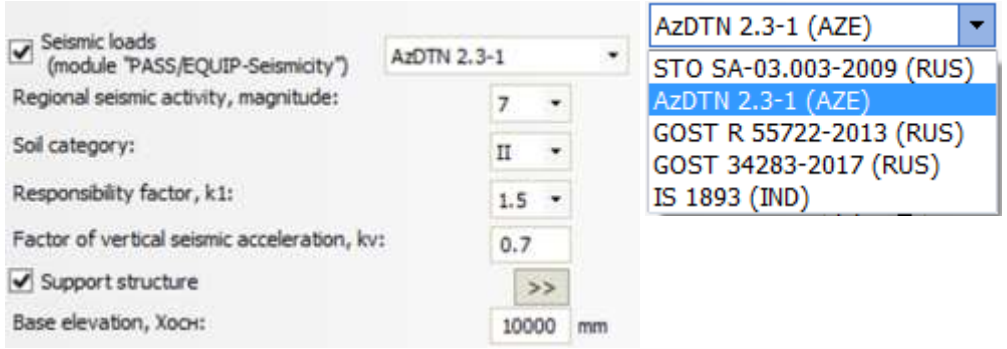
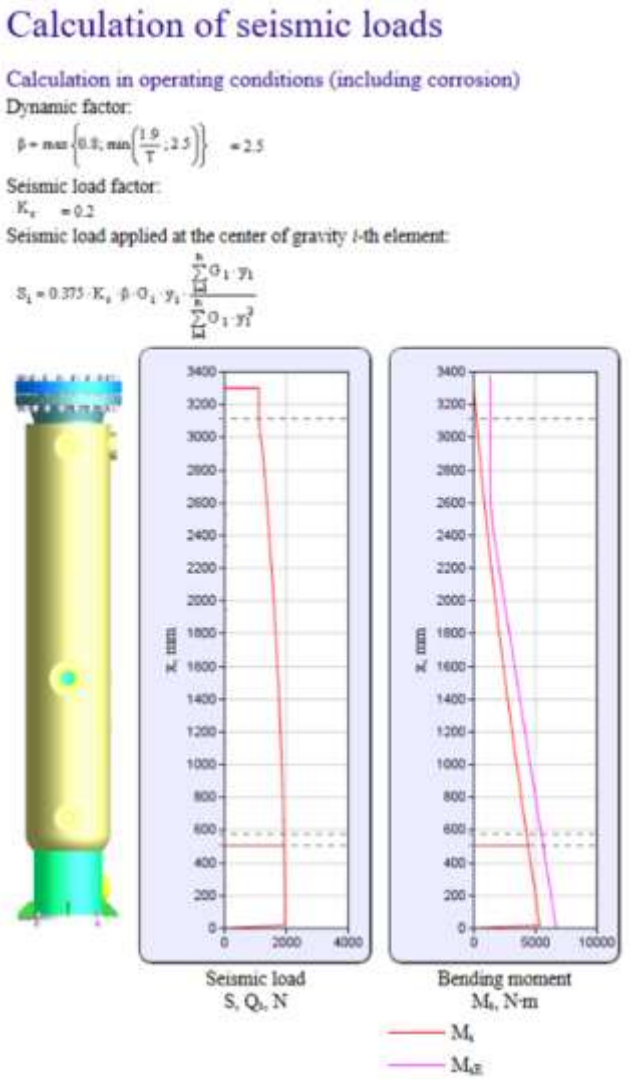
Tank

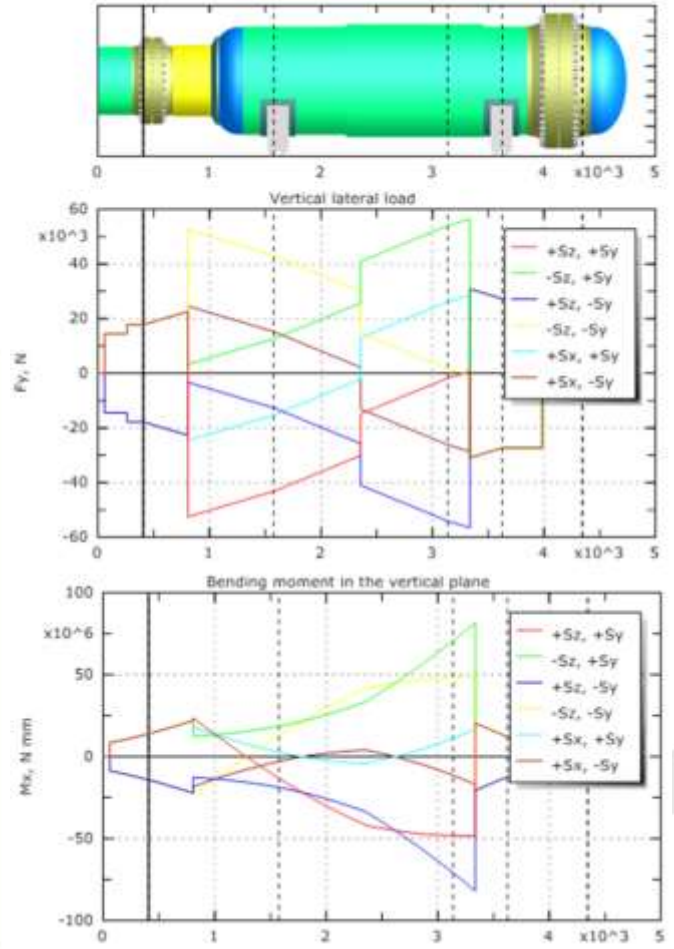


PASS/EQUIP Seismic

- Calculation of seismic loads on horizontal and vertical vessels.
- Analysis of vessel elements considering seismic loads.
- Consideration of support structure and installation height.







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PASS/EQUIP |Reports

Passat report

Summary tables

Basic components

Input data

Component	Material	Diameter, mm	Wall thickness, mm	Length (height), mm	Total allowance, mm	Weld strength ratio
Head elliptical №1	09Г2С	4000	60	1140	15	1
Cylindrical Shell 2	09Г2С	4000	50	4940	6	1
Cylindrical Shel 3	09Г2С	4000	65	2600	6	1
Cylindrical Shel №4	20	1600	26	1043	6	1
Head elliptical №3	09Г2С КП1245	1600	30	490	10	1
Cylindrical Shell 1	09Г2С	4000	50	8540	6	1
Cap flat №1	09Г2С	600	60	218	6	1
Head elliptical №2	09Г2С	4000	60	1140	15.3	1

Calculation results

Operating conditions

Component	Calculation temperature, °C	Calculation pressure, MPa	Allowable stresses, MPa	Effective thickness including allowances, mm	Allowable pressure, MPa	Strength condition
Head elliptical №1	100	3.412	160	57.87	3.58	fulfilled
Cylindrical Shell 2	100	3.412	160	49.1	3.482	fulfilled
Cylindrical Shel 3	100	3.412	160	49.1	4.651	fulfilled
Cylindrical Shel №4	100	3.428	142	25.55	3.506	fulfilled
Head elliptical №3	100	3.433	140	29.74	3.478	fulfilled
Cylindrical Shell 1	100	3.412	160	49.1	3.482	fulfilled
Cap flat №1	100	3.4	160	50	5.121	fulfilled
Head elliptical №2	100	3.412	160	58.17	3.556	fulfilled

Test conditions

Component	Calculation pressure, MPa	Allowable stresses, MPa	Effective thickness including allowances, mm	Allowable pressure, MPa	Strength condition
Head elliptical №1	4.444	254.5	50.07	5.695	fulfilled
Cylindrical Shell 2	4.444	254.5	41.22	5.539	fulfilled
Cylindrical Shel 3	4.444	254.5	41.22	7.4	fulfilled
Cylindrical Shel №4	4.46	200	24.04	4.938	fulfilled
Head elliptical №3	4.465	222.7	26.12	5.534	fulfilled
Cylindrical Shell 1	4.444	254.5	41.22	5.539	fulfilled

Calculation of wind loads

Calculation as per GOST 34283-2017

Normative value of the average wind load on the i-th section:

$q_{ist} = q_0 \cdot \theta_i \cdot K_i$,

where θ_i – coefficient taking into account the dependence of the wind pressure of the vessel height:

$$\theta_i = \begin{cases} 0.75, \left(z_j + z_{ocn}\right) \le 5\ m \\ \left(\dfrac{z_j + z_{ocn}}{10}\right)^{0.3}, \left(z_j + z_{ocn}\right) > 5\ m \end{cases}$$

Average share of wind load on the i-th section:

$P_{ist} = q_{ist} \cdot D_i \cdot h_i$,

where D_i – outer diameter of the i-th section,

h_i – height of the i-th section.

The coefficient of the spatial correlation of the wind pressure fluctuations:

$v = 0.968 - 0.025 \cdot \sqrt{H + z_{ocn}}$

Fluctuating component of the wind load on the i-th section:

$P_{ipm} = v \cdot G_i \cdot \xi \cdot \eta_i$,

where G_i – weight of the i-th section,

ξ – dynamic factor,

η_i – relative acceleration of the center of gravity of the i-th section.

Wind load on the i-th section:

$P_i = P_{ist} + P_{ipm}$

The bending moment in the cross-section at the height x_0, caused by wind load on the j-th serving platform:

$M_{vj} = 1.4 \cdot q_0 \cdot \theta_j \cdot (x_i - x_0) \cdot \{1 + 0.75 \cdot \xi \cdot \chi_j \cdot m_j\} \cdot \sum A_{vj}$

In the absence of accurate data about the shape of platform the bending moment is given by:

$M_{vj} = 1.85 \cdot q_0 \cdot \theta_j \cdot (x_i - x_0) \cdot \{1 + 0.75 \cdot \xi \cdot \chi_j \cdot m_j\} \cdot A_j$,

where $\sum A_{vj}$ – sum of the areas of all projections profiles of j-th platform in a plane perpendicular to the wind direction;

A_j – area bounded by the j-th platform;

$$\chi = 1.56 \left(\frac{x_j + z_{ocn}}{H + z_{ocn}}\right)^{1.6},$$

m_j – pulsation factor of the wind pressure,

$$m_j = 0.76 \cdot \left(\frac{x_j + z_{ocn}}{10}\right)^{-0.15}$$

H = 3379 mm - total vessel height from the ground.

Calculation bending moment in the cross section at a height x_0:

$$M_v = \sum_{i=1}^{n} P_i \cdot (x_i - x_0) + \sum_{i=1}^{m} M_{vi}$$

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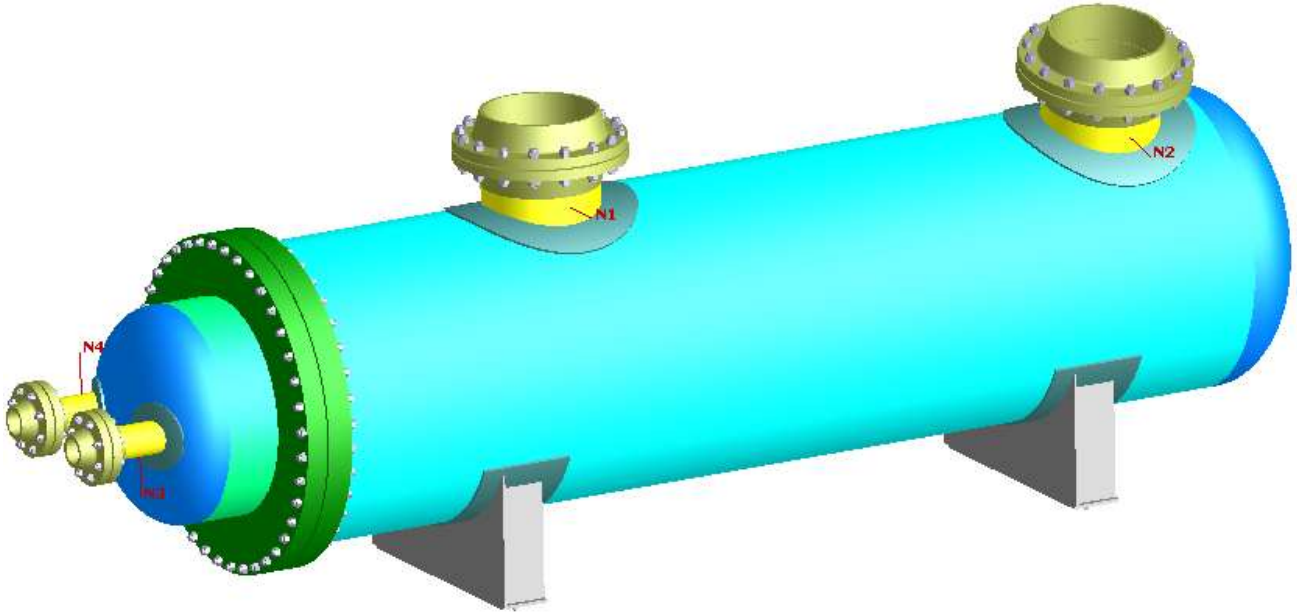
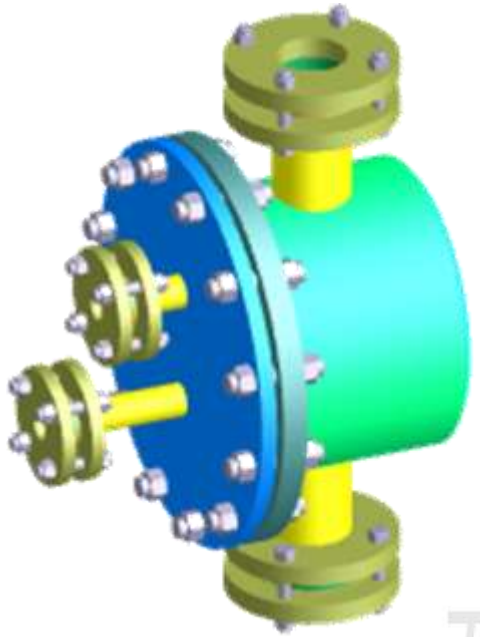
ANALYSIS & SIZING SUITE

PASS/EQUIP | Examples





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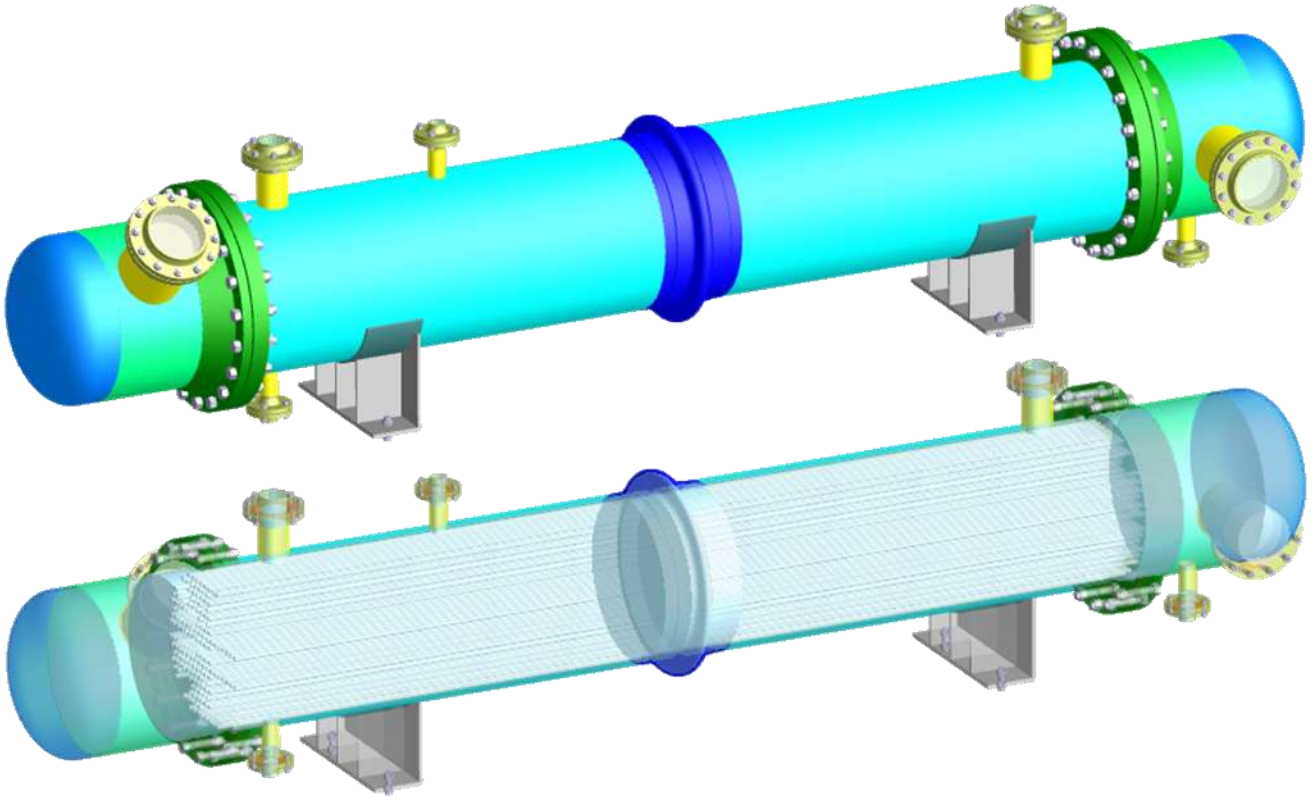
ANALYSIS & SIZING SUITE

PASS/EQUIP | Examples (Heat Exchangers)



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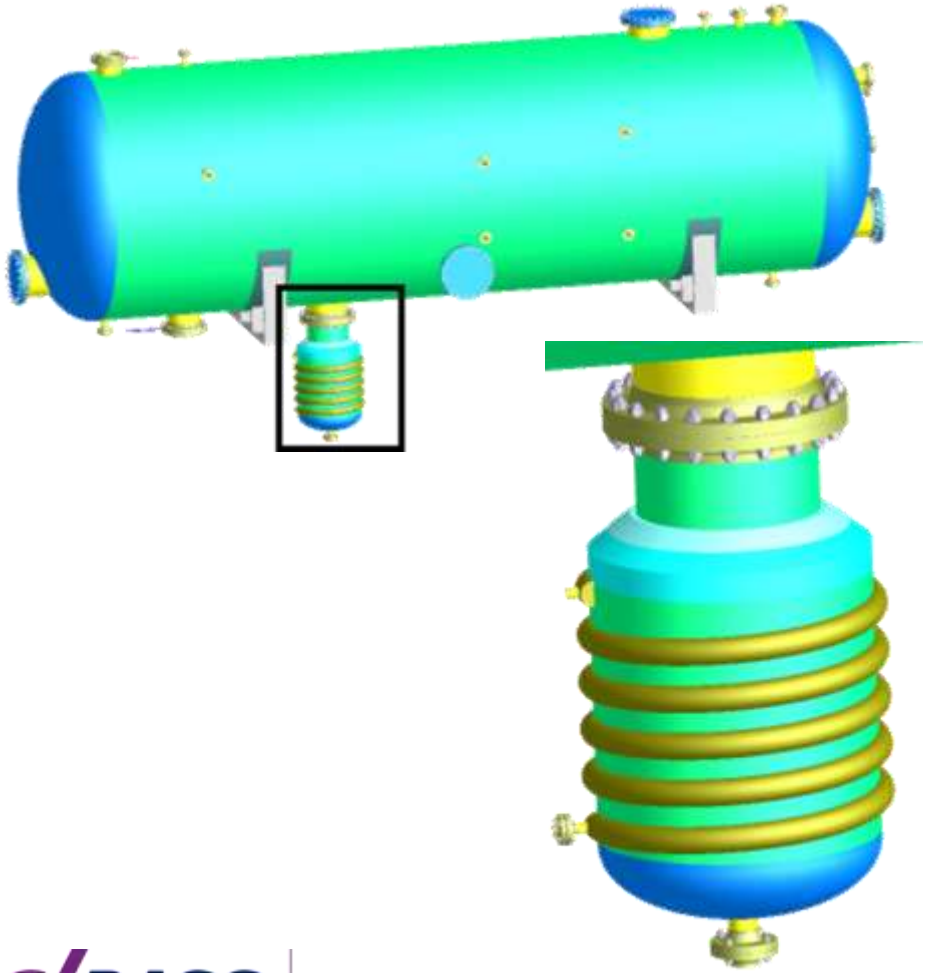
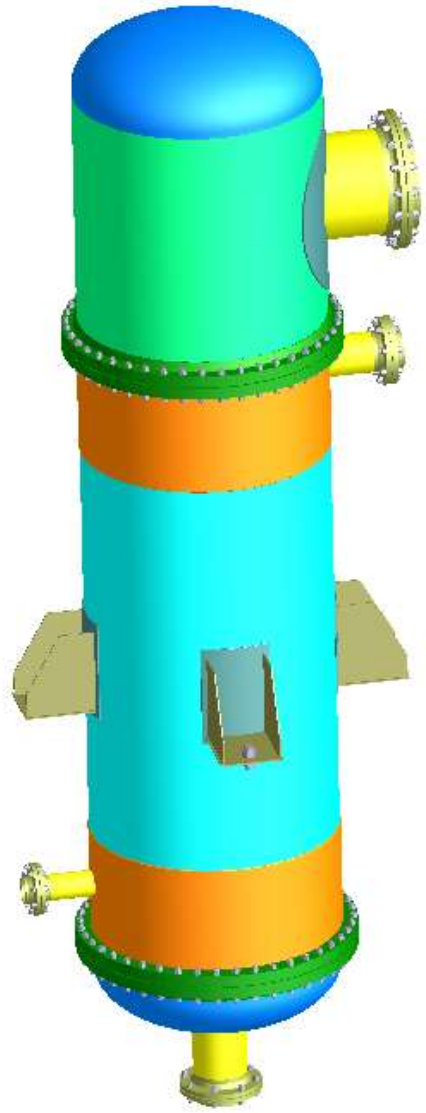
PIPING AND EQUIPMENT
ANALYSIS & SIZING SUITE

PASS/EQUIP | Examples





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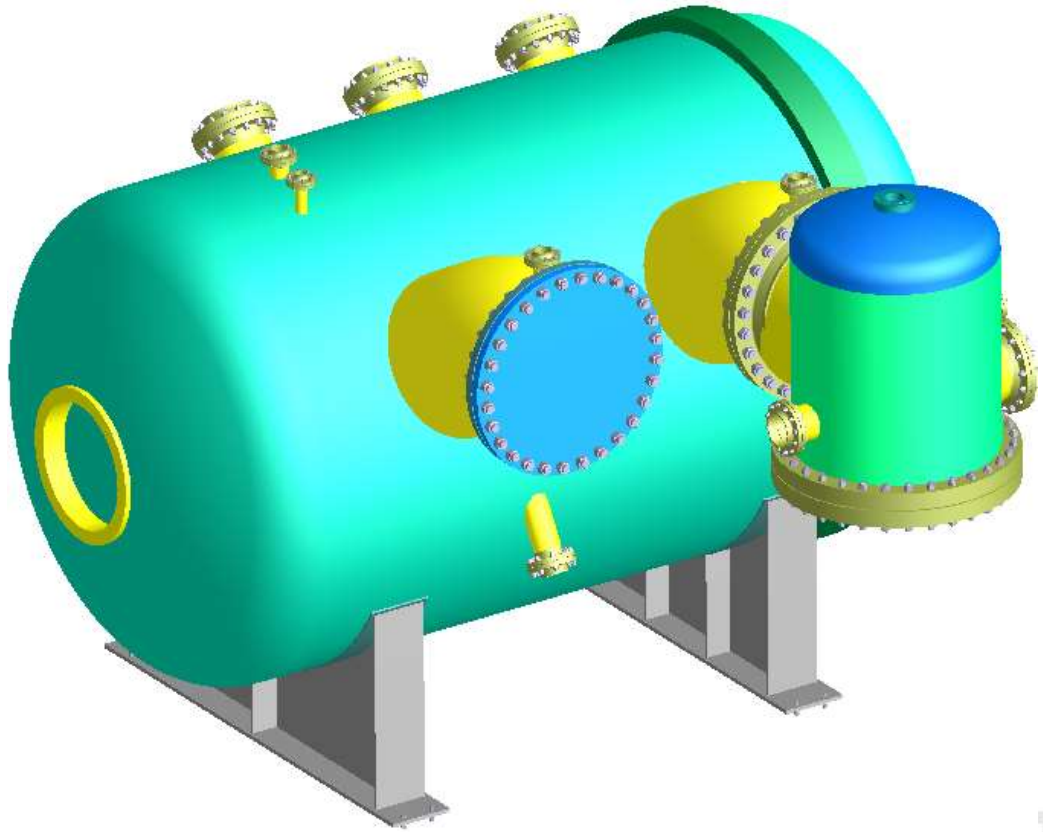
ANALYSIS & SIZING SUITE

PASS/EQUIP | Examples



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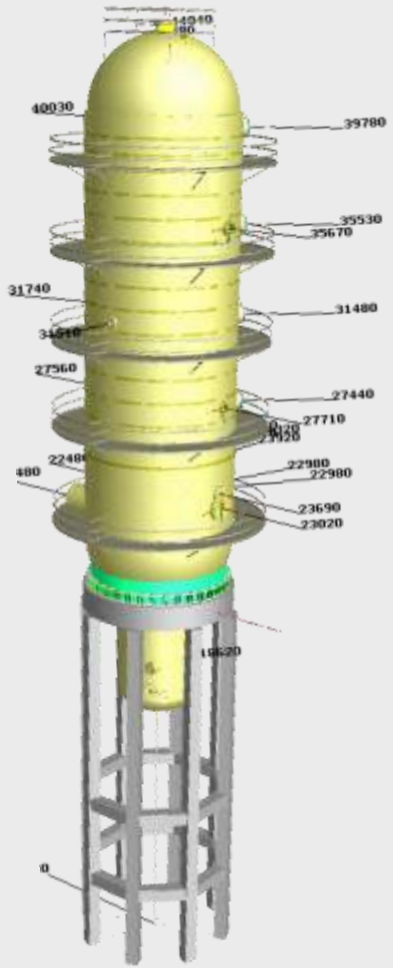
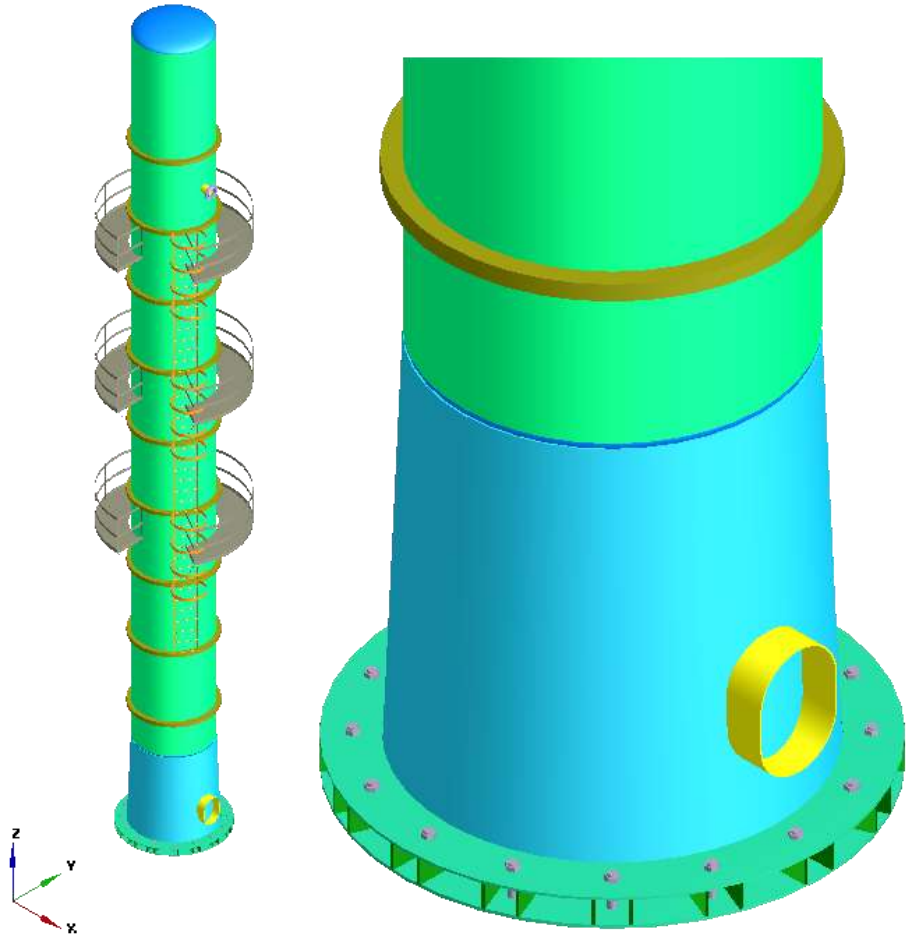
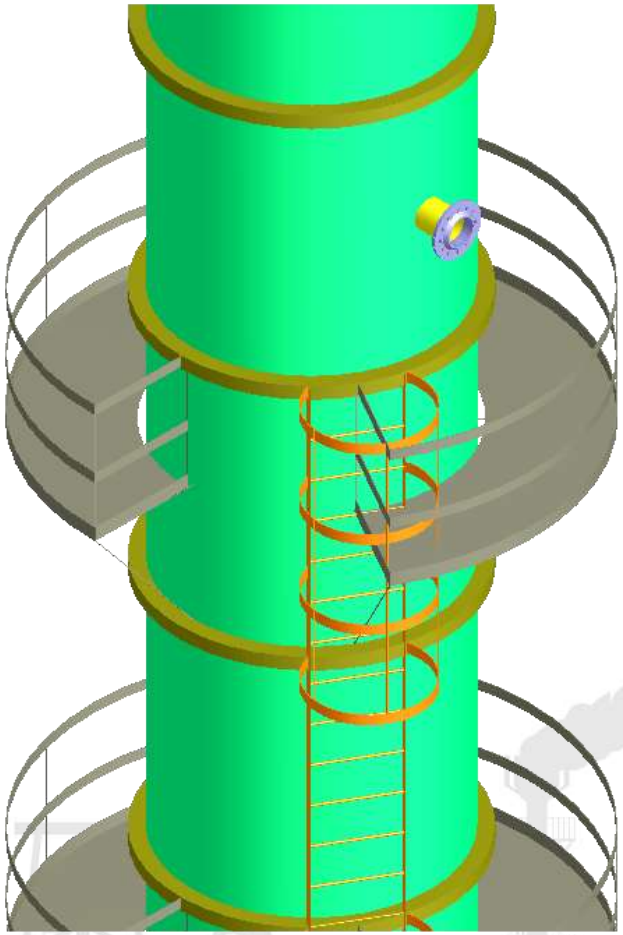
PASS/EQUIP

Example (Columns)







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PASS/EQUIP

Industries:

- Oil refining
- Chemical
- Petrochemical
- Oil and Gas
- Thermal power
- and others

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WW Users

PASS/EQUIP | Russian Users

PASS/EQUIP | In the Upcoming Version 3.02

- The ability to calculate the model simultaneously for several loading cases
- Calculation of the minimum material applicability temperature (MDMT) in accordance with ASME VIII-1
- Calculation of seismic loads according to EN-1998, wind loads according to EN 19914
- Calculation of the Ring support of a vertical vessel according to EN 13445-3
- Saddle support with full coverage
- Calculation of support skirts according to ASME VIII-1, ASME VIII-2, EN 13445-3
- Calculation of the skirt basering according to Bednar, D. Moss, EN-13445-3

PASS
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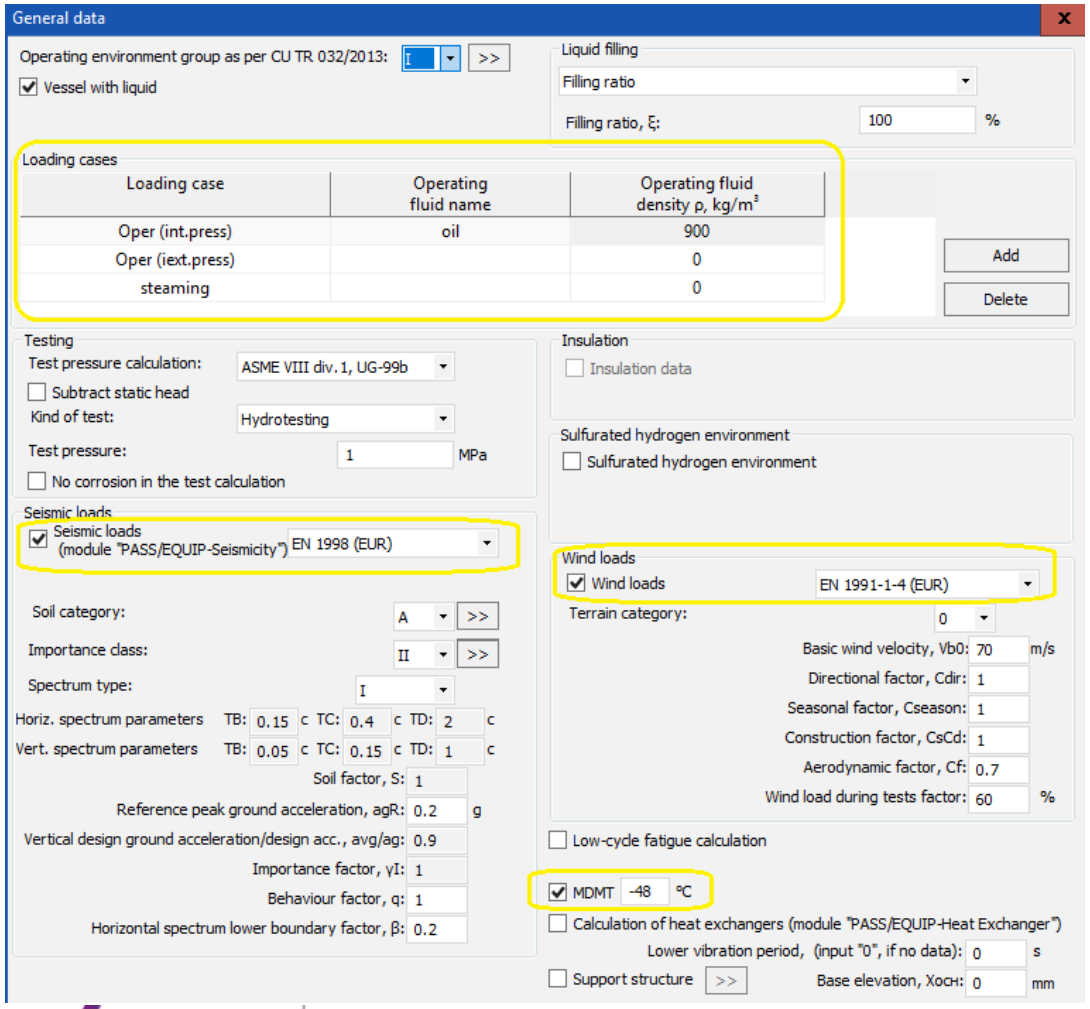
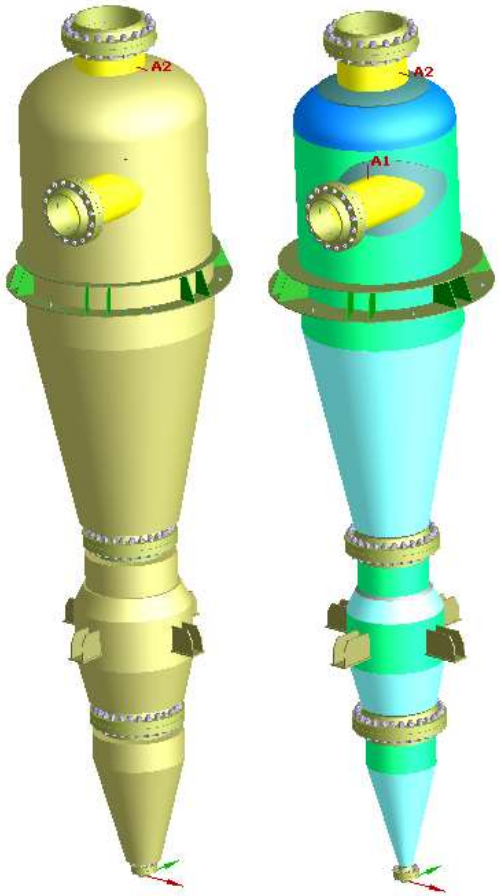
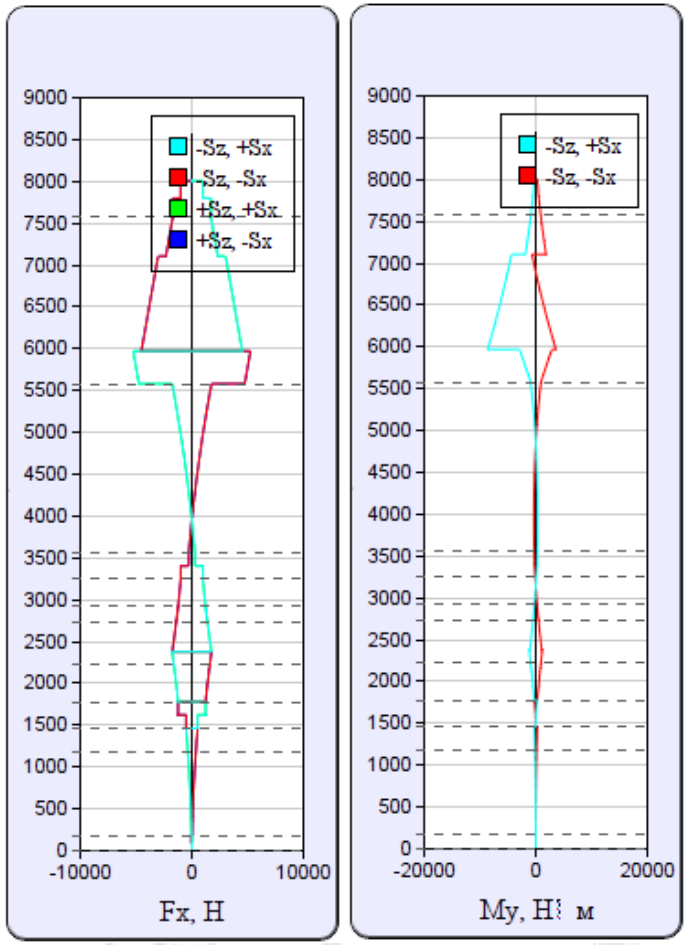
PASS/EQUIP | In the Upcoming Version 3.02





Two supports together



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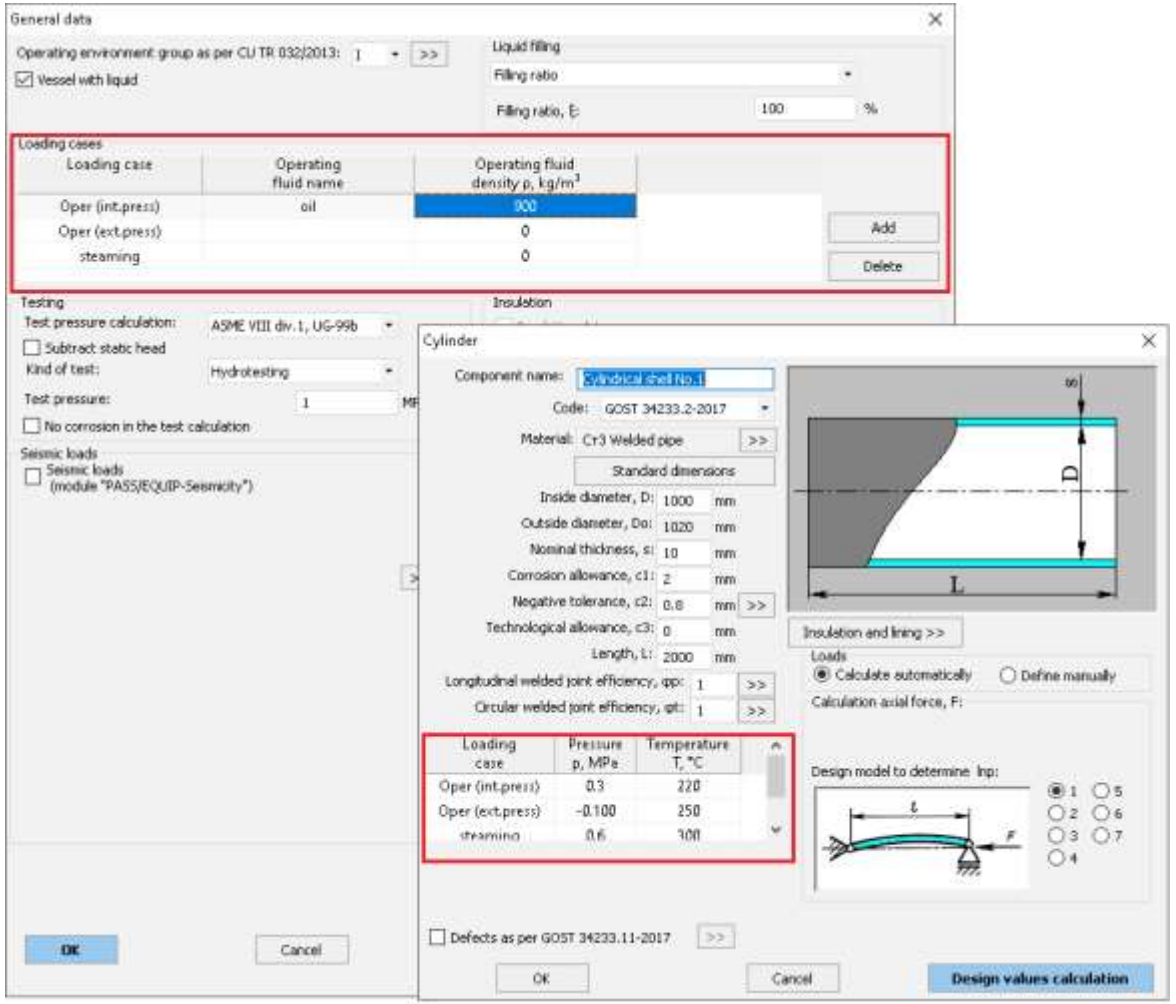
PASS/EQUIP | In the Upcoming Version 3.02

The ability to calculate the model simultaneously for several loading cases



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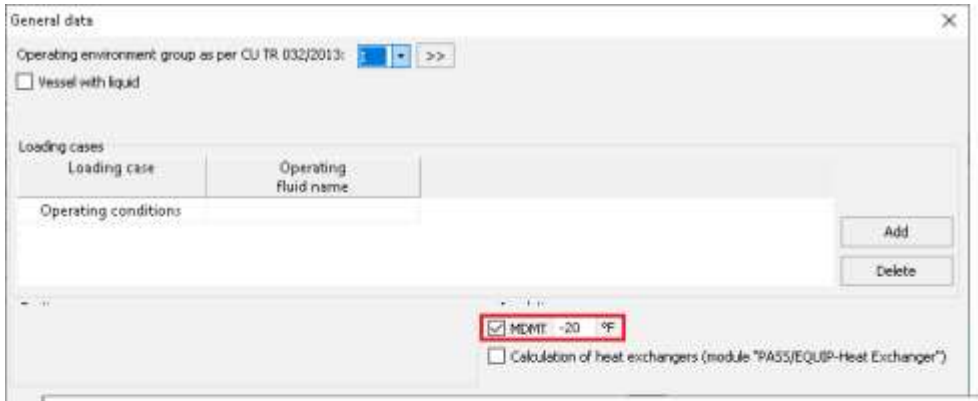

Calculation of the minimum material applicability temperature (MDMT) in accordance with ASME VIII-1

Отчёт Passat

Проблемные элементы

Общие данные

Сводные таблицы
- Таблица основных элементов
- Таблица штуцеров
- Расчет заполнения
- Расчет весов и центров тяжести
- Использование материалов
- Категория оборудования по ТР ТС 032/201
- Приложенные нагрузки
- MDMT

Прочность от опорных нагрузок
- Эпюры сил и моментов

Элементы сосуда
- Обечайка цилиндрическая №1
  - Штуцер №1
- Фланцевое соединение №1
- Обечайка цилиндрическая №2
  - Штуцер №2

Список литературы

MDMT

Название элемента	Стандарт	Материал	Governing thickness, in	MDMT, °F	R_T ratio	MDMT reduction, °F	Curve	Примечание
Обечайка цилиндрическая №1	ASME VIII div.1	SA-516 Gr.70 Плита	1,81	-7,6	–	–	Curve D	Impact test required
Штуцер №1	ASME VIII div.1	SA-516 Gr.70 Плита	1,81	-7,6	–	–	Curve D	Impact test required
		SA-105 Поковки	1,81	58,97	–	–	Curve B	Impact test required
		SA-656 Gr.T7 Плита	1,81	21,17	–	–	Curve C	Impact test required
Обечайка цилиндрическая №2	ASME VIII div.1	SA-516 Gr.70 Плита	1,81	-7,6	–	–	Curve D	Impact test required
Штуцер №2	ASME VIII div.1	SA-516 Gr.70 Плита	1,81	-7,6	–	–	Curve D	Impact test required
		SA-216 Gr.WCC Отливки	1,81	58,97	–	–	Curve B	Impact test required

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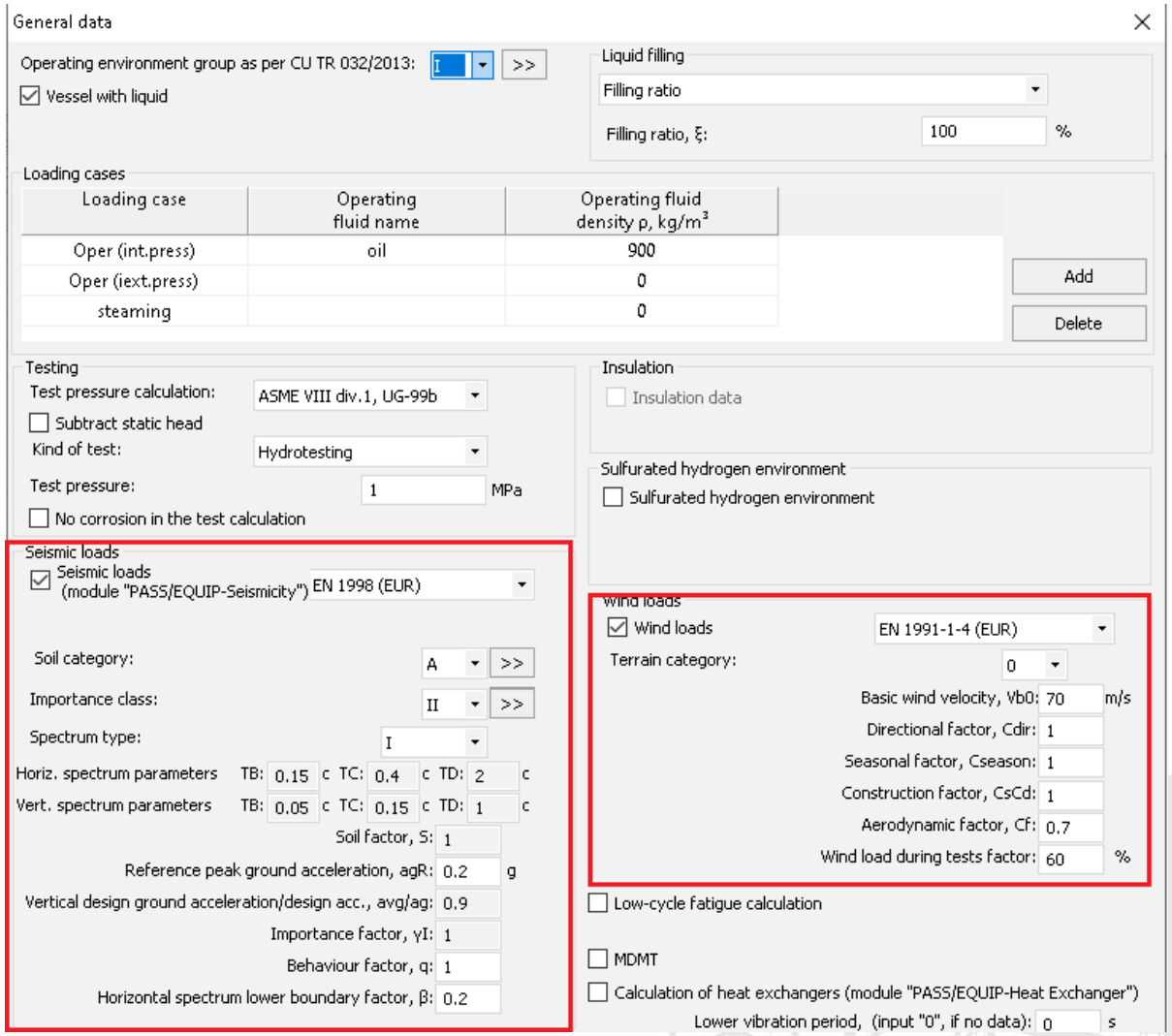
Calculation of seismic loads according to EN-1998,

wind loads according to EN 19914



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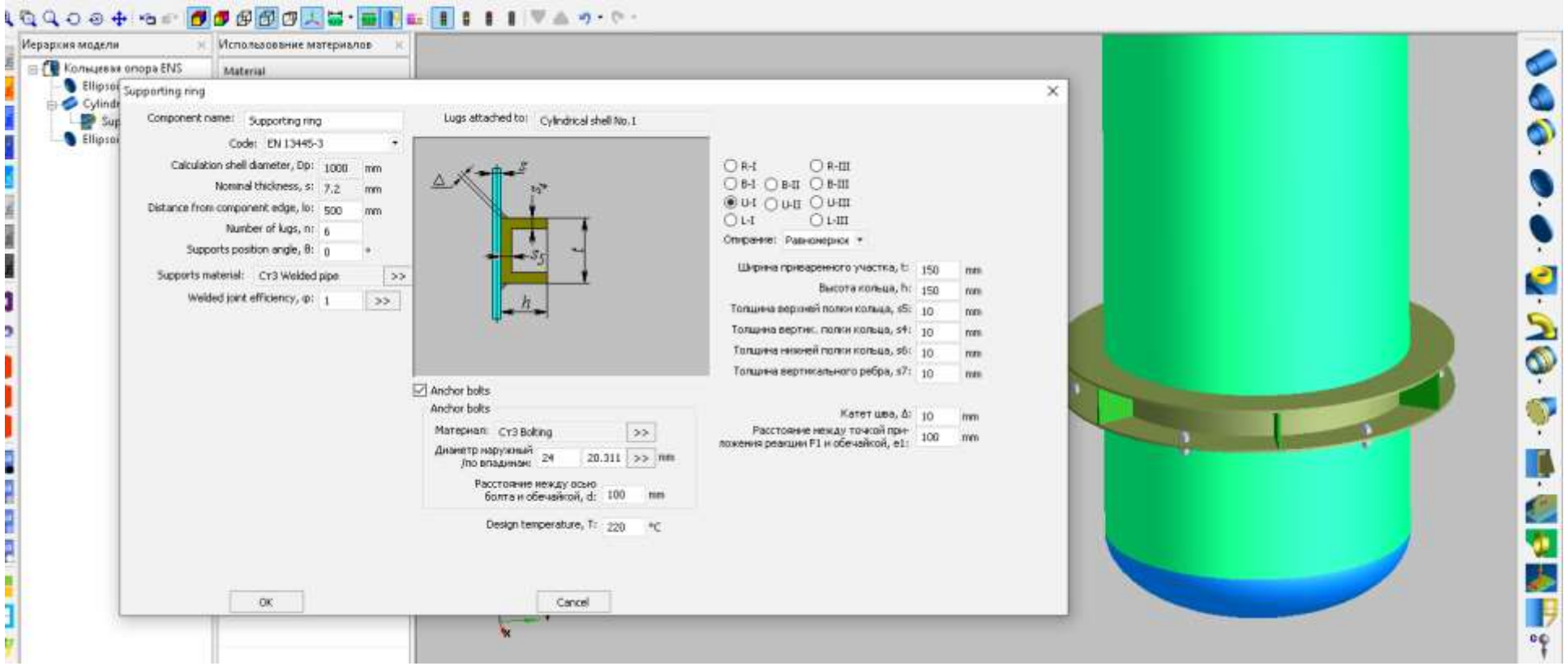

Calculation of Ring support of a vertical vessel according to EN 13445-3

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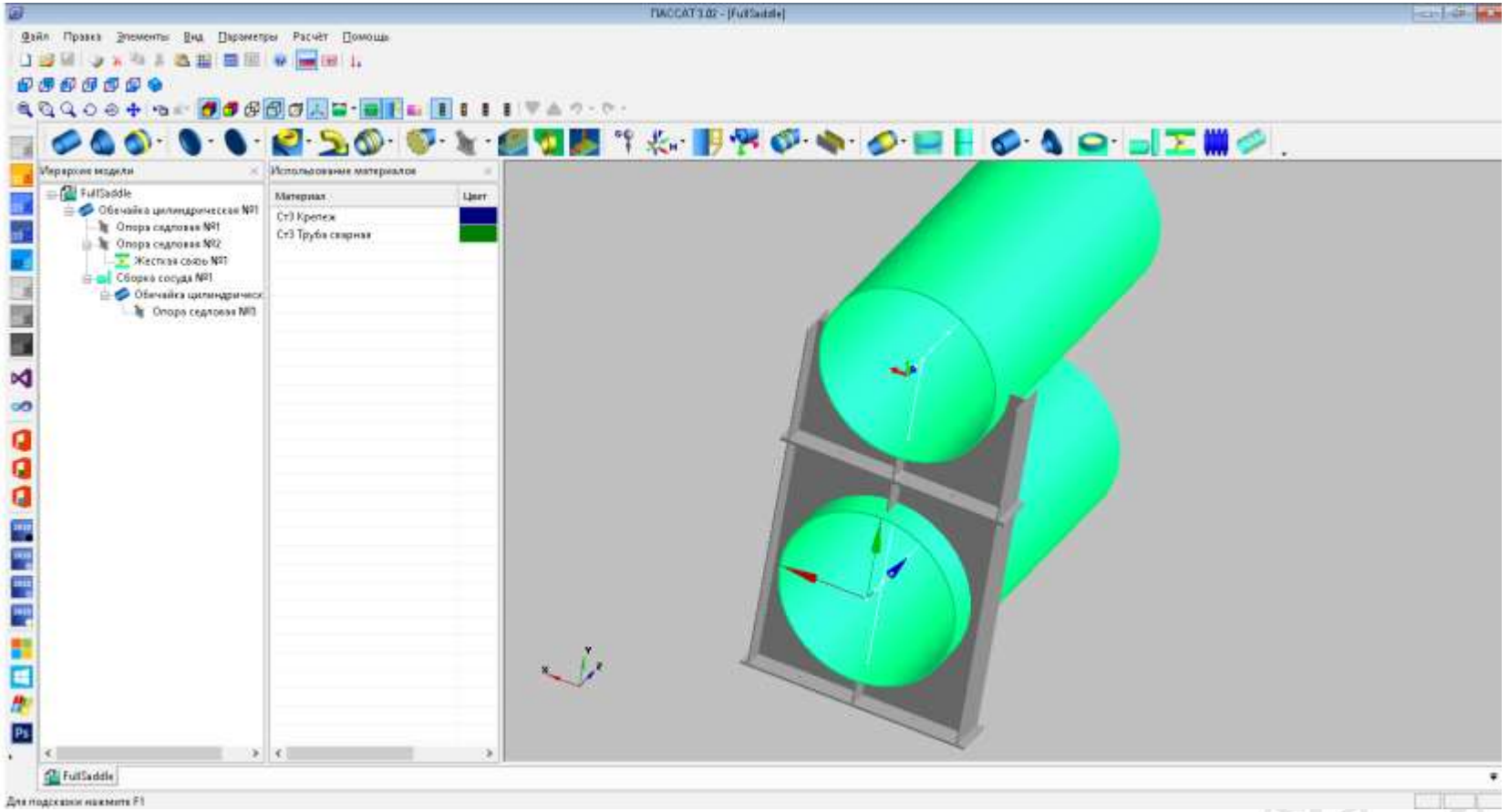
Saddle support with full coverage



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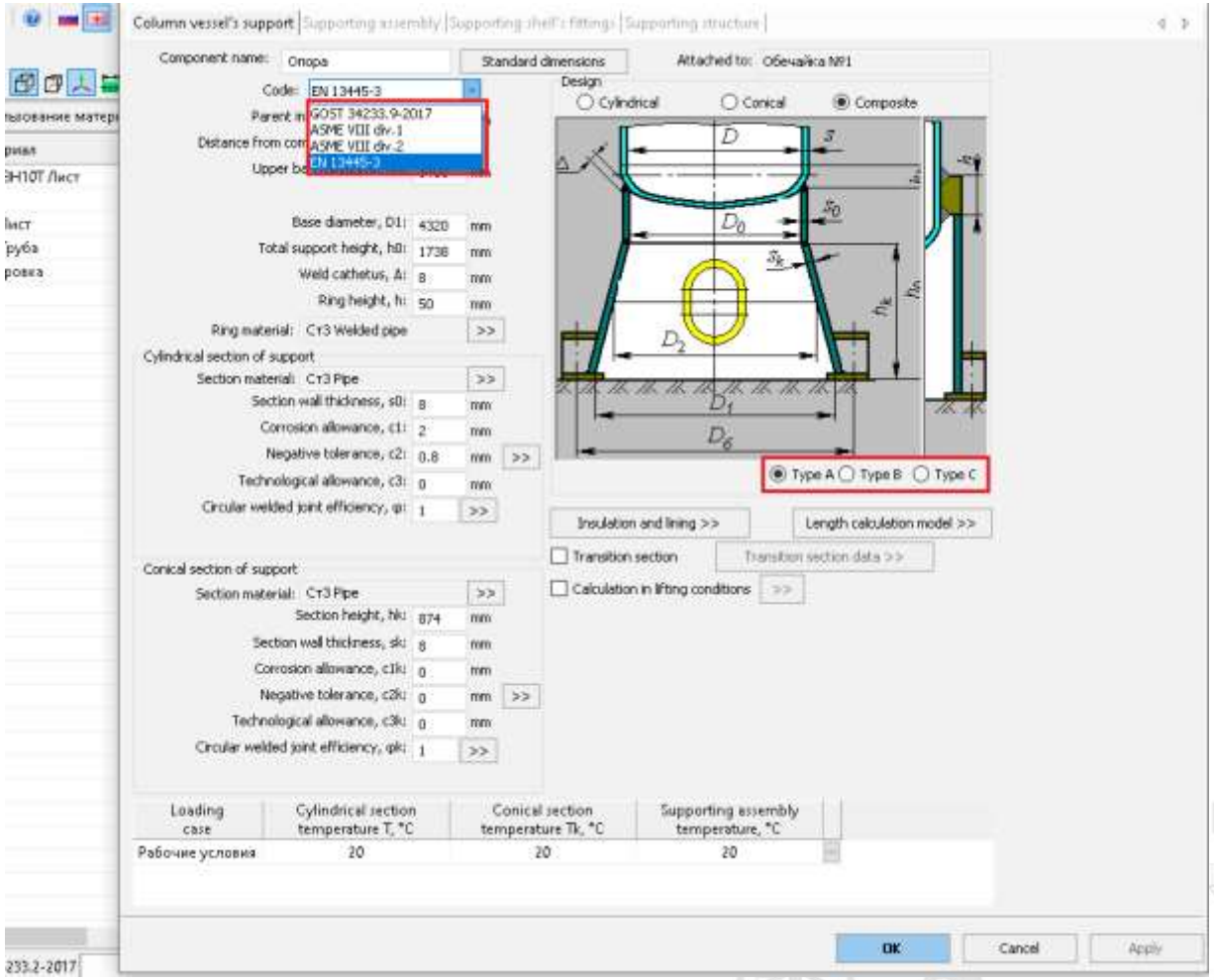
Calculation of support skirts according to ASME VIII-1, ASME VIII-2, EN 13445-3



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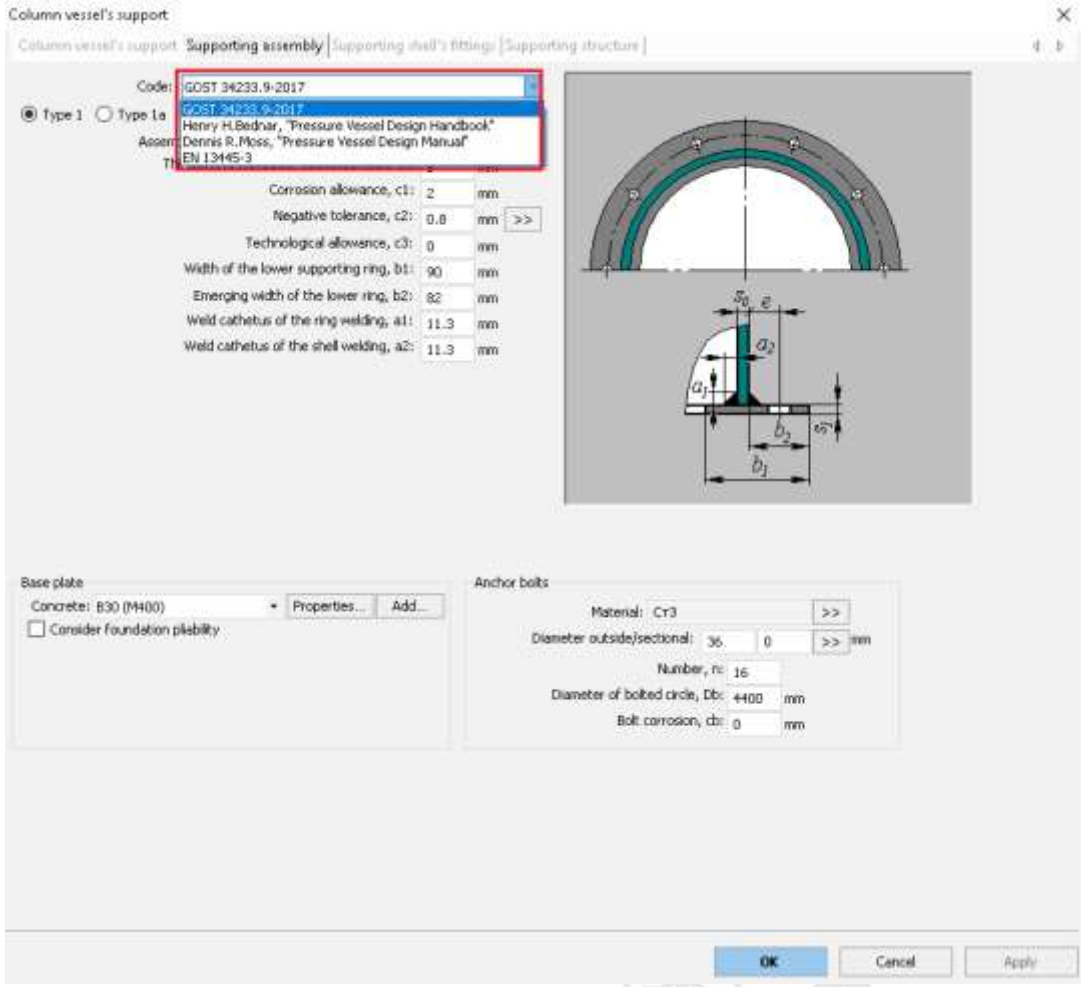
Calculation of the skirt basering according to Bednar, D. Moss, EN-13445-3



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PASS/EQUIP | Development Plan for 2020

- Calculation of vessels and Heat Exchangers by ASME VIII Div.2 Code
- Other national seismic and wind load codes
- Full integration “PASS/EQUIP” with “PASS/Nozzle-FEM”
- API 650 for Tanks
- Calculation of the strength and stability of the frame tank roof using FEM
- Other customer wishes:

we are open for your suggestions!

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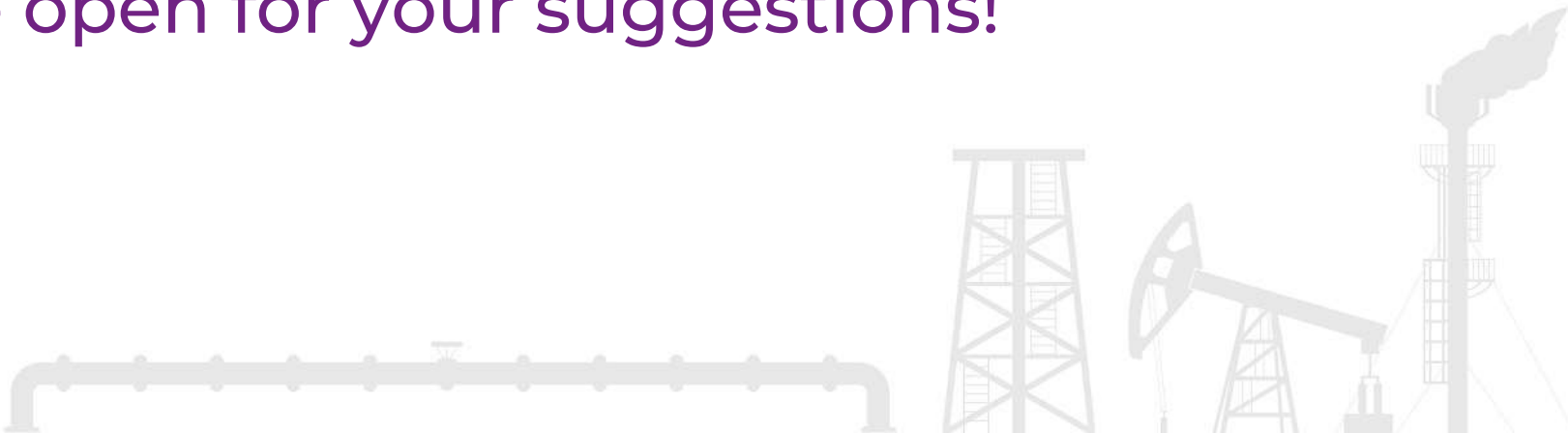

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