PROBAD

Code-based Strength calculations of Pressure parts

PROBAD 01/2021
New Features and Improvements

The program system PROBAD is checked and modified continuously within the scope of the maintenance agreement.

List of innovations, improvements and corrections of the new PROBAD-Releases

EN 12952	Water-tube Boilers	Release 4.09
EN 13445	Unfired Pressure Vessels	Release 3.08
EN 13480	Metallic industrial Piping	Release 3.00
EN 1591	Circular Flange Connections	Release 5.05
EN Piping Series	Serial Piping Calculations	Release 4.09
AD 2000	Pressure Vessels	Release 7.09
TRD	Steam Boilers	Release 8.09
WRC 107 / WRC 537	External Nozzle Loads	Release 8.09
WRC 297	External Nozzle Loads	Release 5.09
FEZEN	Material Information System	Release 4.13

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FEZEN – Information System, Version 4.13:

The following new editions of standards and codes were inserted into the material database FEZEN:

Reference standard EN:

- EN 10216-2 Edition 12/2019 Seamless steel tubes for pressure purpose
- EN ISO 3183 Edition 10/2019 Steel pipe for pipeline transportation systems
- ECCC Edition 01/2019 Data sheet Steel Grade 91

Reference standard DIN:

- AD 2000 - W 2 Edition 01/2020 Austenitic and austenitic-ferritic steels
  AD 2000 - W 7 Edition 01/2020 Bolts and nuts made from ferritic steels
  AD 2000 - W 10 Edition 01/2020 Ferrous materials for low temperatures

- The following modified VdTÜV-Material sheets were entered into the material database FEZEN:

WB 230/1,	WB 230/1 Supplement		
WB 350/3	WB 352/1	WB 352/2 Supplement	WB 352/3
WB 354/1	WB 354/2 Supplement	WB 356/3	
WB 357/1	WB 357/3	WB 357/3 Supplement	
WB 401/1	WB 418	WB 479	WB 479 Supplement
WB 496	WB 496 Supplement	WB 499	WB 399 Supplement
WB 508	WB 511/2	WB 552/3	WB 556

FEZEN – Material Information System, Version 4.13:

- In the new FEZEN-Info-System it is now possible to determine the allowable design stresses and also the allowable temperature according to AD 2000, TRD, EN 12952, EN 13480 or EN 13445 for a lifetime different to the default values.

- The safety factors for creep range can now be chosen via a switch ‚surveillance of creep exhaustion yes/no‘.

- In the diagrams of the allowable design stresses now the operational lifetime and the corresponding safety factor are documented below the graphs.
  By default the basic values, stored in the material database, are marked by a circle in the graphs.

Dimensions Standards:

- By user request the following dimensions standards were entered into the database:
  DIN 28086, 06/1994 Lifting lugs at vessels for assemly

- The dimensions database was updated according to the following new editions of standard:
  E DIN 2510-7, 08/2020: Bolt connections with extension sleeves

EN 12952: Water-Tube Boilers, Release 4.09

Maximum usage ratio:

In the survey table of the results now in addition to allowable pressure and the maximum allowable temperature also the maximum usage ratio of the component is documented.

Bended pipes:

For bended pipes PROBAD determines the wall thicknesses on the intrados and extrados side of the bending via the selected bending method and with this the resulting stress and pressure reserves.

Often the bending method is not defined in the early phase of calculation. So in the new release ‚Bending method unknown' can now be selected. In this cae only the required wall thicknesses on the intrados and extrados side of the bending are determined.
Since the actual wall thicknesses expected after bending are unknown, no stress usage and no pressure reserves can be determined.

Additions / corrections:

- Also for austenitic cast material the increased safety factors for steel cast are now taken into account.
- For calculations in creep range, the maximum allowable temperature may have been determined too low. This has now been corrected.

EN 13445: Unfired Pressure Vessels, Release 3.08

New Component: Lifting lugs at vessel shells

In the new release the calculation of ‚Lifting lugs at vessel shells' according to EN 13445-3, chapterl 16.7 is now possible.

- The lifting lugs may be placed on cylindrical, conical or spherical shells in longitudinal or circumferential direction.
- The lifting lugs may be with or without reinforcement plate.
- EN 13445-3, chapter 16.7 contains only the proof of the vessel shell.
  Thus the lifting lug and the reinforcement plate, if defined, are poved according to DIN 28086.
- Standard dimensions for the lifting lug and the reinforcement plate can be loaded according to DIN 28086.

Maximum usage ratio:

In the survey table of the results now in addition to allowable pressure and the maximum allowable temperature also the maximum usage ratio of the component is documented.

Horizontal vessels on saddles / rings
Vertical vessels on support skirts

In the new release the percentage usage ratio in the various regions of the vessel and the saddles or support skirts is documented in the results.

Additions / corrections:

- Also for austenitic cast material the increased safety factors for steel cast are now taken into account.

- Tubesheets:
  In certain cirumstances for tubesheets in a fixed tubesheet heat exchanger a too low allowable test pressure was determined. This has now been corrected.

EN 13480: Metallic industrial Piping, Release 3.01

Maximum usage ratio:

In the survey table of the results now in addition to allowable pressure and the maximum allowable temperature also the maximum usage ratio of the component is documented.

Bended pipes:

For bended pipes PROBAD determines the wall thicknesses on the intrados and extrados side of the bending via the selected bending method and with this the resulting stress and pressure reserves.

Often the bending method is not defined in the early phase of calculation. So in the new release ‚Bending method unknown' can now be selected. In this cae only the required wall thicknesses on the intrados and extrados side of the bending are determined.
Since the actual wall thicknesses expected after bending are unknown, no stress usage and no pressure reserves can be determined.

Surveillance of creep exhaustion:

In PROBAD EN 13480 up to now for calculations in creep range by default the surveillance of creep exhaustion was assumed. Thus according to EN 13480-3, Table 5.3.2-1 the creep rupture strength values were evaluated with safety factort Sfcr = 1.25.
In the new release now (conform to Rohr2) no surveillance of creep exhaustion is assumed.
So by default the creep rupture strength valus are now evaluated with safety factor Sfcr = 1.5.
In case of surveillance of creep exhaustion the corresponding switch has to be changed.

Additions / corrections:

- The menu items 'Order - rename' and 'Drawing - rename' have been added.
- Also for austenitic cast material the increased safety factors for steel cast are now taken into account.
- For calculations in creep range, the maximum allowable temperature may have been determined too low. This has now been corrected.

EN 1591: Circular Flange Connections, Release 5.05

Determination of the gasket force FGI:

To determine the gasket force FGI now the original formula (68), EN 1591-3, Edition 2009 is used again. So the factor PQRI is only regarded in the first term:
FGI = {FG0d x YG0 x **PQRI** – [FQI x YQI + (FR Ix YRI – FR0 x YR0) + DeltaUI]} /YGI
This results in a little less gasket forces in the subsequent conditions than the modified formula with factor PQRI in front of the brace.

Correction of lever arm:

Up to now the usage ratio of integral flanges, stubs or collars was determined via
EN 1591-1, formula (129): PhiF = |FG x hG + FQ x (hH – hP) + FR x hH| / WF

Especially for small flanges this formula produces unreasonable results.
In the new release the lever arms were corrected as follows:
PhiF = |FG x hG + FQ x (hH – hP **+ hQ**) + FR x (hH **+ hR**) | / WF

In the same way the counter and the denominator in formula (136) for jM were corrected.

Nominal toruqe Mt.Bnom of the bolt shank:

Up to now the nominal torque Mt.Bnom of the bolt shank was determined acoording to
EN 1591-1:2014, formula (B.9): Mt,Bnom = (0.159 x pt + 0.577 x miBt x dB2) x FB0nom/nB

In the new release Mt,Bnom is now determined via a modified formula (B.9‘):
Mt.Bnom = [0.159 x pt + miBt x dt / (2 x cos alfa)] x FB0nom/nB
This modified formula is not only valid for ISO threads, but is general.

Allowable load limit of wide flanges:

In the new release for wide integral flanges with chi = d4/d0 > 2.0 and for loose flanges with chi = d4/d6 > 2.0 a reduced allowable load limit is required again.
Instead of Phi ≤ 1,0 now again Phi ≤ Phimax according to formula (70), EN 1591-1, Edition 2011 is valid.

Soft packing O-ring gaskets:

The diameters for soft packing O-ring gaskets, documented in EN 1514-8 and also in DIN 2693, are smaller than the diameter of the corresponding O-ring undercutting.
In the new release the diameters of the O-ring gaskets are internally adapted to the groove diameters, if the deviation is less than 5%. A corresponding hint is displayed.

Input of material characteristics:

For materials not available in the material database FEZEN the characteristics must be entered explicitly for the single components of the flange connection. Now the calculation temperatures for the single loadcases are displayed on the corresponding input screens. This faciliates the input of the corresponding material characteristics.

Documentation of results:

The PDF results can now be requested including the result graphics.

Also the total documentation of a drawing as PDF or Doc file can now be requested including the result graphics.

Additions / corrections:

- Bolts with blind hole:
  Possibly the length of bolts with blind hole was determined to small. This has been corrected.

- Also for austenitic cast material the increased safety factors for steel cast are now taken into account.

- In case of unlimited leakage rate or in case of not controlled tightening method the input of a ‚Minimum load ratio of bolts PhiB0min‘ is not valid.

AD 2000: Pressure Vessels, Release 7.09

Tubesheets:

Additional types:

In addition to the types of tubesheets implemented so far

- Simply supported according to AD-B5, Table 1g)
- Subjected to supplementary marginal moment according to AD-B5, Figure 3 and 4
- Beidseitig eingeschweißt according to AD-B5, Tafel 1c)

The following types were realized:

- Welded in from one side according to AD-B5, Tafel 1h)
- Welded on from both sides according to AD-B5, Tafel 1f)
- Forged according to AD-B5, Tafel 1b)

Input of factor C:

By default the design factor C is determined internally in dependence of the type of tubesheet according to AD-B5, Table 1. A different factor C has to be entered.
The design factor C is used

- for partially perforated U-tubesheets to determine the design factor C4 (AD-B5, Figure 14).
- for heat exchangers with a floating head to determine the design factor C5 (AD-B5, Figure 16).

In this cases the design factor C is documented in addtion to factor C4 or C5 in teh results.

Elliptical exchanger tubes:

In the new release elliptical exchanger tubes may now be defined entering of the long diameter da2 additionally. (This is not part of AD-B5.)
The elliptical cross-sectional area of the tubes is taken into account proving the tensile load of the tubes. In case of buckling load, as for circular tubes, only the short diameter da is taken into account.

Unpierced areas:

If not entered the strengthened area AR for one tube is internally determined according to AD-B5, fig. 12. But in the case of partially perforated plates the portion of the border area must be cosidered additionally according to AD-B5, 6.7.1.4.
In the new release for circular fixed tubesheets without expansion bellow PROBAD determines the perforated area based on the number of tubes and the tube pitch.
If the difference 'inside diameter of shell – diameter of perforated area' > 2 x tube pitch, a hint is displayed now, that an increased strengthened area AR for the border tubes might be entered.

AD-S3/2: Horizontal vessels on saddles
AD-S3/4: Vessels on support brackets

In the new release the percentage usage ratio in the various regions of the vessel and the saddles or support brackets is documented in the results.

Additions / corrections:

- Modified safety factors:
  For calculations done with safety factors different from the default values a corresponding hint is dsplayed.

- For calculations of flange connections the corresponding result graphic is now true to scales.

DIN/EN-Piping Series, Release 4.09

Branches:

In the new release for each diameter combination of branches an individuel type of branch can now be defined. festgelegt werden. Possible types of branch:

Not reinforced:	The wall thicknesses of the corresponding straight pipes enter into the reinforcement calculation.
Main run reinforced:	The increased wall thickness e3 in the main run at the nozzle can be selected or entered explicitely.
Nozzle reinforced:	The increased wall thickness e4 of the nozzle can be selected or entered explicitely.
Reinforcement by pad:	The thickness eP and / or the width wP of the pad can be entered explicitely.
T-Fitting / Weldolet:	No reinforcement calculation is done. These components are only documented in the results in the short nozzle pattern. T-fittings may be checked in the corresponding component of the piping calculation.

After the calculation the determined dimensions and types of the branch connections may be loaded into the input screens via the button ‚Result Import' and may be modified individually.

An increased wall thickness of the main run and/or the branch can be placed to the inside, to the outside or to both sides for each diameter combination individually.

Individual selection:

On all panels for the individual selection of components it is possible now, to mark several components and to ‚Delete' or ‚Copy' them via the corresponding button.

Surveillance of creep exhaustion:

By default for piping calculations according to EN 13480 in creep range the surveillance of creep exhaustion was assumed. Thus according to EN 13480-3, Table 5.3.2-1 the creep rupture strength values were evaluated with safety factort Sfcr = 1.25.
In the new release now (conform to Rohr2) no surveillance of creep exhaustion is assumed.
So by default the creep rupture strength valus are now evaluated with safety factor Sfcr = 1.5.
In case of surveillance of creep exhaustion the corresponding switch has to be changed.

Export of results:

The results of the piping calculation can now be exported as XML-file into a freely selectable directory.
The corresponding XML-scheme and further descriptions can be found under:
https://github.com/sigmaIngUn/PipeClassTransfer.

Additions / corrections:

- Problems with renaming input files have been solved.
- Also for austenitic cast material the increased safety factors for steel cast are now taken into account.

WRC 107: Local Stresses at cylindrical and spherical Shells, Release 8.09

Additions / corrections:

- The diagrams in Fig. 1C and Fig. 2c are only valid for a very small scope.
  So the bending moments, resulting from the axial force P, are now extrapolated via the functions documented in WRC 537.

- Up to now at point C and D on cylindrical shells
  the local stresses sigma,x were overloaded by the global circumferential stress sigp,phi from internal pressure and the local stresses sigma,phi were overloaded by the global longitudinaö stress.
  Now according to WRC 107, Figure 2 in all points A,B,C,D the local stresses sigma,x are overloaded by sigp,x and the local stresses sigma,phi by sigp,phi.

- Possibly for rectangular nozzles on cylindrical shells Figure 1C - 4C were not evaluated correctly.
  This has now been corrected.

WRC 297: Local Stresses at cylindrical Shells, Release 5.09

Additions / corrections:

- Now also in WRC 927 all results of one drawing can be generated in one document via the menu ‚Documentation'.

- If the data directory is not available starting the PROBAD module, it can now be defined correctly via the menu ‚Files > modify data directory'.

TRD: Technical rules for steam boilers, Release 8.09

Additions / corrections:

If the data directory is not available starting the PROBAD module, it can now be defined correctly via the menu ‚Files > modify data directory'.