SIGMA Ingenieurgesellschaft mbH

PROBAD

Code-based Strength Calculations of Pressure Parts

SIGMA Ingenieurgesellschaft mbH

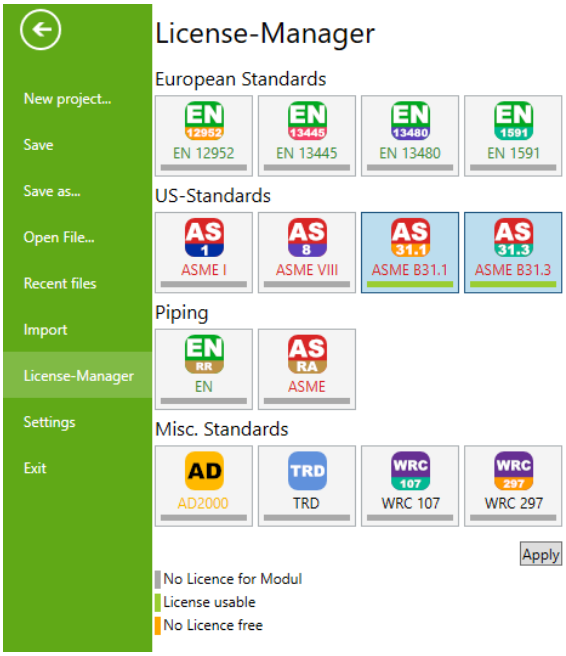
Contents

1 The Program system PROBAD

PROBAD *Code-based Strength Calculations of Pressure Parts*

PROBAD is the standard solution for code-based strength calculations of pressure parts. PROBAD is successfully used for years worldwide by leading companies of the boilers and vessels industry, in plant design and in piping construction.
The latest status of standards in PROBAD and a continuously technical development is guaranteed by PROBAD maintenance agreements.
PROBAD offers solutions for the effective use of calculation modules in accordance with the standards:

- AD 2000-sheets, TRD-sheets
- EN 12952, EN 13480, EN 13445, EN 1591
- ASME Sect. I., ASME Sect. VIII./1, ASME B31.1, B31.3, B31.12
- WRC 107, WRC 297



2 Highlights

Some highlights of these PROBAD calculation modules:

- PROBAD is of modular design; this enables licensing individual modules in relation to the company needs (see available PROBAD solutions).
- PROBAD allows not only re-checking defined component dimensions, but also designing or optimizing components.
- The comprehensive component databases of PROBAD include additional norms and standards regarding dimensions, wall thickness´, tolerances etc.
- Material databases containing EN, DIN and ASME materials are supporting the calculation modules. The values can be edited or modified individually by the user.
- **Standard-safety factors of the calculation rules are stored** and can be modified in accordance with the projects requirements.
- PROBAD **Modeler**
- For all PROBAD modules screen **inputs** and print outputs are currently available in German and English. The dialog system provides convenient help screens, either as text or graphic.
- PROBAD is continuously subject to technical **changes** and novelties as also for monitoring systems etc.
- Based on the various maintenance agreements, SIGMA GmbH is obliged to keep the solutions up to date by annual releases, so the PROBAD **modules** are always following the actual codes/standards.
- For PROBAD licensees with maintenance contract a **hotline** is available.
- **Pipe classes can be exported** from the pipe series modules **to ROHR2**
- **Import of complex structures from ROHR2** with transfer of the essential parameters such as dimensional standards and materials.

3 PROBAD modules - Overview

The PROBAD package PB1 is the basis for the operation of all other calculation modules.

	PROBAD Modules **1. license (Single user license or Network license)**	**Details** **see chapter**
PB1	**Basic Module** **incl. License and Project management,** FEZEN- Information and Evaluation System Components databases, Input/Output DIN/EN and ASME Material databases	4
F12	AD-Code Series B	5.1
F13	AD-Code Series B and S3 (incl. S1)	5.2
F14	TRD-Code Series 300 und 508	5.3
F21	EN 12952 Water Tube Boilers	6.1
F22	EN 1591 Flange Connections	6.2
F23	EN 13445 Unfired Pressure Vessels	6.3
F24	EN 13480 Metallic Piping	6.4
F33	WRC 107 / 297	7.5
F41	DIN-/EN-Pipe Series	
A11	ASME Sect. I	7.1
A22	ASME B31 (B31.1, B31.3, B31.12)	7.2
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4 Module PB1: PROBAD Basic module

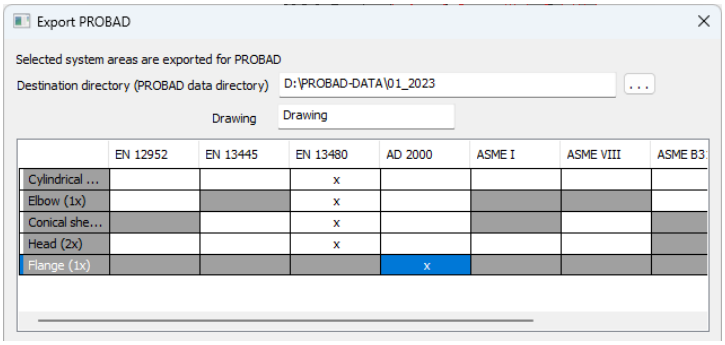
The basic package PB1 is a prerequisite for the operation of all other calculation modules.

- PROBAD graphical user interface
- License management, Project administration
- FEZEN- Information system
- Component databases, Input and Output
- DIN/EN and ASME material databases
- PROBAD Modeler

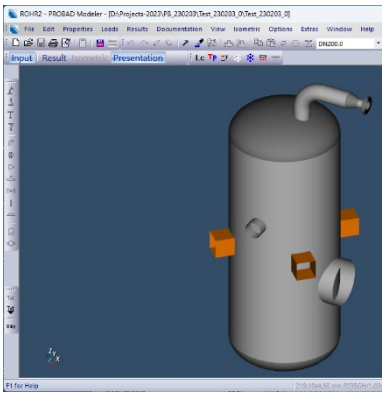
The number of base package PB1 defines the number of simultaneous accesses to the calculation modules.

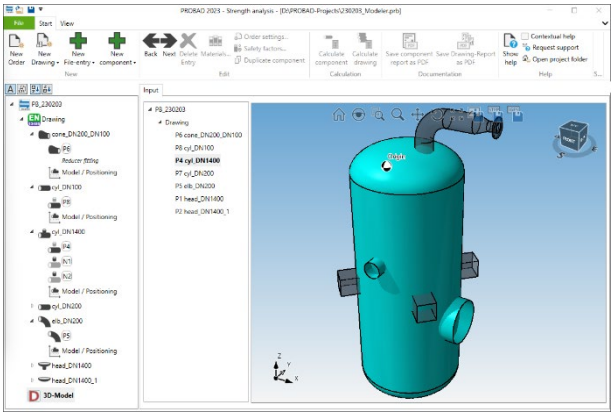
4.1 PROBAD Modeler

PROBAD includes a modeler allowing to define entire structures which can be transferred to one or more PROBAD calculation modules for calculation.
The assignment can be made to a different rule for each group of components so that it is also possible to carry out a verification across different sets of rules.



The entire project structure is generated by the specified calculation modules. The structure is subdivided in accordance with the particular standard.





Important parameters of the components like materials, dimensions referring to standards as well as load cases are taken over into the calculation modules.

4.2 ROHR2 connection

Analog to the modelling process in PROBAD, ROHR2 can be used as a modeler for PROBAD structures (ROHR2 34.0 and higher) This allows to export structures into PROBAD which have been generated in ROHR2.

Export of pipe classes to be used in ROHR2. ROHR2 allows to access pre-defined PROBAD pipe classes directly as an alternative to the code-based selection of components. This allows pre-selection of standard dimensions and components.

4.3 FEZEN Material database

4.3.1 Materials

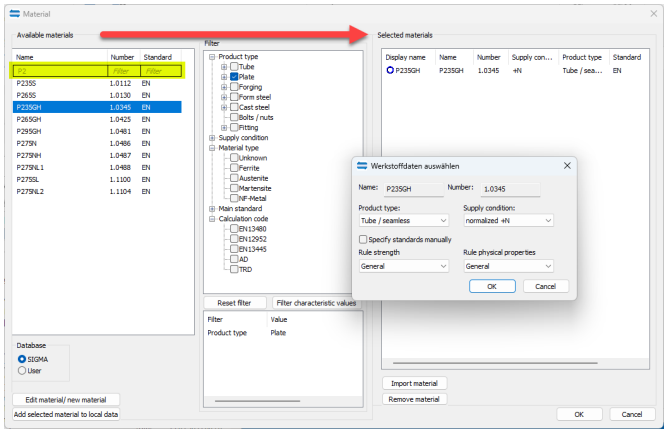
The material database FEZEN provides material properties for metallic materials for standardized materials acc. to EN, DIN and ASME material-codes/standards:

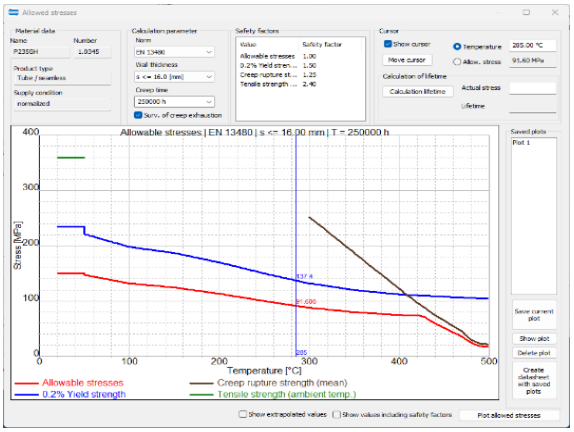
- Approximately 1.500 sheets containing material reference data basing on standard data of the EN material codes. Material data deviating from the above standards (revaluation or devaluation) are taken into account in line with EN 12952, EN 13480, EN 13445 and the AD-2000 and TRD codes.
- Approximately 700 material sheets with materials reference data based mainly on standard data of the DIN codes, but also on data of VdTÜV or SEW sheets. Material data deviating from the above standards (revaluation or devaluation) is considered following AD-2000 and TRD codes.
- Approximately 1.400 sheets with ASME material data containing allowable stresses and other data from ASME Sect. II Part D, ASME B31.1 and ASME B31.3.

The FEZEN material database is used by all available modules

Materials can be used for all standards, so it is possible to calculate ASME materials in EN standards and vice versa. User-defined materials can be defined and saved in a user database. This enables the use of these user-defined materials across all projects.

Additionally a comparison of the new European material names according to EN 10027 and the old designations according to DIN 17006 and 17007 is available.
The material database FEZEN is revised permanently by SIGMA. Annual updates provide the latest strength values.





4.3.2 FEZEN information system

The “FEZEN information system" provides the interactive use of the material database and is even working independent of PROBAD calculation modules. The program is used to recall material properties (individually or in total) and to print material data sheets.

This module analyzes and shows characteristic values (tensile strength, yield strength or proof stress values, creep strength values etc.) as well as the components physical properties, allowable stresses, allowable temperatures and life cycle parameters.
FEZEN can be used to perform lifetime calculations based on calculated stresses and the inter-/extrapolation of known lifetime values from the material database.

5 PROBAD - National Codes

5.1 Module F12: AD 2000- sheets, Series B

• Cylindrical parts with up to 10 nozzles and their interactions under internal and external pressure	**AD 2000 B1/B6/B9/B10**
• Pipe bends and elbows under internal and external pressure	**AD 2000 B1, App. 1**
• Conical parts (concentric and eccentric cones) with up to 10 nozzles and their interactions under internal and external pressure	**AD 2000 B2/B1/B6/B9/B10**
• Dished ends and hemispherical heads with up to 10 nozzles and their interactions under internal and external pressure	**AD 2000 B3/B1/B6/B9/B10**
• Flat round and square heads or plates with centered nozzle under internal and external pressure	**AD 2000 B5**
• Flanges, single and pair, including bolts and gasket as welding-neck flanges, weld-on flanges, welding-neck stub, weld-on stub with loose ring or lap joint flanges for collars	**DIN 2505+ B7/B8**
• Welded and flanged tube sheets with or without marginal moment including tubes under internal and external pressure	**AD 2000 B5/B1/B6**
• Dished covers under internal and external pressure	**AD 2000 B4**
• Expansion joints under internal and external pressure (single bellows or unguided or guided intermediate tube)	**AD 2000 B13**

5.2 Module F13: AD 2000- sheets, S-Series

Includes all codes of PROBAD Module F12 and additionally

• Simplified analysis for cyclic loading	**AD 2000 S1**
• Vessels with support skirts	**AD 2000 S3/1**
• Horizontal vessels on saddles	**AD 2000 S3/2**
• Vessels with dished ends on feet	**AD 2000 S3/3**
• Vessels with support brackets	**AD 2000 S3/4**

5.3 Module F14: TRD - Technical regulations for steam boilers (TRD)

• Cylindrical parts with up to 10 nozzles and nipples and their interaction	**TRD 301**
• Cylindrical as Y-shaped branches	**TRD 301**
• Cylindrical shells with up to 10 nozzles; optional calculation of combined cyclic changes; allowable rate of temperature change / allowable number of load cycle changes / fatigue analysis	**TRD 301, App.1**
• Bended tubes and Elbows	**TRD 301, App. 2**
• Spherical shells and dished heads with up to 10 nozzles and their interactions	**TRD 303**
• Spherical shells and dished heads, optional calculation of combined cyclic changes; allowable rate of temperature change / allowable number of load cycle changes / fatigue analysis	**TRD 303, App.1**
• Flat heads with central nozzle	**TRD 305**
• Fire tubes under external pressure (straight tube with/without reinforcing pad, fire box and corrugated tubes)	**TRD 306**
• Fatigue calculation based on the creep rupture strength for cylindrical shells, y-shaped form pieces and bended tubes and elbows	**TRD 508**

6 PROBAD - European codes

6.1 Module F21: EN 12952 - Water tube boilers

The PROBAD module "EN 12952 - Water Tube Boilers" provides the following components for strength calculations due to internal pressure and temperature:

- Determination of hazard category acc. to PED, Annex II, diagram 5
- Cylindrical parts with up to 10 nozzles and nipple fields and their interactions
- Tees
- Cylindrical shells with Y-branches
- Pipe bends and elbows
- Square tubes with single openings and rows of holes in longitudinal direction
- Spherical shells and dished heads with up to 10 nozzles and their interactions
- Spherical shells with Y-branches
- Unstayed flat ends with centered nozzle
- Lifetime calculation
- Creep fatigue calculation for all items listed above
- Calculation of the fatigue strength due to cyclic internal pressure or combined cyclic changes due to internal pressure and temperature for cylindrical shells and spherical shells with up to 10 nozzles; optional calculation of the allowable rate of temperature change, the allowable number of changes for one load cycles, the determination of the usage factor or the equal temperature rate for all load cycles

6.2 Module F22: EN 1591 - Flange connections

The PROBAD module "EN 1591 Flange Design" provides re-checking or designing of flanged joints in accordance with EN 1591 including leakage analysis, e. g. to fulfill the requirements of "TA Luft".
For standard flanges in accordance with DIN, EN 1092-1, EN 1759-1, ASME-B16.5 and ASME B16.47A/B16.47B the dimensions of flanges, bolts and gaskets as well as clamping parts (washers, expansion sleeves, HYTORC discs resp. HYTORC expansion nuts) are stored in a database and can always be retrieved into convenient, easy-to-use input panels. Non-standard measures can be entered additionally.

Available flange types:

- weld-on flanges, welding-neck flanges, slip-on flanges, put-in flanges with tube stopper, integral flanges, blind flanges, threaded flanges
- stub constructions with loose rings as weld-on stub, welding-neck stub, slip-on stub, put-in stub with tube stopper, integral weld-on stub, blind stub
- collar construction with loose rings as welding collars or as welding collar with long neck.

The usage ratios are determined by given loads like pressures, temperatures, forces and moments for:

- **flanges** considering the possibly connecting component (cylindrical, conical, spherical, hemispherical shell, dished head)
- **bolts** and
- **gaskets** under consideration of the req. leakage rate

The gasket database includes about 400 types of gaskets.The characteristic values are taken from these sources:

- EN 1591-2
- www.gasketdata.org
- www.esadata.org
- manufacturer measurement

Only one single calculation step is used to check the flange connection for the assembly condition and up to nine subsequent conditions.

Special verifications like nominal tighten torque, bolt forces, maximum flange rotation or minimum usage ratio of the bolts can be provided additionally.

6.3 Module F23: EN 13445 - Unfired pressure vessels

The PROBAD module "EN 13445 Unfired Pressure Vessels" provides strength calculations of the following parts under internal and/or external pressure:

- Cylindrical components with up to 10 nozzles and their interactions
- Tees
- Dished heads, hemispherical and spherical heads with nozzles and their interactions
- Reducers (concentric and eccentric cones) with nozzles and their interactions
- Flat circular, elliptical and square heads and plates with openings
- Tube sheets on heat exchangers
- Vessels at lifting lugs according to EN 13445-3, section 16.5
- Calculation of 'Lifting lugs' according to EN 13445-3, section 16.7
- Horizontal vessels on saddles or ring supports according to EN 13445-3, section 16.8-16.9
- Vertical vessels on bracket supports according to EN 13445-3, section 16.10
- Vertical vessels with supporting legs according to EN 13445-3, section 16.11
- Vertical vessels with skirts according to EN 13445-3, section 16.12
- Vertical vessels with ring supports according to EN 13445-3, section 16.13
- Local loads on nozzles in spherical shells according to EN 13445-3, section 16.4
- Local loads on nozzles in cylindrical shells according to EN 13445-3, section 16.5
- Simplified analysis of fatigue life according to EN 13445-3, section 17
- detailed analysis of fatigue life according to EN 13445-3, section 18

6.4 Module F24: EN 13480 - Metallic Piping

The PROBAD module "EN 13480 Metallic Piping" provides strength calculations of the following parts under internal and/or external pressure:

- Cylindrical components with nozzles and their interactions
- Tees
- Pipe bends and elbows
- Dished ends and hemispherical ends with nozzles and their interactions
- Reducers (concentric and eccentric cones) with nozzles and their interactions
- Circular flat ends and plates with openings
- Cylindrical shells with Y-branches
- Miter bends
- Hollow circular and rectangular attachments acc. to EN 13480-3, section 11
- Simplified analysis for cyclic loading

6.5 Module F41: EN- and DIN pipe series

The PROBAD module "DIN-/EN-Piping" provides serial calculations of standard pressure parts in piping systems for:

- straight pipes
- corresponding nozzle tables
- corresponding bended pipes
- elbows
- tees
- reducers
- caps
- flanges
- blinding plates

The calculation optionally can be carried out for internal pressure or external pressure according to

- EN 13480 (metallic industrial piping)
- EN 13445 (unfired pressure vessels)
- EN 12952 (water tube boilers)
- AD-2000
- TRD
- DIN 2413

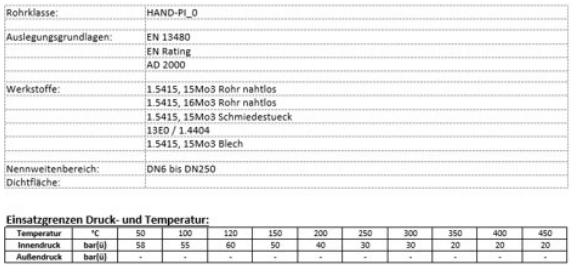
As an alternative to the codes the selection of fittings may be carried out by integrated rating tables.
The analysis of flanges is provided by integrated P/T-Rating-tables (e g. acc. to EN 1092-1).

For detailed analysis of flanges, the export to PROBAD module F22 is recommended

Calculated pipe classes can be exported in *.xml format and after that imported into ROHR2 for / stress analysis/ flexibility analysis.
A short report following DIN21057 is created.

The documentation of the pipe class can be completed by gasket and bolt details.

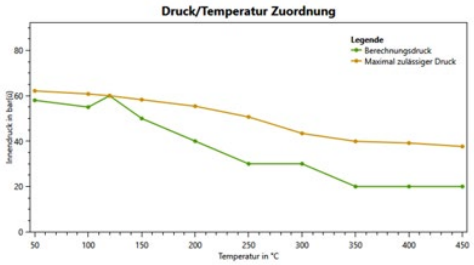
Calculated pipe classes can be exported in .xml format and be used in ROHR2 to carry out pipe stress calculation. Besides the .xml output and an output in .pdf or .docx also a short documentation including rating- and branch tables can be created:



Rohrklasse:	HAND-PI_0
Auslegungsgrundlagen:	EN 13480
	EN Rating
	AD 2000
Werkstoffe:	1.5415, 15Mo3 Rohr nahtlos
	1.5415, 16Mo3 Rohr nahtlos
	1.5415, 15Mo3 Schmiedestueck
	13E0 / 1.4404
	1.5415, 15Mo3 Blech
Nennweitenbereich:	DN6 bis DN250
Dichtfläche:	

Einsatzgrenzen Druck- und Temperatur:

Temperatur	°C	50	100	120	150	200	250	300	350	400	450
Innendruck	bar(ü)	58	55	60	50	40	30	30	20	20	20
Außendruck	bar(ü)	-	-	-	-	-	-	-	-	-	-



DN	s/mm	6	8	10	15	20	25	32	40	50	65	80	100	125	150	200	250
6	1,6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	1,8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	1,8	F 2/1,8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	2,0	B 2	B 2,3	-	TA 3,2	-	-	-	-	-	-	-	-	-	-	-	-
20	2,0	B 2,3	B 2,3	F 2,3/2,3	F 2,3/2,6	-	-	-	-	-	-	-	-	-	-	-	-
25	2,3	B 2	B 2,3	B 2,6	B 2,6	F 2,6/2,6	-	-	-	-	-	-	-	-	-	-	-
32	2,6	B 1,8	B 2	B 2,3	B 2,6	B 2,9	B 3,2	-	-	-	-	-	-	-	-	-	-
40	2,6	B 2	B 2,3	B 2,6	B 2,9	B 3,2	B 3,2	F 2,9/3,2	-	-	-	-	-	-	-	-	-
50	2,9	B 1,8	B 2,3	B 2,6	B 2,9	B 3,2 TA 3,6	B 3,6 TA 3,6	B 4 TA 3,6	TA 4 F 3,2/3,6	TA 5,6	-	-	-	-	-	-	-
65	2,9	B 2,6	B 2,9	B 3,2	B 3,6	B 3,6	B 4 TA 5,6	B 4,5 TA 5,6	TA 5,6 F 3,2/4,5	TA 5,6 F 3,6/4,5	TA 5,6	-	-	-	-	-	-
80	3,2	B 2,6	B 2,9	B 3,2	B 3,6	B 4	B 4,5	B 4,5 TA 5,6	B 5 TA 5,6	TA 5,6 F 3,6/5	TA 5,6 F 4,5/5	TA 5,6	-	-	-	-	-
100	3,6	B 2,6	B 3,2	B 3,6	B 3,6	B 4	B 4,5	B 5	B 5,6 TA 6,3	TA 6,3 F 4/5,6	TA 6,3 F 4/6,3	TA 6,3 F 4,5/6,3	TA 8,8	-	-	-	-
125	4,5	A	B 2	B 2,6	B 3,2	B 3,6	B 4,5	B 5	B 5,6	B 6,3 TA 10	B 7,1 TA 10	B 7,1 TA 10	TA 10 F 5,6/7,1	TA 10	-	-	-
150	5,0	A	B 2,3	B 2,9	B 3,6	B 4	B 5	B 5,6	B 5,6	B 6,3	B 8 TA 11	B 8 TA 11	TA 11 F 5,6/8	TA 11 F 6,3/8	TA 11	-	-
200	5,6	B 2,6	B 3,2	B 3,6	B 4,5	B 5	B 5,6	B 6,3	B 7,1	B 8	B 8,8	B 10	B 10 TA 12,5	TA 12,5 F 6,3/10	TA 12,5 F 8/10	TB 12,5	-
250	7,1	A	A	B 2,3	B 3,2	B 4	B 5	B 6,3	B 7,1	B 8	B 8,8	B 10	B 11 TA 12,5	TA 12,5 F 8/11	TA 12,5 F 10/10	TA 16 F 10/12,5	TA 16

A	=	Form A: unverstärkter Abzweig
B	=	Form B: verstärkter Abzweig - innenverstärkt
TA	=	Form TA: T-Stück "verminderter Ausnutzungsgrad"
TB	=	Form TB: T-Stück "voller Ausnutzungsgrad"
F	=	Form F: Abzweig mit verstärktem Durchgang und verstärktem Stutzen

7 PROBAD - ASME Codes

The input values and results can be done either in European or American units. The required pressure p' acc. to the Pressure Equipment Directive can be determined selectively.

7.1 Module A11: ASME Section I - Power Boilers

The PROBAD module "ASME Section I." is used to calculate the strength of the parts under internal pressure:

- Cylindrical shells with up to 20 nozzles and up to 10 nipple fields and their interactions
- Dished ends and hemispherical ends with up to 10 nozzles and their interactions
- Flat circular and non-circular ends with centered nozzle

The required pressure p' acc. to the Pressure Equipment Directive can be determined if required.

7.2 Module A22: ASME B31.xx

7.2.1 ASME B31.1 - Power Piping

The PROBAD module 'ASME B31.1' includes the following parts for pipes under internal pressure in plant design and boilers industry:

- Straight tubes with up to 10 nozzles and their interactions
- Bent tubes and elbows
- Hollow circular and rectangular attachments acc. to ASME III, App. Y

7.2.2 ASME B31.3 - Process Piping

The PROBAD module "ASME B31.3" includes the following parts for pipes under internal pressure in petroleum refineries and chemical plants:

- Straight tubes with up to 10 nozzles and their interactions
- Bent tubes and elbows
- Hollow circular and rectangular attachments acc. to ASME III, App. Y

7.2.3 ASME B31.12 - Hydrogen Piping, IP + PL

The PROBAD module "ASME B31.12" includes the following parts for pipes under internal pressure in petroleum refineries and chemical plants:

- Straight tubes with up to 10 nozzles and their interactions
- Bent tubes and elbows
- Hollow circular and rectangular attachments acc. to ASME III, App. Y

7.3 Module A41: ASME Section VIII, Division 1 - Pressure Vessels

The PROBAD module "ASME Section VIII, Div. 1" provides strength calculations of the following parts under internal and/or external pressure:

- Cylindrical shells with up to 10 nozzles and up to 10 nipple fields and their interactions
- Conical shells and ends (concentric and eccentric cones) with up to 10 nozzles and their interactions
- Dished ends and hemispherical ends with up to 10 nozzles and their interactions
- Flat unstayed ends with centered nozzle
- Dished covers with flanges (spherical dished covers) under internal pressure
- Flanges, single and pair, including bolts under internal pressure
- Tube sheets for heat exchangers according to ASME for U-tube heat exchanger, fixed tube sheet heat exchanger and heat exchanger with immersed floating head and heat exchanger with externally or internally sealed floating head

7.4 Module A51: ASME Pipe series

The PROBAD module "ASME Piping" permits the serial calculation of standard pressure parts under internal pressure in piping systems for

- straight pipes
- corresponding nozzle tables
- corresponding bended pipes
- elbows
- tees
- reducers
- caps
- flanges
- blinding plates

The calculation proof can be done optionally according to the codes:

- ASME Section I.
- ASME Section VIII. Div.1
- ASME B31.1 (Power Piping)
- ASME B31.3 (Process Piping)

As an alternative to the codes the selection of fittings may be carried out by integrated rating tables. The analysis of flanges is provided by integrated P/T-Rating-tables (e.g. acc. to ASME B16.5).
The input values and results can be done either in European or American units.
The required pressure p' acc. to the Pressure Equipment Directive can be selectively determined.

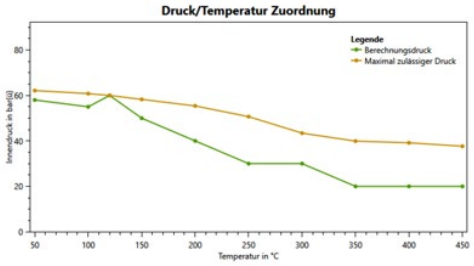
Calculated pipe classes can be exported in *.xml format and after that imported into ROHR2 for / stress analysis/ flexibilty analysis. A short report following DIN21057 is created.

Calculated pipe classes can be exported in .xml format and be used in ROHR2 to carry out pipe stress calculation. Besides the .xml output and an output in .pdf or .docx also a short documentation including rating- and branch tables can be created:

Rohrklasse:	HAND-PI_0
Auslegungsgrundlagen:	EN 13480
	EN Rating
	AD 2000
Werkstoffe:	1.5415, 15Mo3 Rohr nahtlos
	1.5415, 16Mo3 Rohr nahtlos
	1.5415, 15Mo3 Schmiedestueck
	13E0 / 1.4404
	1.5415, 15Mo3 Blech
Nennweitenbereich:	DN6 bis DN250
Dichtfläche:	

Einsatzgrenzen Druck- und Temperatur:

Temperatur	°C	50	100	120	150	200	250	300	350	400	450
Innendruck	bar(ü)	58	55	60	50	40	30	30	20	20	20
Außendruck	bar(ü)	-	-	-	-	-	-	-	-	-	-



DN		6	8	10	15	20	25	32	40	50	65	80	100	125	150	200	250
	s/mm	1,6	1,8	1,8	2,0	2,0	2,3	2,6	2,6	2,9	2,9	3,2	3,6	4,5	5,0	5,6	7,1
6	1,6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	1,8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	1,8	F 2/1,8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	2,0	B 2	B 2,3	-	TA 3,2	-	-	-	-	-	-	-	-	-	-	-	-
20	2,0	B 2,3	B 2,3	F 2,3/2,3	F 2,3/2,6	-	-	-	-	-	-	-	-	-	-	-	-
25	2,3	B 2	B 2,3	B 2,6	B 2,6	F 2,6/2,6	-	-	-	-	-	-	-	-	-	-	-
32	2,6	B 1,8	B 2	B 2,3	B 2,6	B 2,9	B 3,2	-	-	-	-	-	-	-	-	-	-
40	2,6	B 2	B 2,3	B 2,6	B 2,9	B 3,2	B 3,2	F 2,9/3,2	-	-	-	-	-	-	-	-	-
50	2,9	B 1,8	B 2,3	B 2,6	B 2,9	B 3,2 TA 3,6	B 3,6 TA 3,6	B 4 TA 3,6	TA 4 F 3,2/3,6	TA 5,6	-	-	-	-	-	-	-
65	2,9	B 2,6	B 2,9	B 3,2	B 3,6	B 3,6	B 4 TA 5,6	B 4,5 TA 5,6	TA 5,6 F 3,2/4,5	TA 5,6 F 3,6/4,5	TA 5,6	-	-	-	-	-	-
80	3,2	B 2,6	B 2,9	B 3,2	B 3,6	B 4	B 4,5	B 4,5 TA 5,6	B 5 TA 5,6	TA 5,6 F 3,6/5	TA 5,6 F 4,5/5	TA 5,6	-	-	-	-	-
100	3,6	B 2,6	B 3,2	B 3,6	B 3,6	B 4	B 4,5	B 5	B 5,6 TA 6,3	TA 6,3 F 4/5,6	TA 6,3 F 4/6,3	TA 6,3 F 4,5/6,3	TA 8,8	-	-	-	-
125	4,5	A	B 2	B 2,6	B 3,2	B 3,6	B 4,5	B 5	B 5,6	B 6,3 TA 10	B 7,1 TA 10	B 7,1 TA 10	TA 10 F 5,6/7,1	TA 10	-	-	-
150	5,0	A	B 2,3	B 2,9	B 3,6	B 4	B 5	B 5,6	B 5,6	B 6,3	B 8 TA 11	B 8 TA 11	TA 11 F 5,6/8	TA 11 F 6,3/8	TA 11	-	-
200	5,6	B 2,6	B 3,2	B 3,6	B 4,5	B 5	B 5,6	B 6,3	B 7,1	B 8	B 8,8	B 10	B 10 TA 12,5	TA 12,5 F 6,3/10	TA 12,5 F 8/10	TB 12,5	-
250	7,1	A	A	B 2,3	B 3,2	B 4	B 5	B 6,3	B 7,1	B 8	B 8,8	B 10	B 11 TA 12,5	TA 12,5 F 8/11	TA 12,5 F 10/10	TA 16 F 10/12,5	TA 16

A	=	Form A: unverstärkter Abzweig
B	=	Form B: verstärkter Abzweig - innenverstärkt
TA	=	Form TA: T-Stück "verminderter Ausnutzungsgrad"
TB	=	Form TB: T-Stück "voller Ausnutzungsgrad"
F	=	Form F: Abzweig mit verstärktem Durchgang und verstärktem Stutzen

7.5 Module F33: WRC

7.5.1 WRC 107 / WRC 537

The PROBAD module " WRC 107 / WRC 537' is required for calculating stresses resulting from local loads (forces or moments) on cylindrical shells (attachment forms: circular massive, square massive or tubular) and on spherical shells (attachment forms: circular massive and square massive).
Additionally the superposition of several individual load cases is possible, where the superposition also covers single tresses or internal pressure.
At cylindrical shells additionally stresses from internal pressure and bending moments acc. to ASME Section III Class 1 and 2.can be super imposed.
At tube plugs and nozzles an additional proof of the attachment both inside and outside of the intersection area can be requested.

7.5.2 WRC 297

The PROBAD "WRC 297" module provides stress analysis at nozzles in cylindrical shells and nozzles with or without pad reinforcement resulting from 3-axial forces or moments.

Types of calculation available in this module:

- Re-checking of existing geometries
- Design of the shell thickness- or nozzle and pad thickness
- Determination of allowable values of a force or moment component
- Stress analyses (local and global loads) are additionally provided in accordance with 'AD-S3/0', 'AD-S4', 'BS 5500' or by free input.

8 Licensing, system requirements and support

8.1 Licensing

The program license is available as a single user license or network license, perpetual or rental. Licensing a program requires the acceptance of the terms of use by signing a System Contract. Contract samples are available upon request.

Single user license	The single user license allows the installation of the program on the PC-systems of the licensee and the use by means of a license key on one PC system simultaneously. The license is available - Using a USB license key (without assignment to a particular PC)
Network license	The network license enables the access to the program system by any PC in the network, limited by the number of users The license is available - Using a USB license key (without assignment to a particular server) - Using a software license key (SL license, server assigned)
WAN	Wide area network option. The WAN license is a contractual agreement. The scope of services is defined in the system contract. At least one program license is required per location.
Additional modules	Interfaces and additional programs are no stand-alone applications. The modules are integrated into a ROHR2/SINETZ/PROBAD basic license.

License duration

Time unlimited /perpetual license (purchase)	Allows the **time unlimited use of the program.** Maintenance and user support are included during the first six months after delivery. In order to receive continued maintenance and user hotline, the signing of a maintenance contract is recommended.
Time limited program use (rent)	Time limited use of a program license. Minimum rental time is three months. Support and maintenance are included. Fees may be partially reimbursed in event of a purchase of the rented license(s) during the rental period. Long term rental upon request
Payment by installments (leasing)	Time limited single user program license including maintenance and support. Payable by monthly installments. After final installment the license will be converted into a time unlimited program version. Maintenance is included for the lease period.

Options	
Guarantee	**The guarantee on our software is for twelve months.** **Services beyond the guarantee are part of the Program Maintenance:**
Maintenance contract	The program maintenance includes - User Support (Program hotline) - Software-Development (Updates via download and internet connection) - Adaptation of the software to current technical requirements/ actualized stress codes The program license includes a free maintenance period of six months after delivery if not agreed otherwise. For program service maintenance beyond the included maintenance period a maintenance contract is available. Maintenance is included within rental period (time-limited use).
Updates *(Software development)*	Program updates are included in the maintenance contract. Update price for programs without valid maintenance contract upon request.
Upgrades	Additional modules, different program configurations and changes from single user license to network license upon request.
Scope of delivery and system requirements	System requirements, available GUI languages and program features are defined in the program specification. Country or user specific licenses may be different from the specification. Please refer to offer/quotation.
Prices, Shipping and handling costs	The details in this price list are for information and don't represent any obligatory offer. Please ask for a binding quotation. All prices are without VAT and local taxes, custom fees, etc. Standard shipping and handling costs inside EU included if not specified in the quotation. Shipping costs outside of EU will be charged separately.

8.2 Software Development, Sales and Support

SIGMA Ingenieurgesellschaft mbH

Contact:
SIGMA Ingenieurgesellschaft mbH
Bertha-von-Suttner-Allee 19
D-59423 Unna
Germany
Tel +49 2303 33233-0
Email info@rohr2.de

Sales

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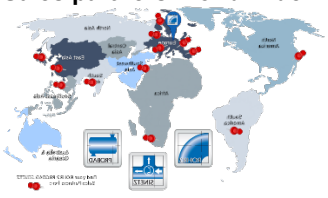
sales@rohr2.com

www.rohr2.de

Support

Tel.: +49 (0)2303 332 33-45
support.probad@rohr2.de
Sales partners World wide



www.rohr2.com

8.3 Scope of supply and license key

The programs´ scope of delivery contains
- the program data by download
- the program manuals, online
- the PROBAD license key (USB dongle or Software License key), available as
  USB license key (without assignment to a particular PC/server)
  Software license key (SL license, PC/server assigned)

The software does not run without the license key.
In case of updates/ upgrades the license module will be replaced or updated.

SL License key

- PROBAD 2020.1 and higher supports Software license keys (SL License) without a USB key.
- SL Licenses allow to „Borrow licenses, i.e. taking a network license access/ user off the network for a specified time period
- For details please refer to the document *PBlicense* or contact the Sales Team

8.4 System requirements

Basically the requirements of the Sentinel runtime software need to be fulfilled which can be downloaded here:
www.rohr2.de/public/sentinel_readme.html

The system requirements of all ROHR2 program versions are as following:

System requirements of single user licenses and PC-workstations in the network

- PC mit mind. 16 GB RAM, 32 GB RAM recommended
- Windows 11/10 (64-bit)
- Screen resolution minimum 1280 x 720 px, 1920 x 1080 px recommended
- USB port (not in case of SL Licenses)
- Internet connection for the activation of the program license *) and program updates

*) Activation by phone/email or internet

System requirements of the network server

In addition to the requirements for single user licenses:
- Installation of the HASP license manager on a Server PC accessible by all users in the network
- Windows 11/10, Windows Server 2022/2019/2016 (64-bit)

In case of integrating PROBAD into company-wide or country-wide networks (WAN) please contact us.

9 Software Services

Maintenance, updates and user support

The PROBAD maintenance contract includes user support, software updates and calculation code releases. PROBAD is equipped with a comprehensive software documentation (manual (online manual). The support team assists the user in questions concerning the application of PROBAD in the daily work on the project.
The direct link to the hotline guarantees an effective use of PROBAD and assures that you receive competent help in a timely manner.
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PROBAD continuously developed and updated

Updating the software by periodical releases is an essential component of the maintenance agreement. The software is developed continuously in order to incorporate the ongoing changes in the calculation codes and norms, according to the user's needs. The technical regulations for the calculation of components are subject to a permanent change. These changes are monitored by our development team and implemented in the program system PROBAD in a timely manner. Updates are available via internet download.

This assures the user of PROBAD that the software always is updated to most recent editions and changes of the codes which are required by the legislator of the current norms and laws.
The technical development in software programming as well as the adaption to technical prerequisites, such as operating systems, are also considered and part of the update service. This ensures a long-term safeguarding of the investment of soft- and hardware.

SIGMA Ingenieurgesellschaft

SIGMA, established in 1989 in Dortmund, Germany has emerged as the partner of choice for leading international companies with its software and wide variety of engineering services. SIGMA is known as one of the leading engineering specialists in the Pipe Stress Business in Europe. SIGMA develops and distributes ROHR2, the European Pipe Stress software and SINETZ, Software for the analysis of pressure drop and heat loss in piping systems.

PROBAD Training

SIGMA distributes PROBAD licenses and offers training units as well as workshops for calculation standards.