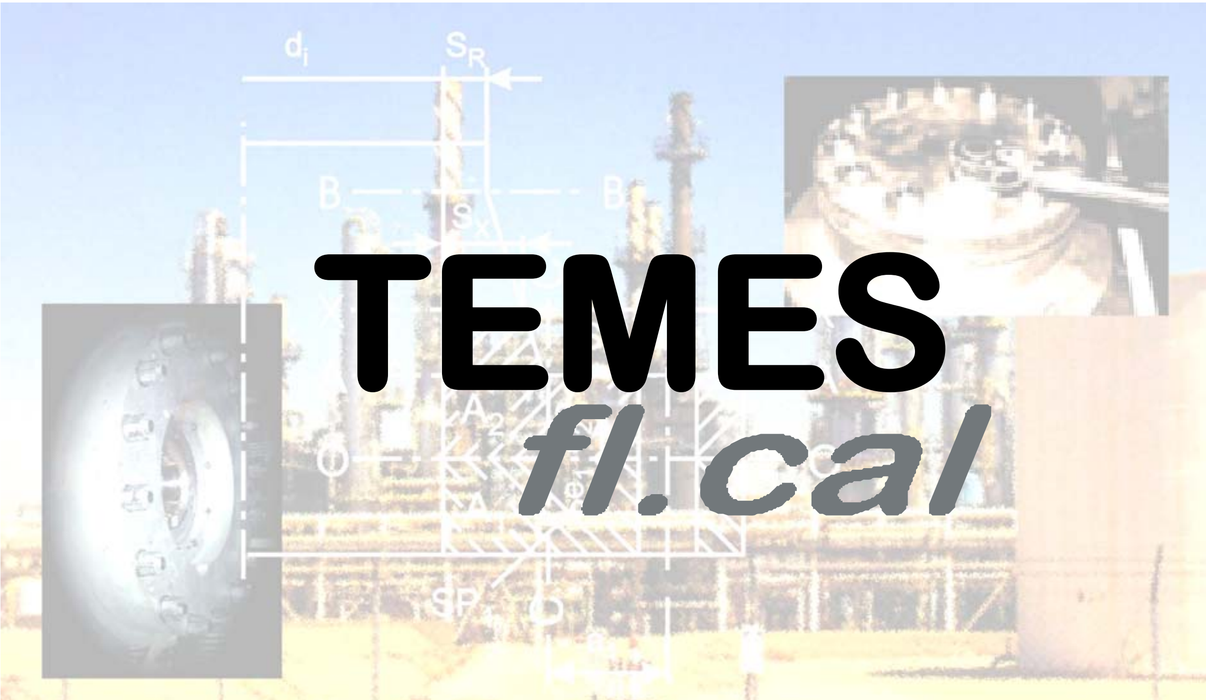
User Manual



Version 8.xx

amtec

Advanced Services GmbH
Hoher Steg 13
74348 Lauffen/N.

www.amtec.de

October 2014

1 Introduction

The software **TEMES*fl.cal*** is used for flange calculations based on the draft of KTA 3211.2 for main load gaskets and power shunt gaskets (rule change proposal draft March 2003) and EN 1591 (April 2001 Amendment A1, amended May 2007)

The ASME calculation procedure is integrated into the next stage of development in the software.

The KTA 3211.2 applies to bolts with a circular and equidistant arrangement as a force-locked connection of pressure parts. The calculation rules take into account primarily static tensile stresses. Shear and bending stresses in the bolt, for example, derived from the deformations of the flanges and caps, of thermal effects (for example, local and temporal temperature gradient, difference in thermal expansion coefficients) are not considered.

The EN 1591-1 is a European calculation-rule for the design of circular flanges and gaskets. It considers the whole system of flange, bolt and gasket under the criteria of strength and tightness.

2 Installing the software TEMES*fl.cal*

The software **TEMES*fl.cal*** is a program developed for Windows-platforms. In order to achieve good display quality and an acceptable processing speed, the following hardware requirements are essential:

- Pentium III with 500 MHz
- 128 MB RAM
- VGA Display (resolution 800 x 600)
- Windows 8, 7, XP or Windows Server 2008, 2003
- 20 MB hard disk space
- 1 free USB port for the dongle

2.1. Software protection

The software **TEMES*fl.cal*** is protected against unauthorized copying. For this purpose the software is delivered with a USB dongle called “Sentinel SuperPro key”. The software can be executed only when this dongle exists on the system on which it is installed.

The software **TEMES*fl.cal*** is therefore installed in several steps, in the following order:

1. Install the software
2. Install the software for the dongle
3. Insert the dongle
4. Setup links and shortcuts on the client computers to the software installed on the host computer (only network version)

2.2. Installing a single user version

Insert the CD into the CD-ROM drive of the PC where the software is to be installed. The installer will start automatically. If the autorun option is disabled on your PC, go to the Windows Start menu, click "Start" and subsequently "Run", enter "X:\setup.exe" in the command line (where X is the name of the CD-ROM drive of your computer) and confirm with "OK".

Follow the instructions during the installation process. After installation is complete you will receive information about whether the program was successfully installed.

Then install the software for the dongle. This must be done in all cases before inserting the USB dongle. Therefore you need to start the installation program **"Installation of Sentinel Super Pro key driver"** (or run "X:\SuperProNet Combo Installer\setup.exe" from the installation CD).

Finally, you can insert the USB dongle.

The software is now ready for use, as long as the dongle on the associated USB port is found.

2.3. Installing a network version

The **TEMES*fl.cal*** software can be installed directly on the network server or on a local computer, which serves as a file server. The following description is therefore generally referred to a server.

Insert the CD into the CD-ROM drive of an arbitrary client PC with access to the server or in the CD drive of the server. It is necessary to have write permissions on the destination drive of the server to install the software. The installer will start automatically. If the autorun option is disabled on your PC, go to the Windows Start menu, click "Start" and subsequently to "Run", enter "X:\setup.exe" in the command line (where X is the name of the CD-ROM drive your computer) and confirm with "OK". Enter the installation drive and directory on the server

Follow the instructions during the installation process. After installation is complete you will receive information about whether the program was successfully installed. The installation directory of the software must be shared on the network, so that this can be accessed by other workstations.

Then you can install the software for the dongle. This must be done in all cases before the insertion of the USB dongle itself. The software installation for the dongle must be done on the server. For this you need to start the installation programm

“Installation of Sentinel Super Pro key driver” (or run “X:\SuperProNet Combo Installer\setup.exe" from the installation CD).

Now you can install the USB dongle on the corresponding port of the server.

Finally, relevant links from the client machines need to be established with the software on the host computer. For this purpose click to the desktop with the right mouse button and select "New" and "Shortcut". With the "**Browse**" button you can select the installation directory of the software and the file "**TEMESflcal.exe**"

At first start of the software, the user must have local administrator rights because the file **"sx32w.dll"** is copied from the server to the local machine into the directory **"system32".**

The software can be now started from the individual workstations if the host computer is running and the installation directory is shared. The number of users that can run the program in parallel is limited to the number of licenses purchased.

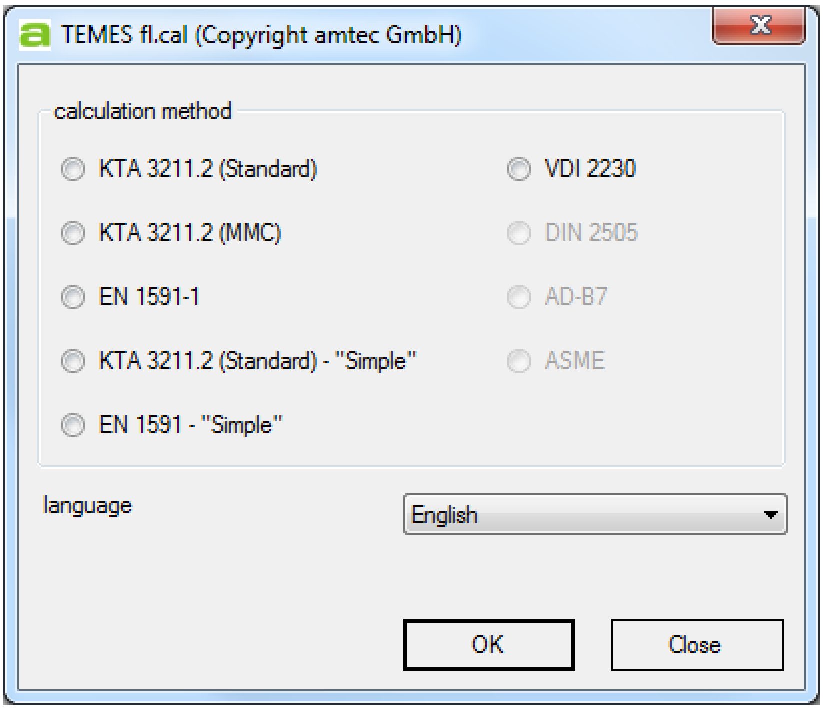
2.4. Uninstalling the software TEMES*fl.cal*

During the installation of the software **TEMES*fl.cal*** an uninstaller was created on your PC which can help you to uninstall the software. Follow the instructions shown after starting the uninstaller. For the case of a network version the links need to be deleted manually on the individual workstations.

3 Software TEMES$_{fl.cal}$

3.1 Program start

After starting the software **TEMES**$_{fl.cal}$ a menu window pops up where the calculation method and the language are selected. Click "OK" to load the corresponding calculation module and user interface in the selected language.



Choices are:

- KTA 3211.2 (KHS): Calculation of a main load seal flange connection based on KTA 3211.2 rules;
- KTA 3211.2 (KNS): Calculation of a force shunt flange connection based on KTA 3211.2 rules;
- EN 1591: Calculation of a flanged connection based on EN 1591-rules.

For display, input and output the languages German and English can be chosen.

The description of the user interface and the results in this manual is for the following calculation methods:

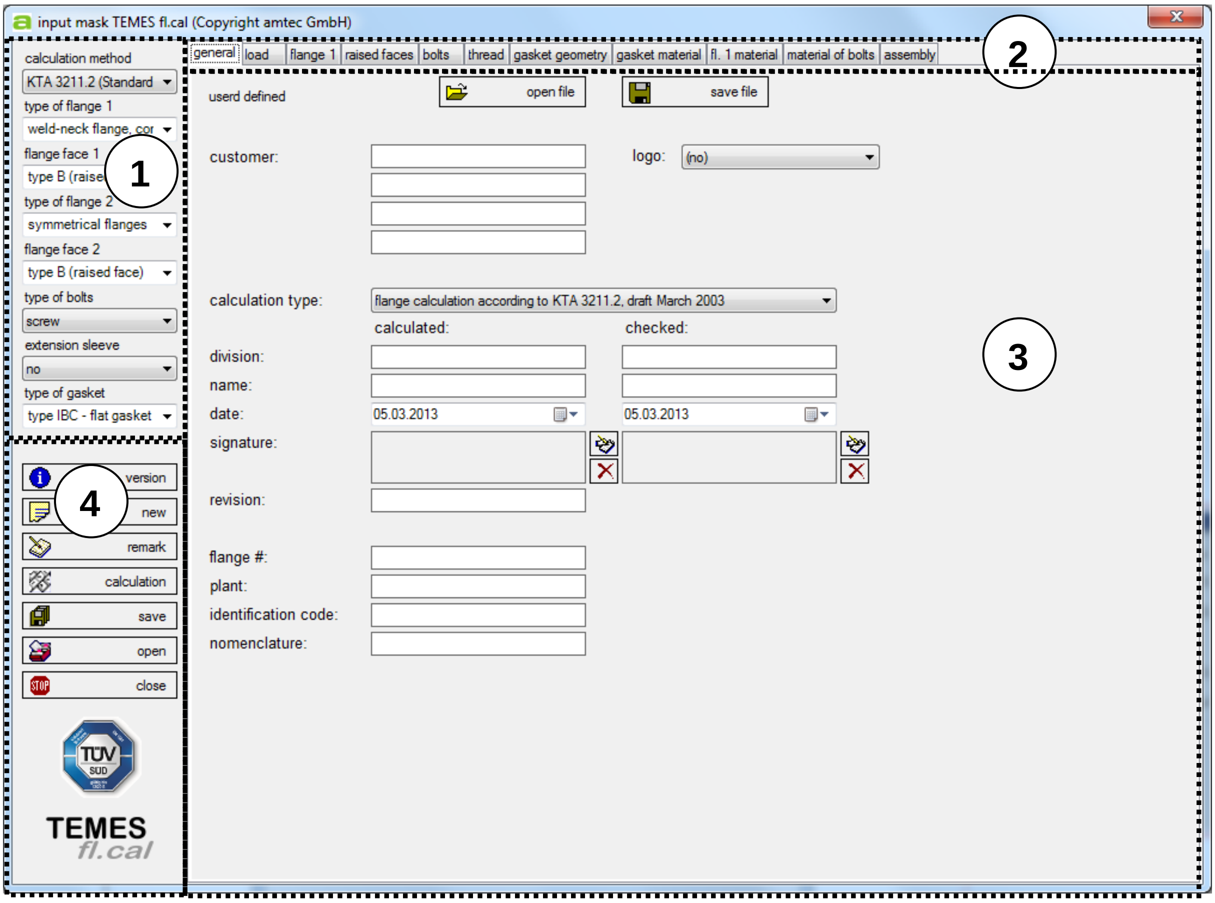
- KTA 3211.2 (KHS): in sections of 3.4 und 3.5;
- KTA 3211.2 (KNS): in sections of 3.6 und 3.7;
- EN 1591: in sections of 3.8 und 3.9.

In the following section 3.2 the main page of the TEMESfl.cal - user interface will be described.

3.2 TEMES$_{fl.cal}$ input window – general information

The user interface of the **TEMES$_{fl.cal}$** – software is arranged in four areas:

- Presets (1)
- Selection of input masks (2)
- Input fields of the selected input masks (3)
- File management (4).



In the upper part of the left panel (area 1), the geometric designs of the flanges, the bolts, the expansion sleeves and the seal of the selected method are defined:

Calculation methods: At the moment KTA 3211.2 (Standard), KTA 3211.2 (MMC) and EN 1591 are available.

The following list shows all the parameters of the implemented methods of calculation. The selections in the program parameters depend on the selected method:

- **Flange type 1:**

Loose flange conical neck	(only KTA 3211.2 (KHS), EN 1591)
Loose flange with cylindrical neck	(only KTA 3211.2 (KHS)
Loose flange cylindrical 1	(only EN 1591)
Loose flange cylindrical 2	(only EN 1591)
Hubbed threaded flange	(only EN 1591)
Weld with conical neck	(only KTA 3211.2)
Weld-neck flange, conical shell 1	(only EN 1591)
Weld-neck flange, conical shell 2	(only EN 1591)
Weld-neck flange, conical shell 3	(only EN 1591)
Slip-on-welding flange with neck	(only EN 1591)
Weld-on plate flange	(only EN 1591)
Weld-neck flange, cylindrical shell	
Flange conical shell 1	(only EN 1591)
Flange conical shell 2	(only EN 1591)
Flange- spherical shell 1	(only EN 1591)
Flange- spherical shell 2	(only EN 1591)

- **Flange face 1:**
  - type A (flat face)
  - type B (raised face)
  - type C (tongue)
  - type D (groove)
  - type E (spigot)
  - type F (recess)
  - type G (O-ring spigot)
  - type H (O- ring groove)
  - type I (RTJ-groove)
  - type J (chamfer)

- flange type 2:

Same like flange type 1
additional:
symmetrical flange
blank flange (only KTA 3211.2)
blank flange 1 (only EN 1591)
blank flange 2 (only EN 1591)

- **Flange face 2:**

Like flange 1: flange face 2

- **Type of bolts:**

screw
anti fatigue bolt
stud bolt
stud metal end (only KTA 3211.2)

- **Extension sleeve:**

yes
no

- **Type of gasket:**

Flat gasket (Form FF)
Type IBC- flat gasket
Non-metallic flat gasket (Form TG)
Non-metallic flat gasket (Form SR)
Rubber gasket with inserts
Sheet gasket with inner eyelet
Spiral wound gasket
Sheet gasket with PTFE- envelop
Metallic gasket with flat or corrugated profile (type SC)
Metallic gasket with flat or corrugated profile (type CR)
RTJ- gasket (oval type)
RTJ- gasket (octogonal type)
Kammprofile gasket
Metal jacketed gasket with layers

In the header of the user interface (area 2) the tabs representing various input masks are displayed. Tabs that are not required according to the preselections made in area 1 are not displayed. If you miss a tab, please check preselections.

In the central region (region 3) of the user interface are the specific Input fields. These tabs include drawings which illustrating the required data.

In all input masks there is the possibility to save the input data by clicking the button "save record“ and selecting a drive, a folder and a file name. The stored data can be read via the button “open data“ after selecting a drive, a folder and a file name.

Some of these input tabs are always available, while others are only displayed if the corresponding preset value is selected. The tabs, which are always present, include:

- **general:** In this tab can be entered general information for the flange calculation;
- **load:** In this tab the temperature and pressure loads can be defined which will be included in the calculation. Similarly, external loads can be defined;
- **flange 1:** Depending on the type of flange appear different tabs to define the flange geometry;
- **raised faces:** Here the geometric dimension of the raised faces of the flanges cam be entered;
- **bolts:** Depending on the type of bolt different screens for defining the geometry of the bolt will appear;
- **thread:** Tab for entering the thread dimensions;
- **gasket geometry:** Entering the gasket dimensions;
- **material of gasket:** Tab for entering the required gasket characteristics;
- **flange 1 material:** Entering the strength characteristics of the material for flange 1;
- **material of bolts:** Entering the strength characteristics of the material for the bolts;
- **assembly:** Defining the assembly parameters.

Furthermore, additional tabs can be displayed, which shall also be completed:

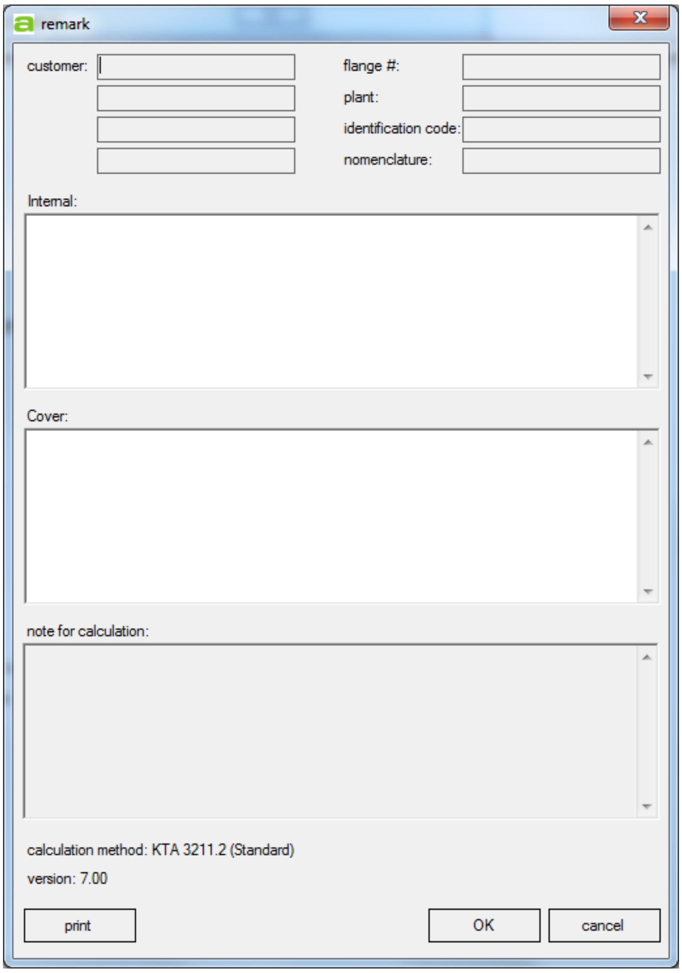
- **Flange 2:** If the geometries of the two flanges differ, these can be entered separately.

- **Flange 2 material:** If the materials of the two flanges differ, these can be entered separately.
- **Loose flange 1 material:** is for flange 1 the type “loose flange” selected and the material of the loose flange differs from stub/flare, these can be entered separately.
- **Loose flange 2 material:** is for flange 2 the type “loose flange” selected and the material of the loose flange differs from stub/flare, these can be entered separately.
- **Shell 1 material:** Entering the strength characteristics of the material for shell 1 (only EN 1591).
- **Shell 2 material:** Entering the strength characteristics of the material for shell 2 (only EN 1591).
- **Extension sleeve geometry:** In these selection must be entered the geometry of the expansion sleeves.
- **Extension sleeve material:** In these selection must be entered the material of the expansion sleeves.

In the lower left region of the window (area 4) several buttons are arranged to give access to the following functions:

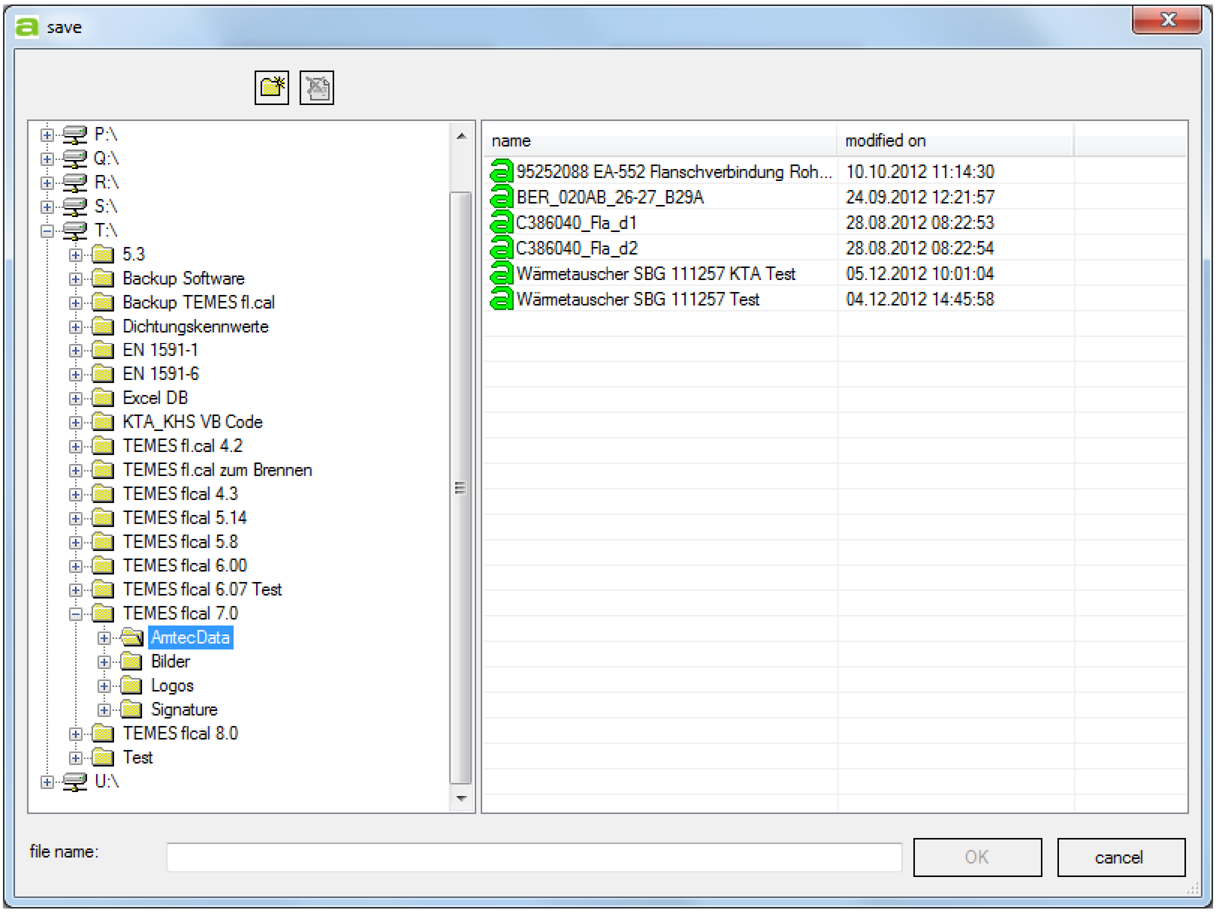
- **version:** contains information about the installed versions of each **TEMES*fl.cal*** - component ,

- **new:** a new, empty file is created,
- **remark:** a remark window opens to document important information about the present calculation,

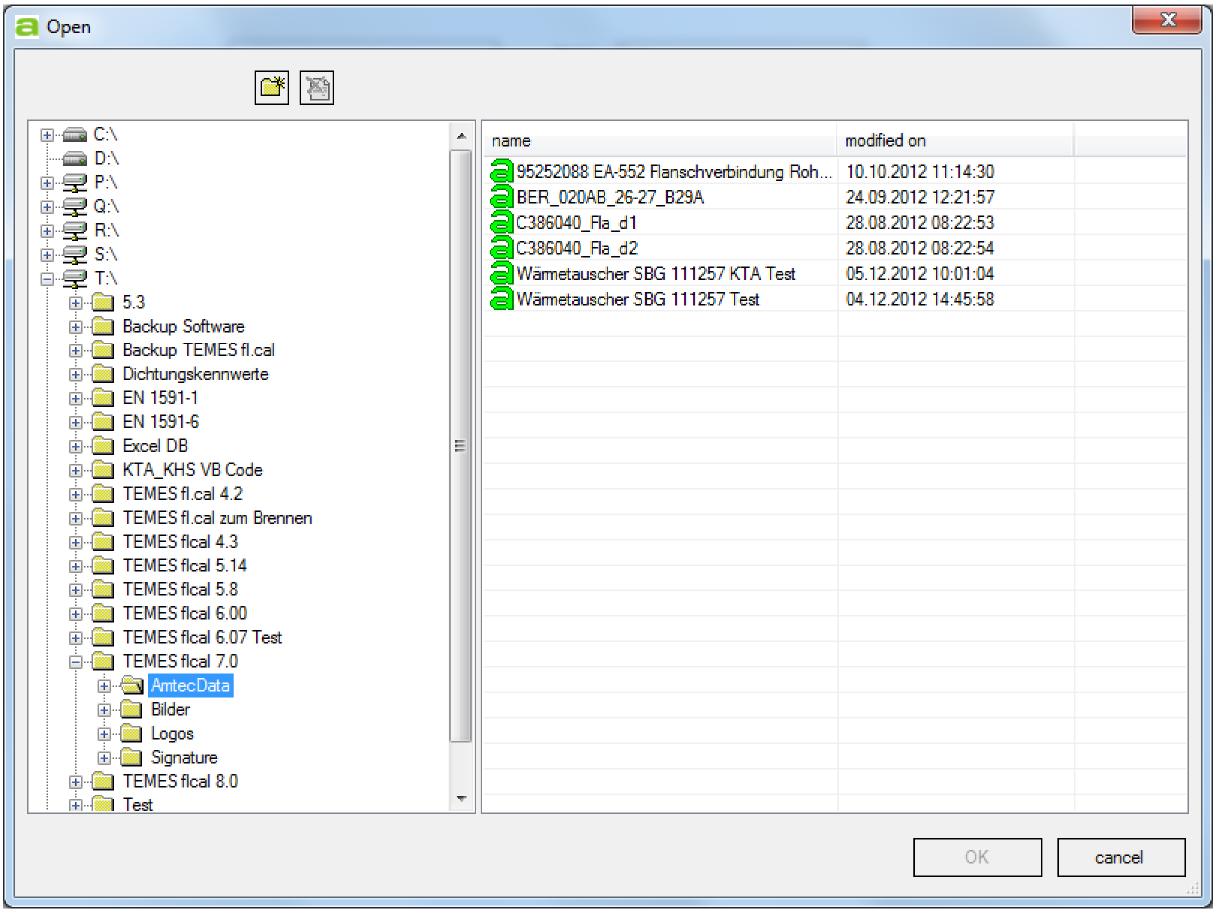


- **calculation:** the calculation can be started as soon as you have entered all information,

- **Save file:** save file before a calculation starts,



- **Open file:** open an existing file,



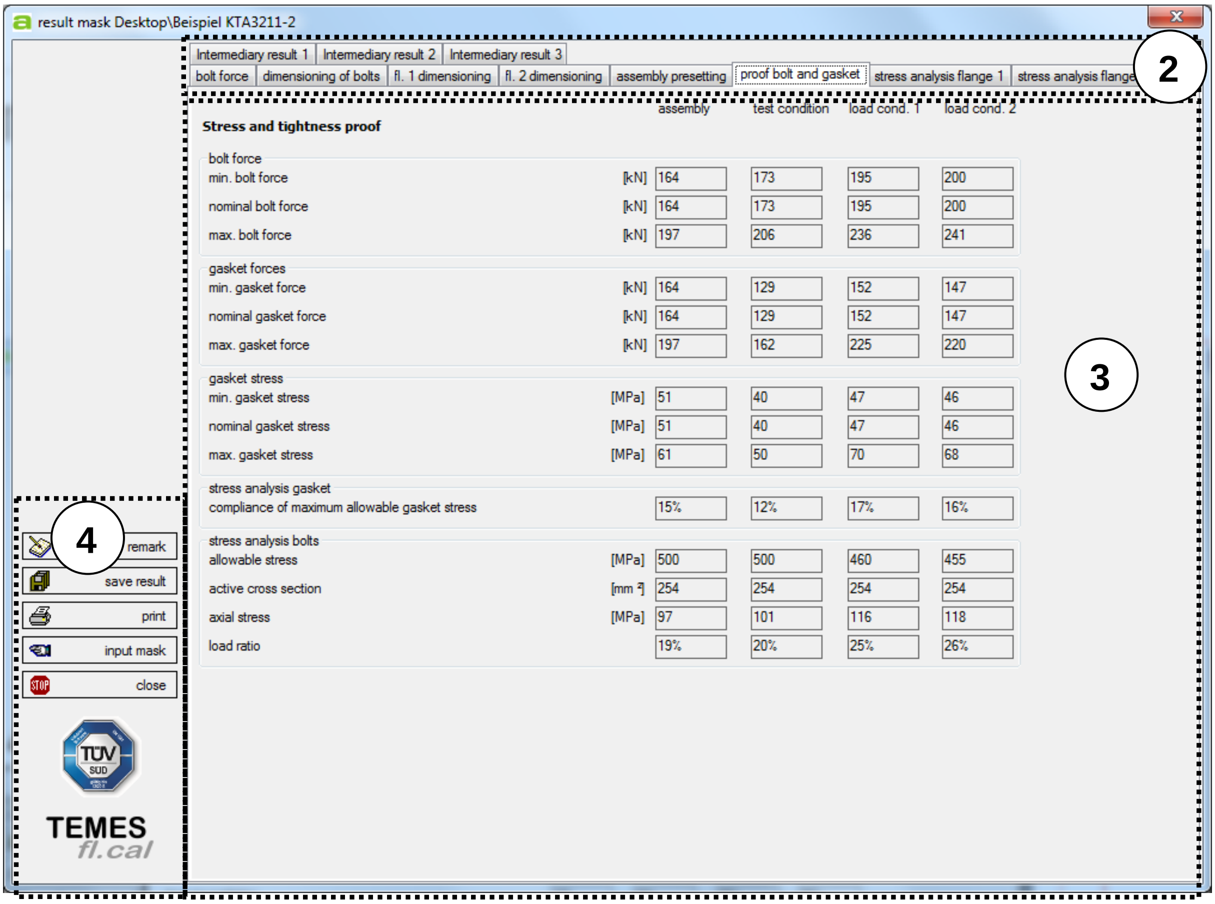
- **Close:** closes the program.

The following section 3.3 describes the main page of the **TEMES*fl.cal*** - presentation of results.

3.3 TEMES$_{\text{fl.cal}}$ – Results - General information

With the button “calculation“ in the input mask you can start the calculation. If all input data is available, the calculation is performed and the program in the KTA 3211.2 calculation modules jumps to the output mask "strength and tightness proof" or in EN 1591 calculation module to the output tab "assembly value".

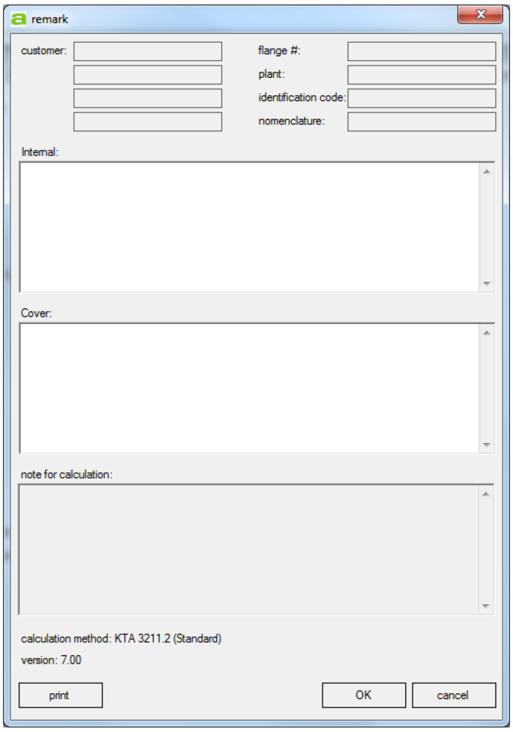
The structure of the results masks is similar to the structure of the input masks (as an example, the output mask "proof bolt and gasket" of KTA 3211.2 (KHS) calculation module).



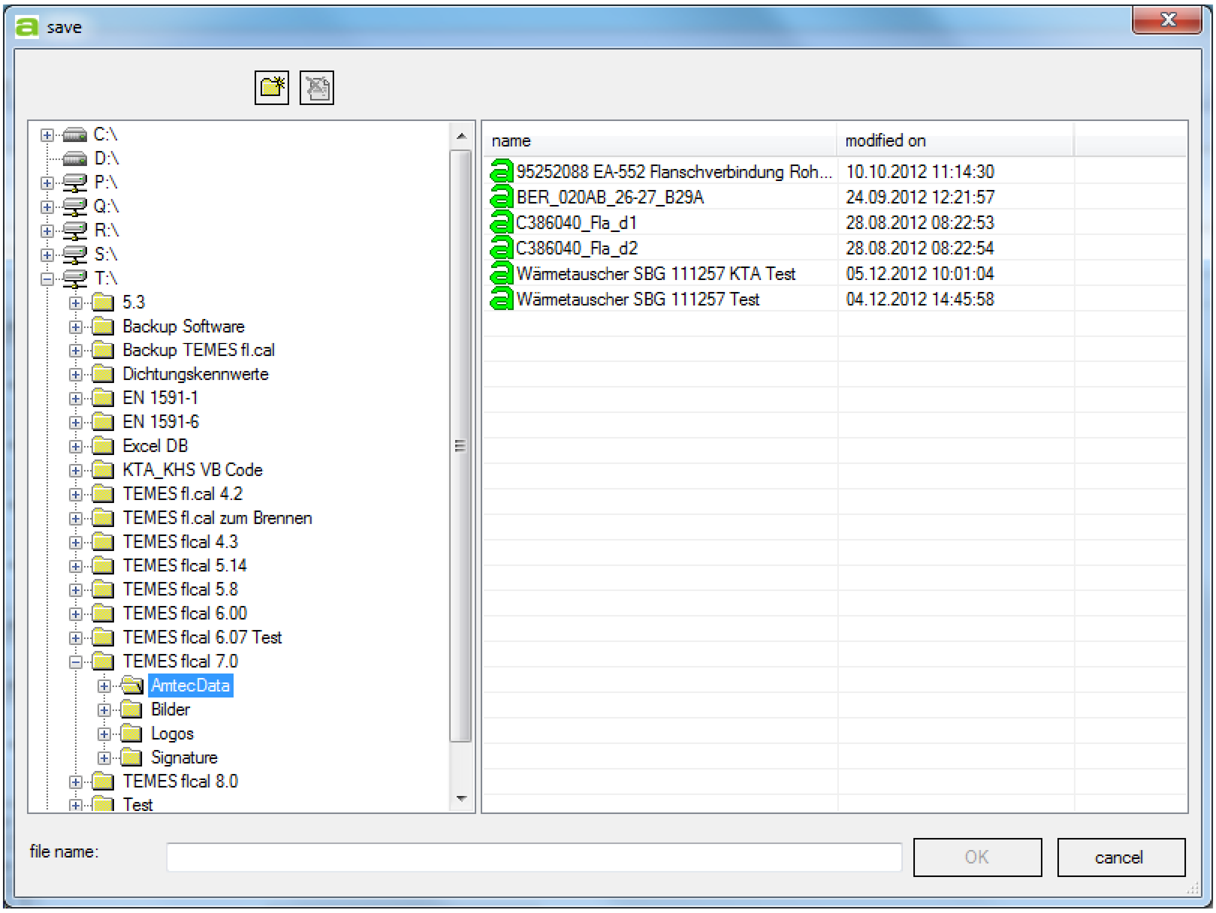
The header of the result mask (area 2) appears in dependence of the choices made for preset data (area 1 of the input window). For each tab a different set of data will be displayed in the results section (area 3). A detailed description of the different result tabs is given in the results sections for the different program modules below.

On the left side (area 4), the arranged buttons have the following functions:

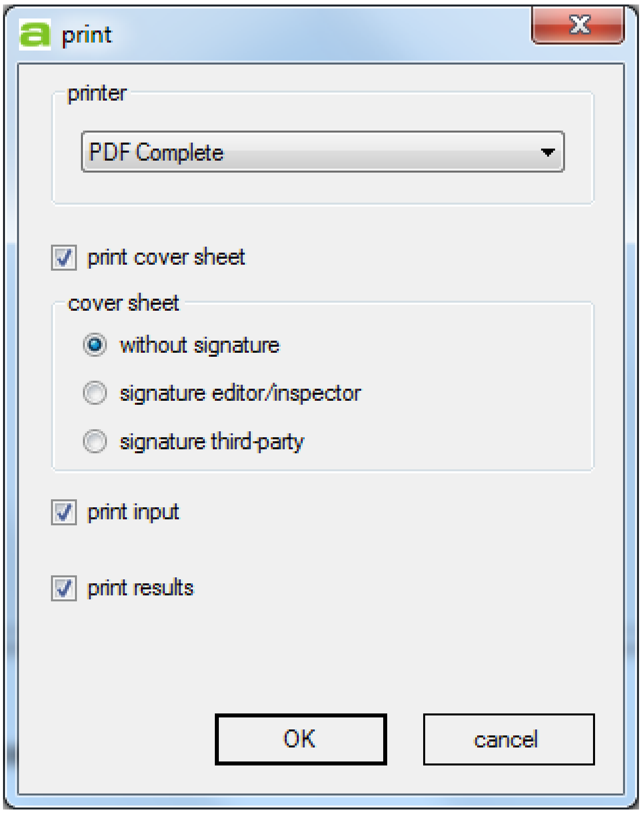
- **remark:** enter additional information about the current calculation (it is also possible to print this information),



- **save result:** Saves the entire file, including the input values, calculation results and the selected assembly requirements,



- **print:** With this button, the calculation data is sent to the configured default printer or another printer installed. The scope (input, result) can be selected. If a PDF writer is installed on the PC, the calculation can be saved as a pdf-file.



- **input mask:** back to the input mask to modify input values or to change the calculation method,

- **Close:** Button, to close the software **TEMES*fl.cal*** or to change the calculation method.

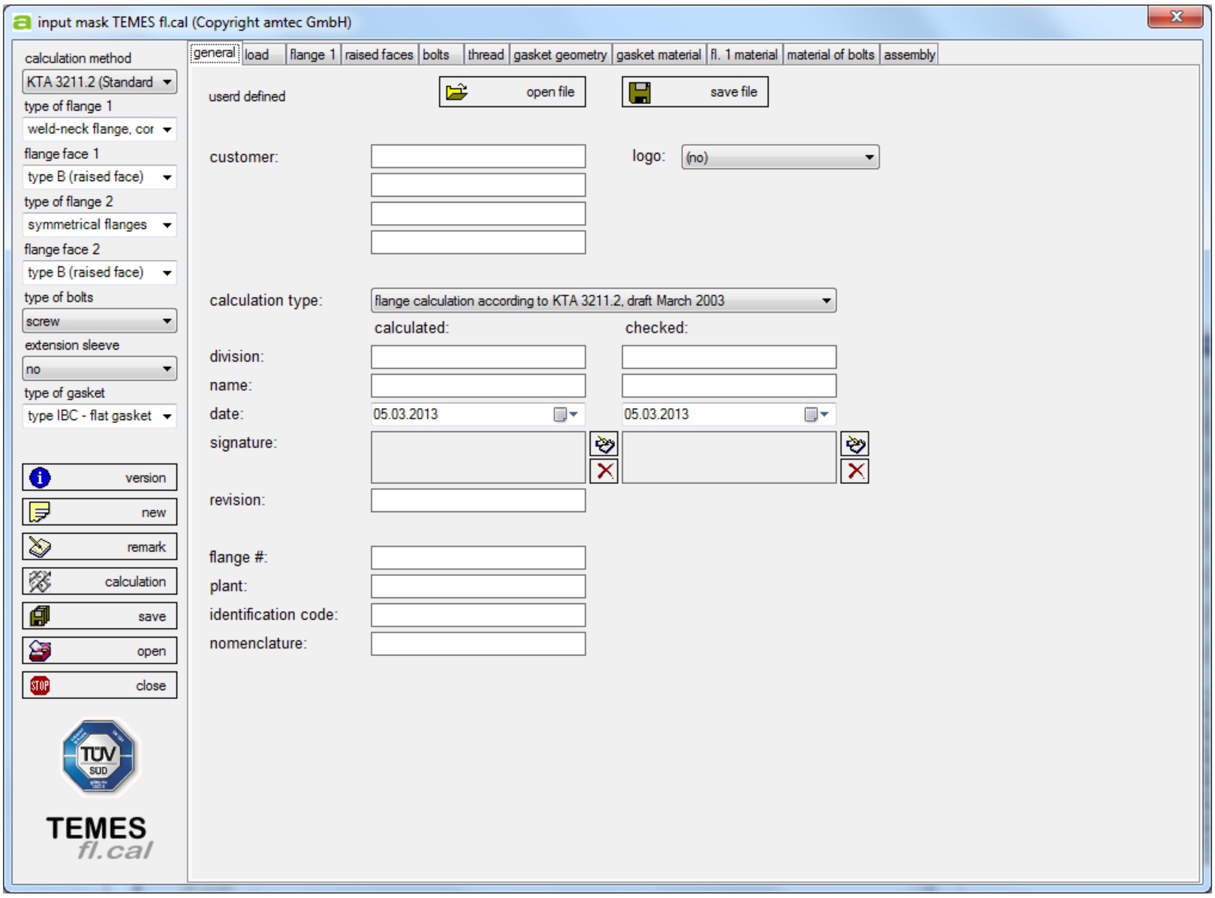
In the following chapters the different input masks will be described in detail in the context of the chosen calculation method.

3.4 Program module KTA 3211.2 (KHS) – user interface

This chapter describes the input masks of the program module KTA 3211.2 (KHS) in detail.

3.4.1 Mask "general"

In the mask „general" you can enter information about the calculation which are seen on the printout.



There are four panels for entering customer data, the name of the editor and the auditor can be entered as well as the revision of the calculation. For a unique assignment of the calculation to a flanged connection, a plant identifier, identification code and a nomenclature (description) of the flange can be entered as alpha numeric data.

The logo of the customer you are making the calculation for must be in *.wmf-format added in the installation folder of your **TEMES*fl.cal*** installation (e.g. D:\TEMES flcal 7.xx\logo.wmf).
For optimal viewing and logo quality, we recommend an aspect ratio of 1:3.
This logo is then automatically added to the calculation printout.

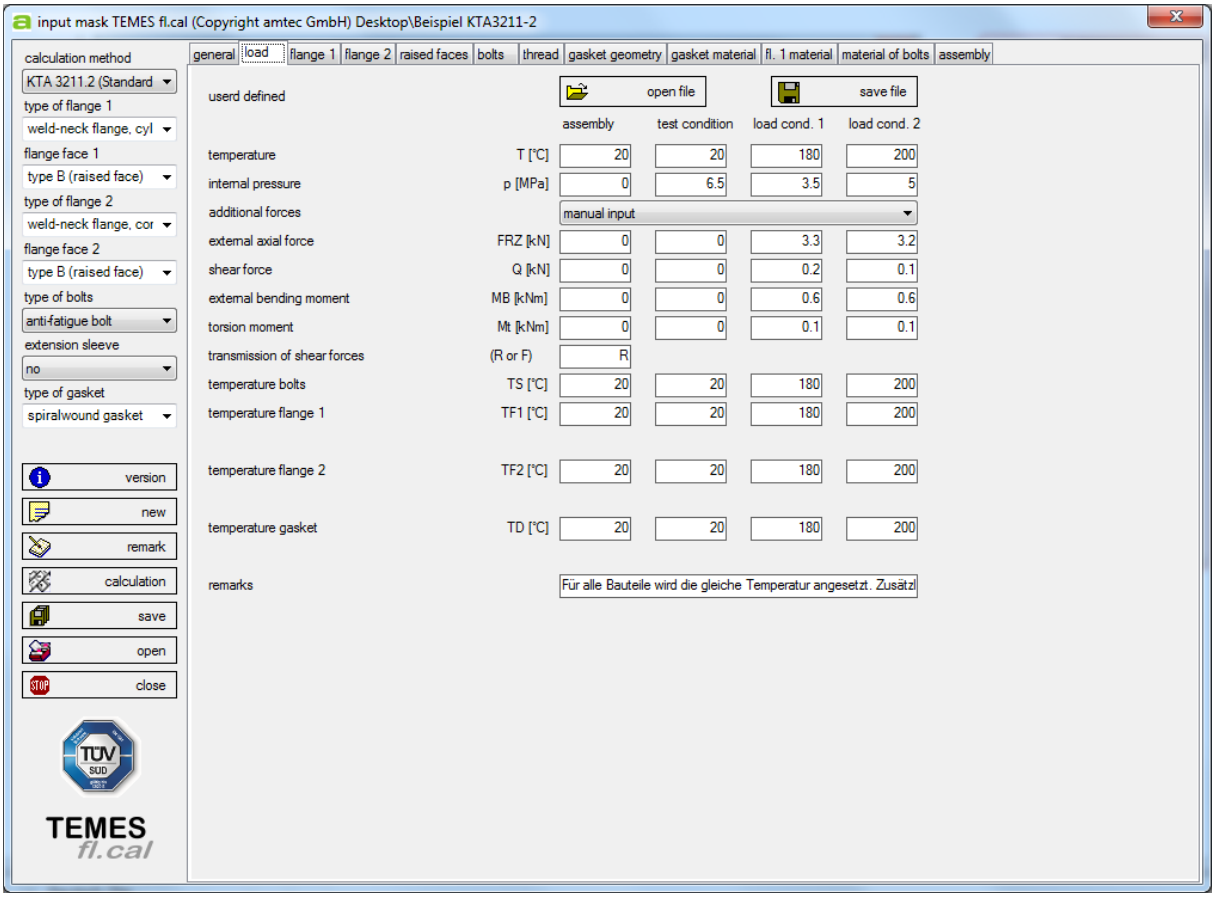
These inputs can be stored with the button "save file" and are available for further calculations.
With the button "open file" you can fill in all input fields on this mask with predefined values.

3.4.2 Mask “load “

In the mask "load" four load cases can be specified:

- assembly (assembly conditions, unpressurized, bolting torque)
- test condition (leak test)
- Operation 1 (eg normal operation)
- Operation 2 (eg operation with design conditions)

For each of the four load cases the loads temperature, internal pressure, external axial force, shear force, external bending moment and torsional moment can be defined. In the "transmission of shear forces" is specified whether these are transmitted via interlocking or by friction.



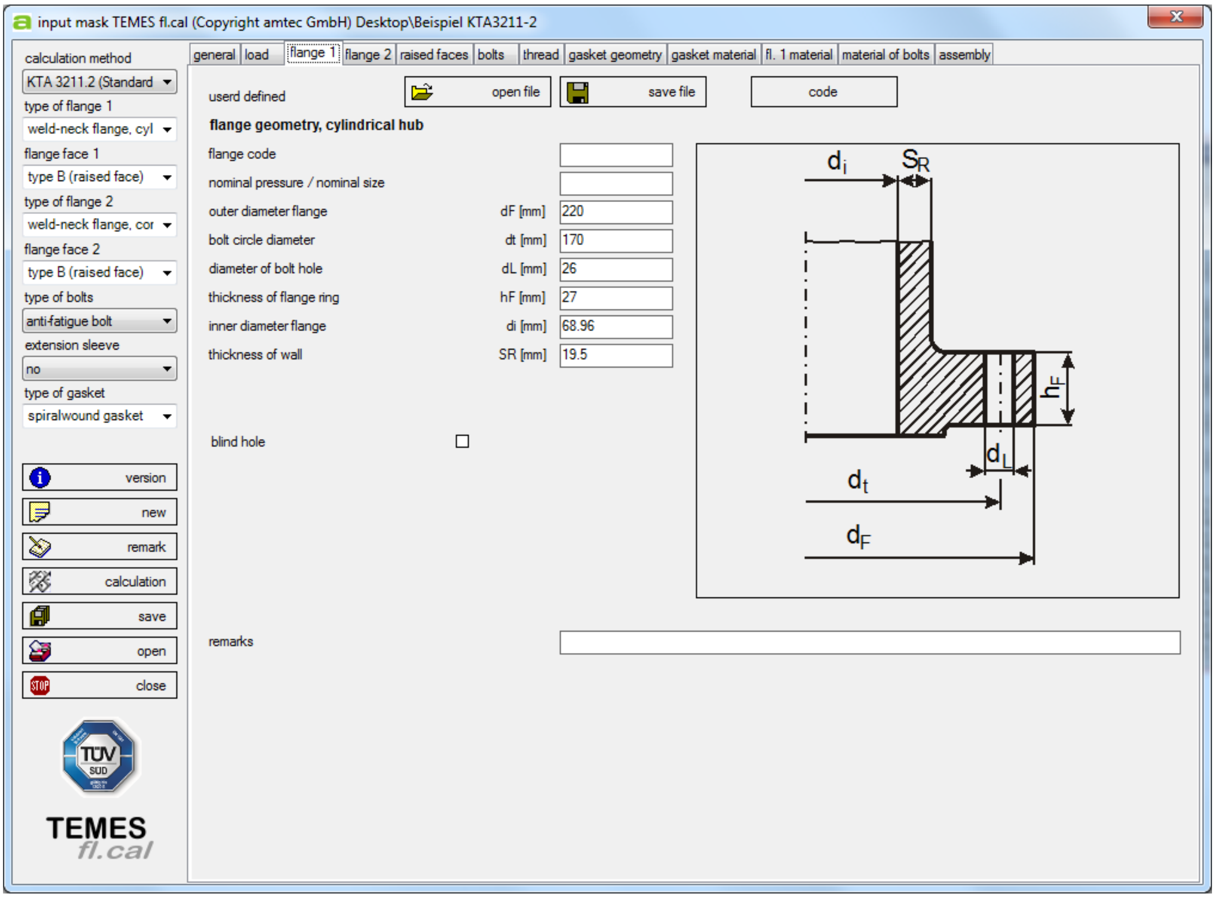
In accordance with the entries in the "temperature" input field, the temperature of each load case is applied to all components of the connection. It is also possible to assign individual component temperatures in the input fields below but if you enter a value in the “temperature” input field at the top of the mask, all individual component temperatures for this load case are replaced with the global value.

Also affected by changes in temperature input are the strength values of the flanges and bolts, unless they are read from the database.

These inputs can be stored with the Button "save file" and are available for further calculations.
The reading of data is done via the button "open file" in this mask.

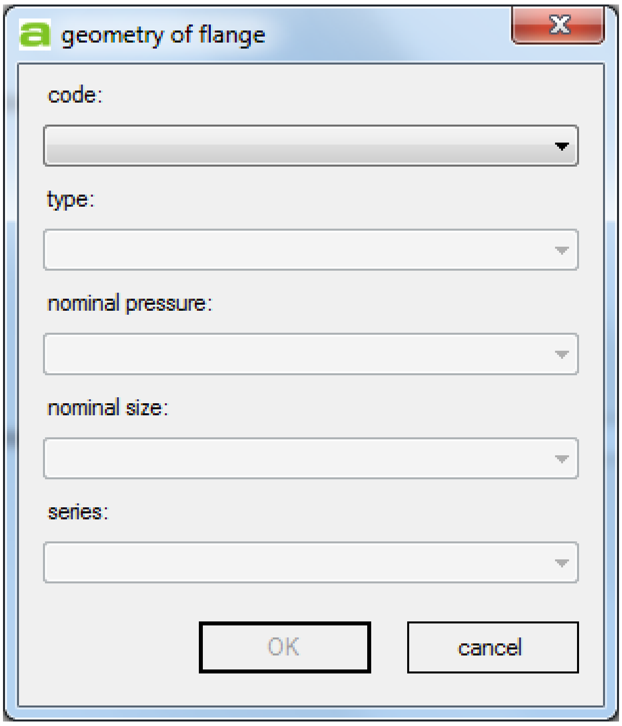
3.4.3 Mask "flange 1"

Depending on the selected flange geometry different input masks are available.



To illustrate the required input variables, a drawing of the part is displayed in the right area, showing the nomenclature of the geometry sizes.

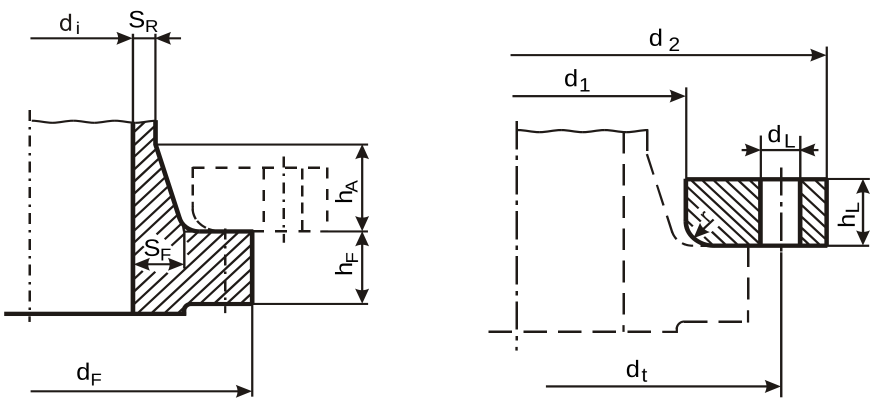
The numerical values can either be entered manually in the fields, or – if the dimensions are defined in a standard – they can be read from a database. For this purpose you find the button "code".



The following different geometrical shapes can be defined for flange 1:

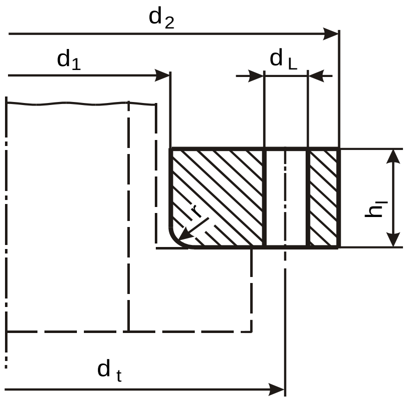
- loose flange, conical hub

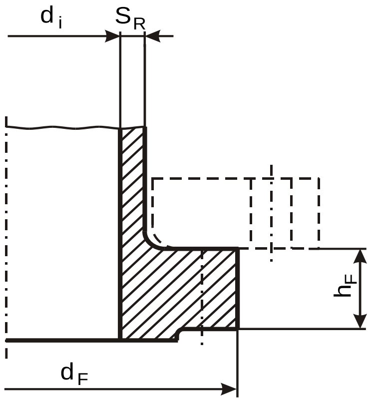
-



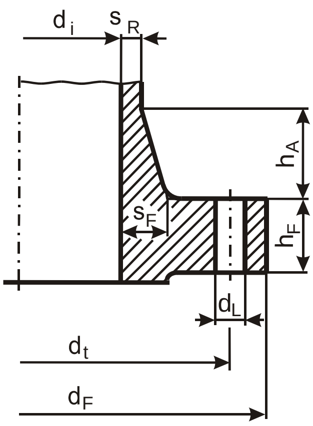
-

- loose flange, cylindrical hub

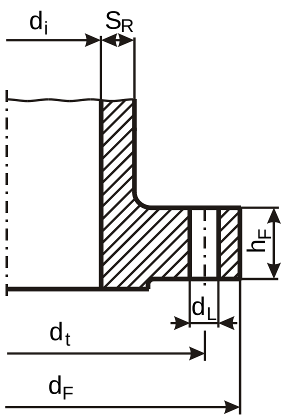




- weld-neck flange, conical shell



- weld-neck flange, cylindrical shell



A blind flange can be modelled only as flange 2.

Container flanges are not explicitly listed in KTA 3211.2, therefore it must be adapted to the model as good as possible.

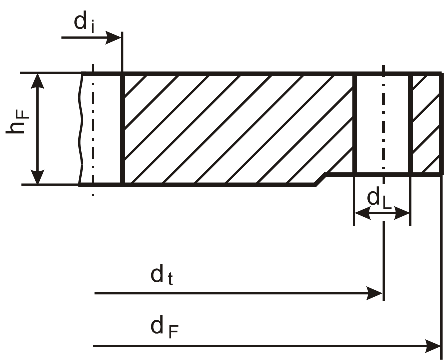
A “blind hole” for welding neck flanges can be modelled on the mask of "flange 1". For this purpose "blind hole" must be selected. With that selection additional input fields will appear.

These inputs can stored with the Button "save file" and are available for further calculations.
The reading of data is done via the button "open file" in this mask.

3.4.4 Mask “flange 2“

Essentially the input masks for flange 1 and 2 are identical and the input options are the same. Following differences should be noted:

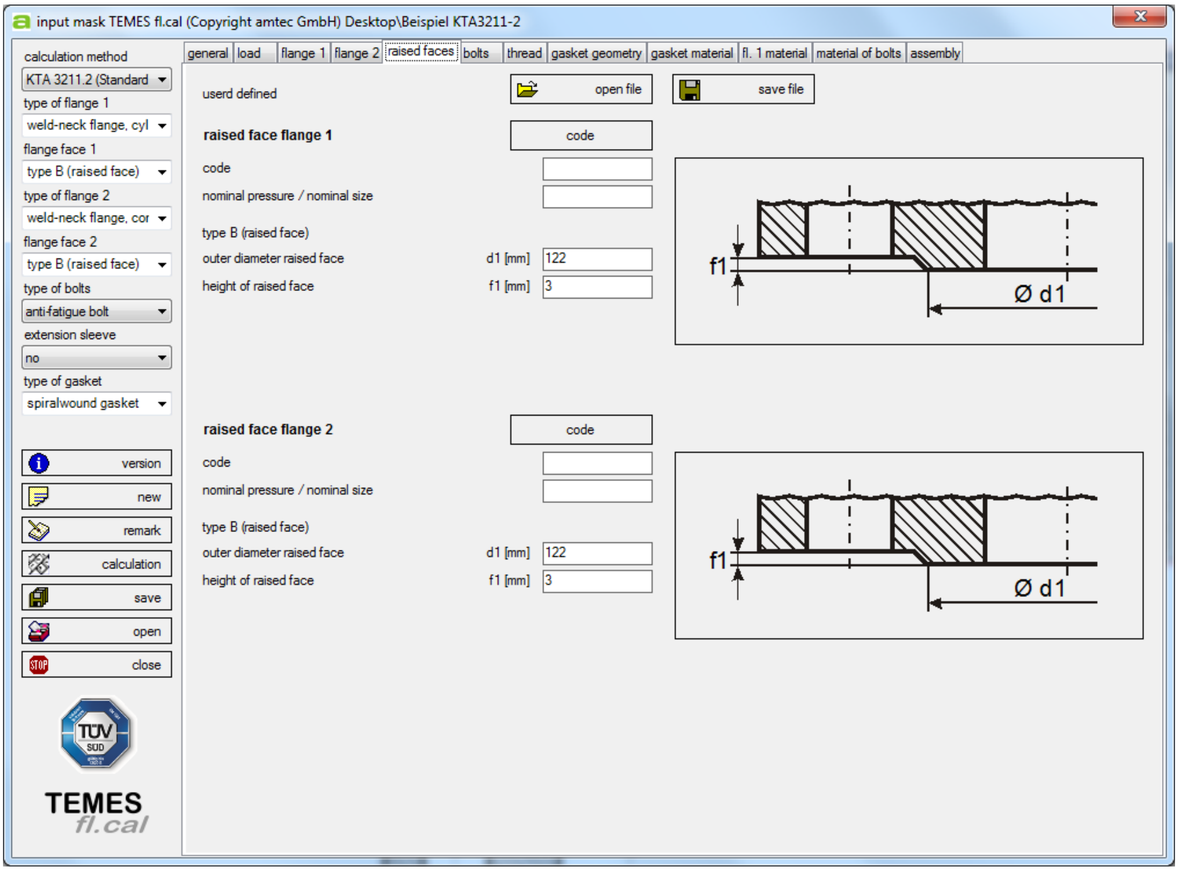
- With the preselection "symmetrical flanges" you don’t need to enter the flange geometry data for flange 2;
- A blind hole can be modelled only in flange 1;
- A blind flange must be modelled as flange 2.



3.4.5 Mask "raised faces"

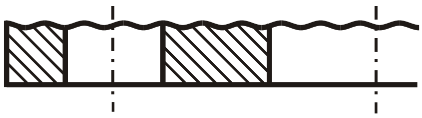
To accurately calculate the clamping length of the bolts and the effective pressed gasket geometry you can define the geometry of the „raised faces" for both flanges in the mask „raised faces" (if the selection has been made in the preset area before).

To illustrate the required input variables, a drawing of the selected raised faces is shown with the required dimensions in the right area.

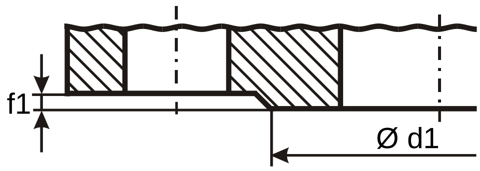


The following raised faces geometries are available:

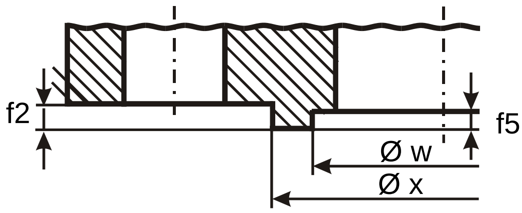
- type A (flat face)



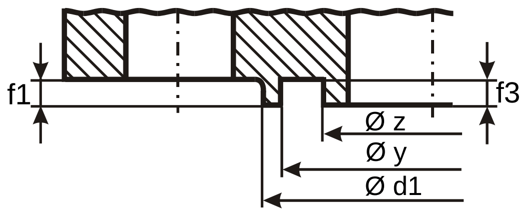
- type B (raised face)



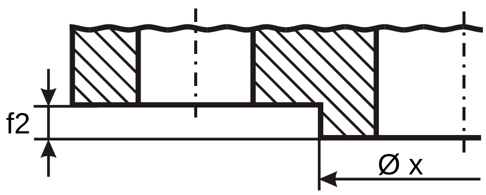
- type C (tongue)



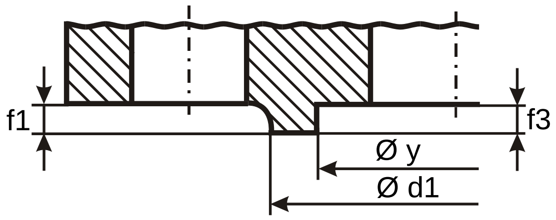
- type D (groove)



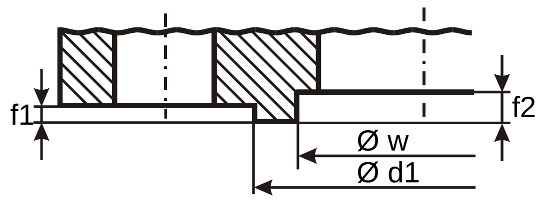
- type E (spigot)



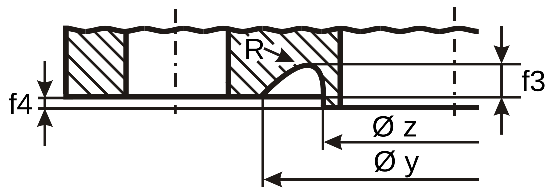
- type F (recess)



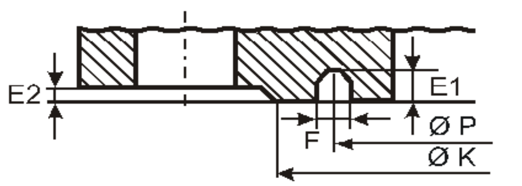
- type G (O-Ring spigot)



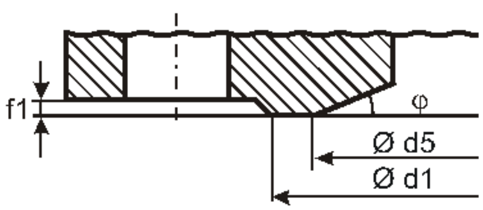
- type H (O-Ring groove)



- type I (RTJ- groove)



-
- type J (chamfer)



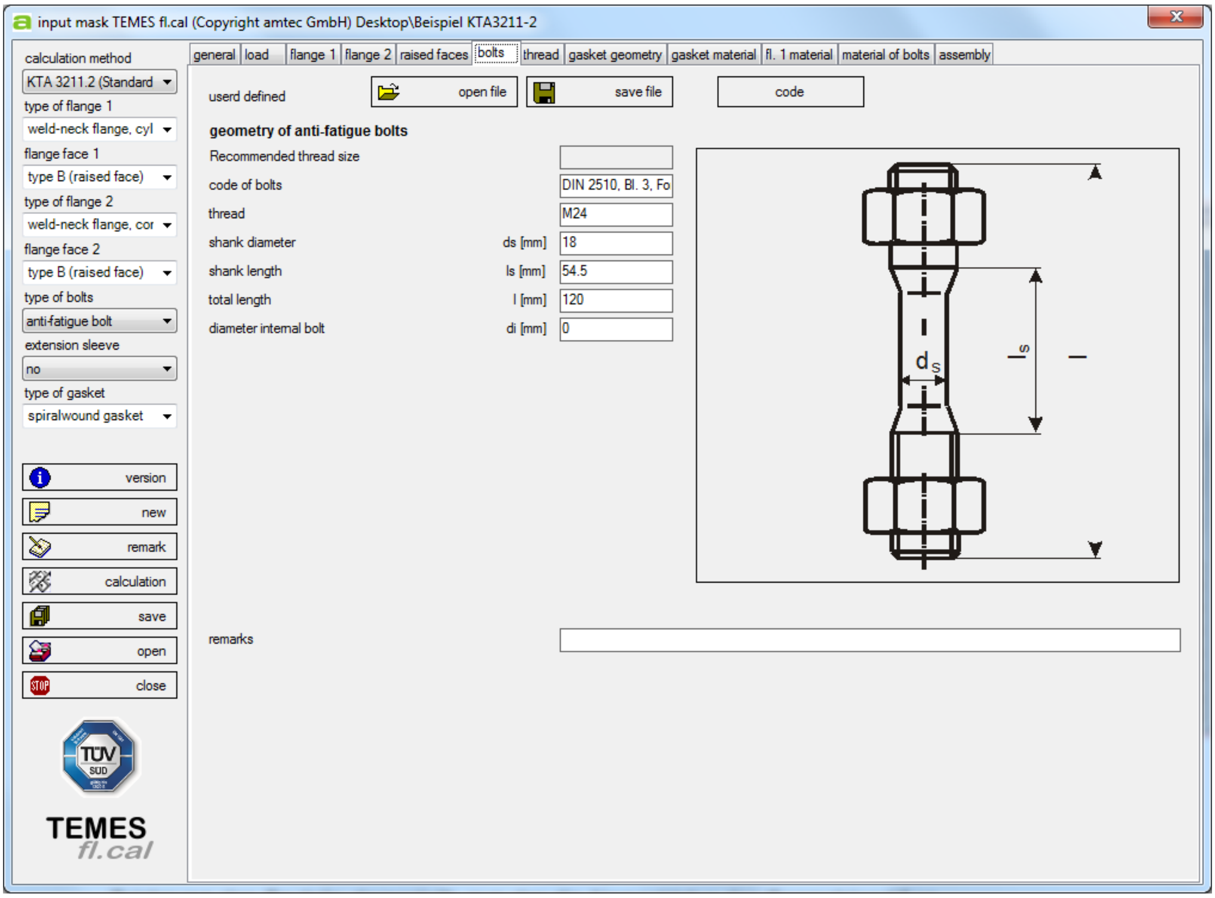
After you have selected "symmetrical flange" in the dialog box "flange 2" and chosen a raised face for this flange, the opposite side is automatically set to the raised face that fits to flange 1. If this is not desired, an individual input must be done for "flange 2".

Also, the gasket surfaces can be stored with the button "save record" and are available for further calculations again. The reading of this data is done via the button "open data" on the same mask.

On a blind flange it is important to ensure the correct entering of the raised face, because the flange thickness of the central portion of the flange must be considered. An additional input of a raised face (Form B) would mean in this case a too large clamping length of the bolt. It is therefore recommended to select the raised face “type A”.

3.4.6 Mask “bolts“

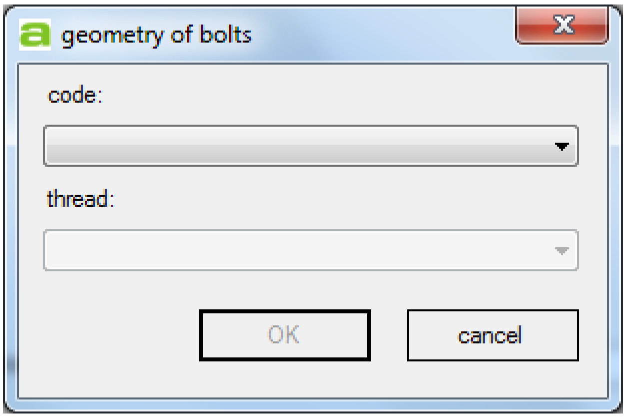
Depending on the selected type of bolt various input masks are available:



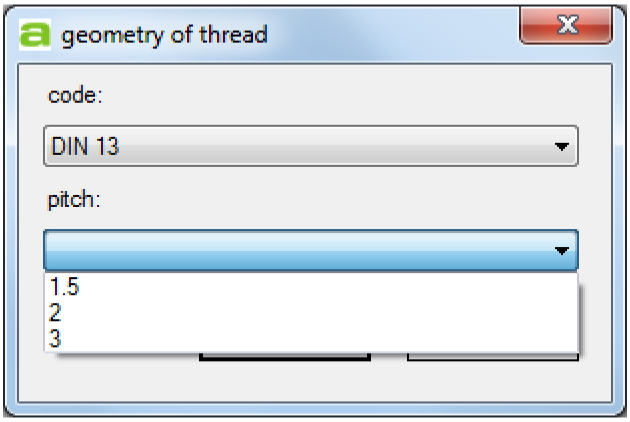
To illustrate the required input variables, a drawing of the part is shown in the right area, showing the nomenclature of the geometry sizes.

At the top line of the input mask, the recommended thread is displayed, which is defined by the flange geometry previously defined.

The numerical values can either be entered manually in the fields or – if the dimensions are defined in a standard – they can be read from a database. For this purpose the button "code" is available.



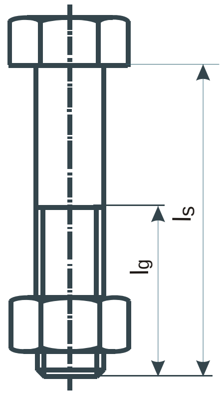
After determining the bolt, the program automatically moves to the input mask "thread geometry" to select the standard thread (and after the choice of the standard thread back to the screen "geometry screws").



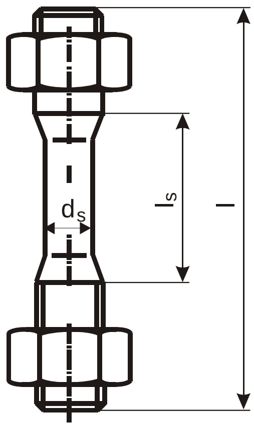
When the bolt geometry is entered manually into the fields, the thread geometry is defined directly in the mask.

For the bolts different forms are available:

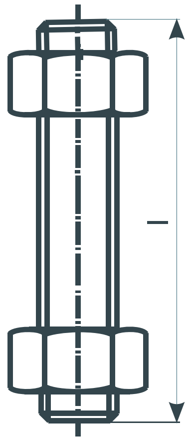
- screw



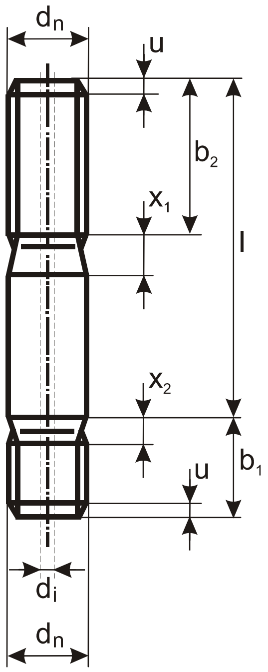
- anti fatigue bolt



- stud bolt



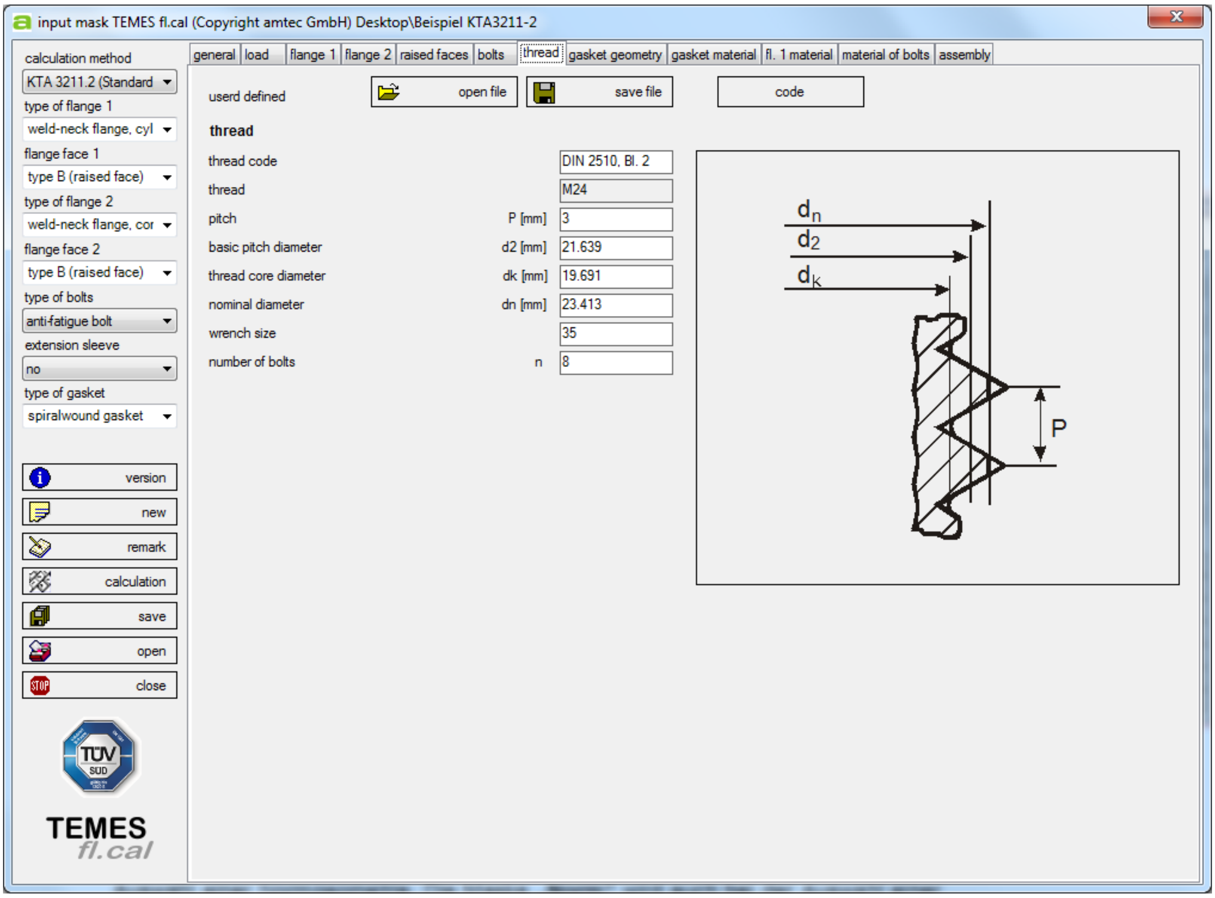
- stud metal end



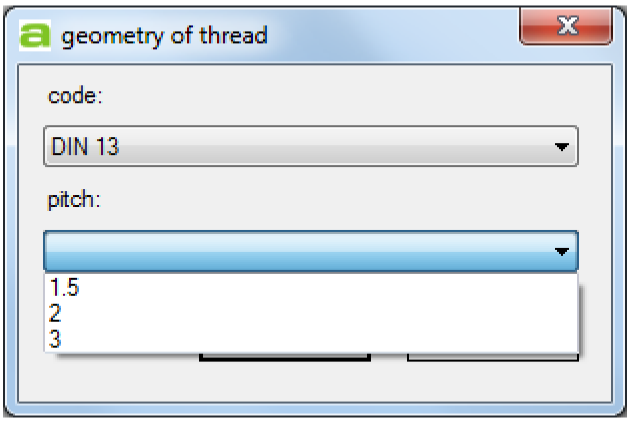
The input variables in the input mask "bolts" can be stored with the button „save record“ and are available for further calculations again. The reading of data is done via the button "open data" on the screen

3.4.7 Mask "thread"

For the geometry data of the thread a separate input mask is available.



Here you have the option of manually entering the thread geometry or the selection of a standard geometry.



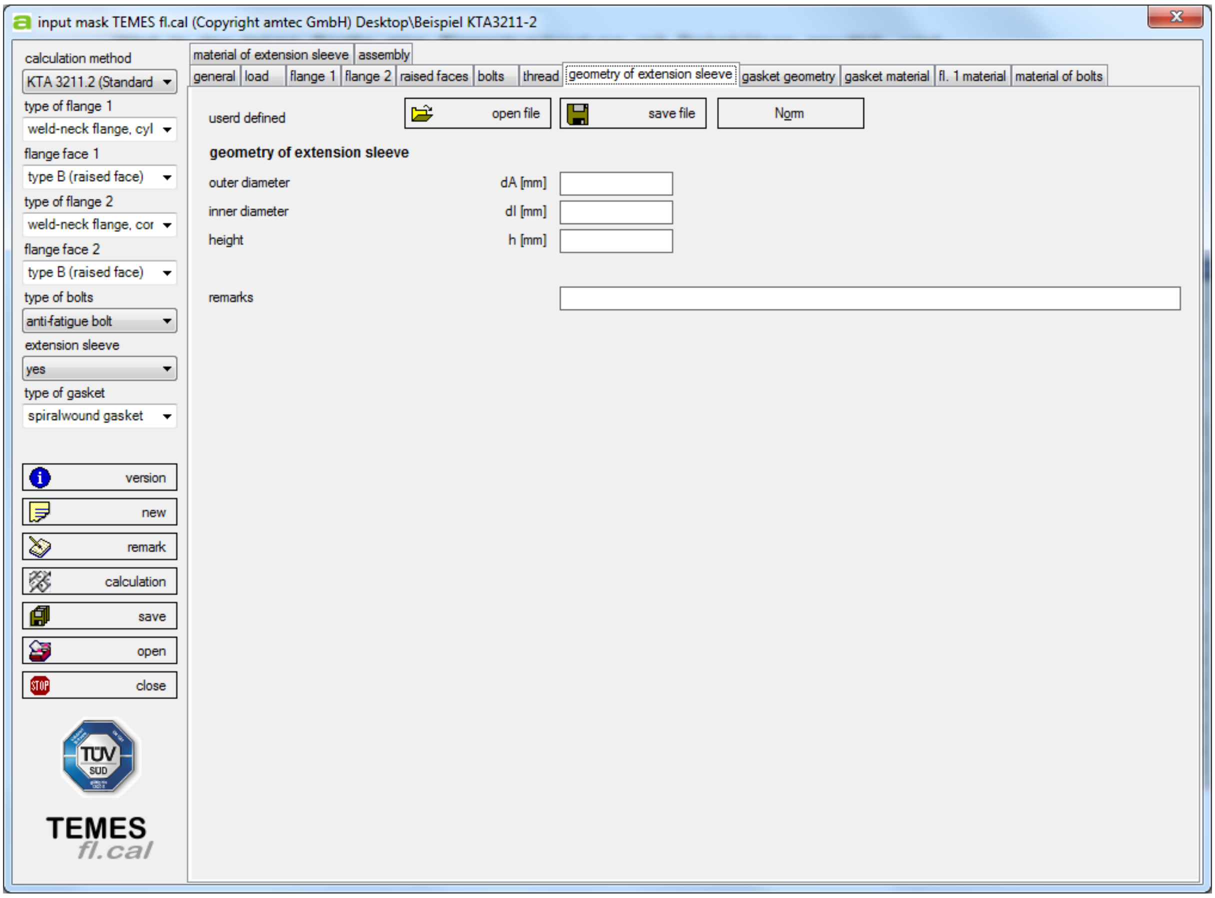
In this mask "thread" the number of bolts of the bolted flanged joint is defined.

These inputs can be stored with the button "save file" and are available for further calculations.
The reading of data is done via the button "open file" in this mask.

3.4.8 Mask “extension sleeve“

If you selected a flange with extension sleeves on the left side, a separate input mask appears. In this mask the outside diameter, the inner diameter and the height of the extension sleeves need to be entered.

The extension sleeves are used to calculate the correct clamping length of the bolts and spring as an additional element in the flanged joint.

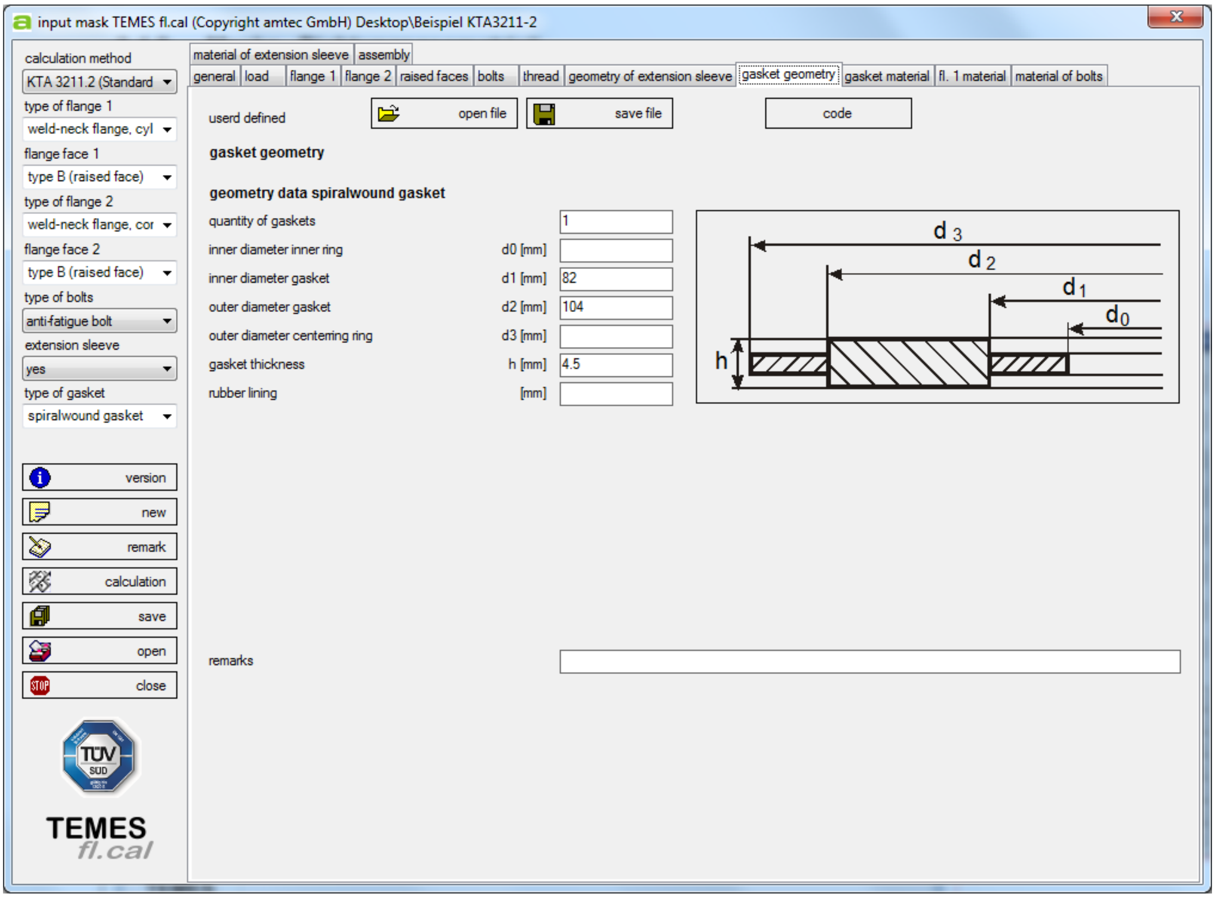


These inputs can be stored with the button "save file" and are available for further calculations.
The reading of data is done via the button "open file" in this mask.

3.4.9 Mask “gasket geometry“

Depending on the selected flange geometry different input masks are available:

To illustrate the required input variables, a drawing of the gasket is shown in the right area, showing the nomenclature of the dimensions:

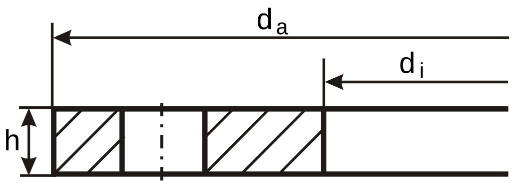


The different gasket parameters can either be entered manually or, – if the dimensions are defined in a standard – they can be read from a database. For this purpose the button "code" is available.

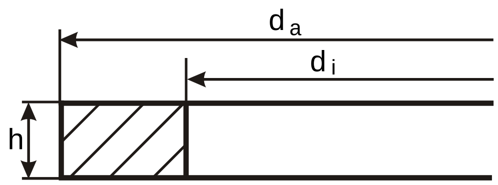
These inputs can be stored with the button "save file" and are available for further calculations.
The reading of data is done via the button "open file" in this mask.

The following different types of gaskets can be defined in order to achieve an accurate determination of the effective gasket surface and the acting lever arms:

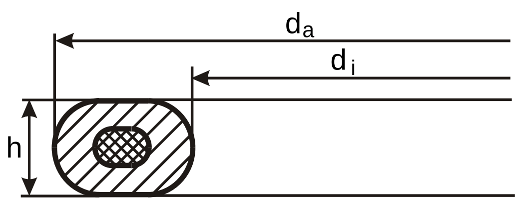
- flat gasket (Form FF)



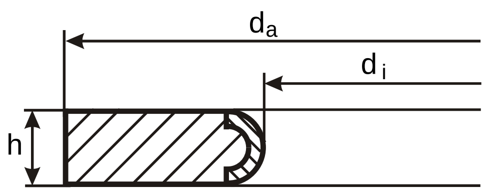
- non-metallic flat gasket (Form IBC / TG / SR)



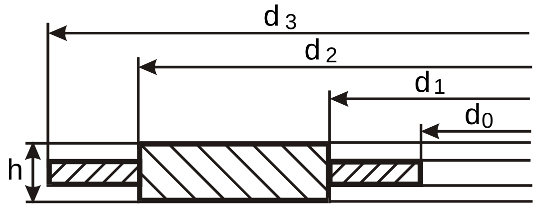
- rubber gasket with inserts



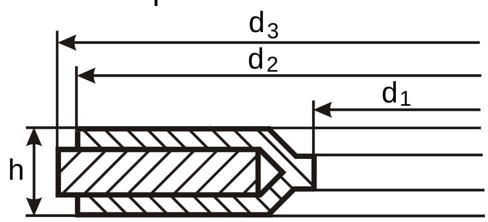
- sheet gasket with inner eyelet



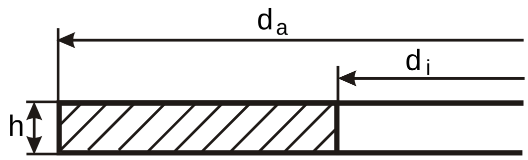
- spiral wound gasket



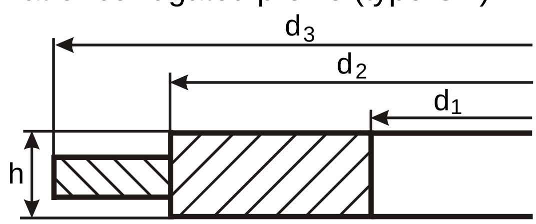
- sheet gasket with PTFE envelop



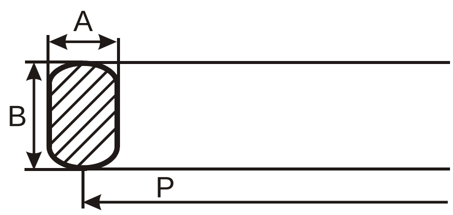
- metallic gasket with flat or corrugated profile (type SC)



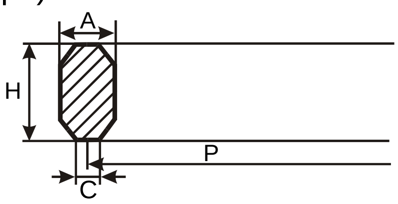
- metallic gasket with flat or corrugated profile (type CR)



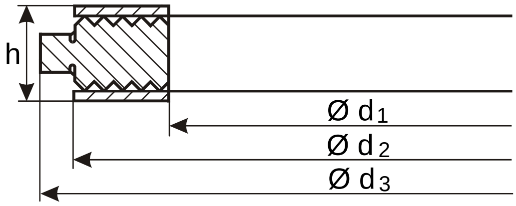
- RTJ-gasket (ovale type)



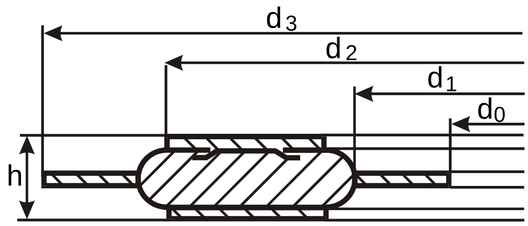
- RTJ-gasket (octogonal type)



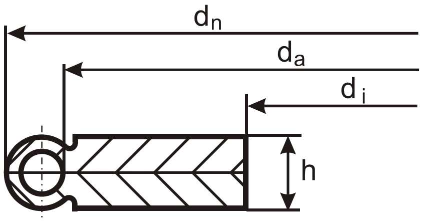
- kammprofile gasket



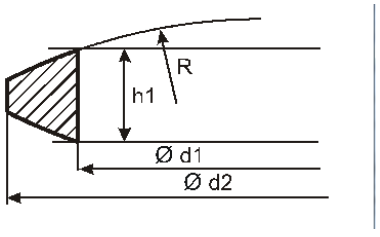
- metall cased gasket with layers



- welded lip gasket

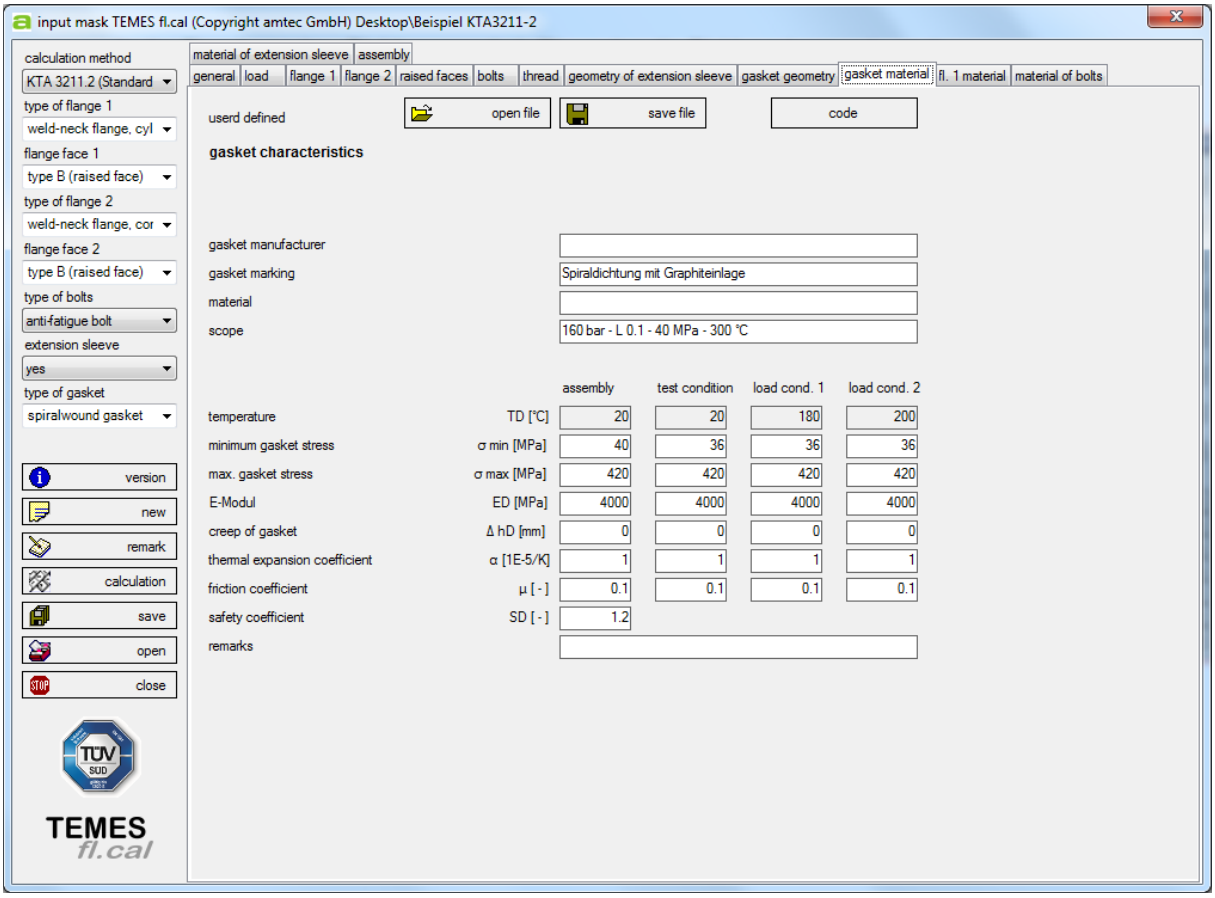


- lense gasket



3.4.10 Mask “gasket material“

In the input mask "gasket material" the gasket characteristics are entered to DIN 28090-1.



Standard data are not available for the gasket characteristics or no longer reflect the state of the art.

Gasket characteristics given from the manufacturers can be stored with the button "save file" and are available for further calculations.
The reading of data is done via the button "open file" in this mask.

The gasket characteristics $\sigma_{VU/L}$ and $\sigma_{BU/L}$ which define the minimum required gasket stress during assembly and during operation shall be specified depending on the required tightness class.
In the software **TEMES*fl.cal*** the values for $\sigma_{BU/L}$ are entered in the input field "minimum gasket stress" for the test condition and load cond. 1/2.

For the assembly condition the minimum gasket stress that is required to obtain the target $\sigma_{BU/L}$ during operation is entered in this field, not the minimum gasket stress $\sigma_{VU/L}$.

The modulus of elasticity of the gasket is dependent on the previously applied maximum gasket stress, from which the gasket is unloaded again.

In a first approximation, therefore, the modulus of elasticity of the gasket should be determined from the minimum surface pressure that is required for $\sigma_{BU/L}$. If the first calculation run reveals that a much higher gasket stress can be applied during assembly, the modulus of elasticity should be adjusted and another calculation run should be performed.

The creep of gasket Δ hD indicates the creeping of the gasket for the applied gasket stress and temperature.

Thermal expansion coefficients are also not available for the gasket materials. The default value is 10 • 10^{-6} 1/K. As the gasket height normally is small compared to the thickness of the flange ring this approximation is acceptable.

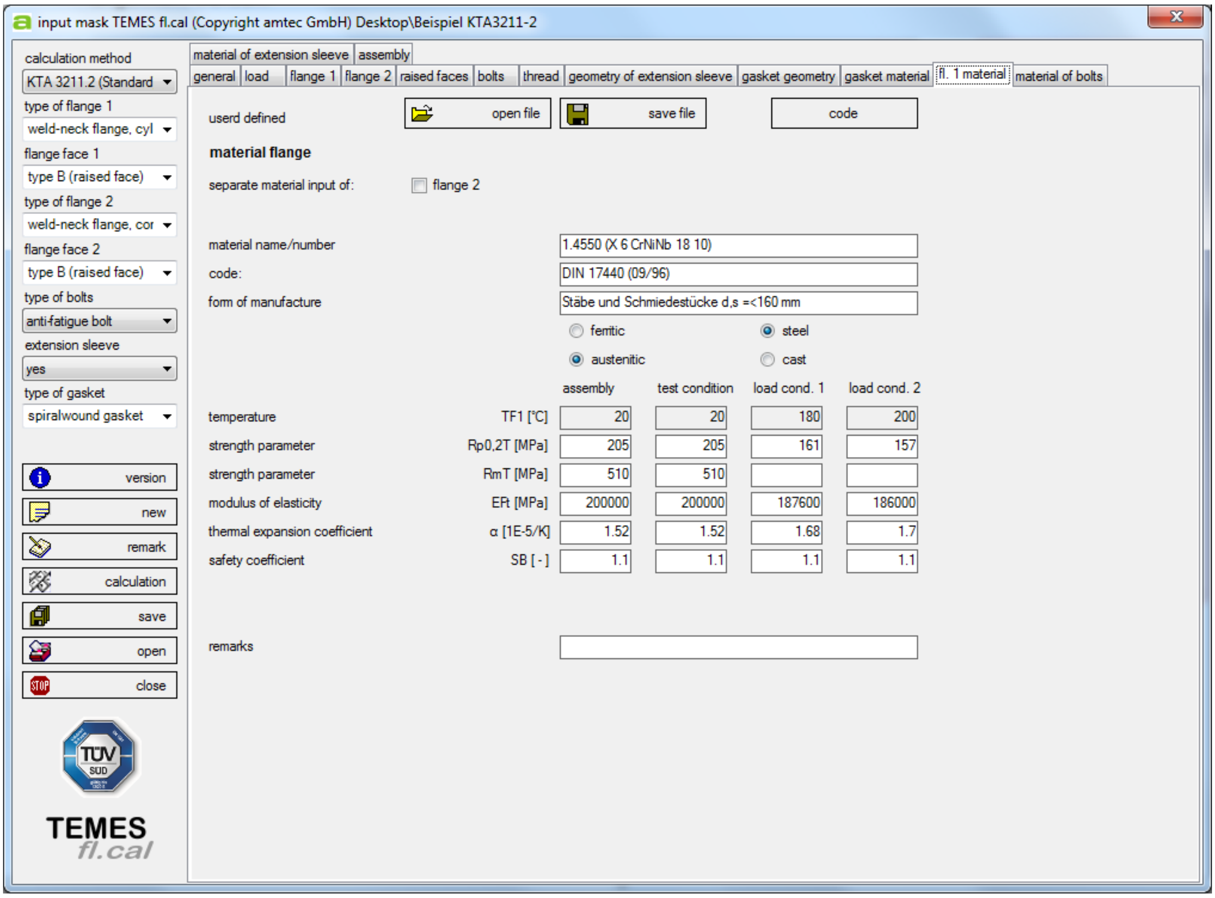
The coefficient of friction for the gasket material is required to calculate the additional axial force needed to transmit shear forces and torsion moments. If no test results are available the coefficient of friction can be defined according to KTA 3211.2 as follows:

- 0.05 for gasket PTFE-based,
- 0.1 for graphite gaskets,
- 0.15 with metallic pads with a smooth surface and
- 0.25 with uncoated fiber based gaskets.

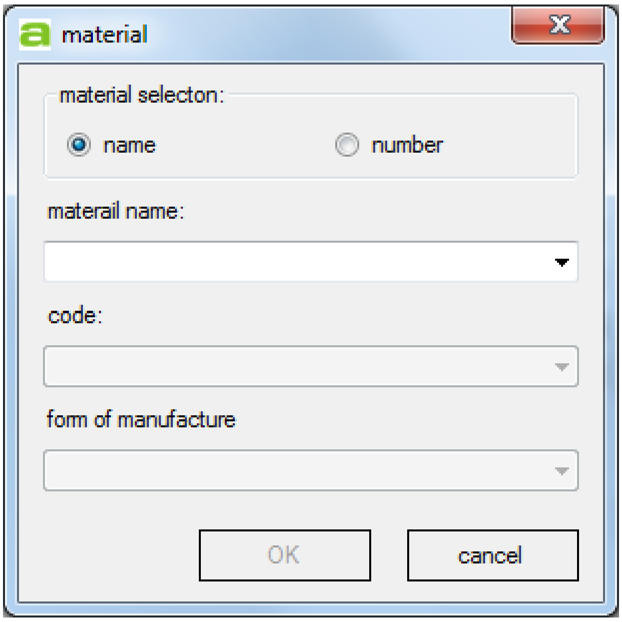
The safety coefficient used in the dimensioning calculation is set to 1.2.

3.4.11 Mask “fl. 1 material“

In the input mask "fl. 1 material", the strength characteristics of the material used for flange 1 or the stub/flare of a loose flange can be entered. At the same time can you can choose the material for the other flange (flange 2, loose flange 1 / 2) if they are made of a different one. Therefore you must click the corresponding check box "separate material input of:" in the input mask.



The values can be entered manually or imported into the fields from a database. For this purpose the "code" button is available.



After the selection of the material via material name or number, the code can be defined in a dialog box, and finally you can select the form of manufacture in a third dialog box.

As long as you make no changes to this selected data from the database, the values are also automatically updated when you are changing the temperature of a load condition. This does not happen if you modify or enter the data manually.

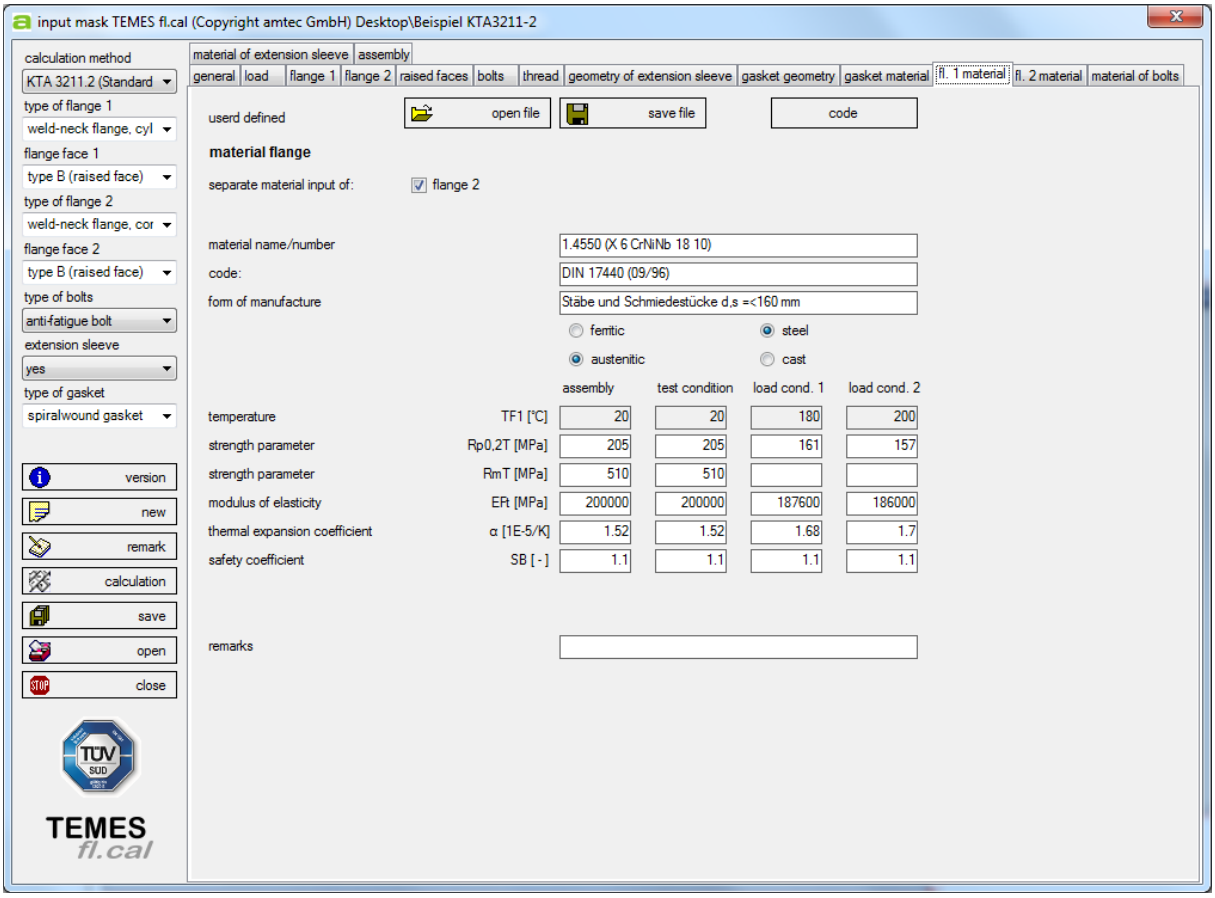
Manual inputs can be stored with the button "save file" and are available for further calculations again. The reading of data is done via the "open file" also on this mask.

3.4.12 Mask “loose flange 1 material“

For the material of loose flange 1, there are the same functions as for the material of flange 1 available. To enable this input mask for the loose flange 1 you need to activate „Separate material input for loose flange 1" in the mask “fl. 1 material“.

3.4.13 Mask “fl. 2 material“

For the material of flange 2 there are the same functions as for the material of flange 1 available. To enable this input mask for flange 2, you need to activate „Separate material input flange 2" in the mask “fl. 1 material“.



3.4.14 Mask “loose flange 2 material“

For the material of loose flange 2, there are the same functions as for the material of flange 1 available. To enable this input mask for the loose flange 2, you need to activate „Separate material input loose flange 2" in the mask “fl. 1 material“.

3.4.15 Mask “material of bolts“

In the input mask "material of bolts" the strength characteristics of the material can be entered.

It offers the same functionality like in the input mask “fl. 1 material” for the material of flange 1.

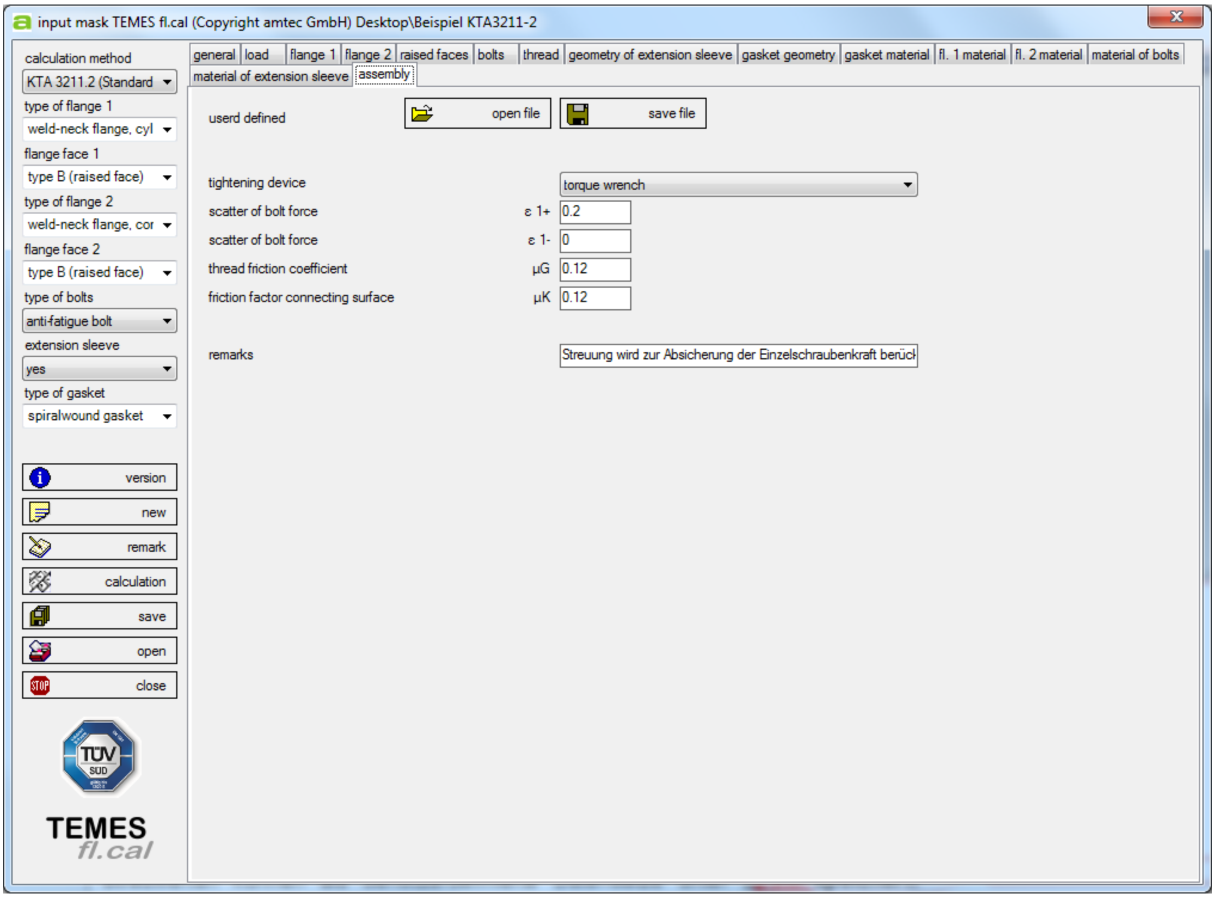
3.4.16 Mask “material of extension sleeve“

In the input mask "material of extension sleeve", the strength characteristics of the material can be entered.

It offers the same functionality like the input mask of the material of flange 1.

3.4.17 Mask “assembly“

The last input mask contains the information that is necessary for the calculation of the assembly requirements specifications, such as tightening device, scatter band of the tightening and friction coefficients.



The tightening device can be selected from a drop down list. The associated scattering values used to calculate the bolt force are provided in Annex C of EN 1591-1.

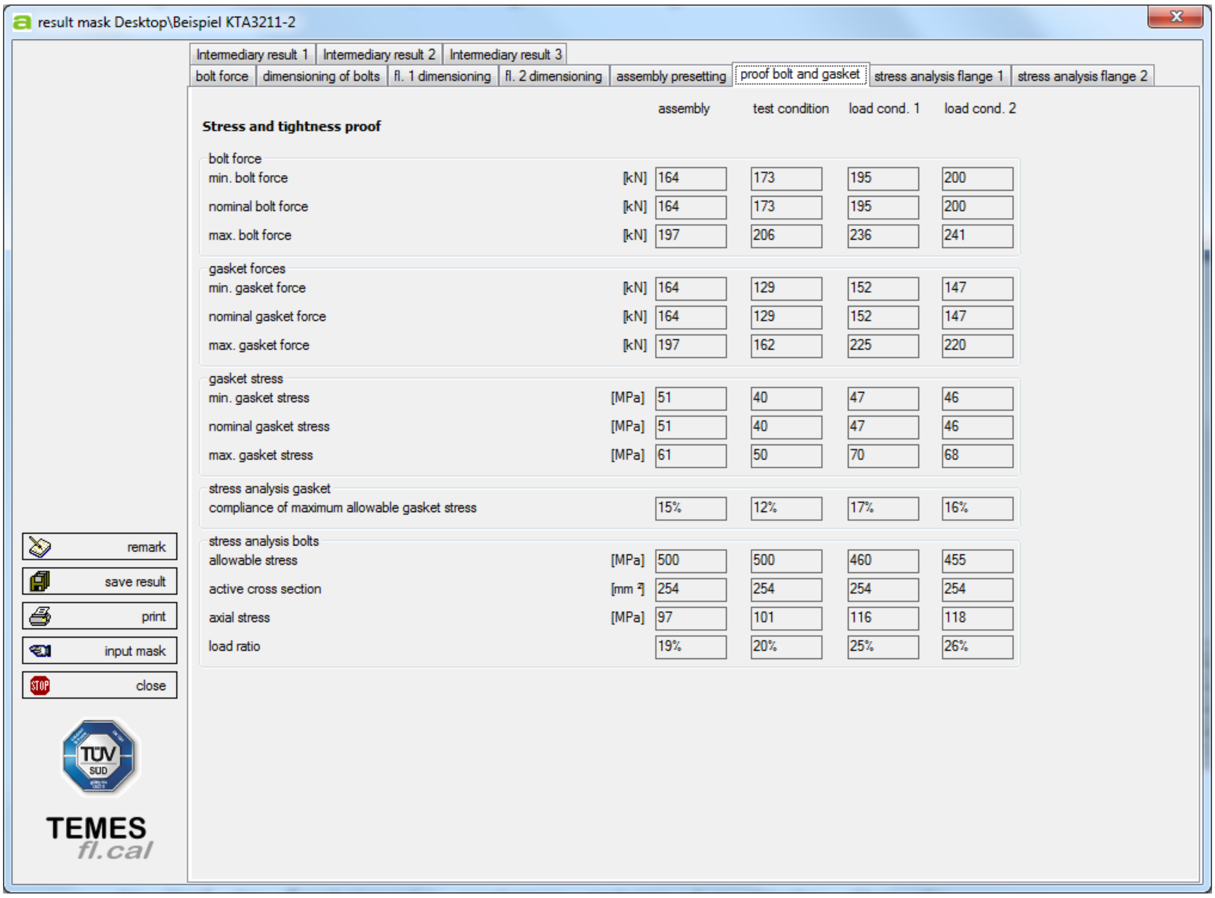
Additional tightening devices with other scatter values can be stored as user records with "save file" and are available for further calculations via the button "open file".

In the draft rule change proposal of KTA 3211.2 it is mentioned that the tightness proof must be provided with the average computational bolt force, so that the negative dispersion value ε_{1-} can be set to "zero". The strength analysis of the flanges and the bolts must be considered with the scatter band of the tightening device.

Verify the strength of the flanges and bolts is to exhibit, taking into account the scatter band of the tightening. For assembly with a torque wrench the factor of "0.2" is proven.

3.5 Program module KTA 3211.2 (standard) – results

With the "calculate" button the calculation is started. If all input data is available, the program displays after the end of the calculation routine the output mask "strength and tightness proof" in which the maximum permissible bolt force and torque as well as the bolt elongation are displayed.



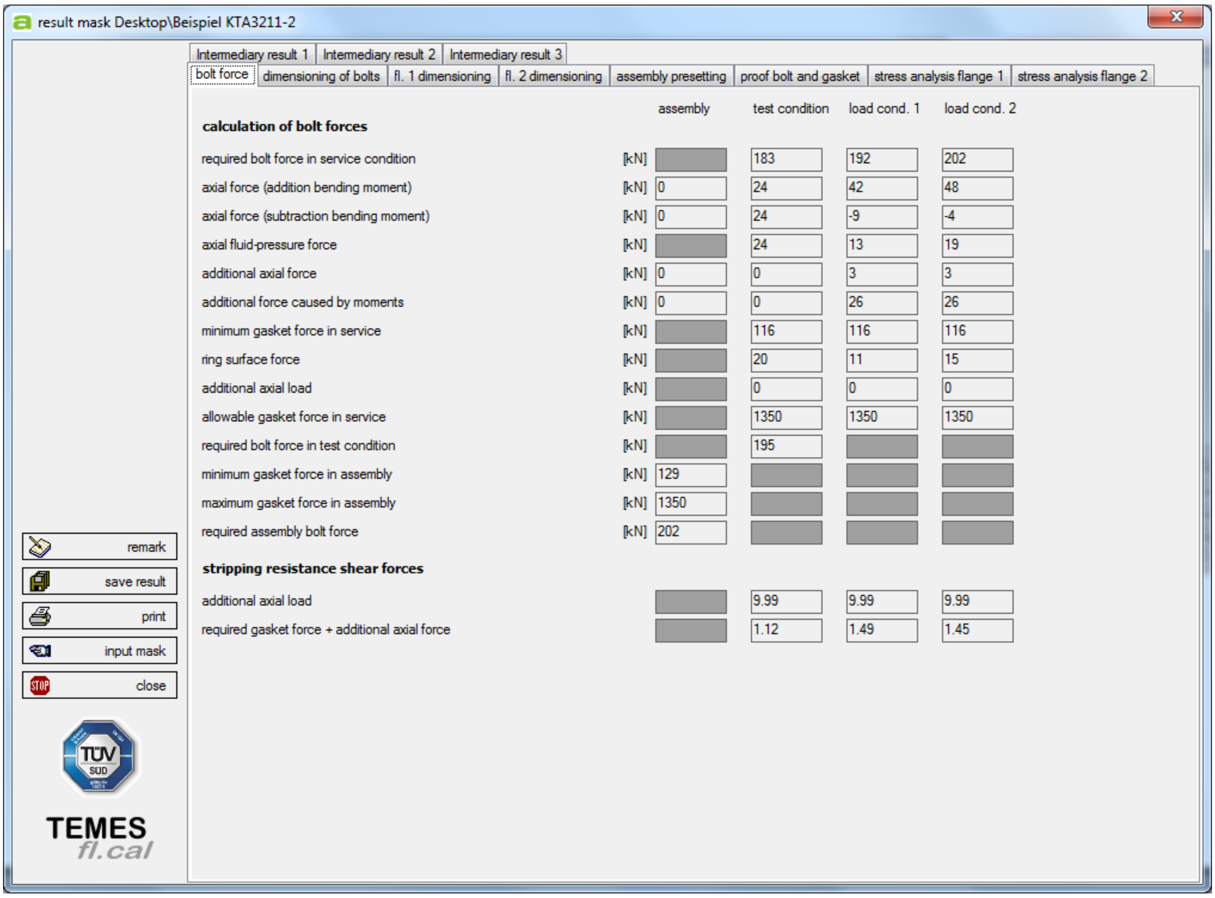
In the head of the result mask multiple tabs appear. These tabs give access to the various output masks. The individual result masks are described below.

3.5.1 Mask “bolt forces“

In the output mask "bolt forces" the calculated bolt forces are shown according to KTA 3211.2 Appendix A 2.9.4

In detail, there are the forces due to internal pressure, the additional forces from an active axial pipe force or bending moment, the ring-shaped surface force, the additional force required to transfer shear forces and torsion moments and the minimum required gasket force. All these forces result in the bolt forces required for each load condition.

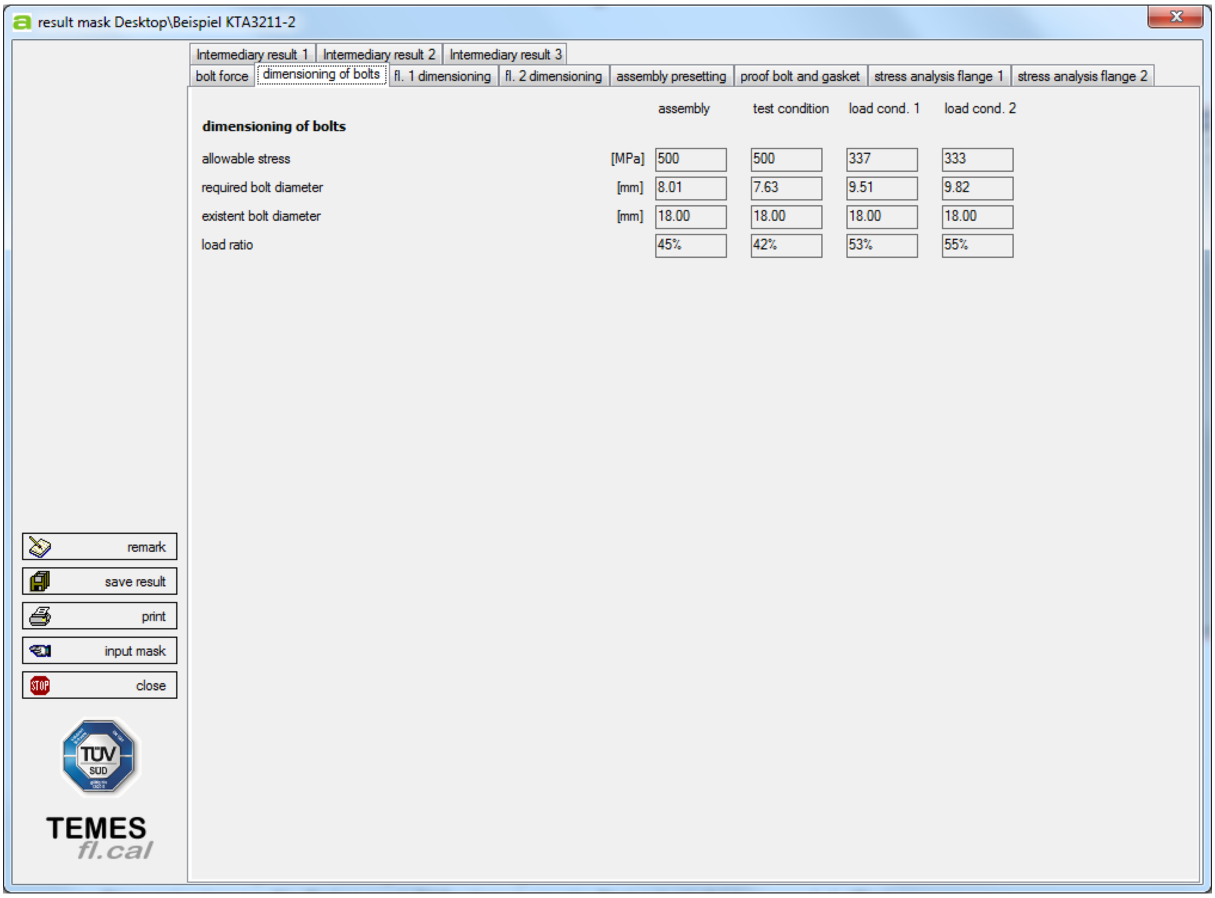
Finally, the required assembly bolt force is determined, which must be used for all further steps for the dimensioning of the components. This required bolt load for the assembly condition is not the same as the bolting-up which is determined in the final detailed tightness and strength assessment after all dimensions have been defined.



For existing bolted flanged joints the sizing calculation is not required since the detailed analysis of a leak and strength assessment can be regarded as superior. In this case, the estimated assembly bolt force from the sizing calculation can be used as initial value for the detailed proof.

3.5.2 Mask "dimensioning of bolts"

In the mask "dimensioning of bolts" the results for the dimensioning of the bolt are shown:



The required bolt diameter is safeguarded according to KTA 3211.2 Appendix A 2.9.4.3.

To determine the allowable stress of the bolt material a safety factor of 1.1 (assembly and test condition) and 1.5 (load cond. 1/2) respectively is applied for the dimensioning of screw and studs. For all other types of bolts a safety factor of 1.3

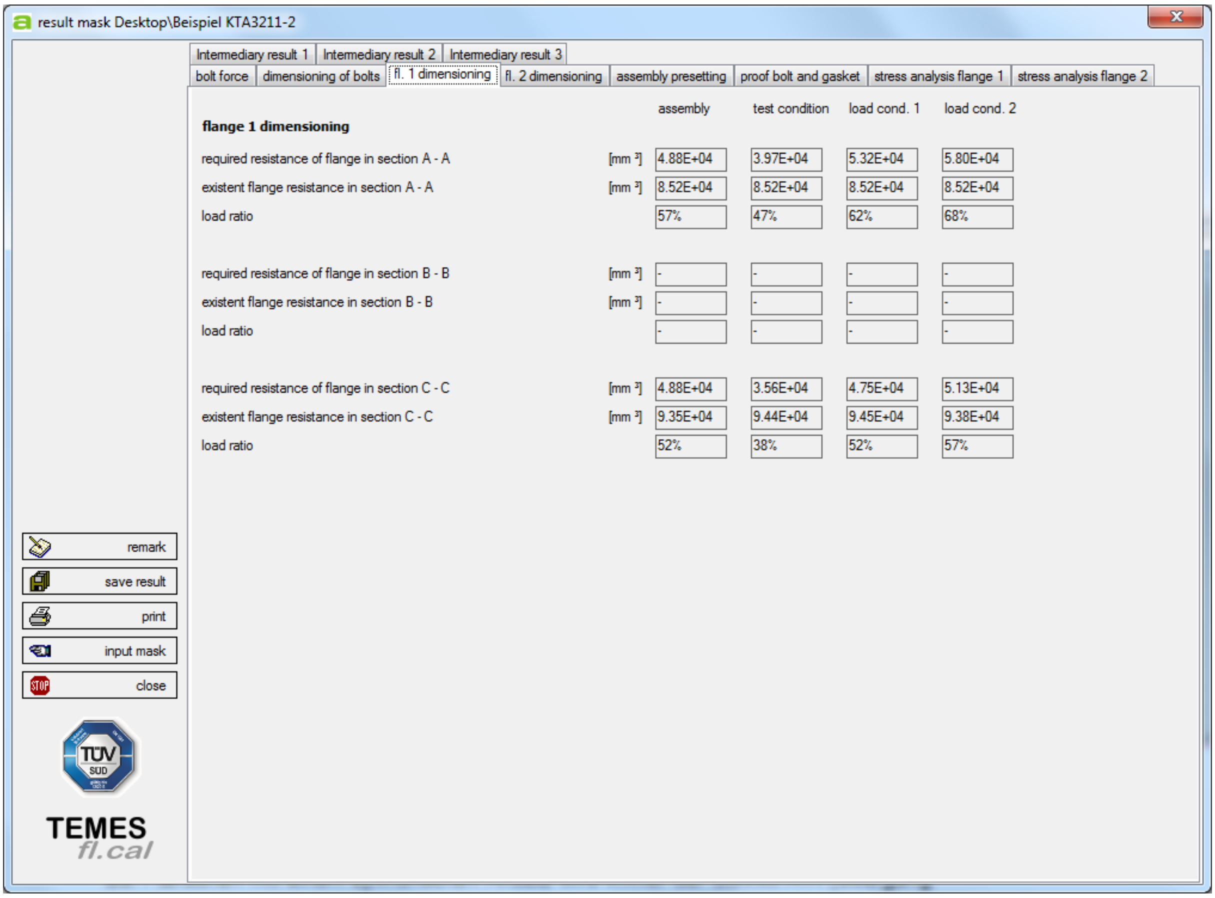
(installation and test condition) and 1.8 (operation 1/2) respectively is applied. The safety factors are fixed default values in **TEMES***fl.cal*.

For existing bolted flanged joints the sizing calculation is not required since the detailed analysis of a leak and strength assessment can be regarded as superior. A shortfall of the required bolt diameter is tolerable in this case.

3.5.3 Mask “fl. 1 dimensioning“

In the dimensioning the required modulus of resistance of the flanges is safeguarded in accordance with KTA 3211.2 Appendix A 2.10.4.

For existing bolted flanged joints the sizing calculation for flange dimensions as well is not required since the detailed analysis of a leak and strength assessment can be regarded as superior. A shortfall in the required modulus of resistance is tolerable in this case.

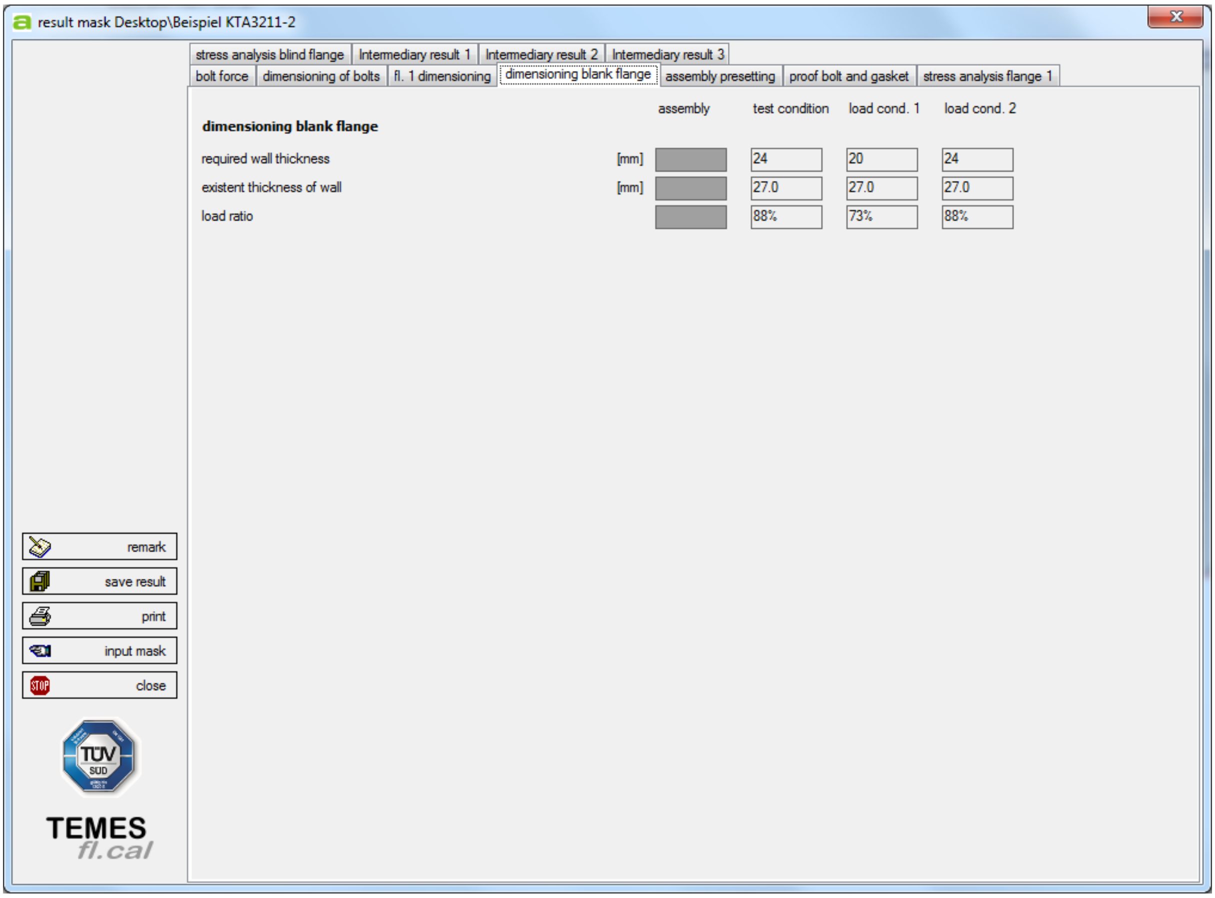


For flanges with cylindrical neck the sections A-A (transition flange face to neck) and C-C (in flange face) are evaluated. For flanges with conical neck the section B-B (transition between neck and pipe) is evaluated as well. For loose flange joints the loose flange itself is evaluated additionally.

For this purpose a modification to KTA 3211.2 is applied. The starting point of the load transmission from the loose flange to the collar / raised edge is moved to the outer edge of the collar / raised edge, reducing the lever arm to a value of $a = a_D$. In a strict approach to KTA 3211.2 the loose flanges are overloaded at relatively low forces. FE analyses confirm this approach.

3.5.4 Mask “fl. 2 dimensioning “

In the dimensioning of flange 2 the required modulus of resistance is safeguarded according to KTA 3211.2 Appendix A 2.10.4. Apart from that the blind flange is safeguarded according to KTA 3211.2 Appendix A 2.7.3.2.

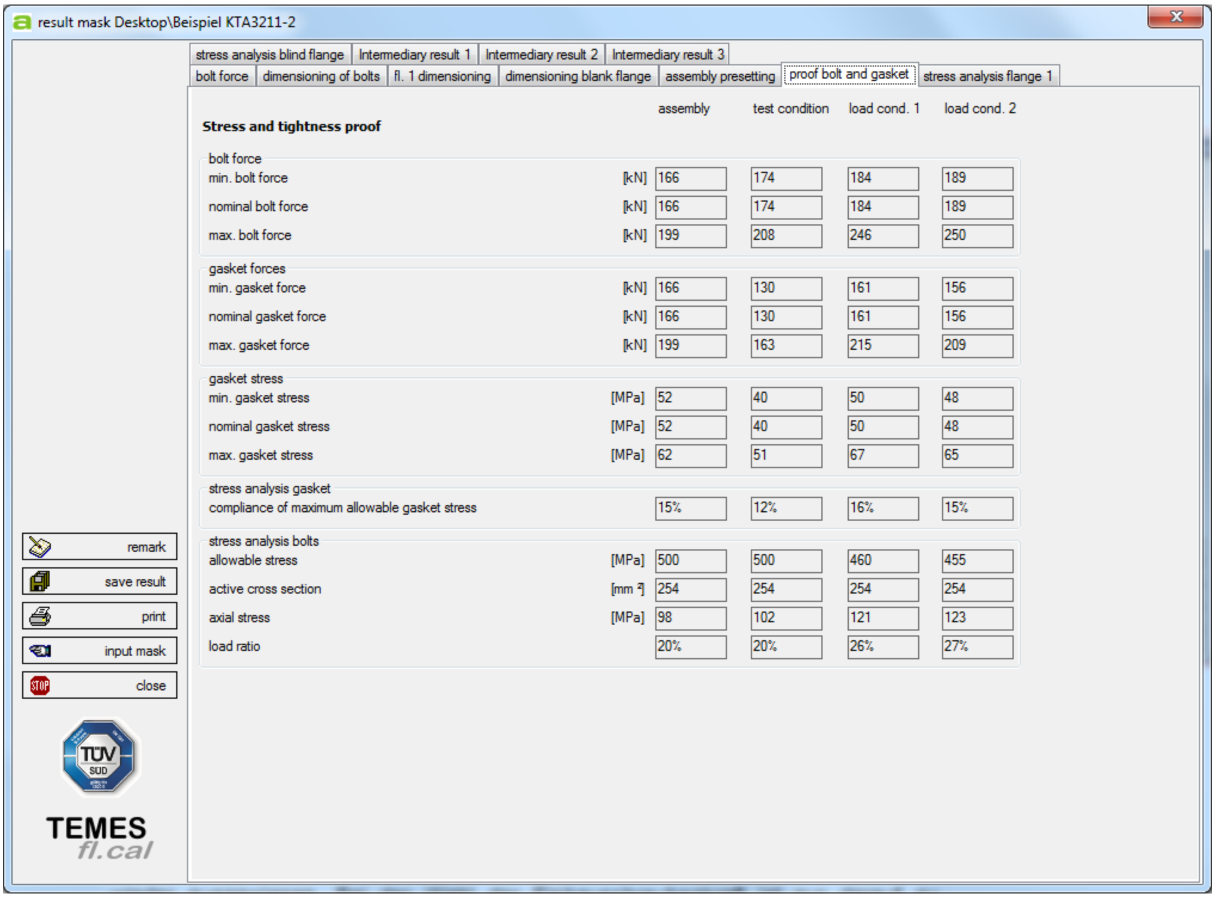


For blind flanges the required thickness is safeguarded in the middle part of the flange.

3.5.5 Mask “proof bolt and gasket“

Just after the calculation routine is finished, the program displays this result mask.

During the calculation the assembly bolt force is increased until – under consideration of the scatter due to the selected tightening device – one of the components has reached 100% of its allowable stress. For this force, the associated bolt elongation and the associated tightening torque are reported (in accordance with VDI 2230). At the same time this force is held as a maximum permissible bolt force in load conditions 1 and 2.



The user can now choose the assembly bolt force in the field "chosen assembly bolt force" under the tab “assembly presetting”. Based on the selected force all results are recalculated and reported. When choosing the assembly bolt force it is necessary to ensure that the maximum allowable bolt force for the assembly condition is not exceeded and that it is not too small in order to avoid unloading of the gasket down to gasket stresses below the minimum value.

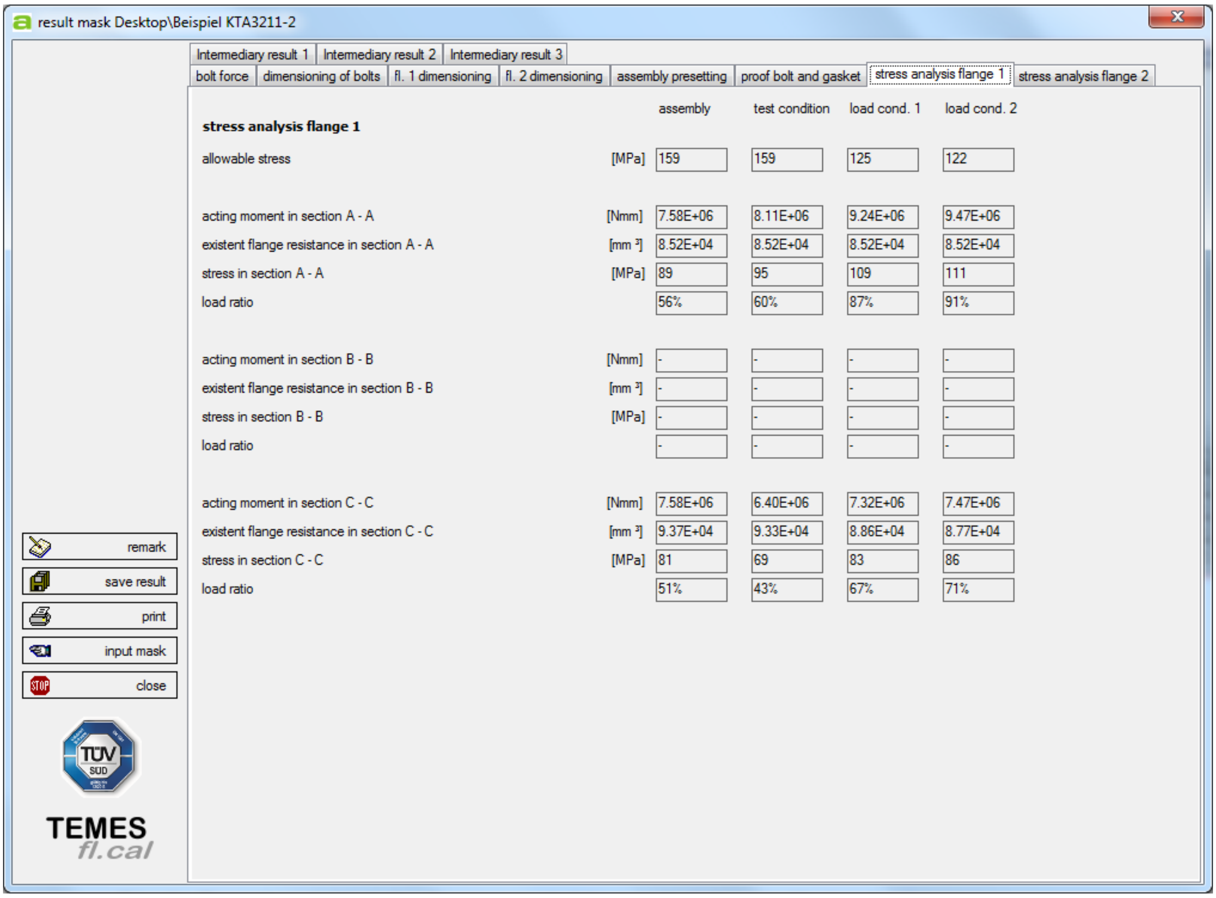
Based on the “chosen assembly bolt force” the minimum and maximum bolt force or gasket stress is determined under consideration of the scatter band of the tightening device. The minimum gasket force and gasket stress respectively is used for the tightness proof. The maximum bolt force and gasket force respectively is used for stress analysis.

With the forces determined for assembly conditions the forces for all subsequent load conditions are calculated. Therefore stiffness and thermal expansion of the individual components are considered according to KTA 3211.2 2.10.6 Appendix A. The minimum forces are used for the tightness proof and the maximum forces are used for stress analysis.

In the detailed stress analysis for the bolts a safety factor of 1.1 is applied according to KTA 3211.2 table 6.7-2 (no. 5: “… considering the tensioning condition”).

3.5.6 Mask „stress analysis flange 1"

For the determined maximum forces in each condition the required moduli of resistance are recalculated and safeguarded against the existing moduli of resistance of the flanges.



stress analysis flange 1		assembly	test condition	load cond. 1	load cond. 2
allowable stress	[MPa]	159	159	125	122
acting moment in section A - A	[Nmm]	7.58E+06	8.11E+06	9.24E+06	9.47E+06
existent flange resistance in section A - A	[mm ³]	8.52E+04	8.52E+04	8.52E+04	8.52E+04
stress in section A - A	[MPa]	89	95	109	111
load ratio		56%	60%	87%	91%
acting moment in section B - B	[Nmm]	-	-	-	-
existent flange resistance in section B - B	[mm ³]	-	-	-	-
stress in section B - B	[MPa]	-	-	-	-
load ratio		-	-	-	-
acting moment in section C - C	[Nmm]	7.58E+06	6.40E+06	7.32E+06	7.47E+06
existent flange resistance in section C - C	[mm ³]	9.37E+04	9.33E+04	8.86E+04	8.77E+04
stress in section C - C	[MPa]	81	69	83	86
load ratio		51%	43%	67%	71%

For flanges with cylindrical neck the sections A-A (transition flange face to neck) and C-C (in flange face) are evaluated. For flanges with conical neck the section B-B (transition between neck and pipe) is evaluated as well. For loose flange joints the loose flange itself is evaluated additionally.

For flanges at the tension protection during the detailed analysis according to KTA 3211.2 2.10-1 Table A ("considering the tension state ..." No. 4) always use a safety facor of 1.1.
At small sizes (diameter ratio dF / di> 2) still takes a requirement for tension reduction by a factor Φ, which is included in the software **TEMES*fl.cal***

If flange 1 is designed with a blind hole, the required depth is calculated according to KTA 3211.2 Appendix A 2.9.4.4.2. There the stripping strength of the bolt thread, the stripping strength of blind hole thread and adherence to a tried and tested criteria is checked. Failure to meet any requirement of this limiting criterion is explicitly shown.

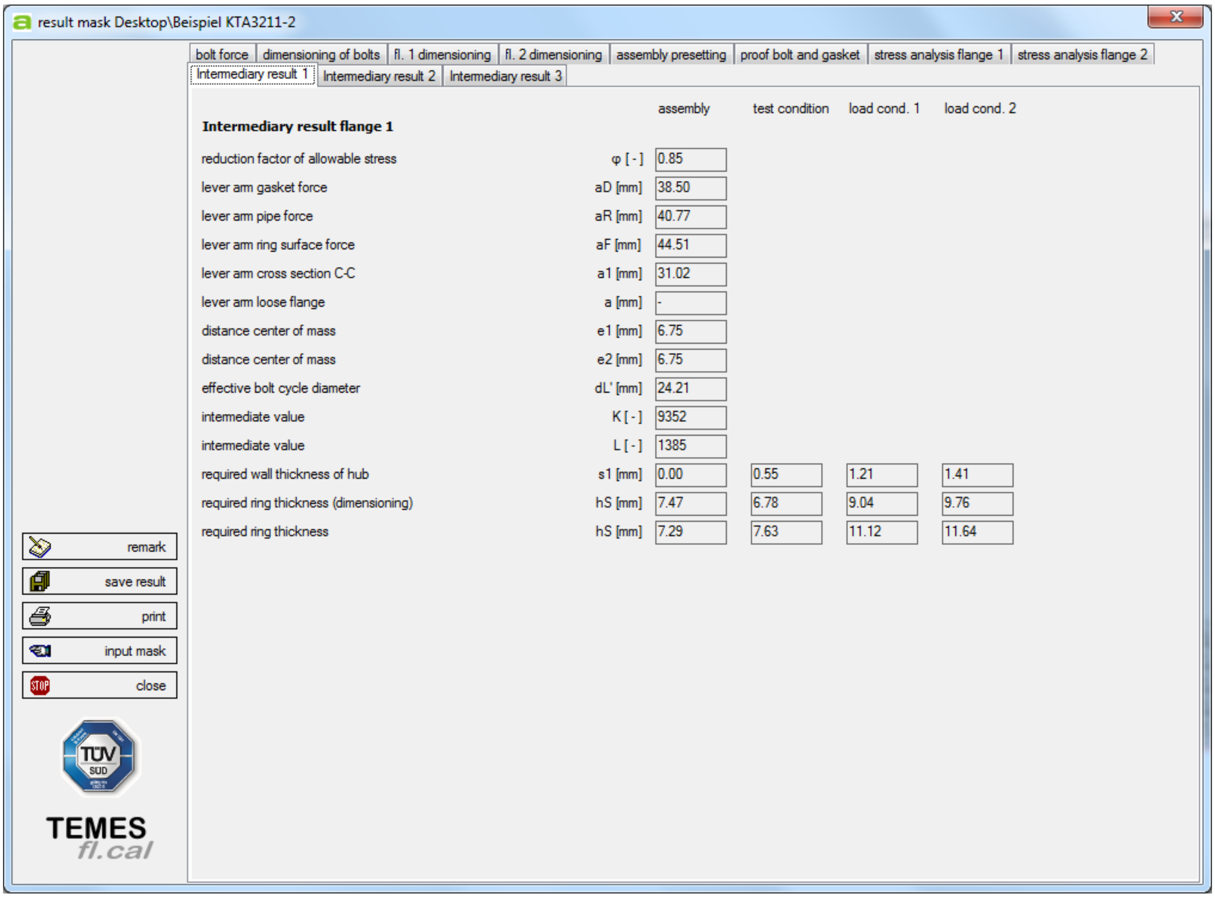
3.5.7 Mask “stress analysis flange 2“

The tension protection of flange 2 is the same lilke the protection of flange 1.
A special feature represents only the blind flange, which is regarded like the dimensioning acc. to KTA 3211.2 Appendix A 2.7.3.2.

3.5.8 Mask “Intermediary result 1“

To make the calculation for the user easier to understand, various intermediate results for flange 1 are shwon, such as the Φ- factor, or lever arms ort he distance of their centres.

With the help of these intermediate results, it should be possible to verify individual calculation steps. These intermediate results are also displayed on the printout of the calculation.

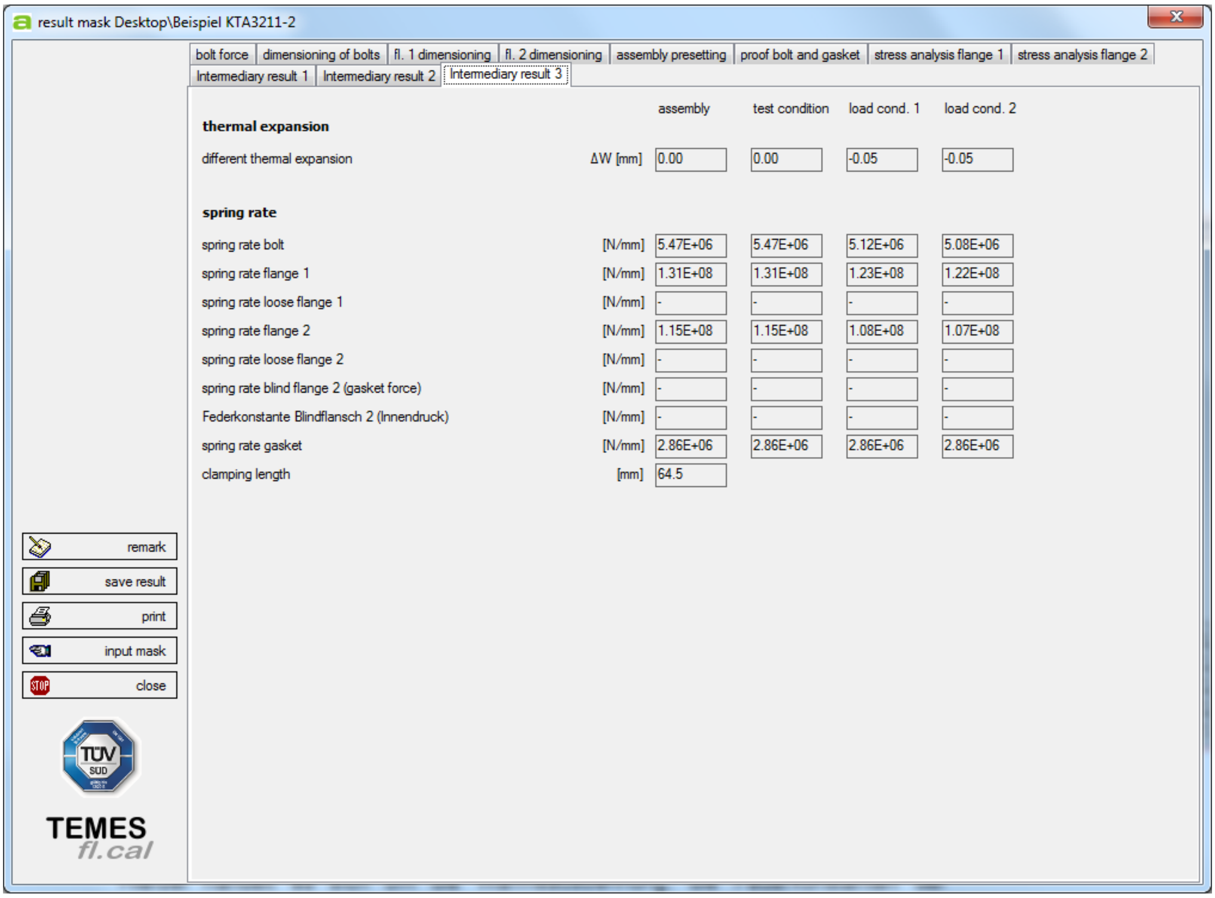


3.5.9 Mask “Intermediary result 2“

In this output mask, intermediate results for flange 2 are reported.

3.5.10 Mask “Intermediary result 3“

Also in this issue mask interim results are reported in order to make the calculation for the user to easier understand.



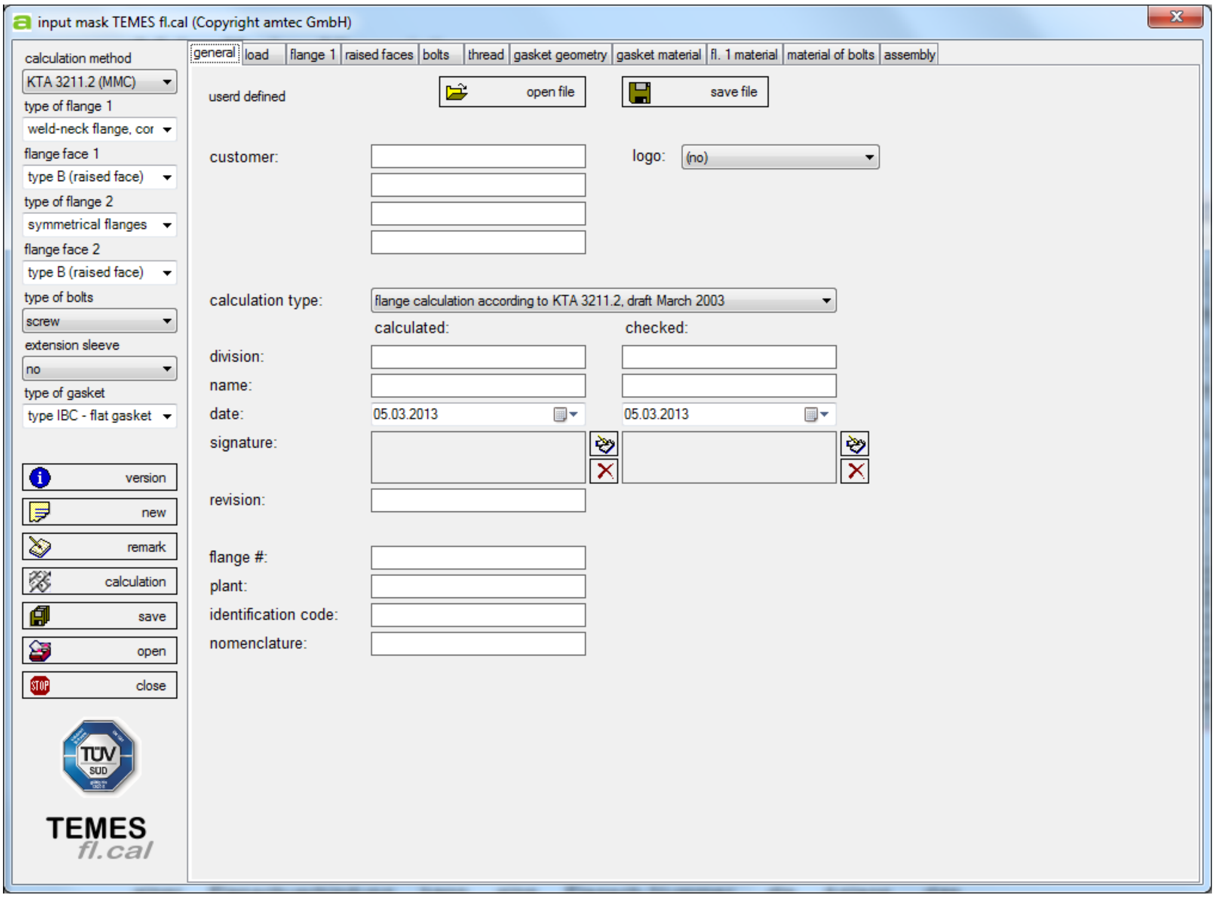
These are the thermal expansion, the spring constants of the individual components of the flange as well as the calculated clamping lengths of the bolt.

3.6. Program module KTA 3211.2 (MMC) – user interface

This chapter describes the data input screens of the program module KTA 3211.2 (MMC).

3.6.1. Mask "general"

In the mask "general" information can be saved for the calculation, and are also displayed on the printout.



There are four panels for entering customer data, the name of the editor and the auditor can be entered as the revision of the calculation. For uniquely assignment of the calculation to a flange connection, a number of plant, plant identification and a description of the flange can be entered.

The logo of the customer for which you are making the calculation must be in *.wmf-format added in the installation folder of your "Temes.flcal.".

(D: \ TEMES flcal 7.0 \ logo.wmf)

For optimal viewing and logo quality, we recommend you an aspect ratio of 1:3.
This logo is then automatically added to the calculation printout.

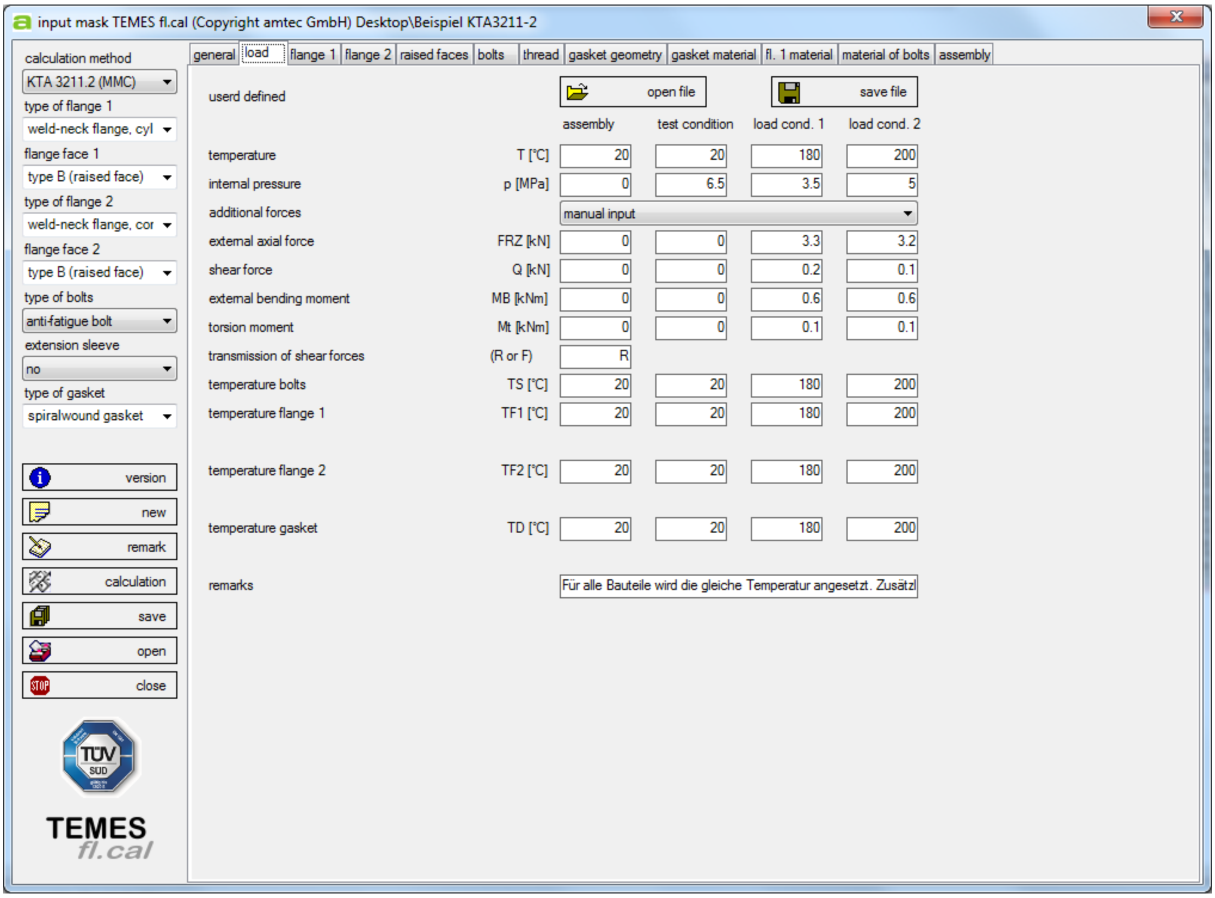
These inputs can stored with the Button "Save File" and are available for further calculations.
The reading of data is done via the button "Open file" in this mask.

3.6.2. Mask “load“

In the mask "loads" are four load cases specified:

- assembly (assembly conditions, unpressurized, torque)
- test condition (leak test)
- Operation 1 (eg normal operation)
- Operation 2 (eg operation with design conditions)

For each of the four load cases the loads temperature, internal pressure, external axial force, shear force, external bending moment and torsion moment can be defined. In the "transmission of shear forces" is specified whether these are transmitted via interlocking or by friction.



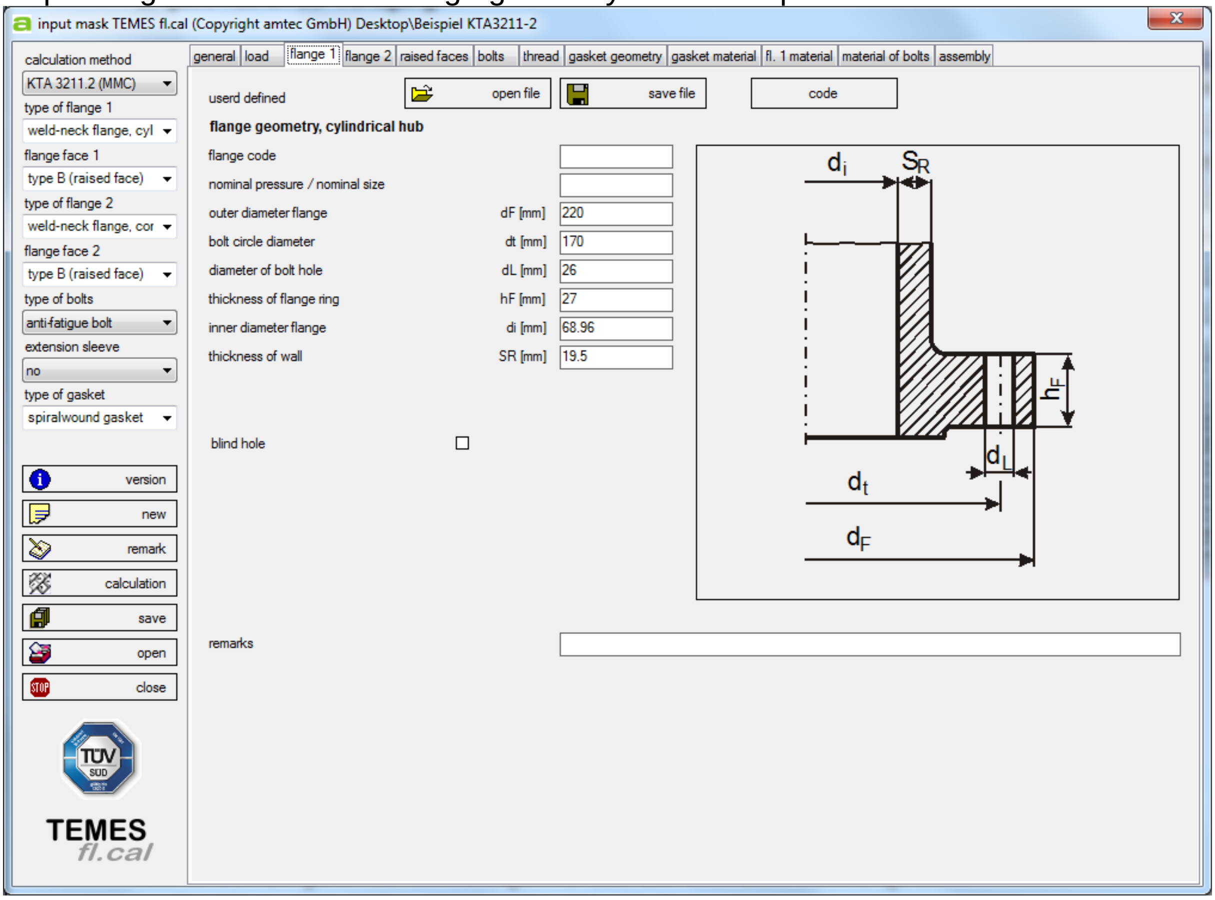
In accordance with the entries in the "temperature", the temperature of each load case are applied to all components of the connection. It is also possible to assign the individual components of the composition at different temperatures. But this will repealed by a new entry in the load-specific again.

Also affected by changes in temperature input are the strength values of the flanges and bolts, unless they are read from the database.

These inputs can stored with the Button "Save File" and are available for further calculations.
The reading of data is done via the button "Open file" in this mask.

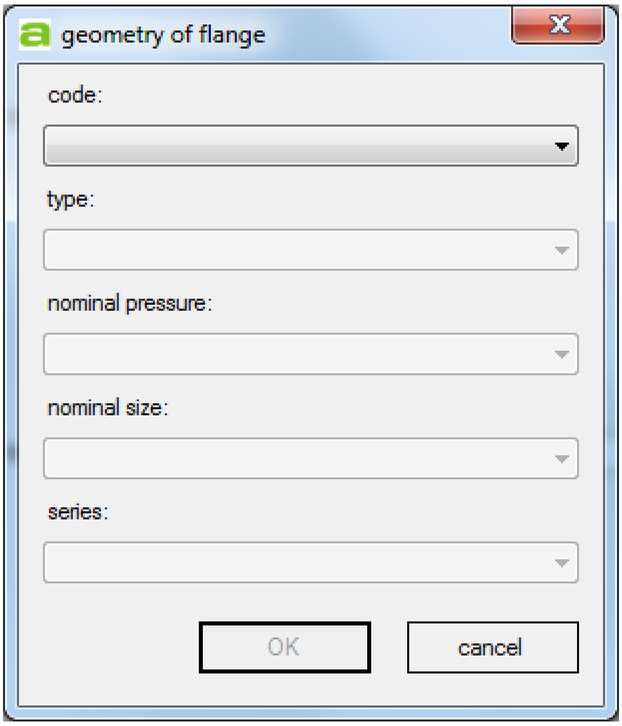
3.6.3. Mask “flange 1“

Depending on the selected flange geometry different input masks are available.



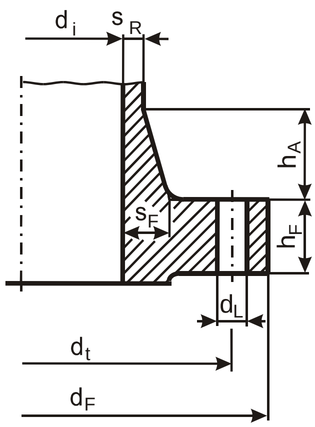
To illustrate the required input variables, a drawing of the part is shown in the right pane, showing the nomenclature of the geometry sizes..

The numerical values can either be entered manually in the fields or, if it is standardized dimensions are read from a database. For this purpose is the button "norm" available.

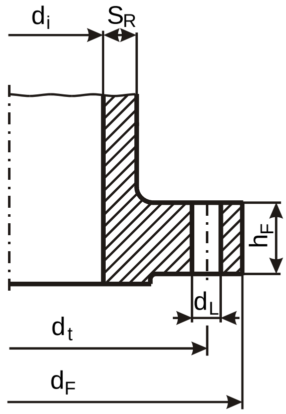


Following different geometrical shapes can be defined for flange 1:

- weld-neck flange, conical shell



- weld-neck flange, cylindrical shell



A blind flange can be modeled only as a flange 2.

Container flanges are not explicitly listed in KTA 3211.2, therefore it must be adapted to the model as good as possible.

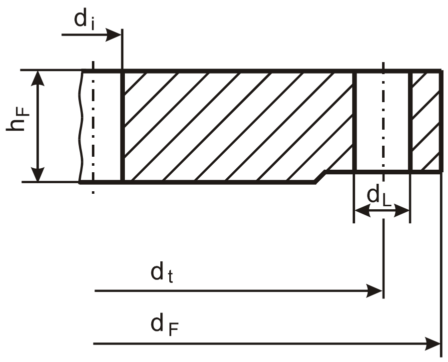
A “blind hole” for welding neck flanges can be modelled on the mask of "flange 1". For this purpose "blind hole" must be selected. There appear additional input fields.

These inputs can stored with the Button "save File" and are available for further calculations.
The reading of data is done via the button "open file" in this mask.

3.6.4. Mask “flange 2“

Essentially the input masks for flange 1 and 2 are identical; the input options are the same. The following differences should be noted:

- In the pre-selection "Symmetrical Flange" you don’t need to enter the geometric data for flange 2
- A blind flange must be modelled as a flange 2.

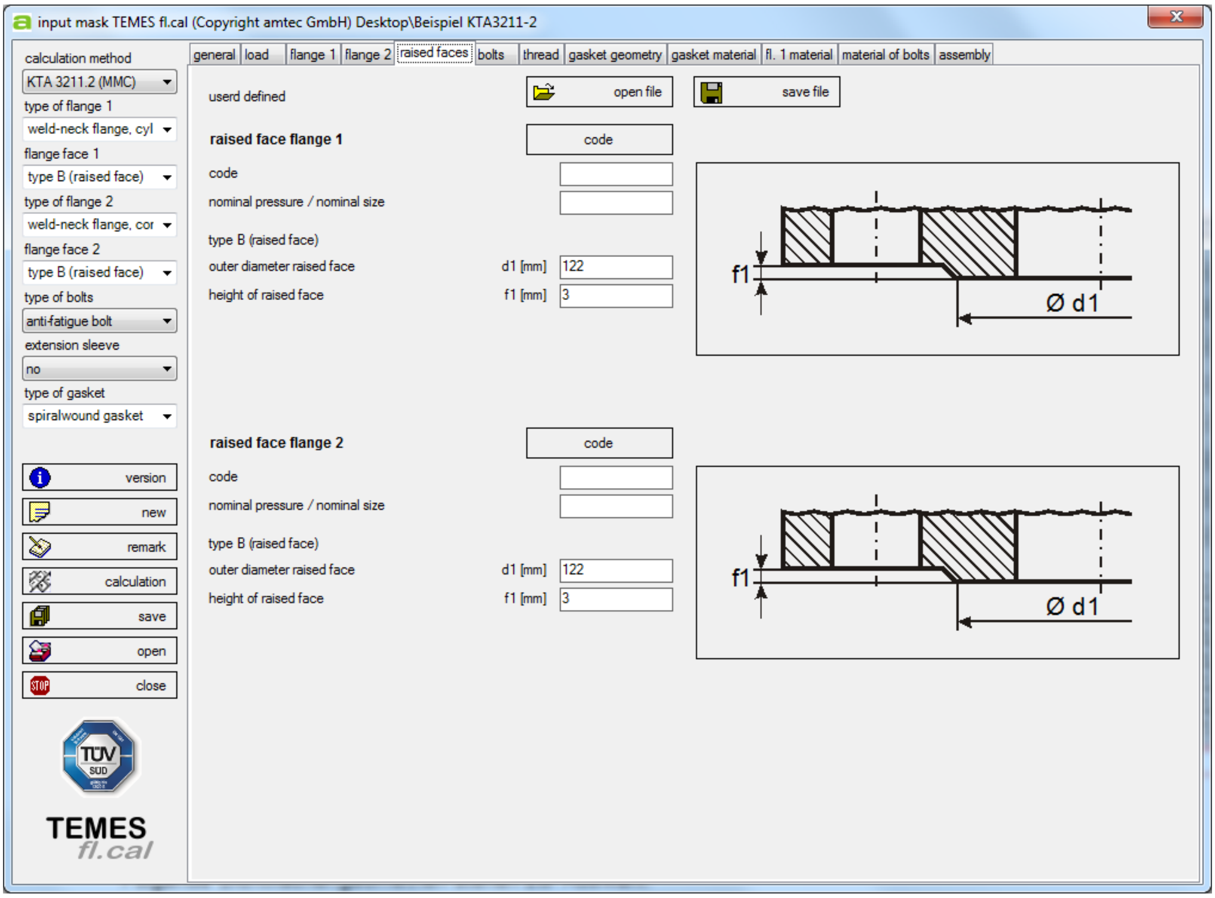


3.6.5. Mask “raised faces“

To accurately calculate the clamping length of the bolts and the effective pressed gasket geometry you can define the geometry of the „raised faces“ for both flanges in the mask „raised faces“ (if earlier the selection made in the dialog boxes).

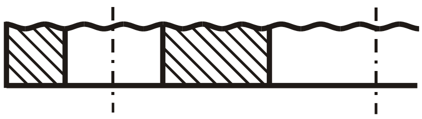
To illustrate the required input variables, a drawing of the selected raised faices is shown with the required geometric quantities in the right area.

.

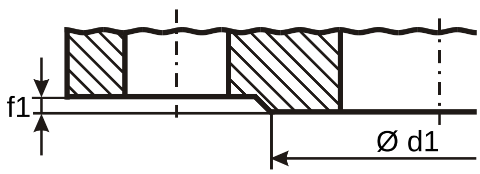


The following raised faces geometries are available:

- type A (flat face)

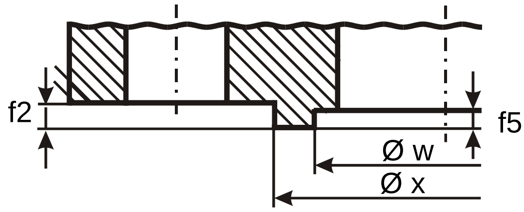


- type B (raised face)

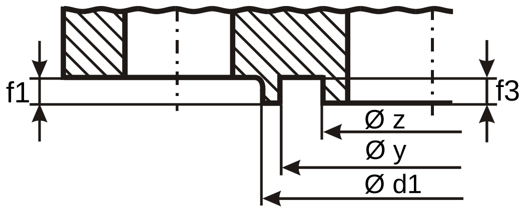


-

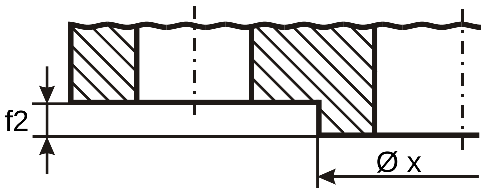
- type C (tongue)



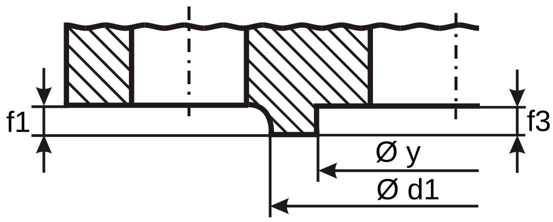
- type D (groove)



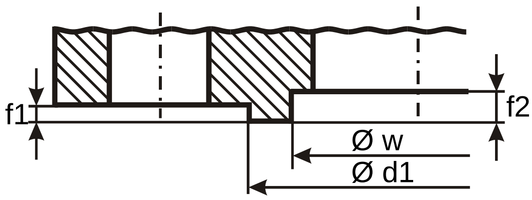
- type E (spigot)



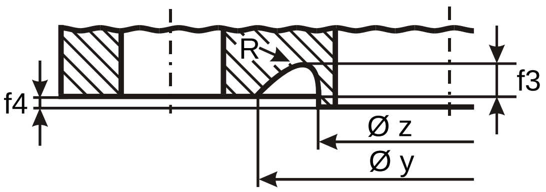
- type F (recess)



- type G (O-Ring spigot)



- type H (O-Ring groove)



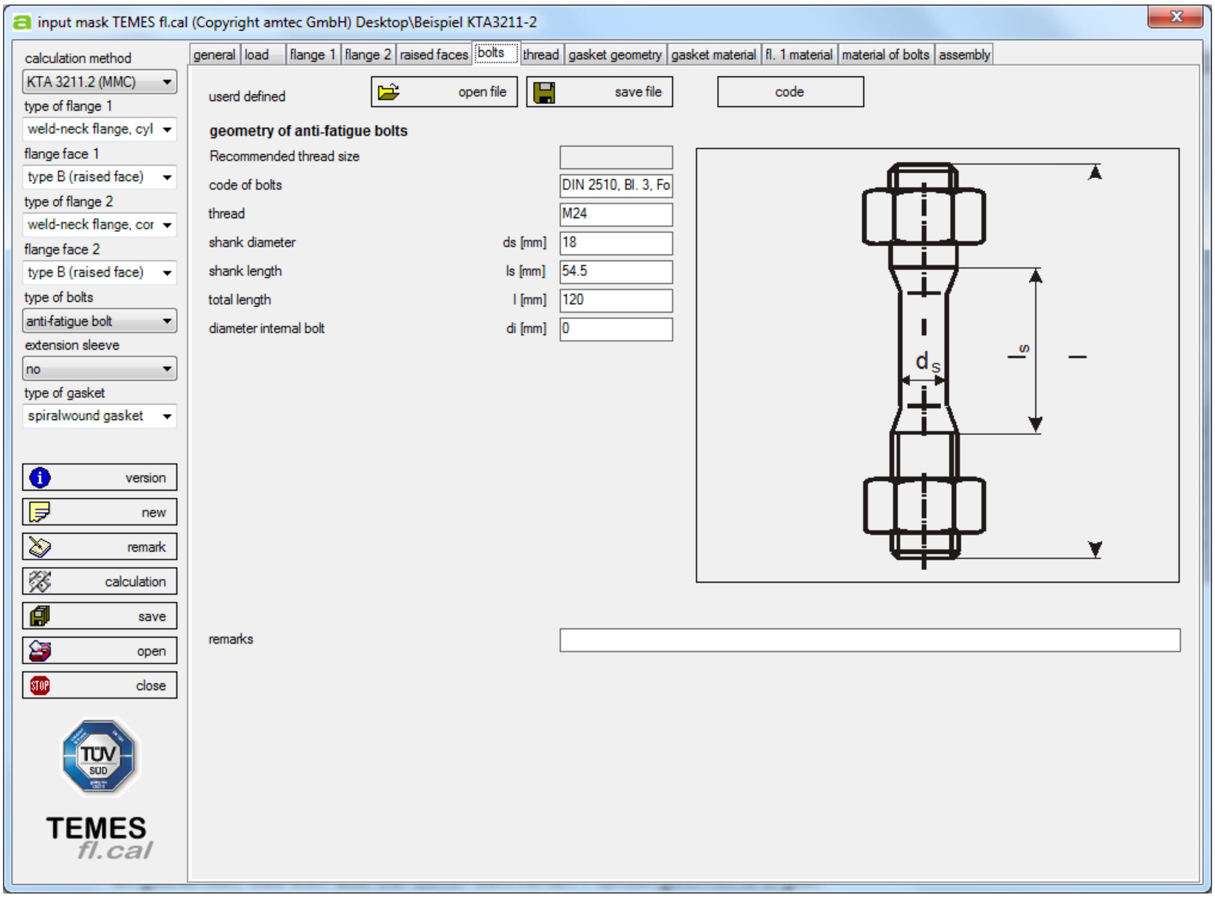
After you select "symmetrical flange" in the dialog box "flange 2" and choosed a raised face for this flange, the opposite side automatically select the the raised face that fits to flange 1. If this is not desired, an individual input must be done for "flange 2"

Also, the sealing surfaces can stored with the button "save record” and are available for further calculations again. The reading of this data is done via the button "open data" on the same screen.

On a blind flange it is to ensure the correct entering of the raised face, because of the flange thickness of the central portion of the flange must be considered. An additional input of a raised face (Form B) would mean in this case a too large clamping length of the bolt. It is therefore advisable to select the raised face type A.

3.6.6. Mask “bolts“

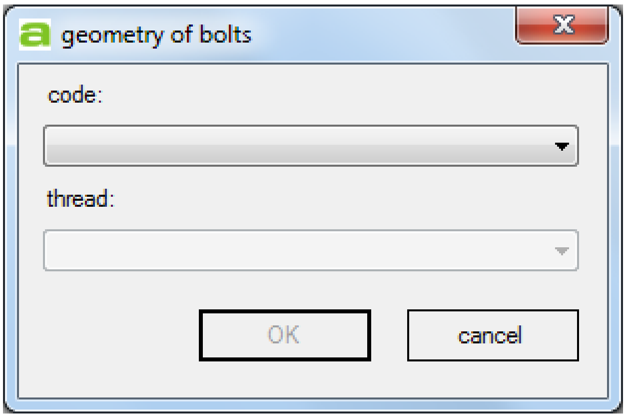
In dependence on the selected bolt various input forms are available.



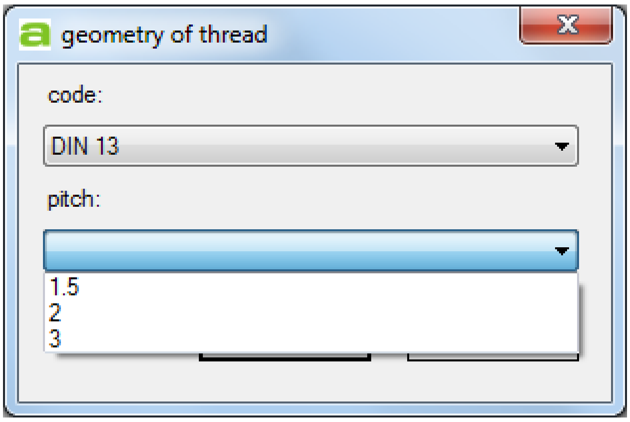
To illustrate the required input variables, a drawing of the part is shown in the right area, showing the nomenclature of the geometry sizes.

At the top line of the input mask, the recommended thread is displayed, which is defined by the flange geometry you previously defined.

The numerical values can either be entered manually in the fields or, if it is standardized dimensions are read from a database. For this purpose is the button "norm" available.



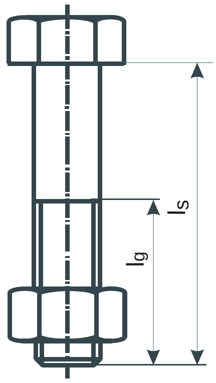
After determining the mounting screw, the program automatically moves to the input mask "thread geometry" to select the standard thread (and after the choice of the standard thread back to the screen "geometry screws").



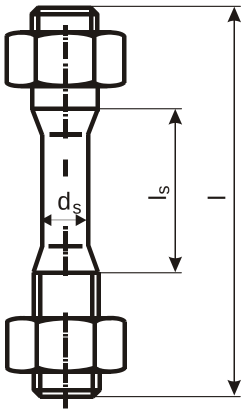
When the bolt geometry manually entered into the fields, the thread geometry is "thread" defined directly in the mask.

In the following different forms bolts are available:

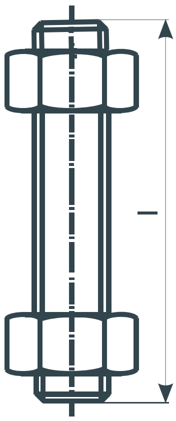
- screw



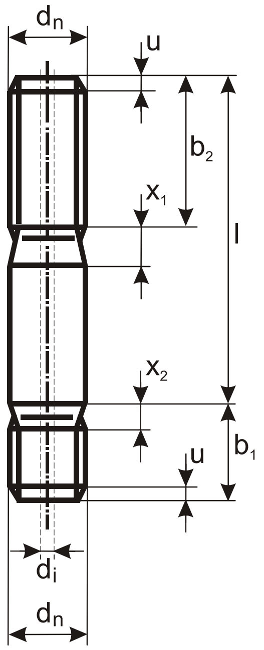
- anti-fatigue bolt



- stud



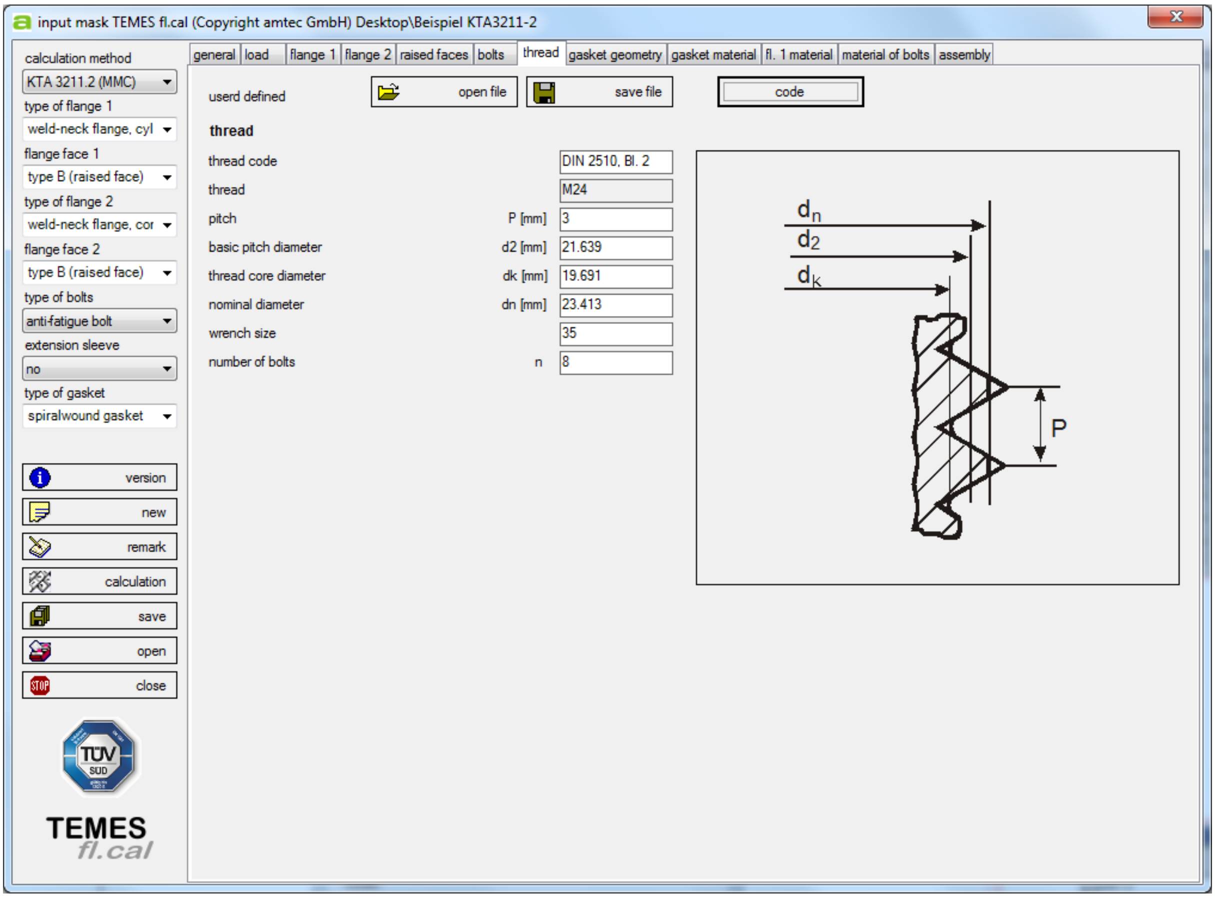
- stud metal end



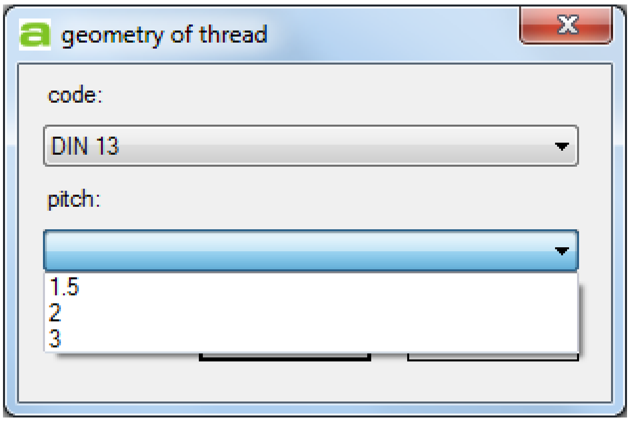
The input variables in the input mask "bolts geometry" can stored with the button „save record“ and are available for further calculations again. The reading of data is done via the button "open data" on the screen

3.6.7. Mask “thread“

For the geometry data of the thread is a separate input mask available. This mask "thread" is skipped and the selection of a standard geometry for screws in the "bolts geometry is shown."



Here you have the option of manually entering the thread geometry or the selection of a standard geometry.



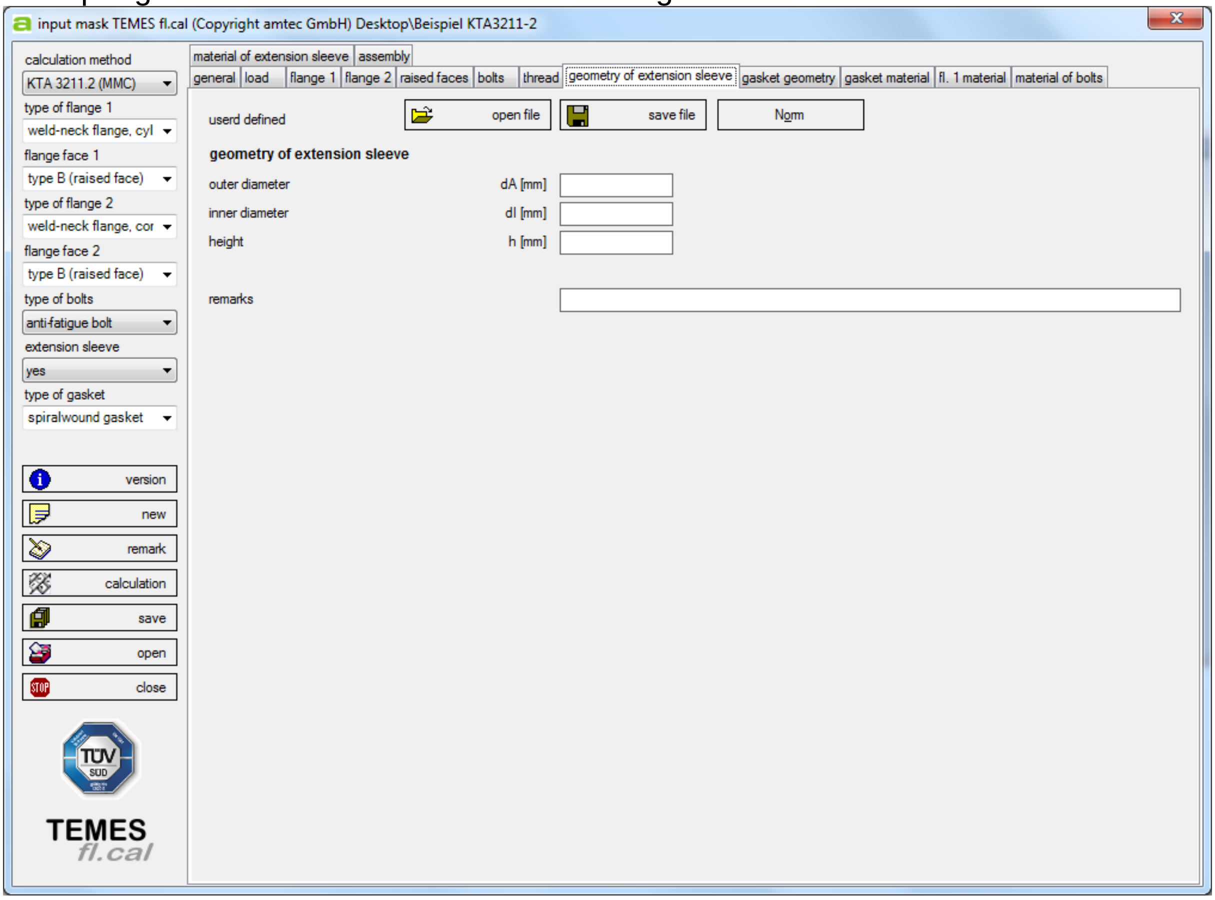
In this screen, the number of bolts of the flange is defined.

These inputs can stored with the Button "Save File" and are available for further calculations.
The reading of data is done via the button "Open file" in this mask.

3.6.8. Mask “geometry of extension sleeve“

If you selected a flange with extension sleeves on the left side, a separate entry screen appears. In this mask the outside diameter, the inner diameter and the height of the expansion sleeves need to be entered.

The expansion sleeves are used to calculate the correct clamping length of the bolts and spring as an additional element in the flange.

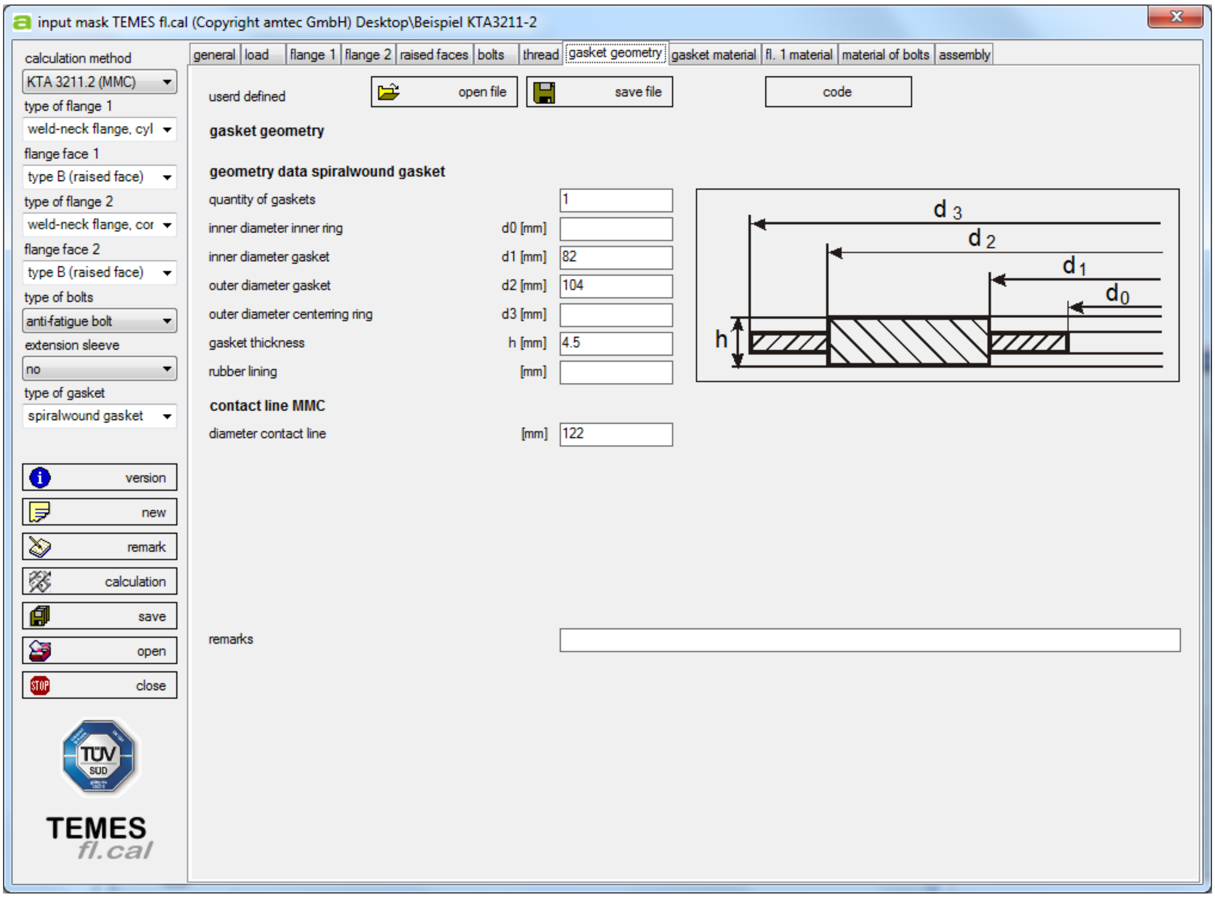


These inputs can stored with the Button "Save File" and are available for further calculations.
The reading of data is done via the button "Open file" in this mask.

3.6.9. Mask “gasket geometry“

Depending on the selected flange geometry different input masks are available:

To illustrate the required input variables, a drawing of the seal is shown in the right area, showing the nomenclature of the geometry sizes:



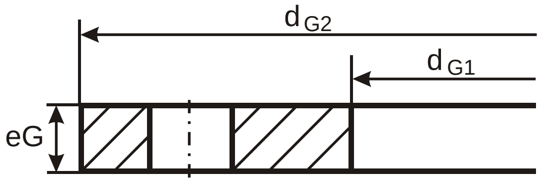
The different gasket parameters can either be entered manually in the fields or, if it is standardized dimensions are read from a database. For this purpose the button "norm" is available.

These inputs can stored with the Button "Save File" and are available for further calculations.
The reading of data is done via the button "Open file" in this mask.

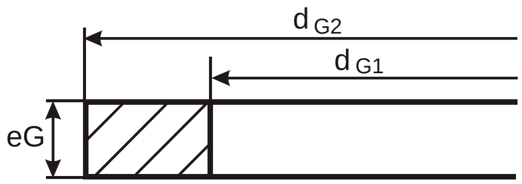
In this mask, the input for the diameter of the contact point of the power shunt takes place.

The following different types of gaskets can be defined in order to achieve an accurate determination of the effective sealing surface and the acting lever arms:

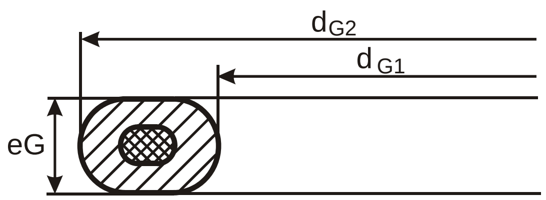
- flat gasket (Form FF)



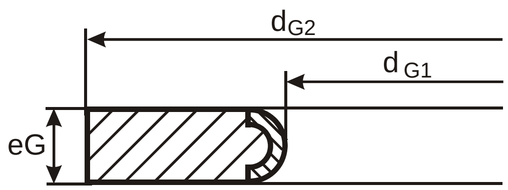
- non-metallic flat gasket (Form IBC / TG / SR)



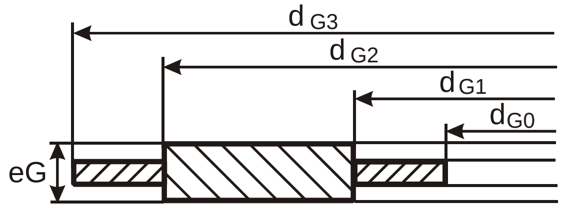
- rubber gasket with inserts



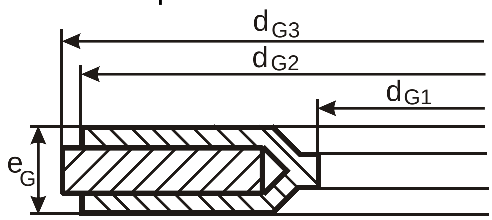
- sheet gasket with inner eyelet



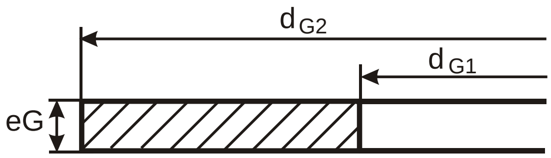
- spiral wound gasket



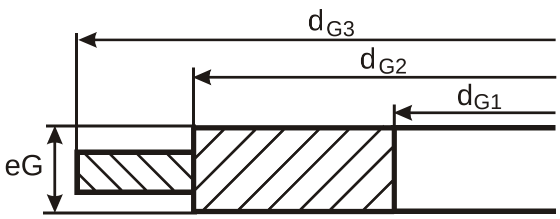
- sheet gasket with PFTE envelop



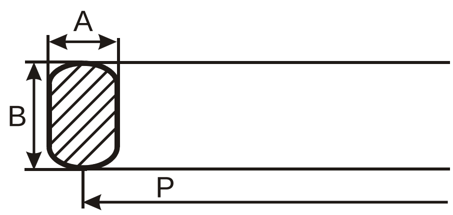
- metallic gasket with flat or corrugated profile (type SC)



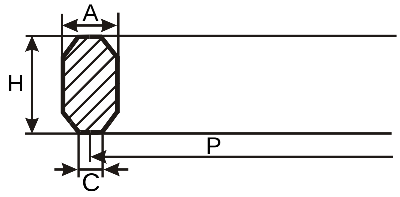
- metallic gasket with flat or corrugated profile (type CR)



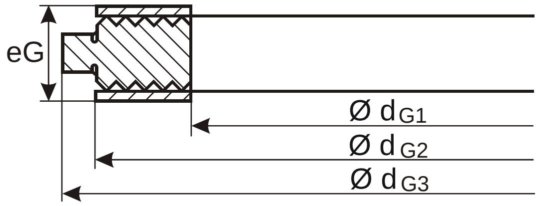
- RTJ-gasket (ovale type)



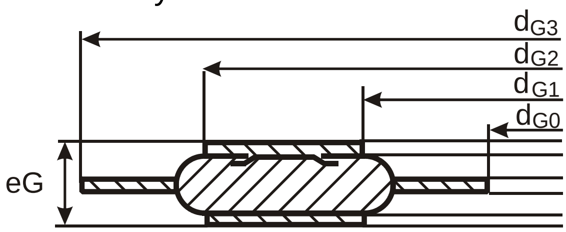
- RTJ-gasket (octogonal type)



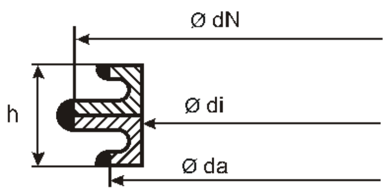
- Kammprofile gasket



- Metal jacketed gasket with layers

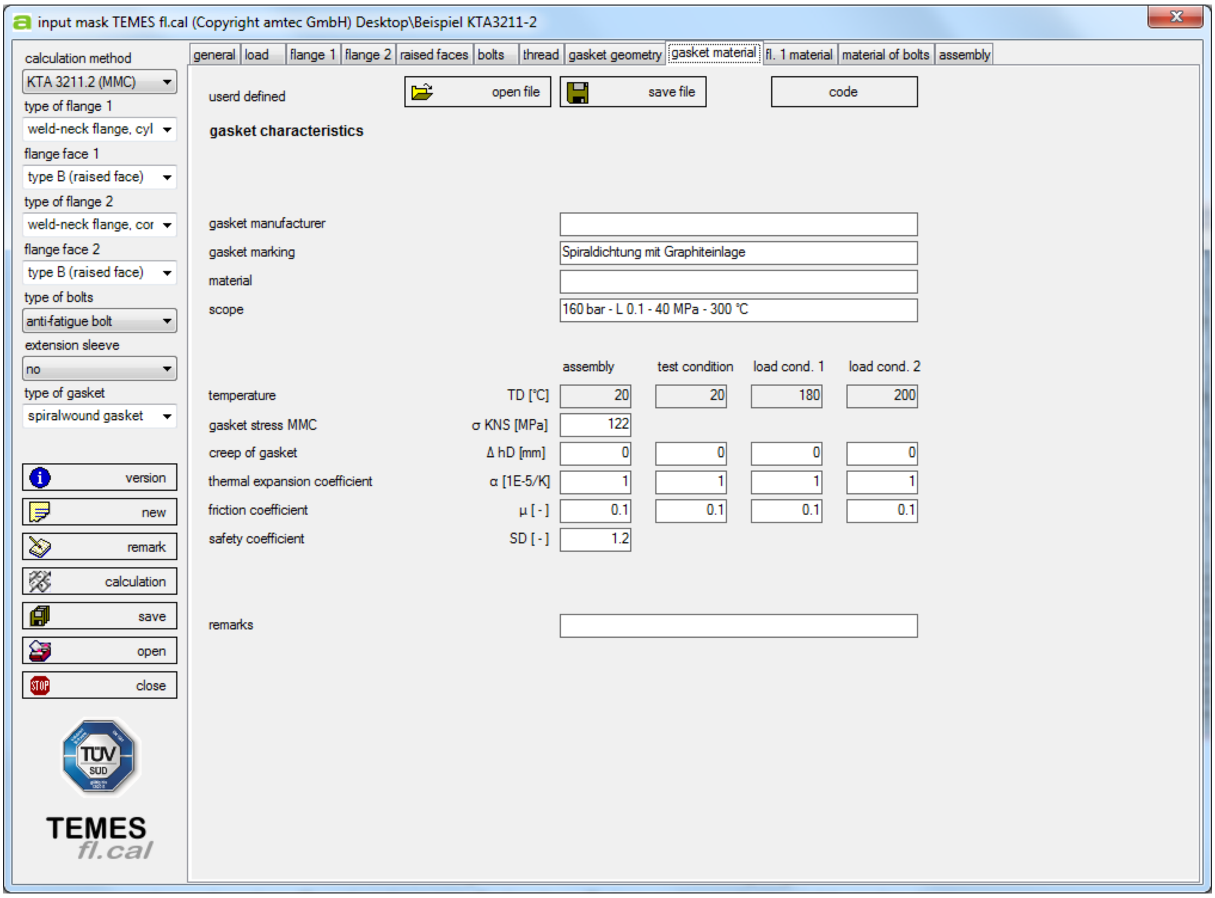


- Welded lip gasket



3.6.10. Mask “gasket material“

In the input mask "gasket material" the gasket characteristics are entered to DIN 28090-1.



Standard Data are not available for the gasket characteristics or no longer reflect the state of the art.

Gasket characteristics given from the manufacturers can stored with the Button "Save File" and are available for further calculations.
The reading of data is done via the button "Open file" in this mask.

To achieve the leakage in a power shunt connection, a characteristic force is required, which depends on the geometric relations between the gasket and the groove in substantially. This force is always related to the gasket face and specified as required gasket stress σ_{KNS} to meet the leakage.

The creep of gasket ∆ hD denotes the creeping of the gasket under the applied strength under temperature.

Thermal expansion coefficients are also not available for the gasket materials. The default value here, a value of 10 • 10-6 1 / K is attached. The usually small gasket height compared to the thickness of the flangering, this approximation is acceptable.

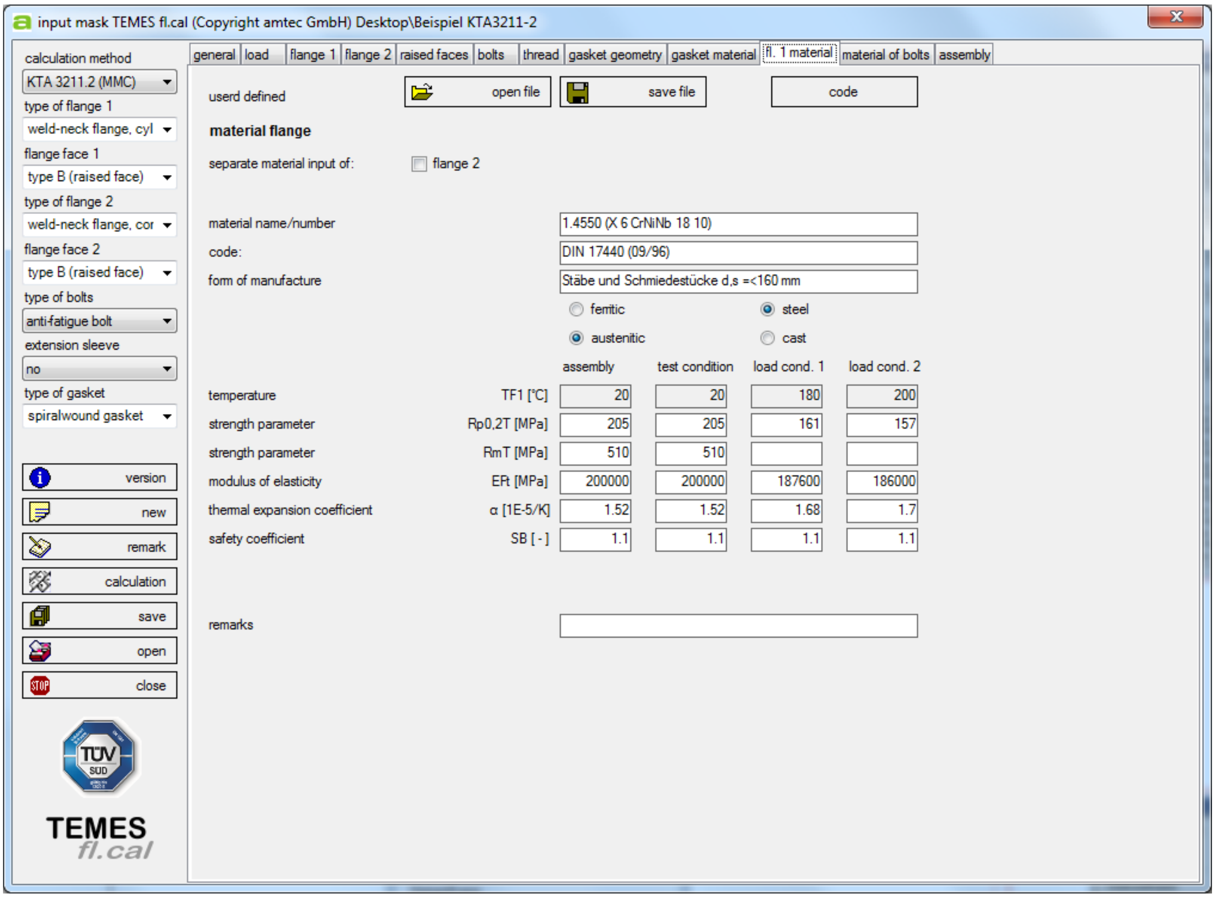
The coefficient of friction for the gasket materials that will be needed to calculate the additional axial force required to shear forces and torsional moments can be transmitted by friction is, if no test results are available, to use of KTA 3211.2 as follows:

- 0,05 for gasket PTFE-based,
- 0,1 for graphit gaskets,
- 0,15 with metallic pads with a smooth surface and
- 0,25 with uncoated fiber based gaskets.

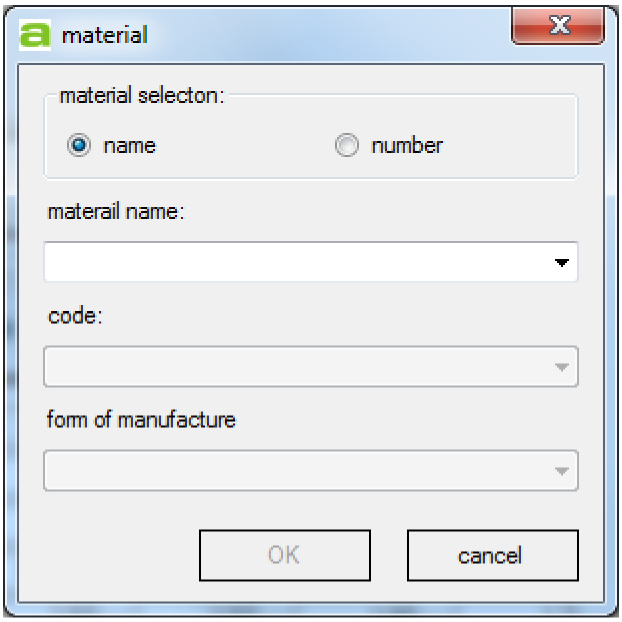
The safety coefficient used in the dimensioning calculation is set to 1,2.

3.6.11. Mask “fl. 1 material“

In the input mask "Flange Material 1", the strength characteristics of the material used for loose flange and flange 1 of the stub/flare can be entered. At the same time can you can choose the material for the other flange (flange 2, loose flange 1 / 2) if they are made of a different one. Therefore you must click "separate material input for ....." in the input mask.



The numerical values can be either manually entered or imported into the fields from a database. For this purpose the button "norm" is available.



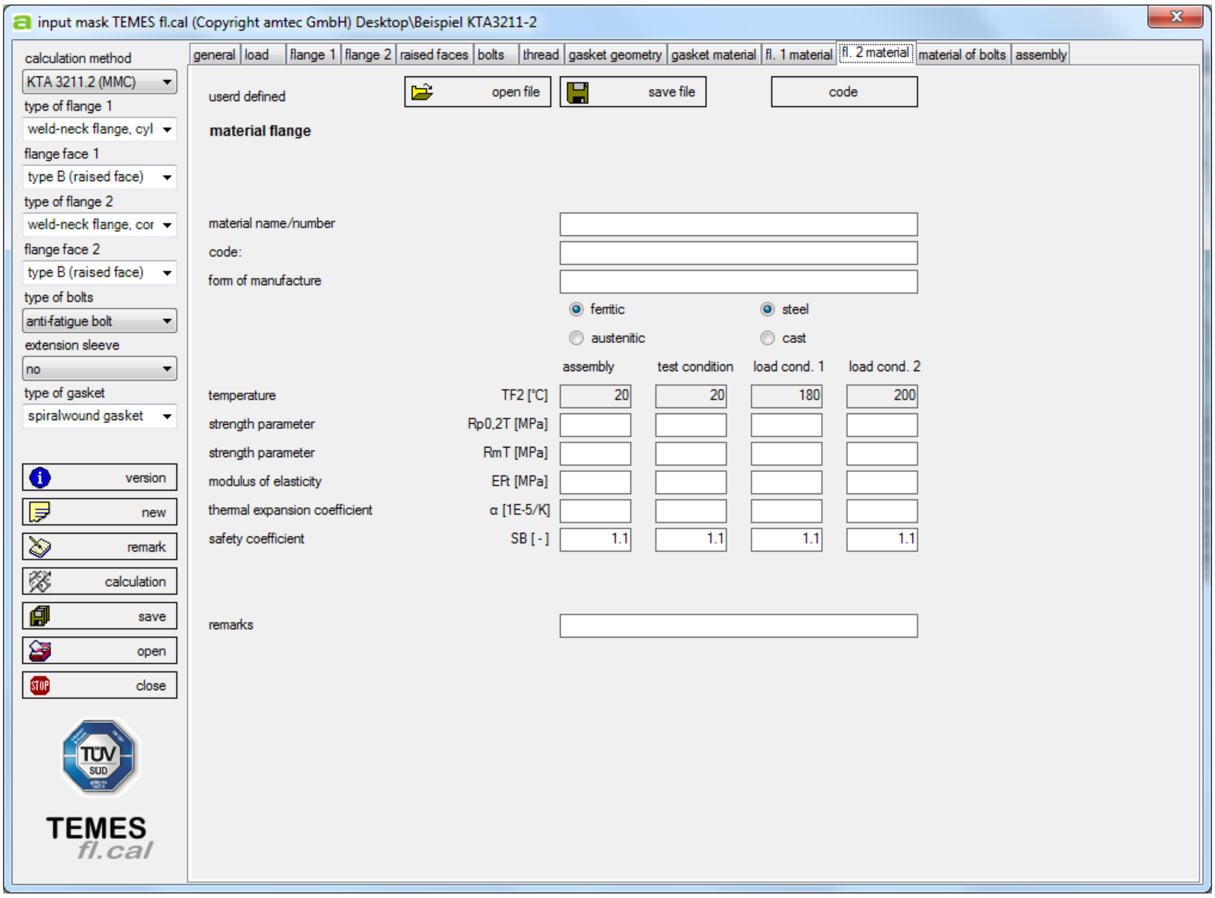
After the selection of the material via material name or number, the code can be defined in a dialog box, and finally you can select the form of manufacture in a third dialog box.

As long you made no changes to this selected data from the database, the values are also automatically updated when you are changing the temperature of a load condition. This does not happen if you modified or entered the data manually.

Manual inputs can stored with the button "save file" and are available for further calculations again. The reading of data is done via the "Open file" also on this mask.

3.6.12. Mask “fl. 2 material“

For the material of flange 2, there are the same functions as for the material of flange 1 available. To enable this input mask for the flange 2, you need to activate „separate material input flange 2" in mask of „flange 1 material“.



3.6.13. Mask “material of bolts“

In the input mask "bolt material", the strength characteristics of the material can be entered.

It offers the same functionality like in the input screen of the material of flange 1.

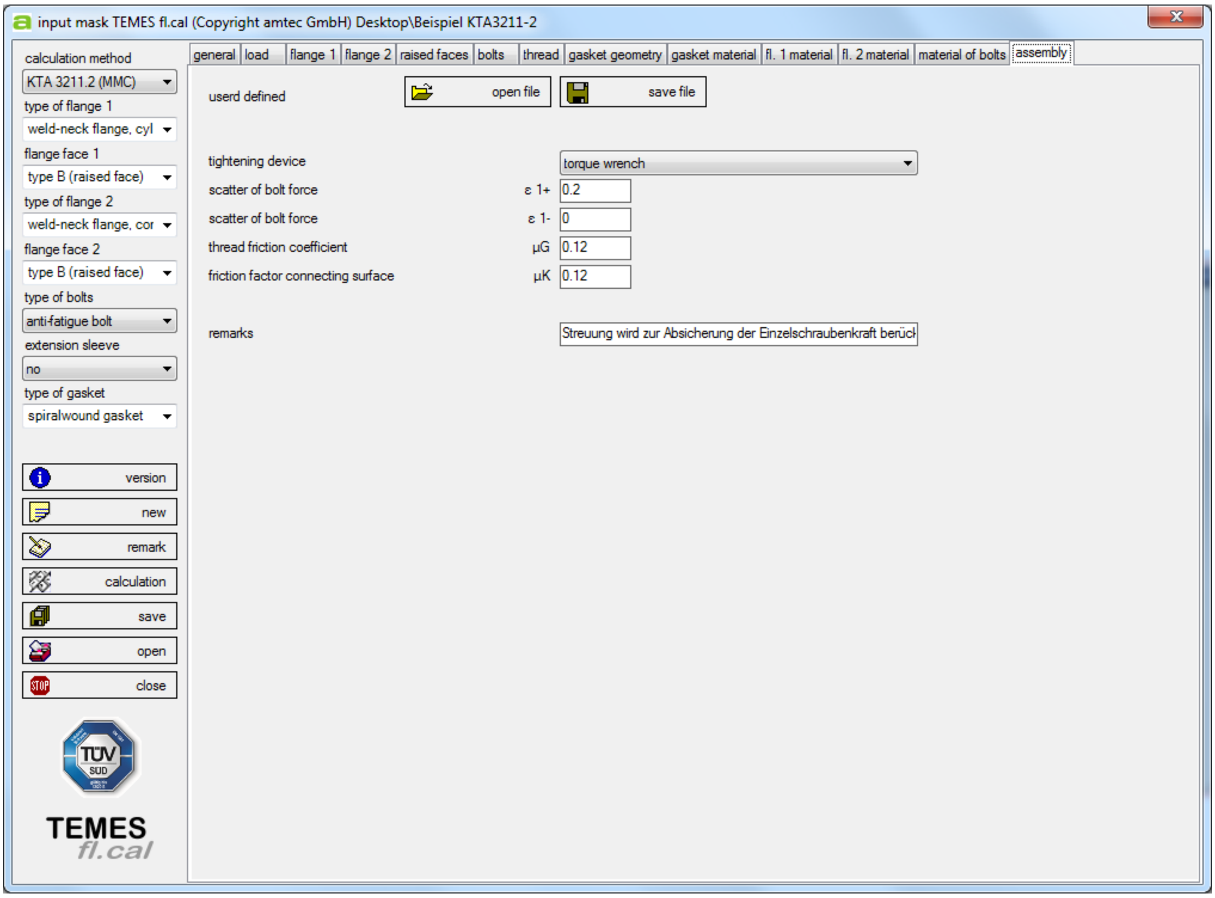
3.6.14. Mask “material of extension sleeve“

In the input mask "material of extension sleeve", the strength characteristics of the material can be entered.

It offers the same functionality like in the input screen of the material of flange 1.

3.6.15. Mask "assembly"

The last input screen contains the information that are necessary for the calculation of the assembly requirements specifications, such as tightening device, scatter band of the tightening and friction coefficients.



The dialog box "assembly" are selectable various tightening devices. The associated scattering values used to calculate the bolt force are provided in Annex C of EN 1591-1.

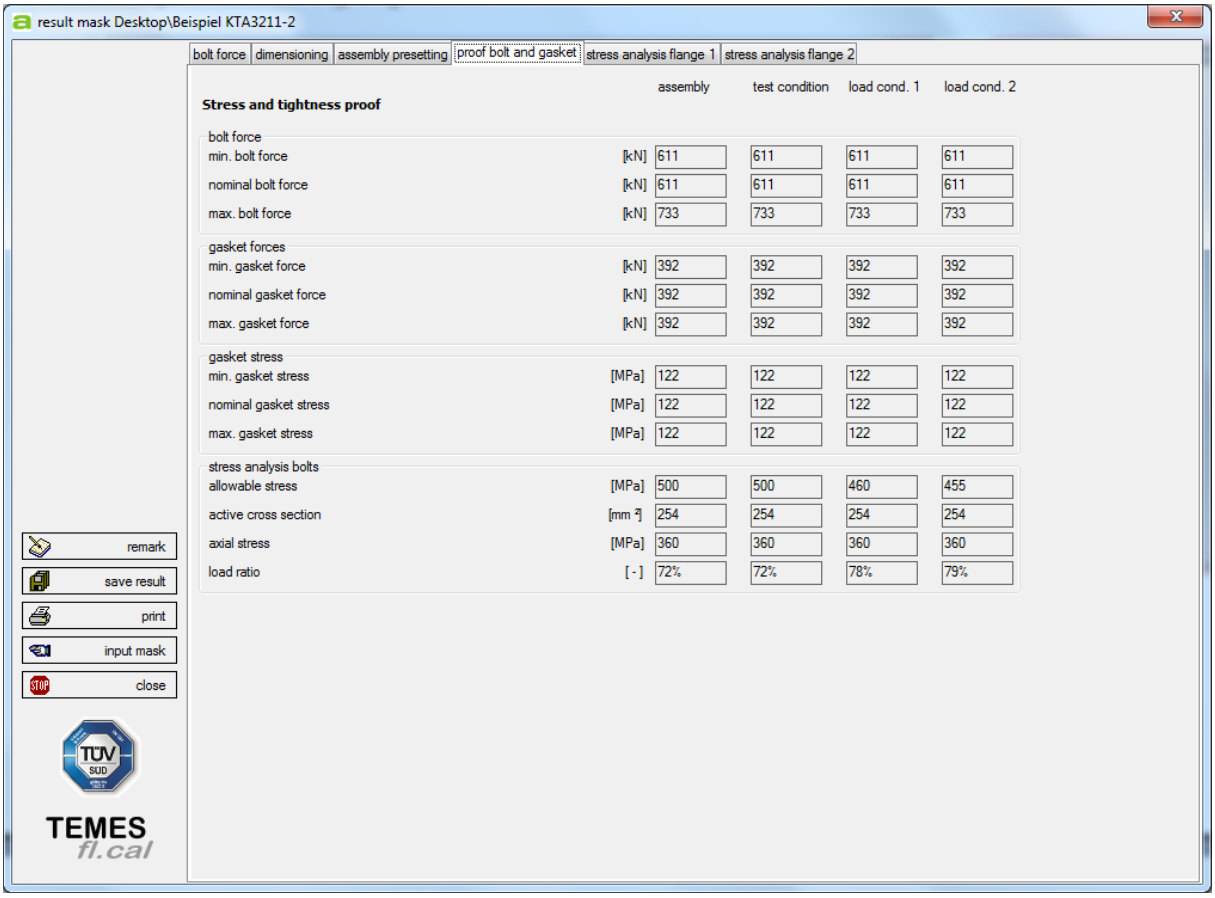
Additional tightening devices with other scatter values can stored as user records with "save file" and are available for further calculations via the button "open file".

In the draft rule change proposal of KTA 3211.2 is mentioned, that the tightness proof must be provided with the average computational bolt force, so that the negative dispersion value ε_{1-} can be set to "zero". The strength analysis of the flanges and the bolts must be considered with the scatter band of the tightening device.

Verify the strength of the flanges and screws is to exhibit, taking into account the scatter band of the tightening. For assembly with a torque wrench the factor of "0.2" is proven.

3.7. Program module KTA 3211.2 (KNS) – results

With the "Calculate" button the calculation is started. Are all input data available, the program displays after the end of the calculation routine the output mask "proof bolt and gasket" in which the maximum permissible bolt force, and torque bolt elongation are displayed.



In the head of the results mask multiple choice riders appear, via these riders you can be accessed through the various output masks.

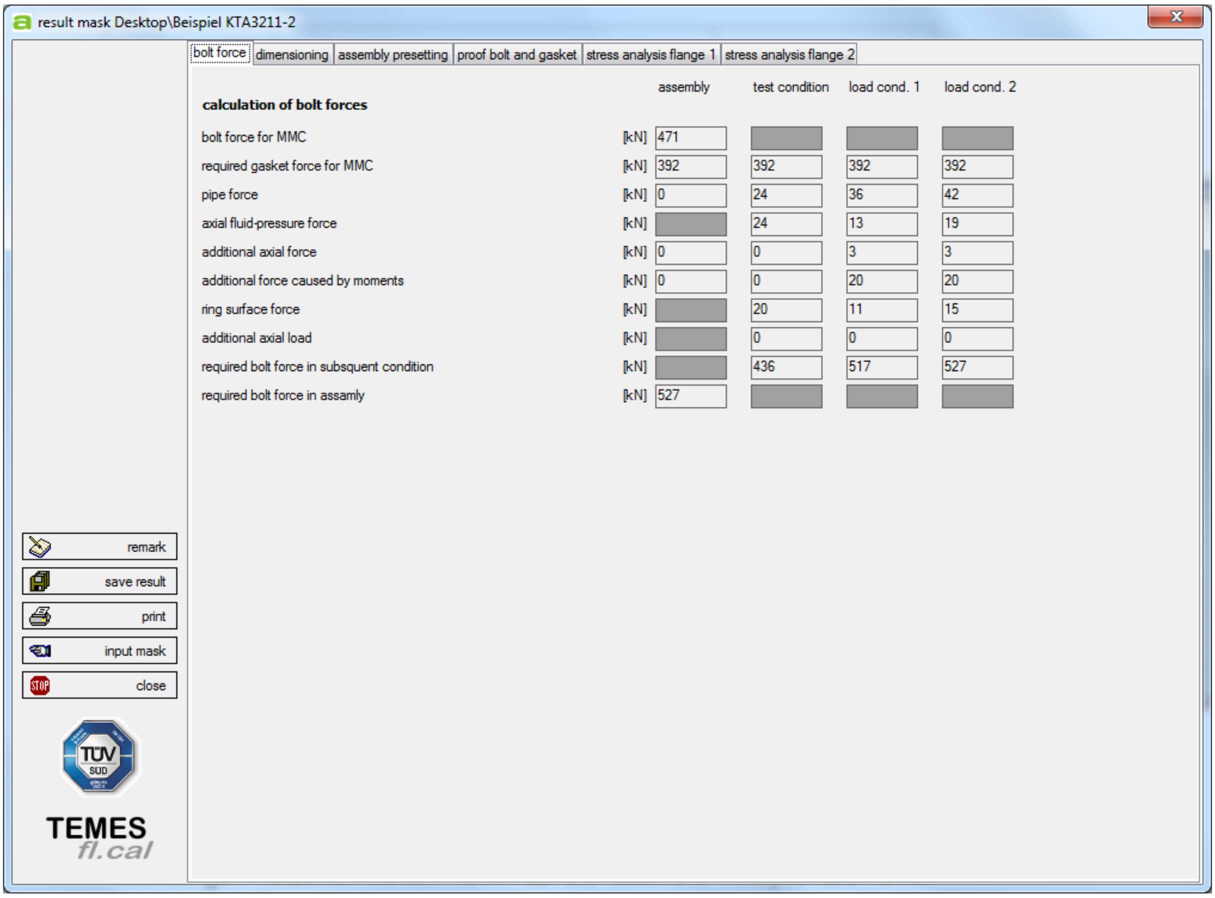
The individual result tables will be described now:

3.7.1. Mask “bolt force“

In the output mask "bolt forces" are the dimensioning of the bolt calculated forces are shown according to KTA 3211.2 Appendix A 2.9.4

In detail, these are the force due to internal pressure, the additional forces from a pipe acting axial force or bending moment, the annular surface force, the additional force to shear forces and torsional moments can ablate and the minimum required gasket force. As a result is the required bolt force for each load condition.

Finally, the required assembly bolt force is determined, which must be used for all further steps for the dimensioning of the components. But this required bolt load for the assembly condition is not the same as the bolting-up, which is determined when detailed tightness and strength assessment.

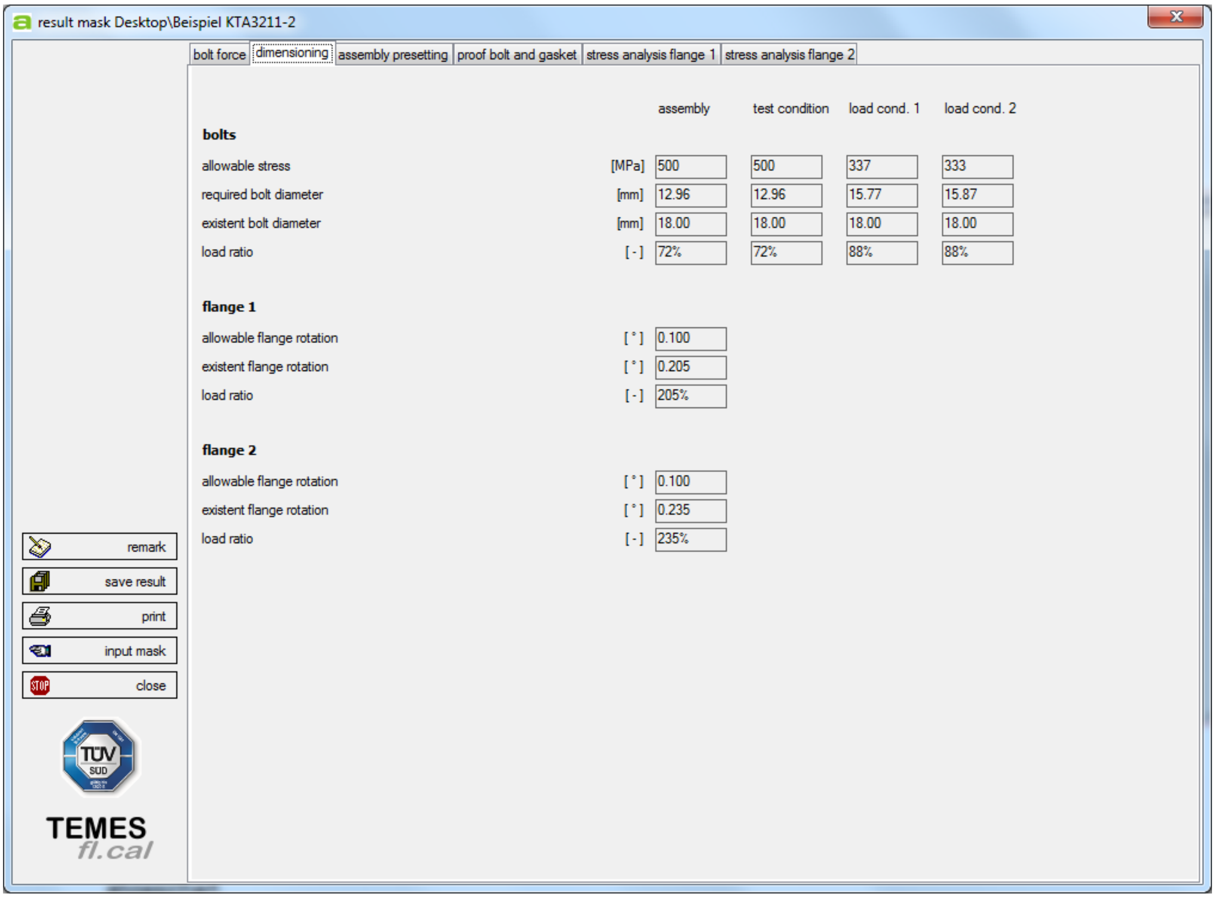


calculation of bolt forces		assembly	test condition	load cond. 1	load cond. 2
bolt force for MMC	[kN]	471			
required gasket force for MMC	[kN]	392	392	392	392
pipe force	[kN]	0	24	36	42
axial fluid-pressure force	[kN]		24	13	19
additional axial force	[kN]	0	0	3	3
additional force caused by moments	[kN]	0	0	20	20
ring surface force	[kN]		20	11	15
additional axial load	[kN]		0	0	0
required bolt force in subsquent condition	[kN]		436	517	527
required bolt force in assamly	[kN]	527			

Principle can be dispensed with sizing calculation for existing compounds, since the detailed analysis of a leak and strength assessment is to be regarded as superior. In this case, the estimate assembly bolt force from the sizing calculation is used as a benchmark for the detailed proof.

3.7.2. Mask “dimensioning“

In the mask "dimension of bolts" the results of the dimensioning of the bolt are shown:



The required bolt diameter is hedged according to KTA 3211.2 Appendix A 2.9.4.3.

To determine the allowable stress of the bolt material is in the dimensioning of screw and studs, a safety factor of 1.1 (assembly and test condition) or 1.5 (load cond. 1/2) for all other types of bolts a safety factor of 1.3 (installation and test condition) or 1.8 (operation 1/2) applied. These values are stored within the program.

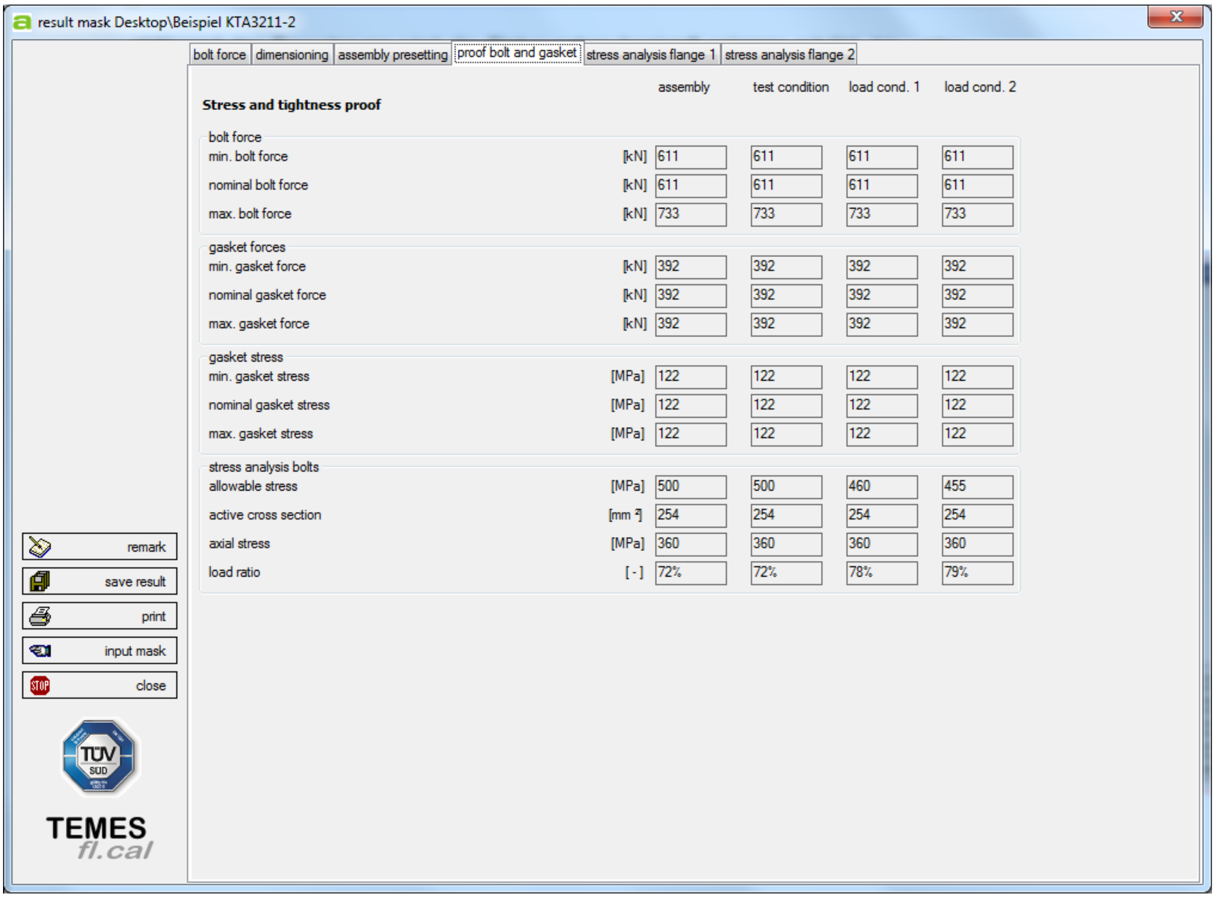
When sizing the required moment of resistance of the flanges is secured in accordance with KTA 3211.2 Appendix A 2.10.4.

It is considered that there is no need for a sizing calculation for existing compounds, since the detailed analysis of a leak and strength assessment is to be regarded as superior. A shortfall of the required bolt diameter is tolerable in this case.

3.7.3. Mask "proof bolt and gasket"

Just after the calculation routine is finished, the program jumps to this result mask.

During the calculation, the assembly bolt force is increased until leakage in consideration of the value of the tightening device is a capacity in a case of 100% load. For this force, the associated bolt elongation and the associated torque are reported (in accordance with VDI 2230). At the same time this power is held as a maximum permissible bolt force in load conditions 1 and 2.



The user can now choose the assembly bolt force in the field "[Selected bolt force for assembly"]. Based on these selected force all resulting quantities are calculated from new and reported back. When choosing the assembly bolt force its necessary to assure that the maximum permissible bolt force in the assembly load is not exceeded, and that it is not too small, ie, to avoid undue discharge of the minimum gasket stress.

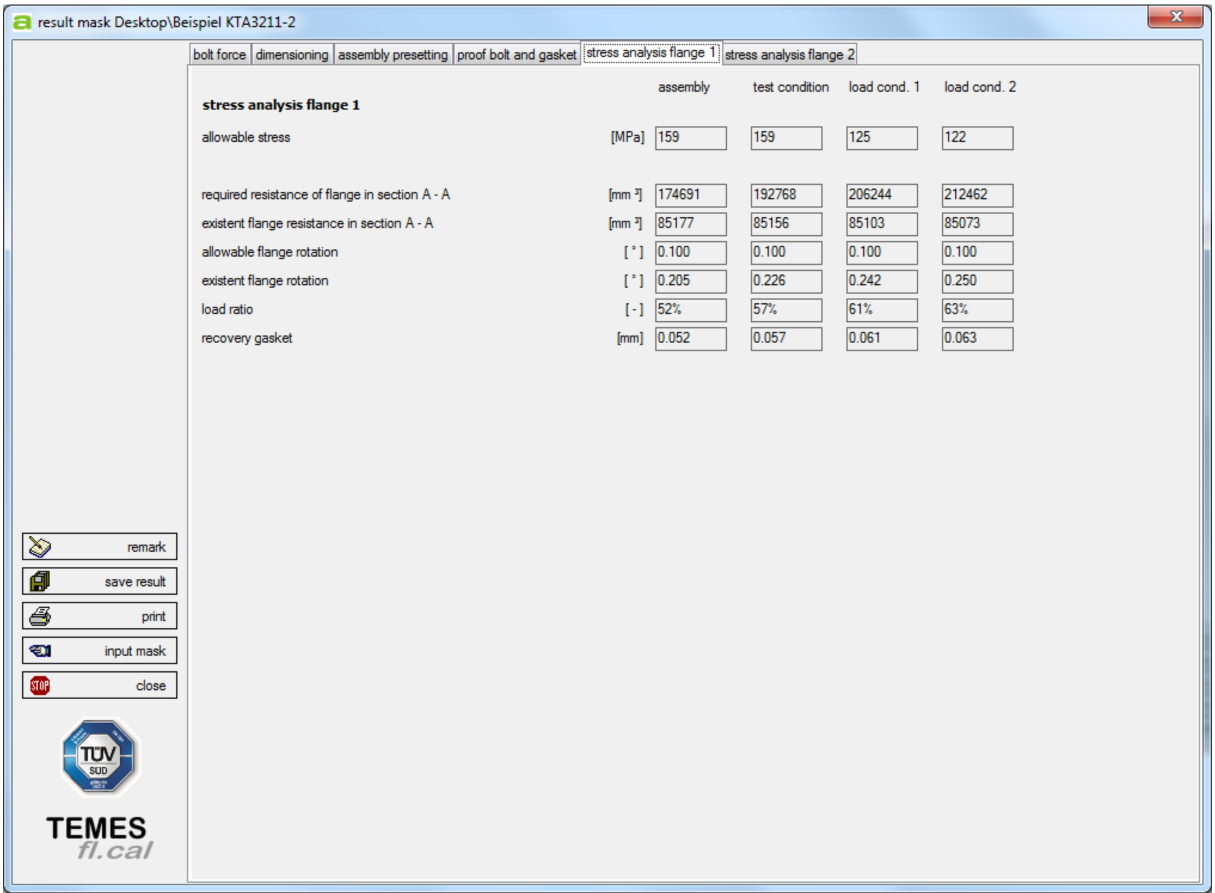
Based on the selected assembly bolt force the minimum and maximum bolt force or gasket stress is determined by considering the scatter band of the tightening device. With the minimum gasket force or gasket stress takes the tension protection..

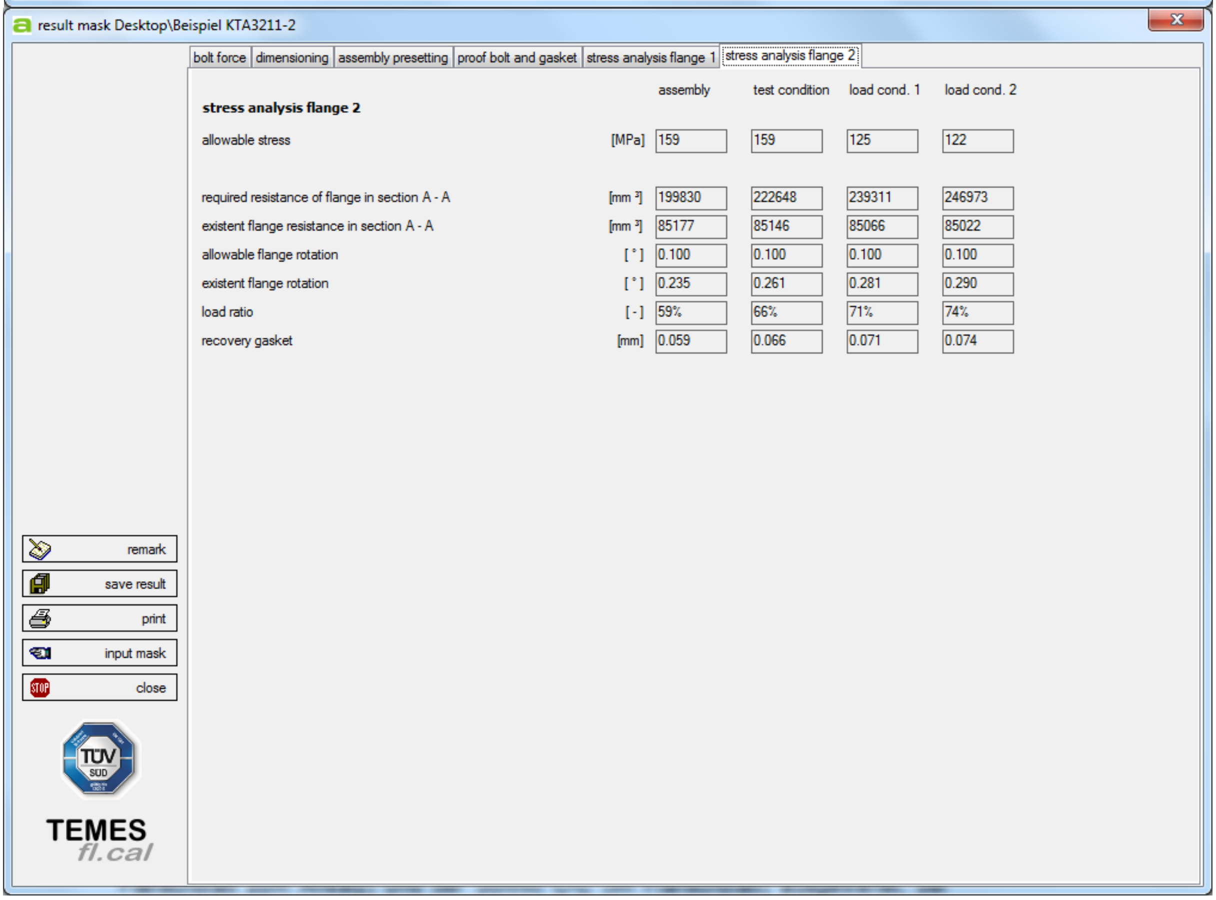
The determined forces in the assembly state are under consideration of the tension state, that means under considaration of the stiffness and the thermal expansion of the individual components, acc. to KTA 3211.2 2.10.6 Appendix A, the forces calculated for the subsequent states. Now you can make the leakproofness test with the minimum force, and the proof of strength with the maximum force.

For the bolts in the detailed analysis of the tension protection according to KTA 3211.2 Table 6.7-2 (no.:5 "taking account to the tension state ..."), always use a safety factor of "1.1":

3.7.4. Mask “stress analysis flange 1”, “… flange 2“

For the determined maximum forces in every condition, the moments of resistance getting calculated new and protected against the available moments of resistance of the flange.


result mask Desktop\Beispiel KTA3211-2
bolt force
dimensioning
assembly presetting
proof bolt and gasket
stress analysis flange 1
stress analysis flange 2
stress analysis flange 1
assembly
test condition
load cond. 1
load cond. 2
allowable stress [MPa] 159 159 125 122
required resistance of flange in section A - A [mm ³] 174691 192768 206244 212462
existent flange resistance in section A - A [mm ³] 85177 85156 85103 85073
allowable flange rotation [°] 0.100 0.100 0.100 0.100
existent flange rotation [°] 0.205 0.226 0.242 0.250
load ratio [-] 52% 57% 61% 63%
recovery gasket [mm] 0.052 0.057 0.061 0.063
remark
save result
print
input mask
close
TEMES
fl.cal


result mask Desktop\Beispiel KTA3211-2
bolt force
dimensioning
assembly presetting
proof bolt and gasket
stress analysis flange 1
stress analysis flange 2
stress analysis flange 2
assembly
test condition
load cond. 1
load cond. 2
allowable stress [MPa] 159 159 125 122
required resistance of flange in section A - A [mm ³] 199830 222648 239311 246973
existent flange resistance in section A - A [mm ³] 85177 85146 85066 85022
allowable flange rotation [°] 0.100 0.100 0.100 0.100
existent flange rotation [°] 0.235 0.261 0.281 0.290
load ratio [-] 59% 66% 71% 74%
recovery gasket [mm] 0.059 0.066 0.071 0.074
remark
save result
print
input mask
close
TEMES
fl.cal

For flanges with a cylindrical neck of the section A-A (transition flange face to approach), and the section C-C (in flange face) is always evaluated, wherein flanges having a conical neck of the section B-B is considered (transition approach to the tube). For loose flange connections nor the loose flange itself is secured beyond.

For flanges at the tension protection during the detailed analysis according to KTA 3211.2 2.10-1 Table A ("considering the tension state ..." No. 4) always use a safety factor of 1.1.
At small sizes (diameter ratio dF / di> 2) still takes a requirement for tension reduction by a factor Φ, which is included in the software **TEMES*fl.cal***

If flange 1 is designed with a blind hole, the required depth is calculated according to KTA 3211.2 Appendix A 2.9.4.4.2. There the stripping strength of the bolt thread, the stripping strength of blind hole thread and adherence to a tried and tested criteria is checked. Failure to meet any requirement of this limiting criterion is explicitly shown.

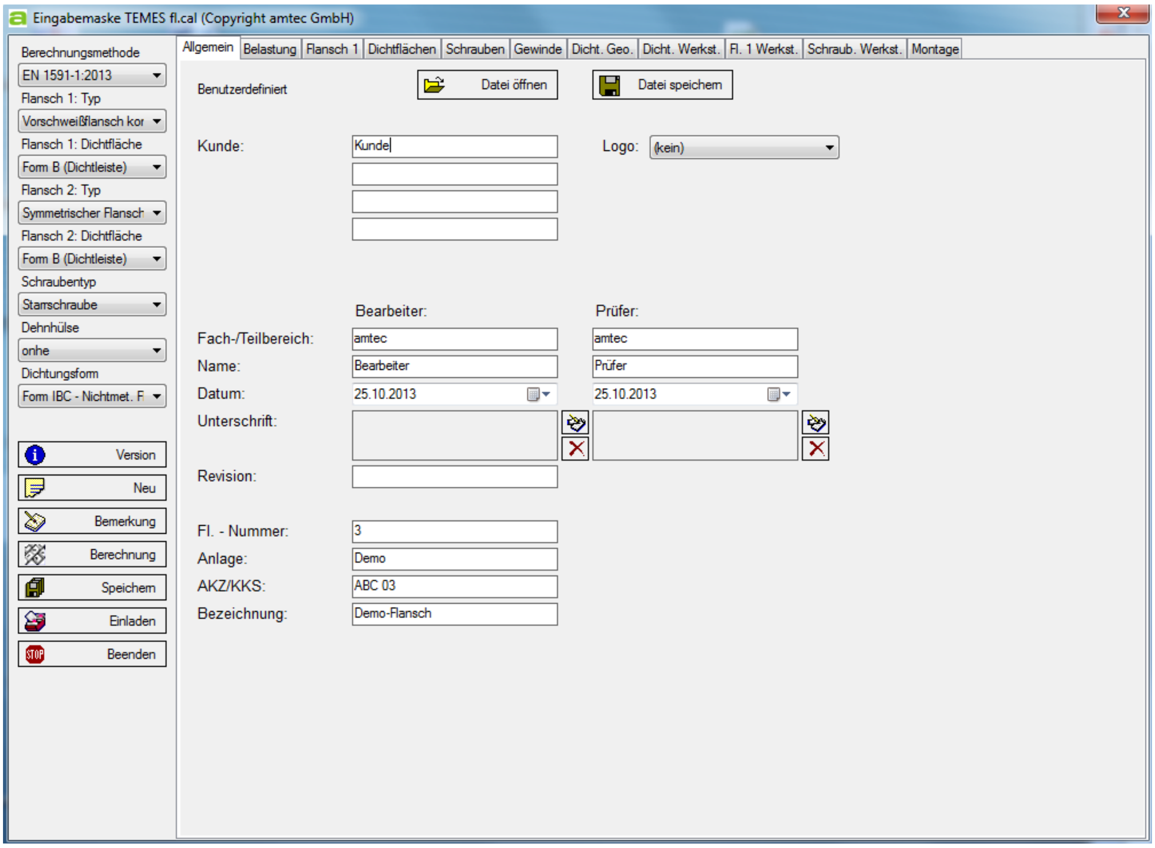
The tension protection of flange 2 is the same like the protection of flange 1.
A special feature represents only the blind flange, which is regarded like the dimensioning acc. To KTA 3211.2 Appendix A 2.7.3.2.

3.8. Program module EN 1591 – user interface

This chapter describes the input screens of the program module EN 1591:

3.8.1. Mask “general“

In the mask “general“ you can enter information about the calculation, see screenshot below.



There are four input fields for customer data, fields for division, name, date and signature of the editor in the column “calculated:” and the same four fields for the auditor in the column “checked:” as well as the revision of the calculation. For a unique assignment of the calculation to a flanged joint, a flange number, plant name, identification code and a nomenclature (description) of the flange can be entered.

The logo of the customer you are making the calculation for must be in *.wmf-format added in the installation folder of your **TEMES*fl.cal*** installation (e.g. D:\TEMES flcal 7.xx\logo.wmf).

For optimal viewing and logo quality, we recommend an aspect ratio of 1:3.
This logo is then automatically added to the calculation printout.

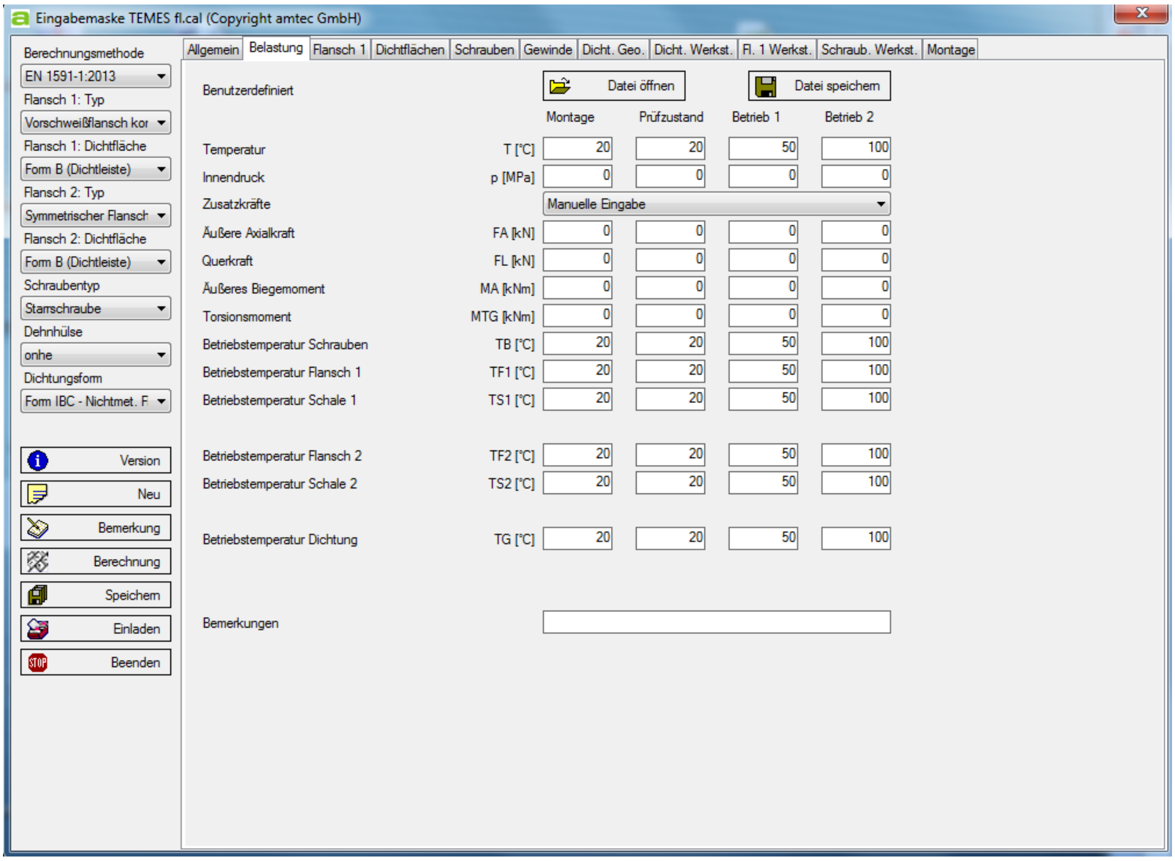
These inputs can be stored with the button "save file" and are available for further calculations.
With the button "open file" you can fill in all input fields on this mask with predefined values.

3.8.2. Mask “load“

In the mask "load" four load cases are specified:

- assembly (assembly conditions, unpressurized, bolting torque)
- test condition (leak test)
- Operation 1 (e.g. normal operation)
- Operation 2 (e.g. operation with design conditions)

For each of the four load cases the loads temperature, internal pressure, external axial force and bending moment can be defined. The consideration of shear forces and torsional moments is not possible in EN 1591-1.



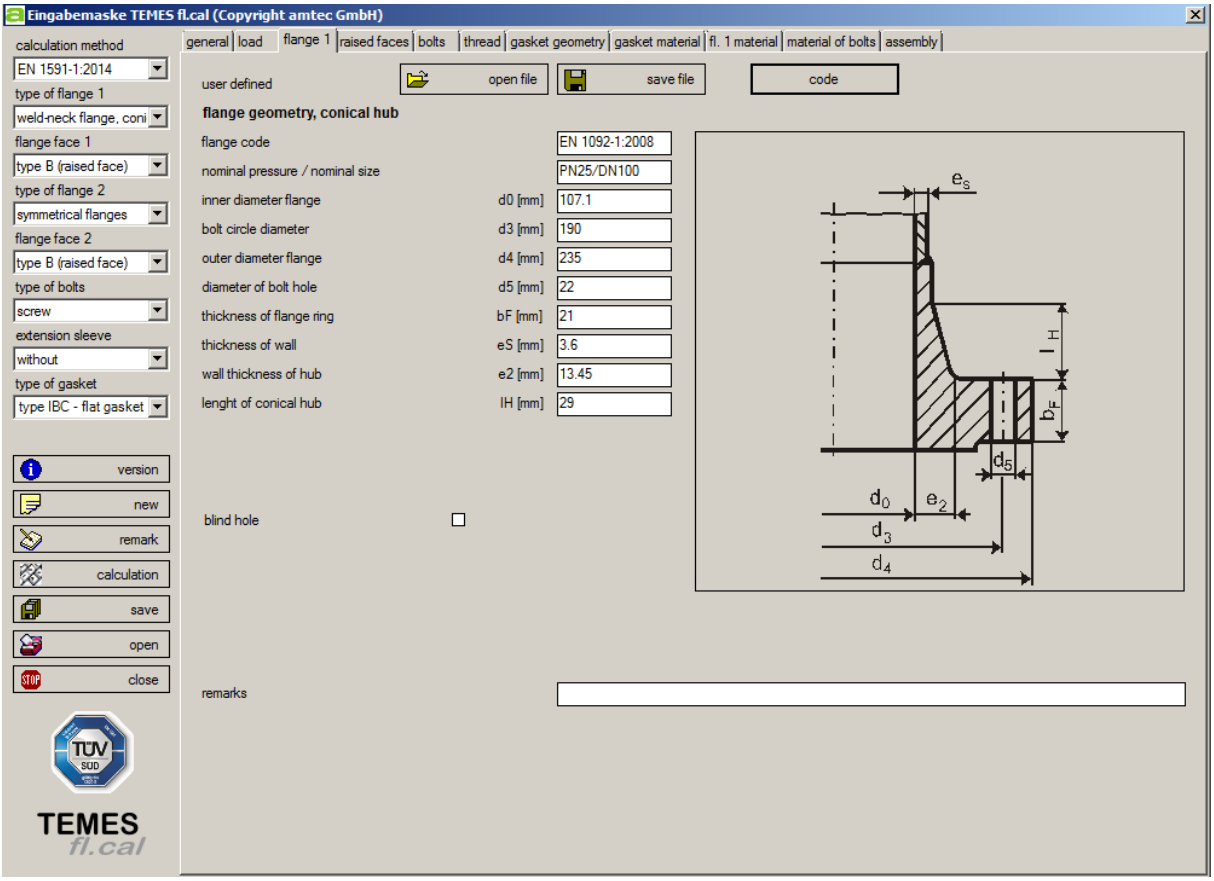
In accordance with the entries in the "temperature" input field, the temperature of each load case is applied to all components of the connection. It is also possible to assign individual component temperatures in the input fields below but if you enter a value in the “temperature” input field at the top of the mask, all individual component temperatures for this load case are replaced with the global value.

Also affected by changes in temperature input are the strength values of the flanges and bolts, unless they are read from the database.

These inputs can be stored with the Button "save file" and are available for further calculations.
The reading of data is done via the button "open file" in this mask.

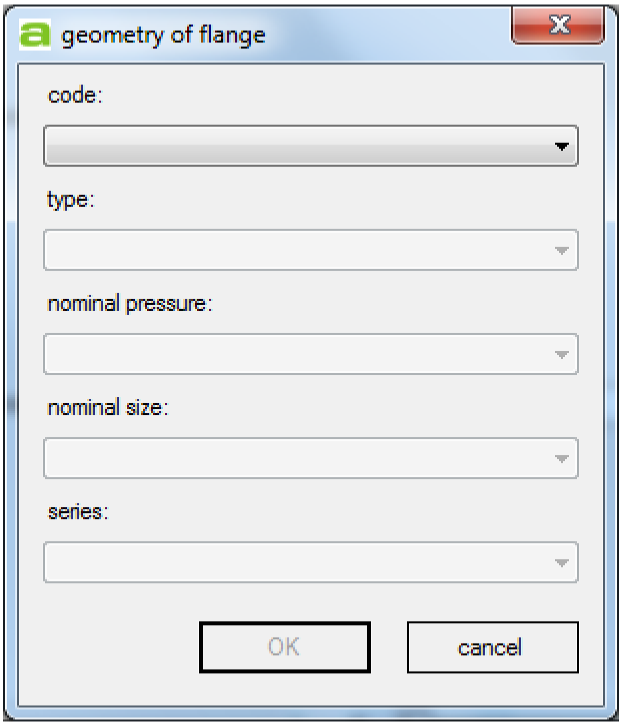
3.8.3. Mask “flange 1“

Depending on the selected flange geometry different input masks are available.



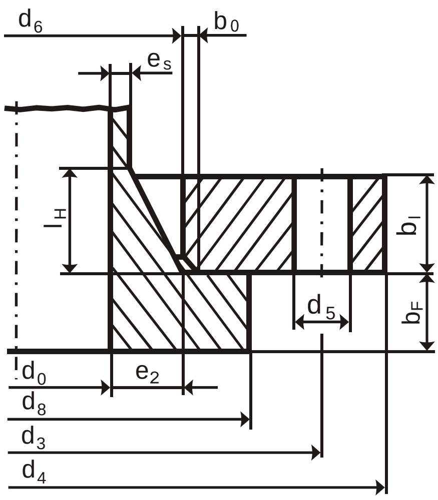
To illustrate the required input variables, a drawing of the part is displayed in the right area, showing the nomenclature of the geometry dimensions.

The numerical values can either be entered manually in the fields, or – if the dimensions are defined in a standard – they can be read from a database. For this purpose you find the button "code".

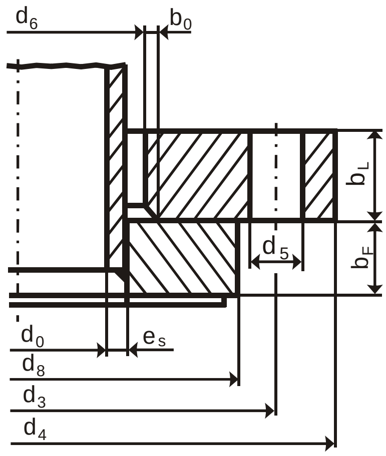


The following different geometrical shapes can be defined for flange 1:

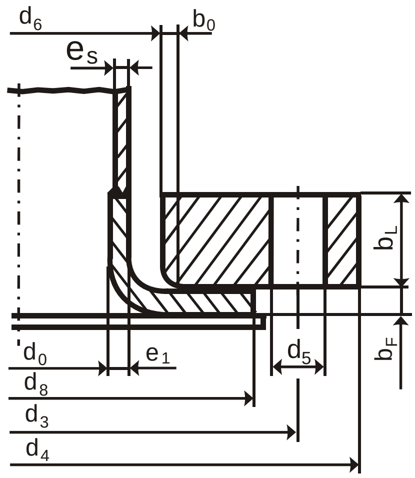
- loose flange, conical hub



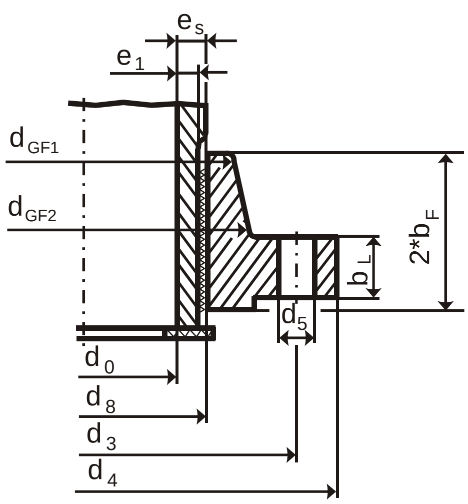
- Loose flange, cylindrical hub 1



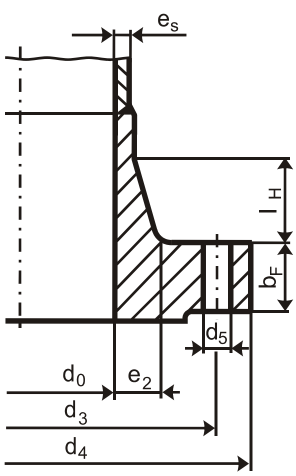
- Loose flange, cylindrical hub 2



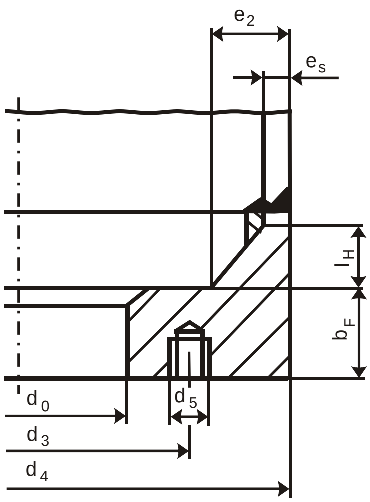
- hubbed threaded flange



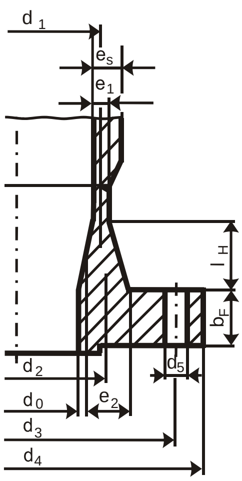
- weld-neck flange, conical shell 1



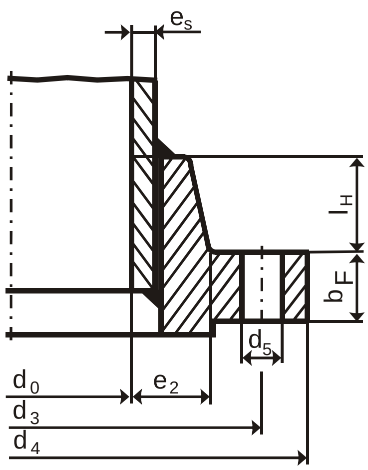
- weld-neck flange, conical shell 2



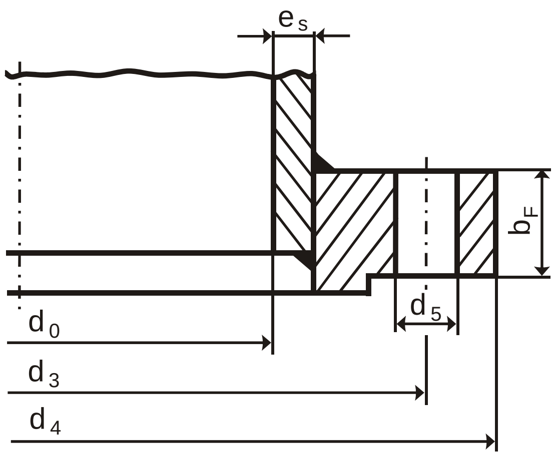
- weld-neck flange, conical shell 3



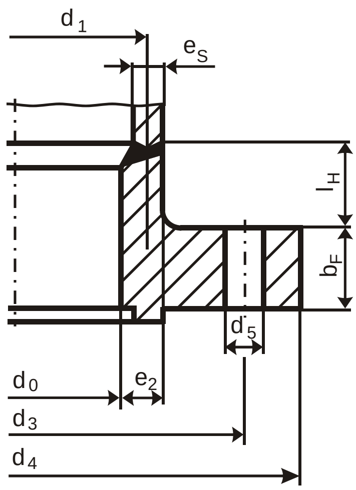
- hubbed slip-on welded flange



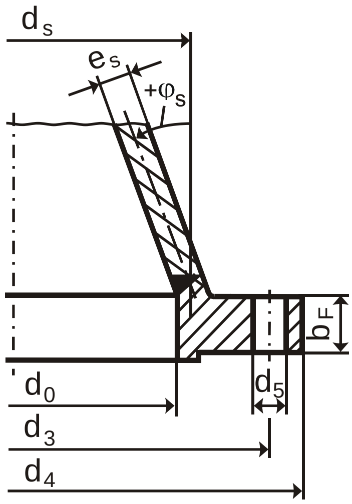
- weld-on plate flange



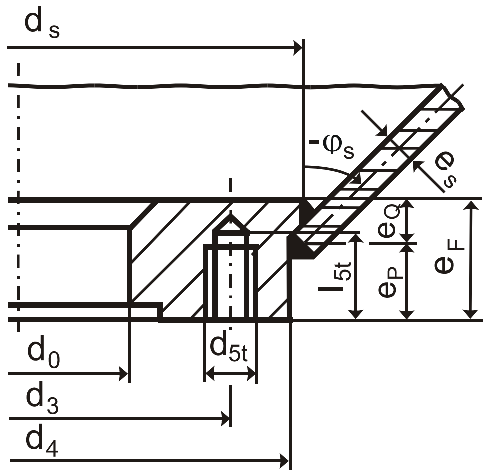
- weld-neck flange, cylindrical shell



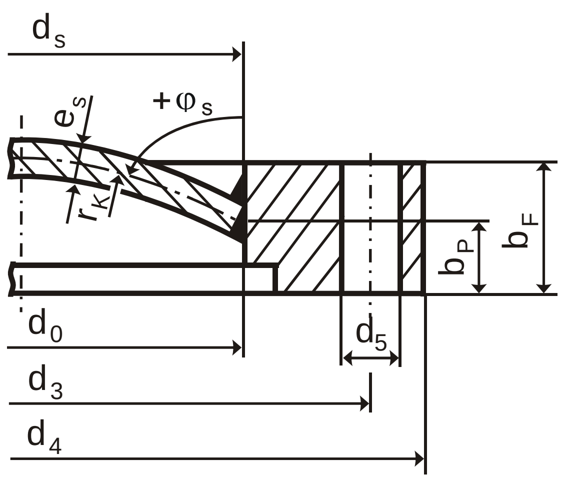
- flange, conical shells 1



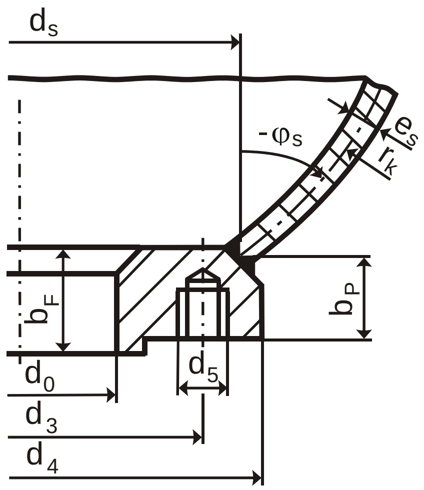
- flange, conical shells 2



- flange spherical shell 1



- flange spherical shell 2



A blind flange can be modeled only as a flange 2.

For welding flanges and flanges on conical and spherical shells, a blind hole can be modeled in the "flange 1". For this purpose, must be labeled "blind hole." Then there appear additional input fields.

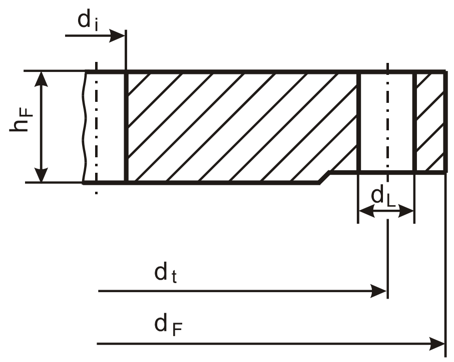
These inputs can stored with the Button "Save File" and are available for further calculations.
The reading of data is done via the button "Open file" in this mask.

3.8.4. Mask „geometry Flange 2“

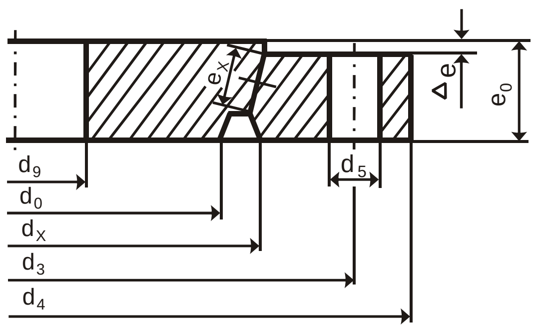
Essentially the input masks for flange 1 and 2 are identical; the input options are the same. The following differences should be noted:

- In the pre-selection "Symmetrical Flange" you don’t need to enter the geometric data for flange 2,
- A blind hole can just be modeled in flange 1,
- Flanges on conical and spherical shells can also be modeled only as a flange first,
- A blind flange must be modelled as a flange 2.

- o blind flange 1



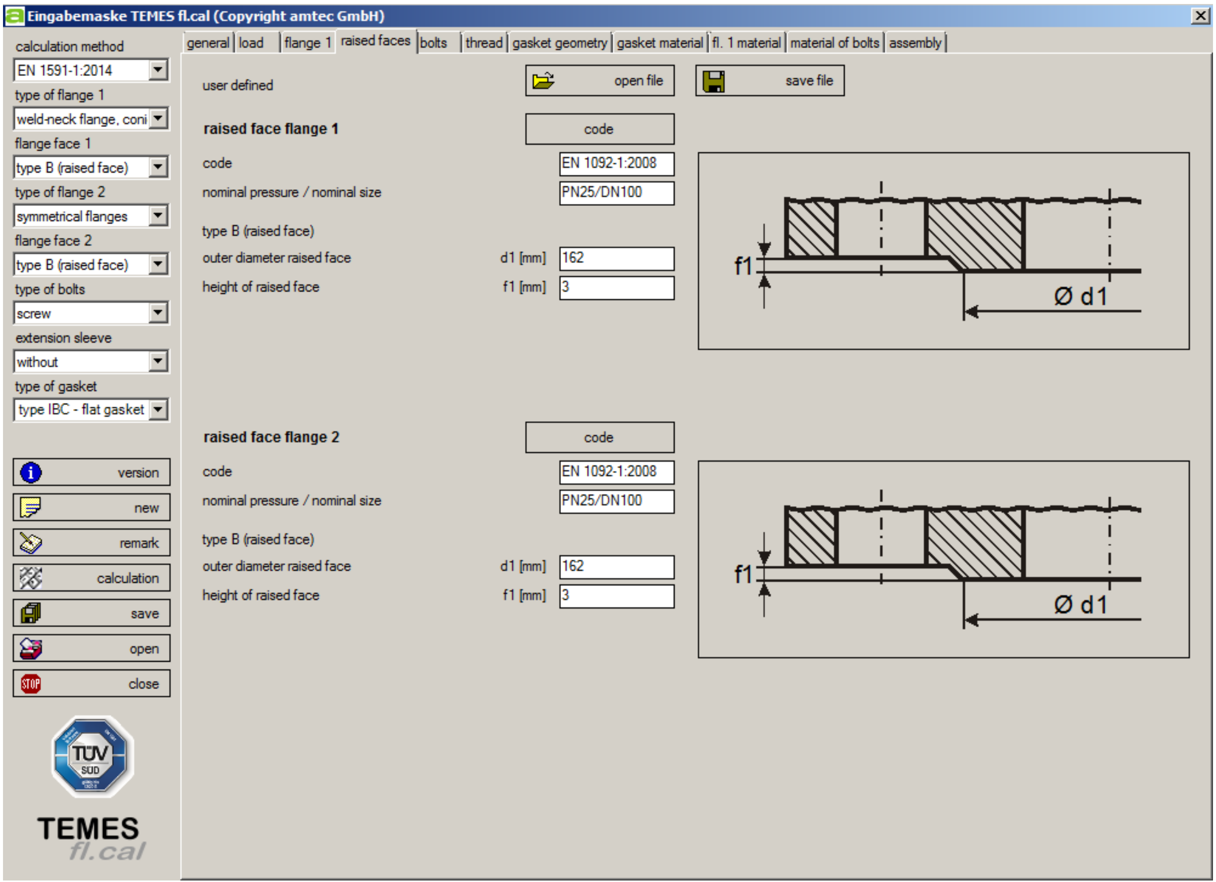
- o blind flange 2



3.8.5. Mask „raised faces“

To accurately calculate the clamping length of the bolts and the effective pressed gasket geometry you can define the geometry of the „raised faces“ for both flanges in the mask „raised faces“ (if earlier the selection made in the dialog boxes).

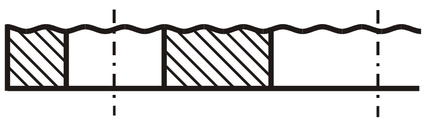
To illustrate the required input variables, a drawing of the selected raised faices is shown with the required geometric quantities in the right area.



The numerical values can either be entered manually in the fields or, if it is standardized dimensions are read from a database. For this purpose is the button "norm" available.

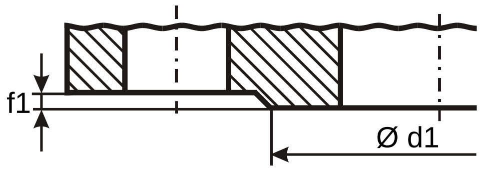
The following raised faces geometries are available:

- type A (flat face)

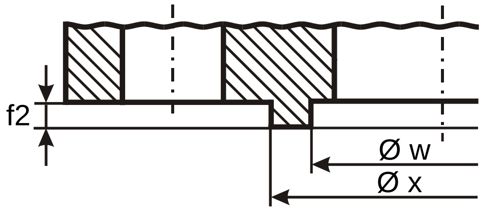


-

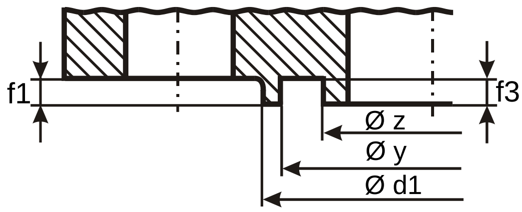
- type B (raised face)



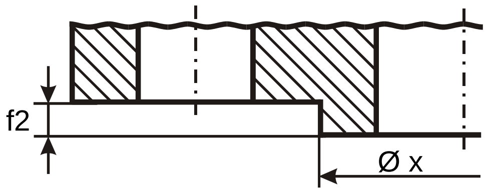
- type C (tongue)



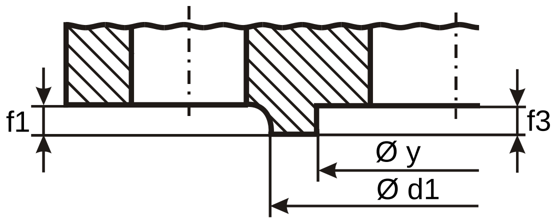
- type D (groove)



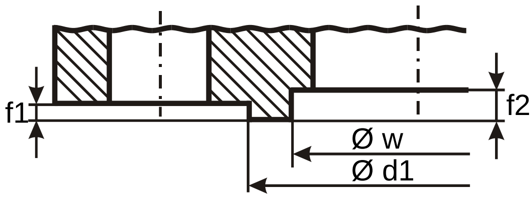
- type E (spigot)



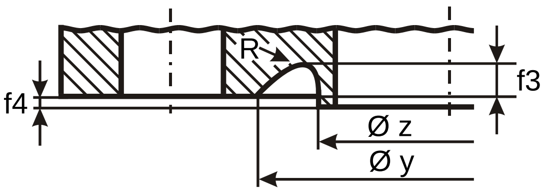
- type F (recess)



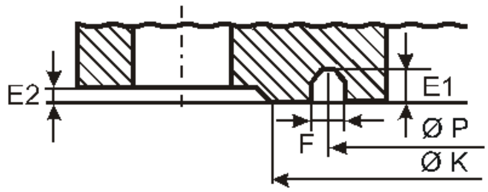
- type G (O-Ring spigot)



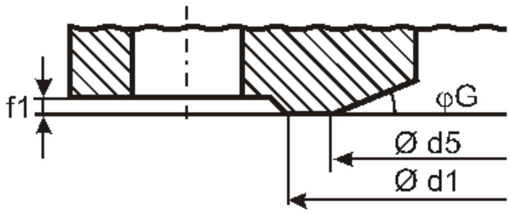
- type H (O-Ring groove)



- type I (RTJ- groove)



- type J (chamfer)



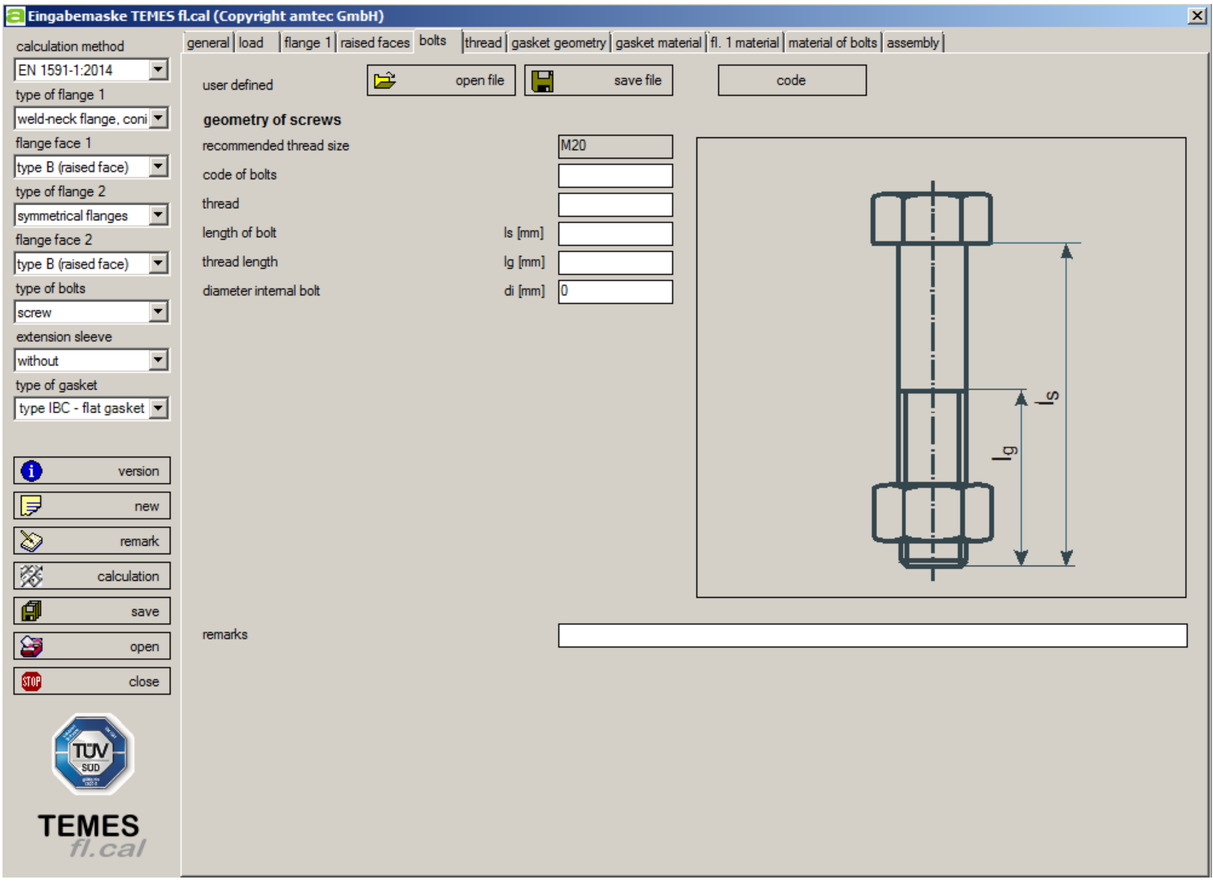
After you select "Symmetrical Flange" in the dialog box "flange 2" and choosed a raised face for this flange, the opposite side automatically select the raised face that fits to flange 1. If this is not desired, an individual input must be done for "flange 2"

Also, the sealing surfaces can stored with the button "save record and are available for further calculations again. The reading of this data is done via the button "open data" on the same screen.

On a blind flange it is to ensure the correct entering of the raised face, because of the flange thickness of the central portion of the flange must be considered. An additional input of a raised face (Form B) would mean in this case a too large length of the clamping lengths of the bolt. It is therefore advisable to select the raised face type A

3.8.6. Mask „bolts“

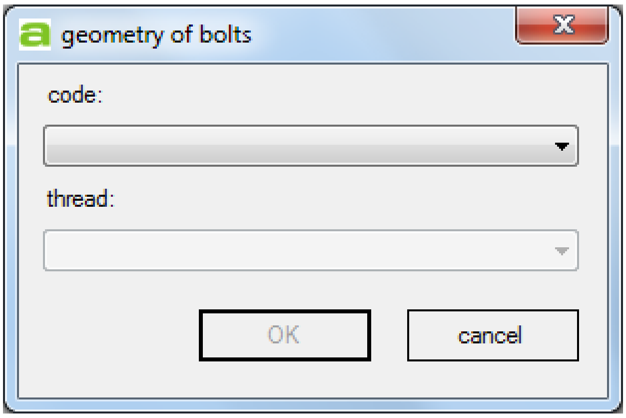
In dependence on the selected bolt various input forms are available.



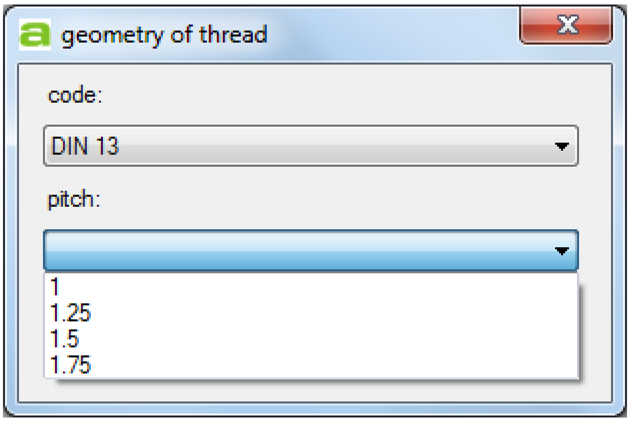
To illustrate the required input variables, a drawing of the part is shown in the right area, showing the nomenclature of the geometry sizes.

At the top line of the input mask, the recommended thread is displayed, which is defined by the flange geometry you previously defined.

The numerical values can either be entered manually in the fields or, if it is standardized dimensions are read from a database. For this purpose is the button "norm" available.



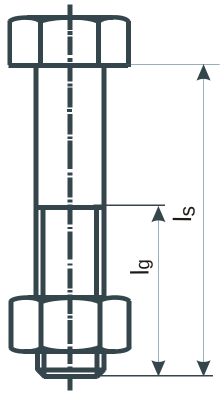
After determining the bolt norm, the program automatically moves to the input mask "thread geometry" to select the standard thread (and after the choice of the standard thread back to the screen "geometry bolts").



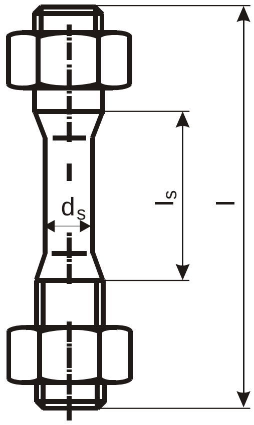
When the bolt geometry manually entered into the fields, the thread geometry is "thread" defined directly in the mask.

In the following different forms bolts are available:

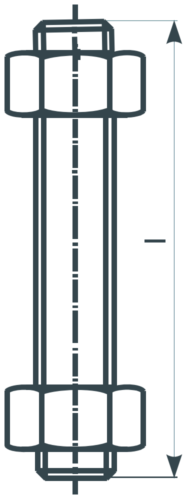
- screw



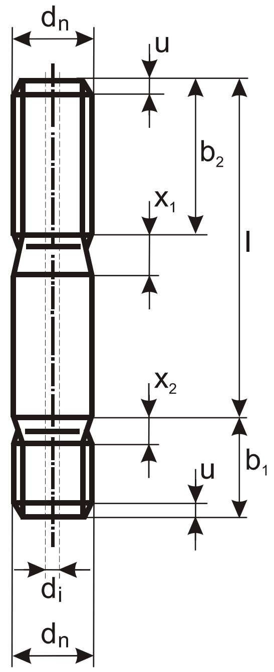
- anti-fatigue bolt



- stud



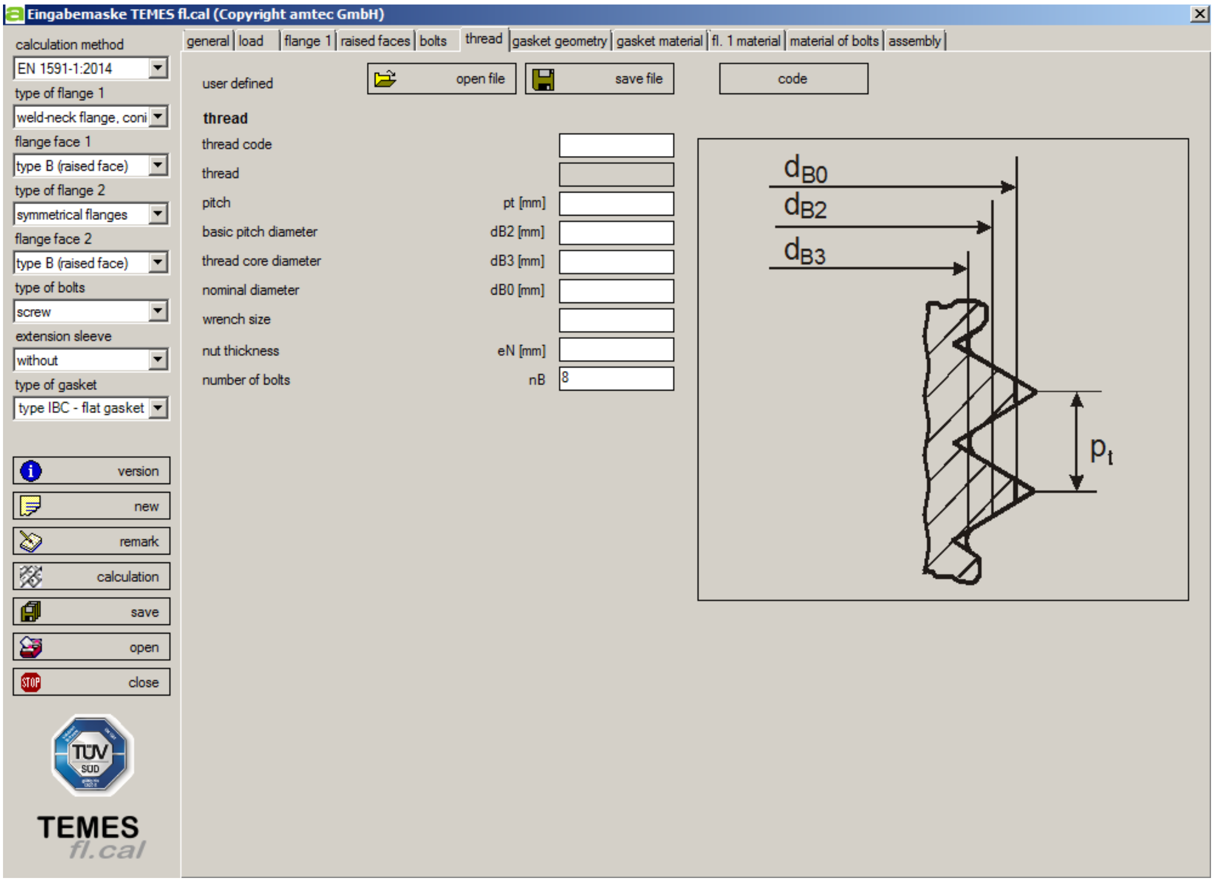
- stud metal end



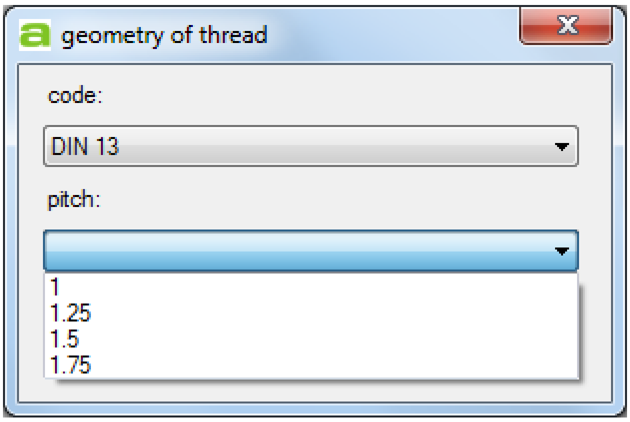
The input variables in the input mask "bolts geometry" can stored with the button „save record“ and are available for further calculations again. The reading of data is done via the button "open data" on the screen

3.8.7. Mask „thread“

For the geometry data of the thread is a separate input mask available. This mask "thread" is skipped and the selection of a standard geometry for bolts in the "bolts geometry is shown."



Here you have the option of manually entering the thread geometry or the selection of a standard geometry.



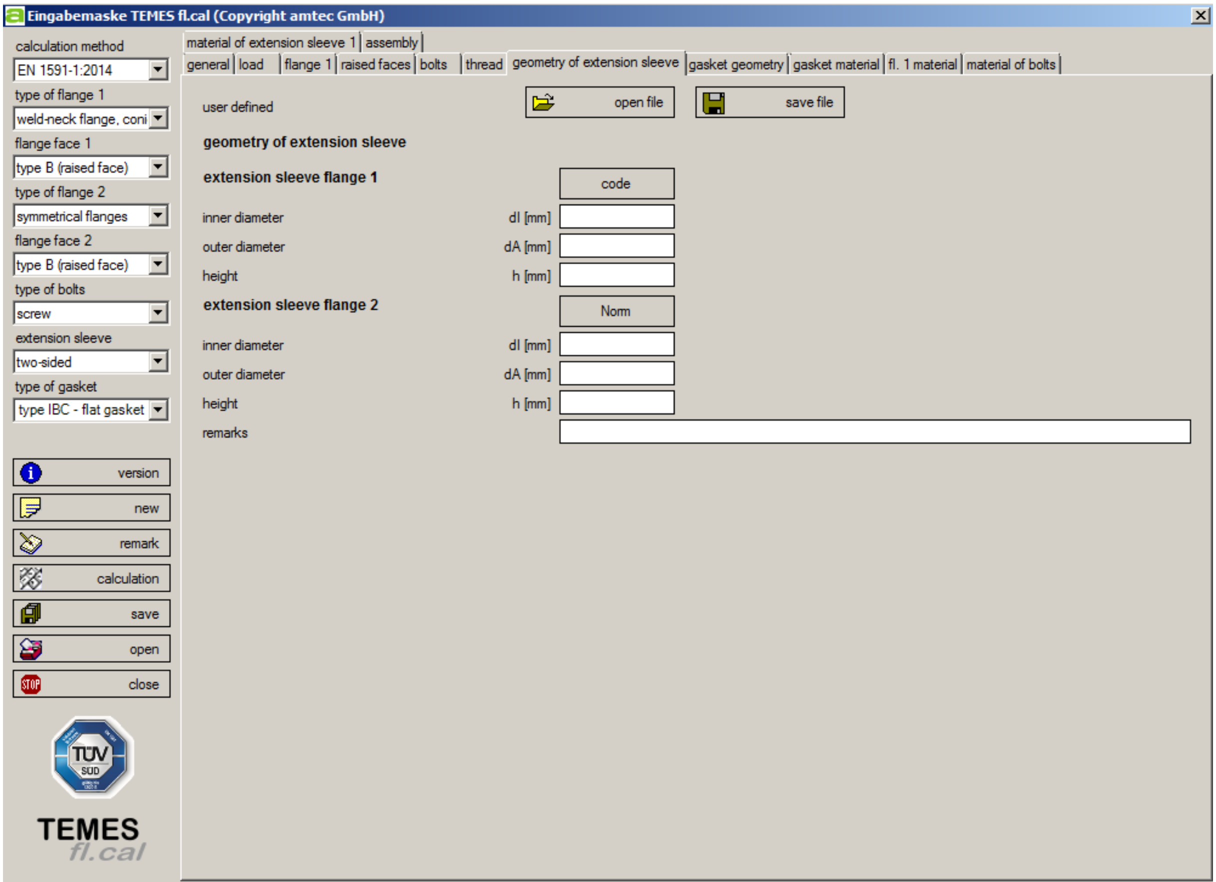
In this screen, the number of bolts of the flange connection is defined.

These inputs can stored with the Button "Save File" and are available for further calculations.
The reading of data is done via the button "Open file" in this mask.

3.8.8. Mask „geometry of extension sleeve“

If you selected a flange with extension sleeves on the left side, a separate entry screen appears. In this mask the outside diameter, the inner diameter and the height of the expansion sleeves need to be entered.

The expansion sleeves are used to calculate the correct clamping length of the bolts and spring as an additional element in the flange.



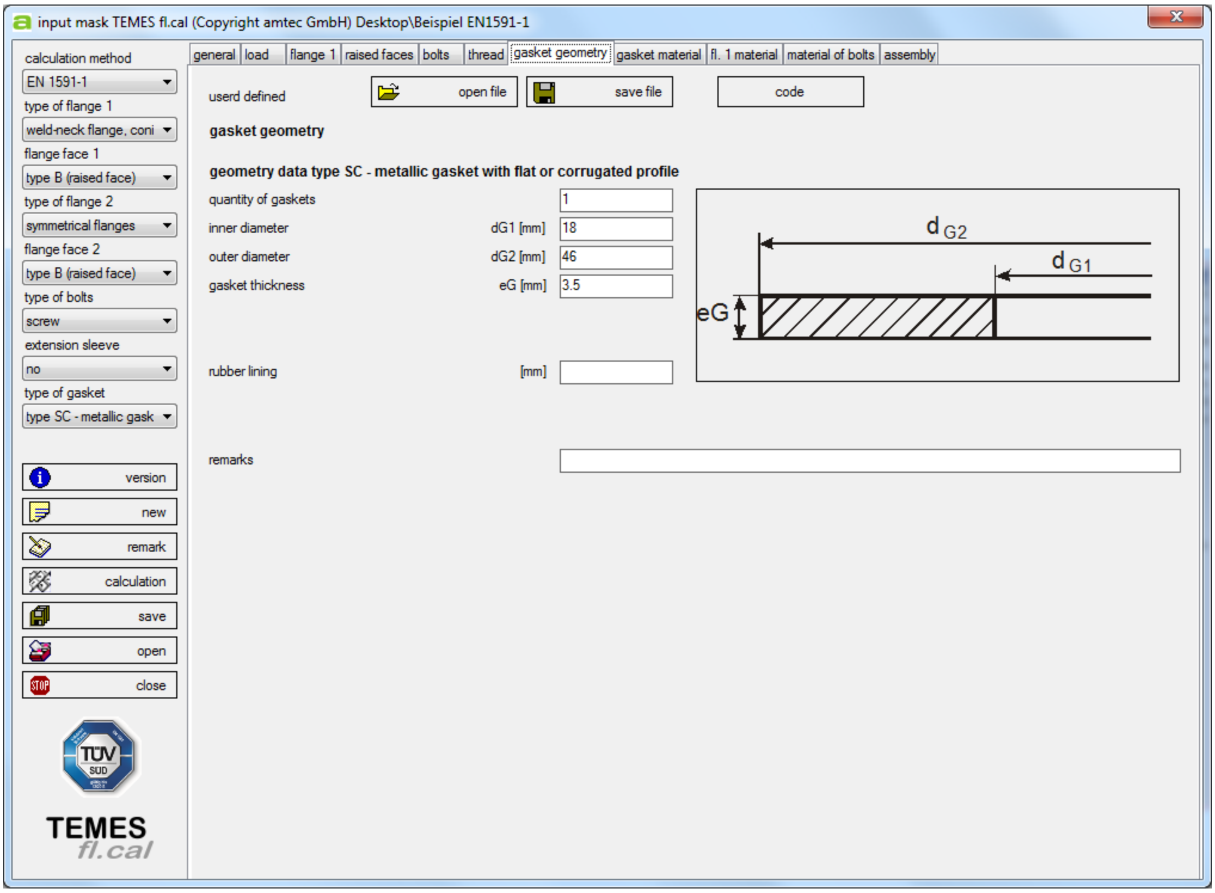
These inputs can stored with the Button "Save File" and are available for further calculations.

The reading of data is done via the button "Open file" in this mask.

3.8.9. Mask „gasket geometry“

Depending on the selected flange geometry different input masks are available:

To illustrate the required input variables, a drawing of the seal is shown in the right area, showing the nomenclature of the geometry sizes:



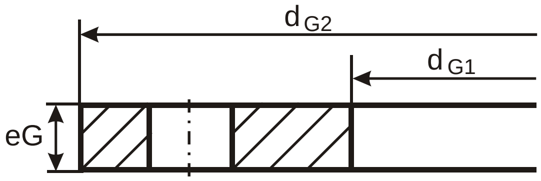
The different gasket parameters can either be entered manually in the fields or, if it is standardized dimensions are read from a database. For this purpose the button "norm" is available.

These inputs can stored with the Button "save File" and are available for further calculations.

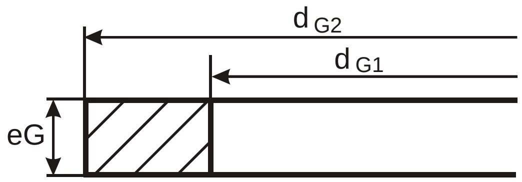
The reading of data is done via the button "Open file" in this mask.

The following different types of gaskets can be defined in order to achieve an accurate determination of the effective sealing surface and the acting lever arms:

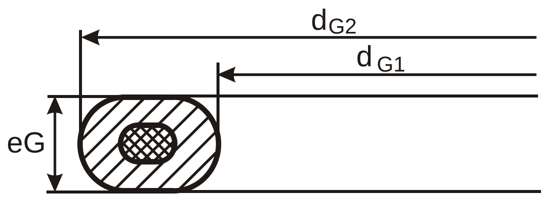
- flat gasket (type FF)



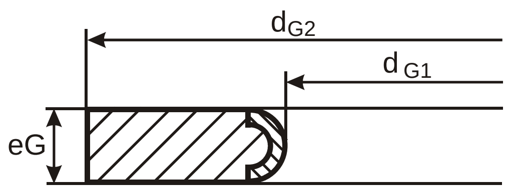
- non-metallic flat gasket (type IBC / TG / SR)



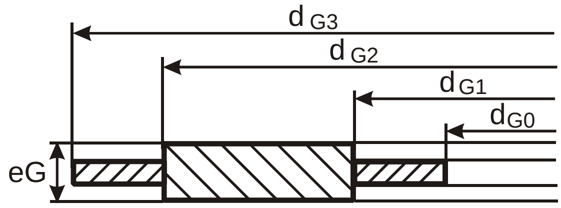
- rubber gasket with inserts



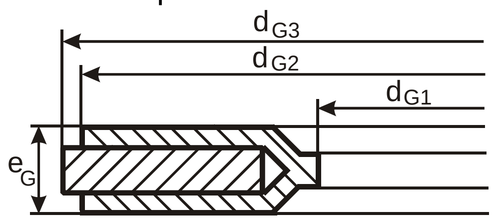
- sheet gasket with inner eyelet



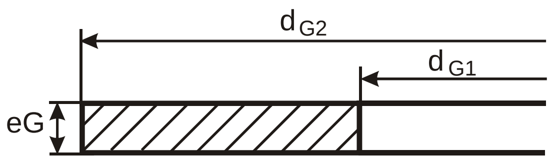
- spiral wound gasket



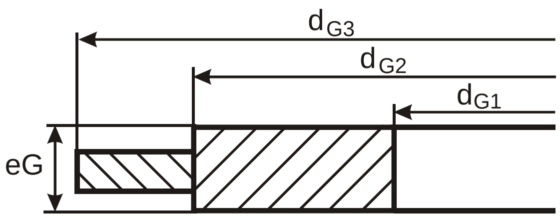
- sheet gasket with PTFE envelop



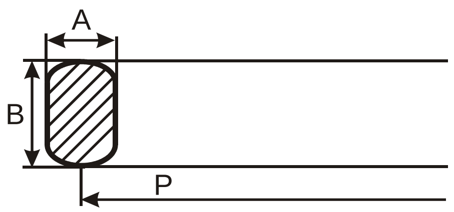
- metallic gasket with flat or corrugated profile (type SC)



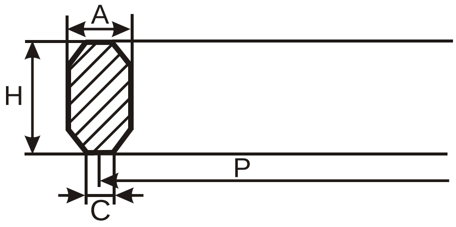
- metallic gasket with flat or corrugated profile (type CR)



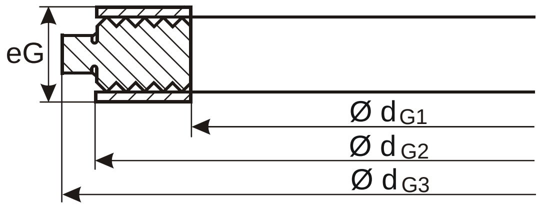
- RTJ-gasket (ovale type)



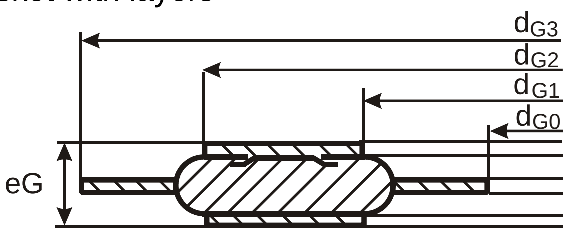
- RTJ-gasket (octagonal type)



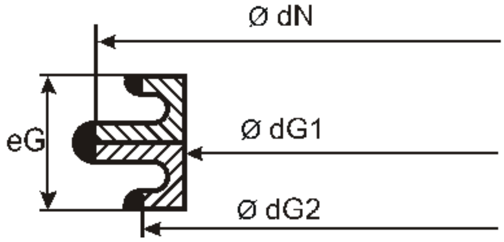
- kammprofile gasket



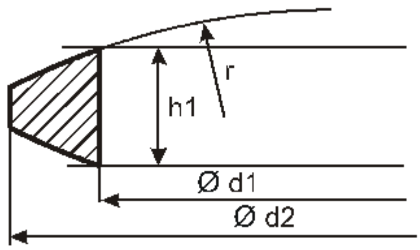
- metal jacketed gasket with layers



- welded lip gasket

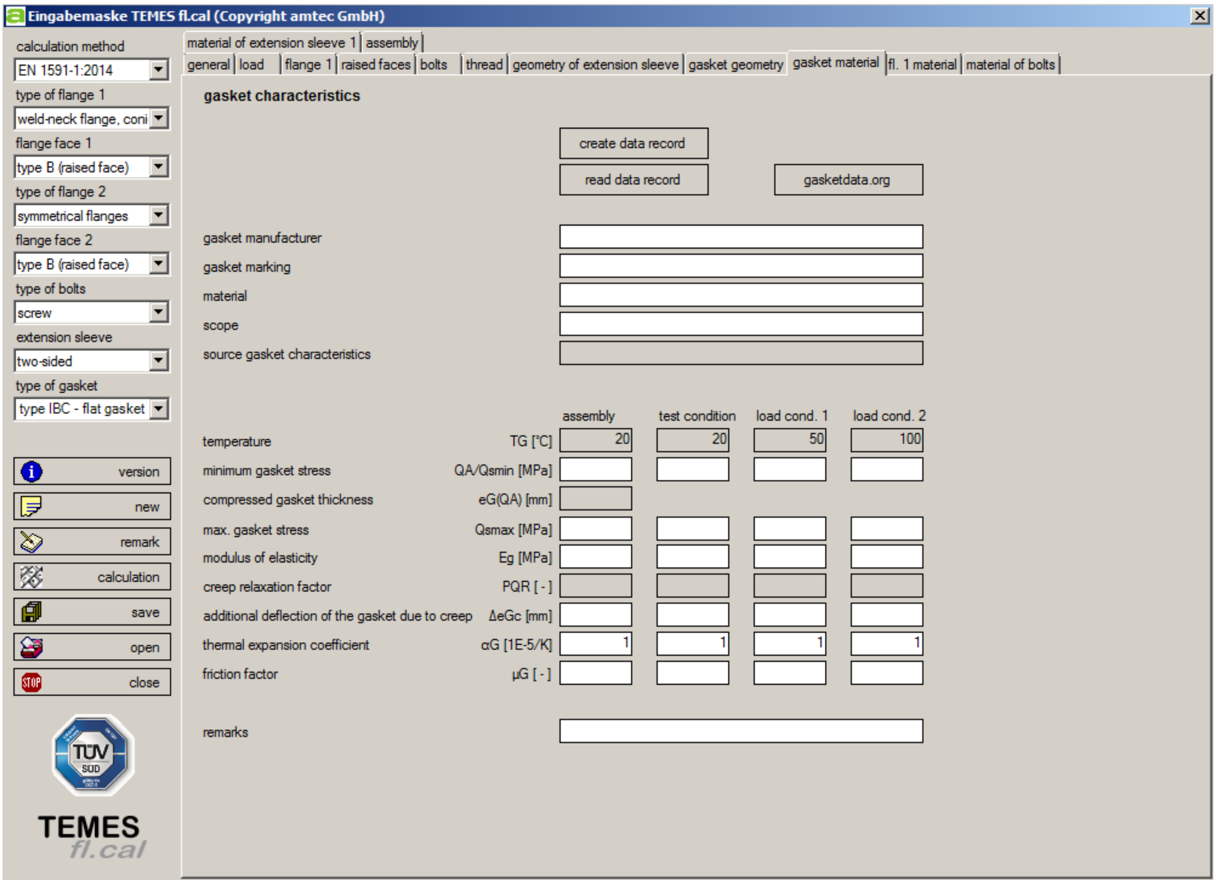


- lense gasket



3.8.10. Mask „gasket material“

In the input mask "gasket material" the gasket characteristics are entered to DIN 28090-1.



Standard Data are not available for the gasket characteristics or no longer reflect the state of the art.

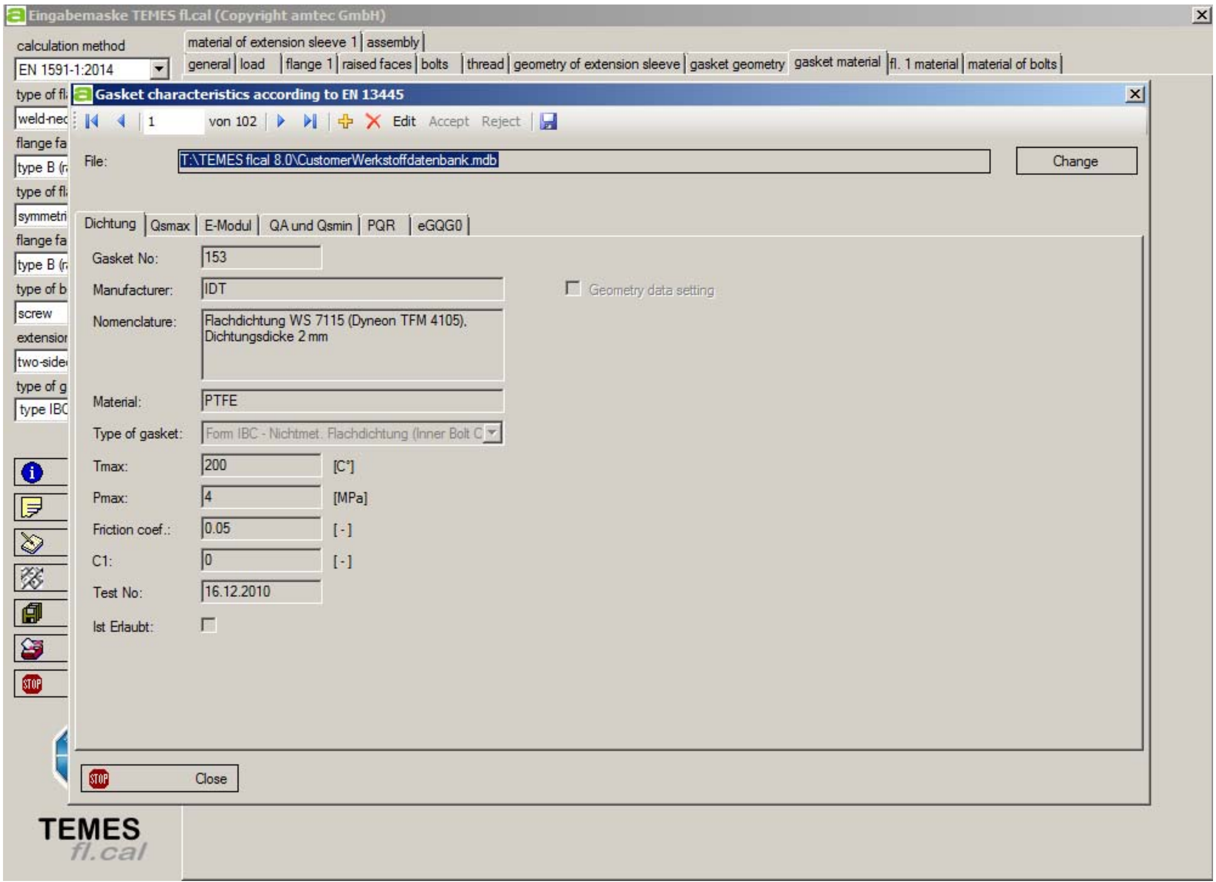
Gasket characteristics given from the manufacturers can stored with the Button "Save File" and are available for further calculations.
The reading of data is done via the button "Open file" in this mask.

Basically in 1591-1 shall be only use gasket characteristics determined according to EN 13555. For this, the gasket manufacturer should be contacted.

With the „CustomerDatabank“ you can add gasket characteristics manually to the database.

Therefore you must open the “CustomerDatabase” in mask „gasket material“. Then you go to „create data record“. You will find the database in the folder of your TEMESfl.cal installation.

X:\TEMESflcal8.x\CustomerWerkstoffdatenbank.mdb



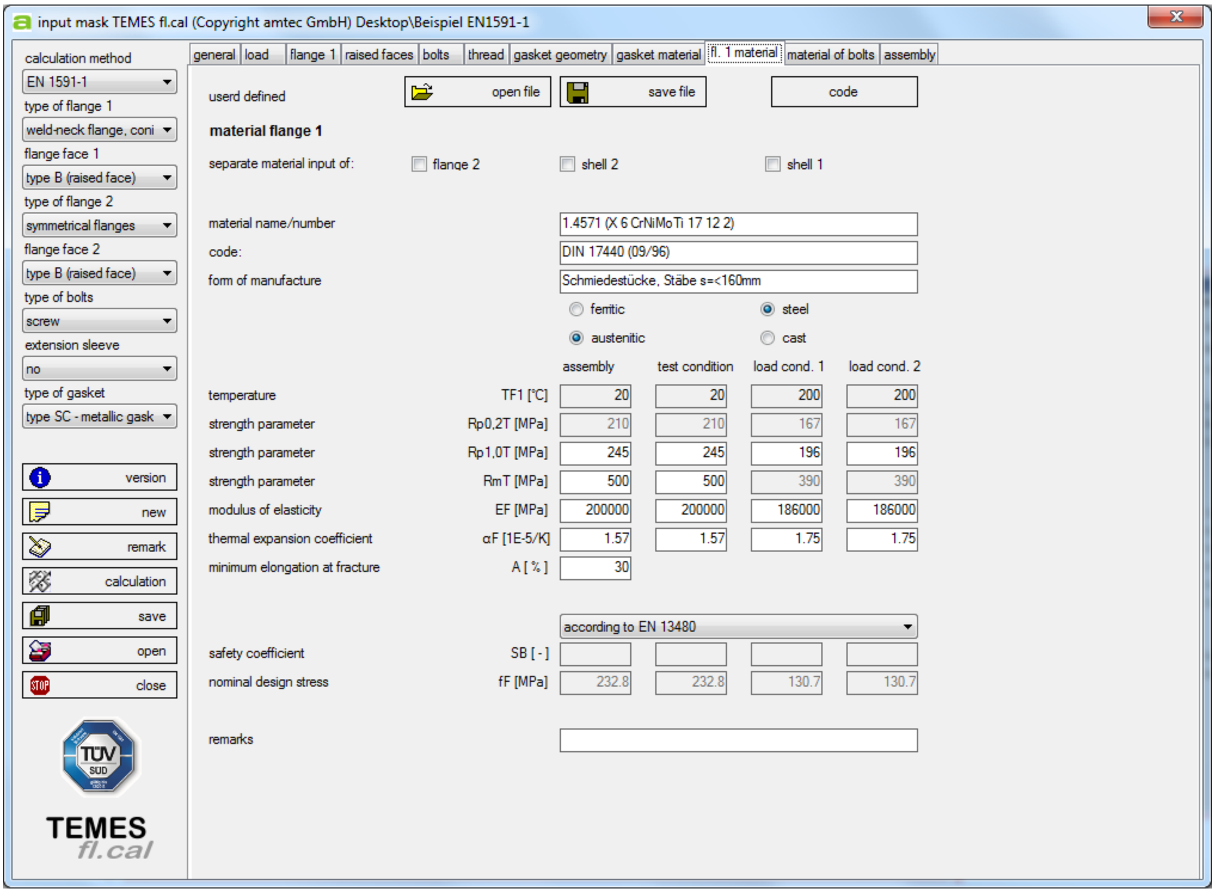
After opening the material database, you can record new characteristics with the button „+“. Here you will be asked in the first mask to specify the type of gasket, the gasket manufacturer and the gasket material.

In the following input masks you can define gasket characteristics as the minimum and maximum required gasket stress, the thermal conductivity, the modulus of elasticity and the PQR value depending on the temperature and the design pressure.

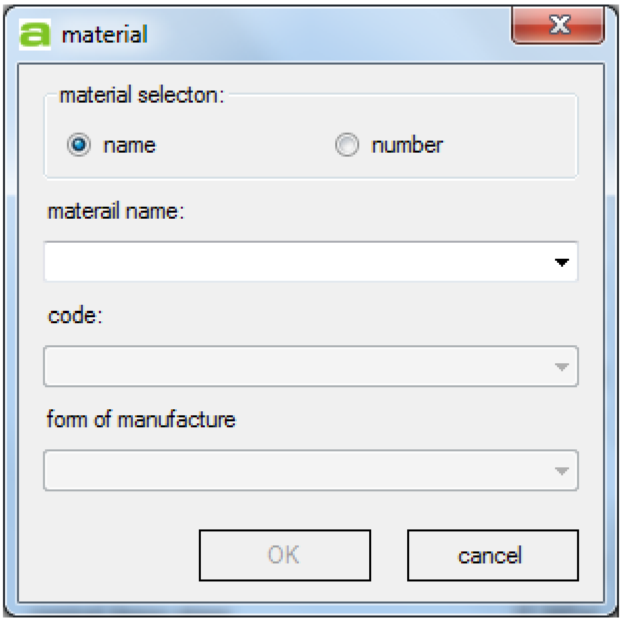
After entering the parameters, click on the "Accept" button and the data is stored in the "Customer Material Database" and is available for any further calculation.

3.8.11. Mask „flange 1 material“

In the input mask "Flange Material 1", the strength characteristics of the material used for loose flange and flange 1 of the stub/flare can be entered. At the same time can you can choose the material for the other flange (flange 2, loose flange 1 / 2) if they are made of a different one. Therefore you must click "separate material input for ....." in the input mask.



The values can be either manually entered or imported into the fields from a database. For this purpose is the "norm" button available.



After the selection of the material via material name or number, the code can be defined in a dialog box, and finally you can select the form of manufacture in a third dialog box.

As long you made no changes to this selected data from the database, the values are also automatically updated when you are changing the temperature of a load condition. This does not happen if you modified or entered the data manually.

Manual inputs can stored with the button "save file" and are available for further calculations again. The reading of data is done via the "Open file" also on this mask.

3.8.12. Mask „loose flange 1 material“

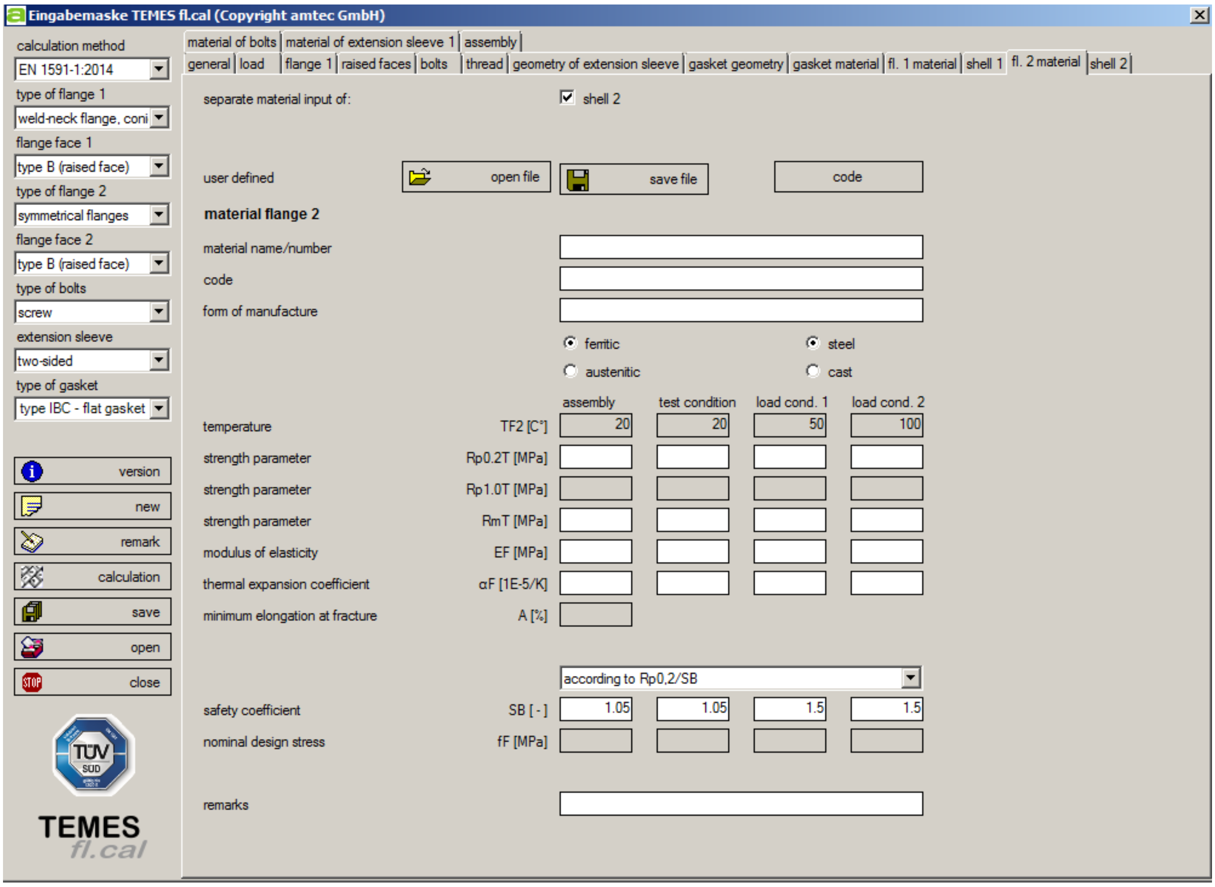
For the material of loose flange 1, there are the same functions as for the material of flange 1 available. To enable this input mask for the loose flange 1 you need to activate „Separate material input for loose flange 1" in mask of „flange 1 material“.

3.8.13. Mask „shell 1 material“

For the material of shell 1, the same functions as for the material of flange 1 are available. To enable this input mask for shell 1, you need to enable "Separate input material for shell 1" in mask of „material for flange 1“.

3.8.14. Mask „flange 2 material“

For the material of flange 2, there are the same functions as for the material of flange 1 available. To enable this input mask for the flange 2, you need to activate „Separate material input flange 2" in mask of „flange 1 material“.



3.8.15. Mask „loose flange 2 material“

For the material of loose flange 2, there are the same functions as for the material of flange 1 available. To enable this input mask for the loose flange 2, you need to activate „Separate material input loose flange 2" in mask of „flange 1 material“.

3.8.16. Mask „shell 2 material“

For the material of shell 2, the same functions as for the material of flange 1 are available. To enable this input mask for shell 2, you need to enable "Separate input material for shell 2" in mask of „material for flange 1“.

3.8.17. Mask „material of bolts“

In the input mask "bolt material", the strength characteristics of the material can be entered.

It offers the same functionality like in the input screen of the material of flange 1.

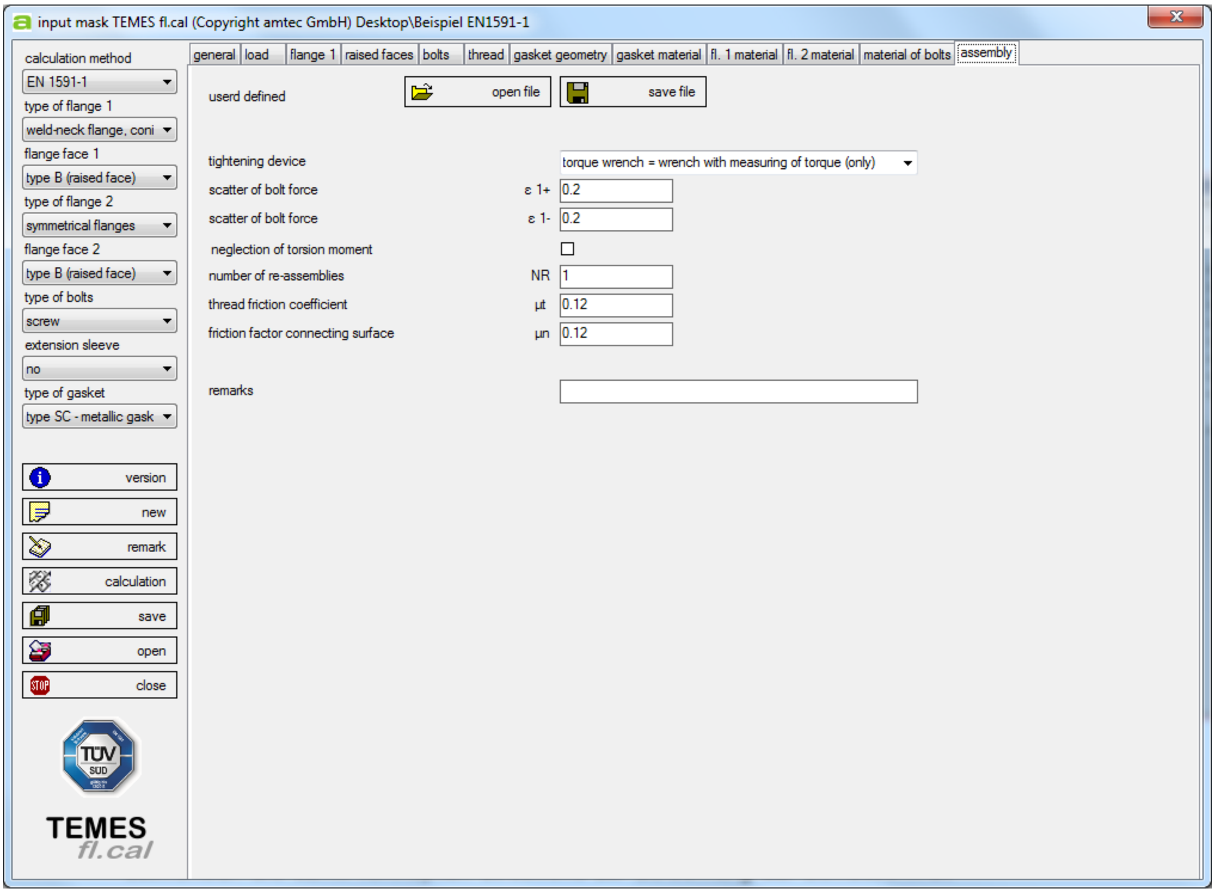
3.6.16. Mask „material of extension sleeve“

In the input mask "material of extension sleeve", the strength characteristics of the material can be entered.

It offers the same functionality like in the input screen of the material of flange 1.

3.8.18. Mask „assembly“

The last input screen contains the information that are necessary for the calculation of the assembly requirements specifications, such as tightening device, scatter band of the tightening and friction coefficients.

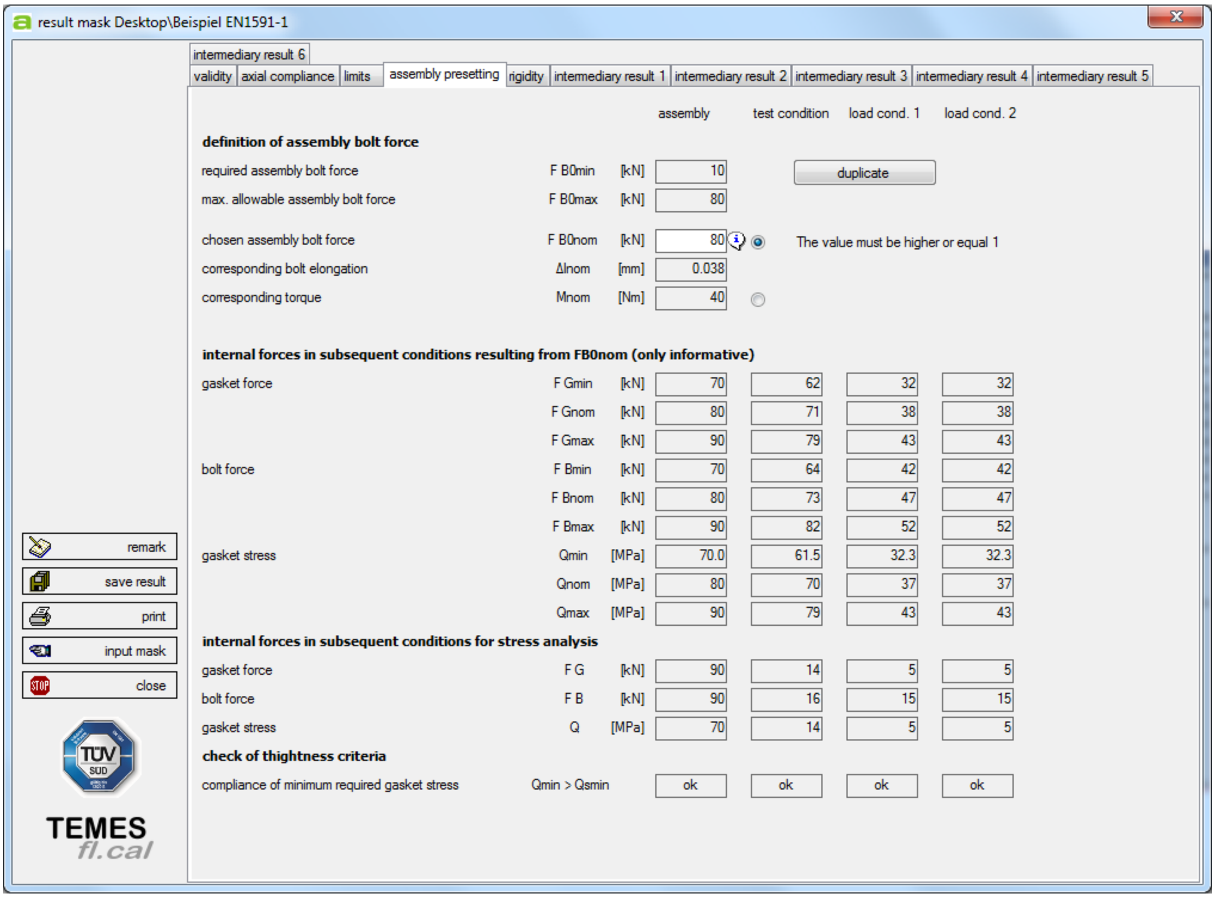


The dialog box "assembly" are selectable various tightening devices. The associated scattering values used to calculate the bolt force are provided in Annex C of EN 1591-1.

Additional tightening devices with other scatter values can stored as user records with "save file" and are available for further calculations via the button "Open file" .

3.9. program modul EN 1591 - results

With the "Calculate" button the calculation is started. Are all input data available, the program displays after the end of the calculation routine the output mask "strength and tightness proof" in which the maximum permissible bolt force, and torque bolt elongation are displayed.



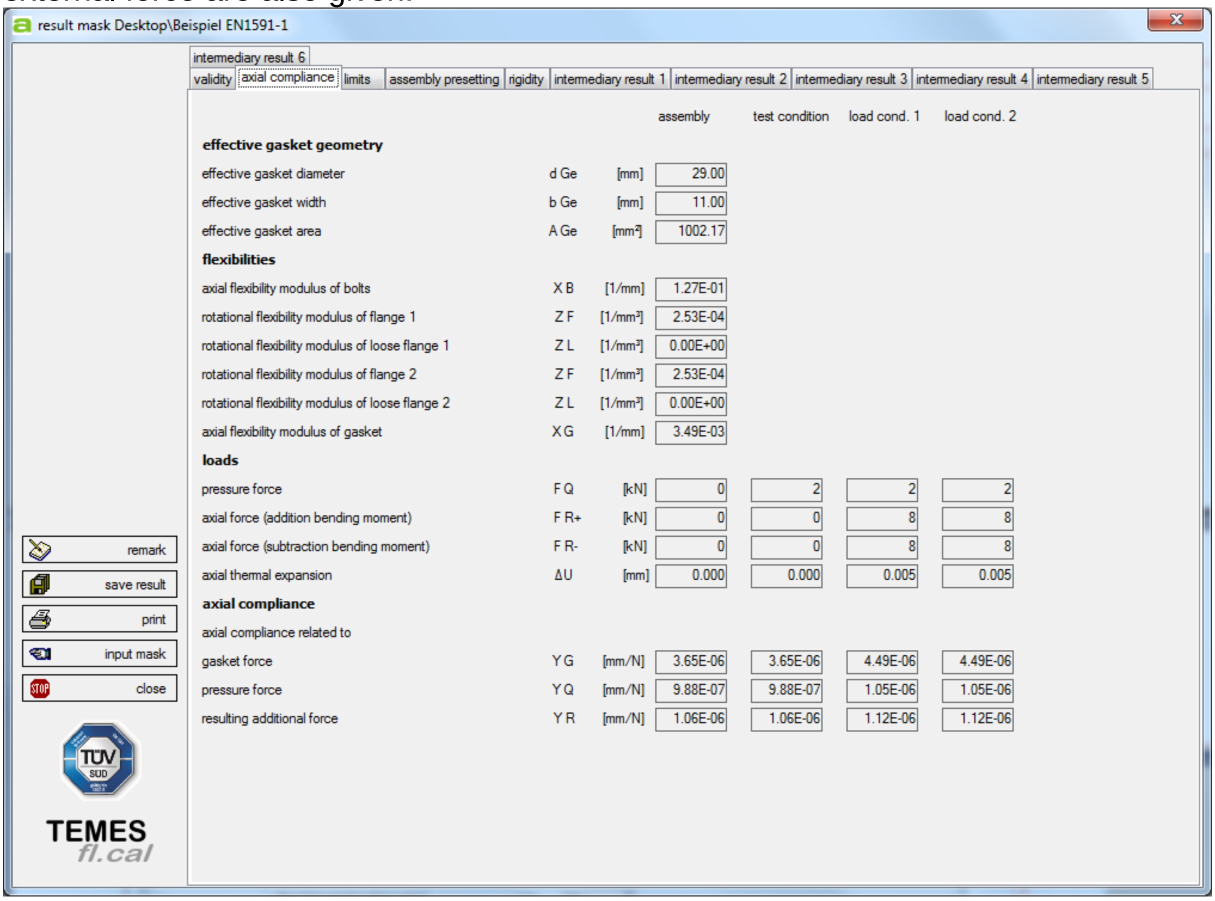
In the head of the results mask multiple choice riders appear, via these riders you can be accessed through the various output masks.

The individual result tables will be described now:

3.9.1. Mask „axial compliance“

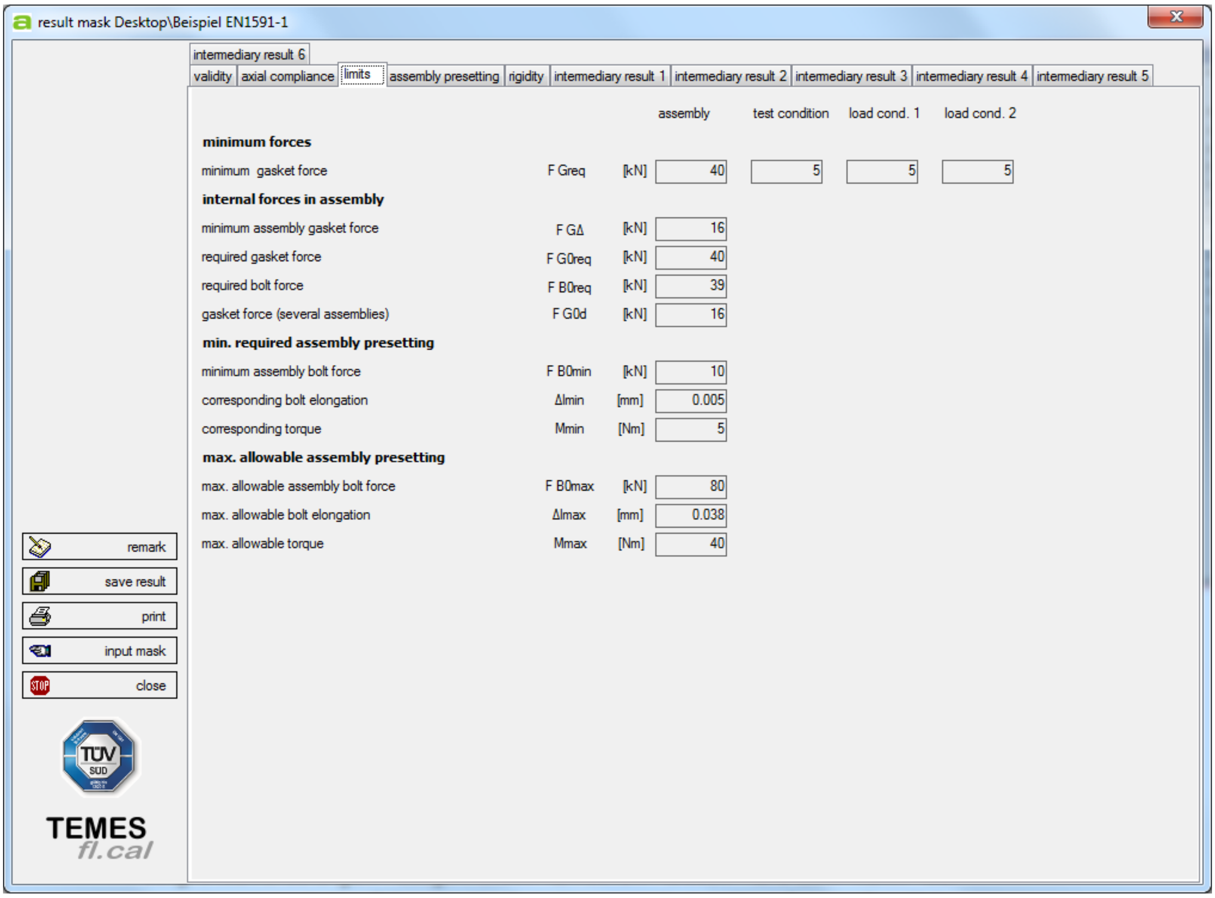
In the mask „axial compliance“ you can see the effective gasket geometry, which results from the flange rotation.

Also in this screen you can see the elasticity’s of the individual components, which are needed to determine the compliances between the various loads. These axial compliances under the loads gasket force, axial force of the media pressure and external force are also given.



3.9.2. Mask „limits“

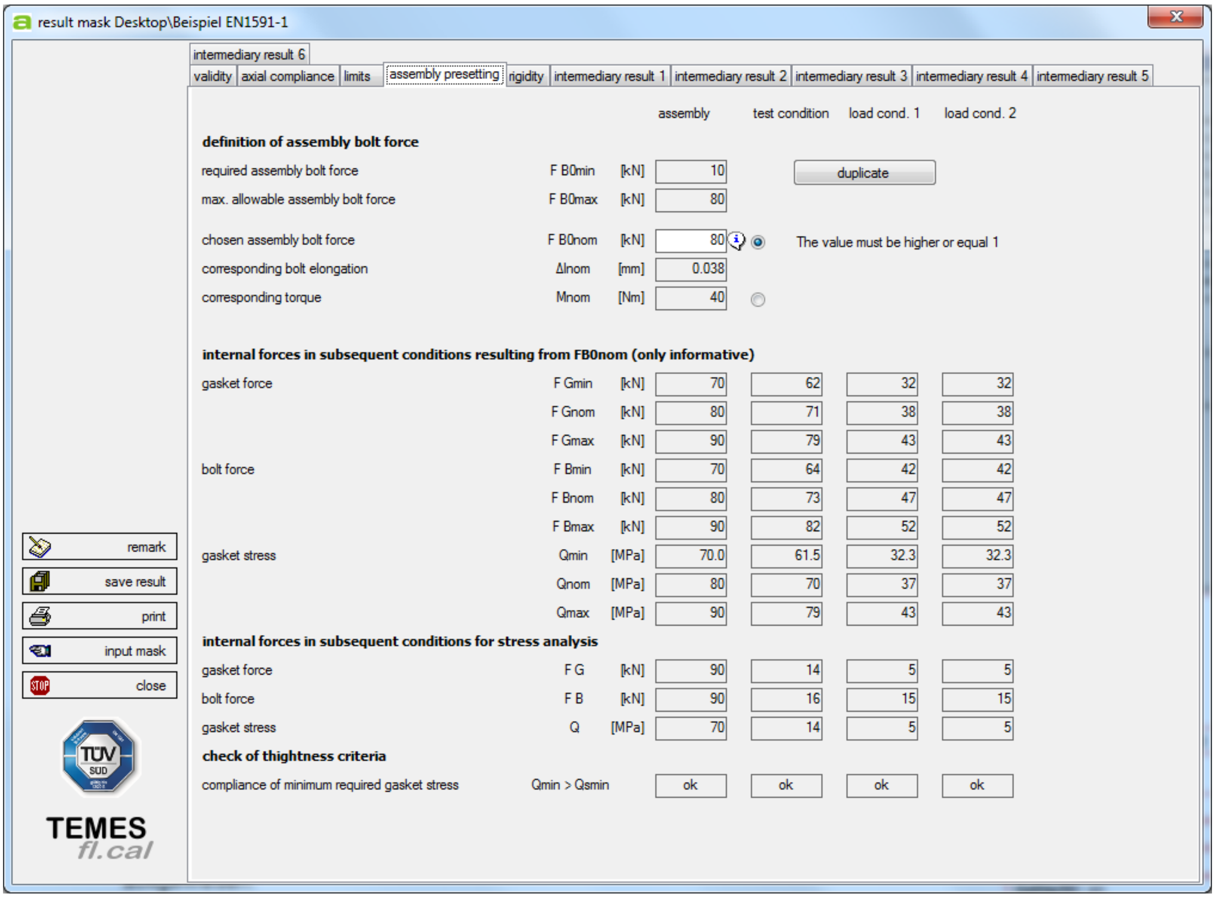
In the mask „limits“ there are given the minimum required forces to reach the tightness requirements. Out of this results from each load condition, you can calculate backwards the assembly bolt force you need to select, so that you don't drop below the minimum required gasket stress.



3.9.3. Mask „assembly presetting“

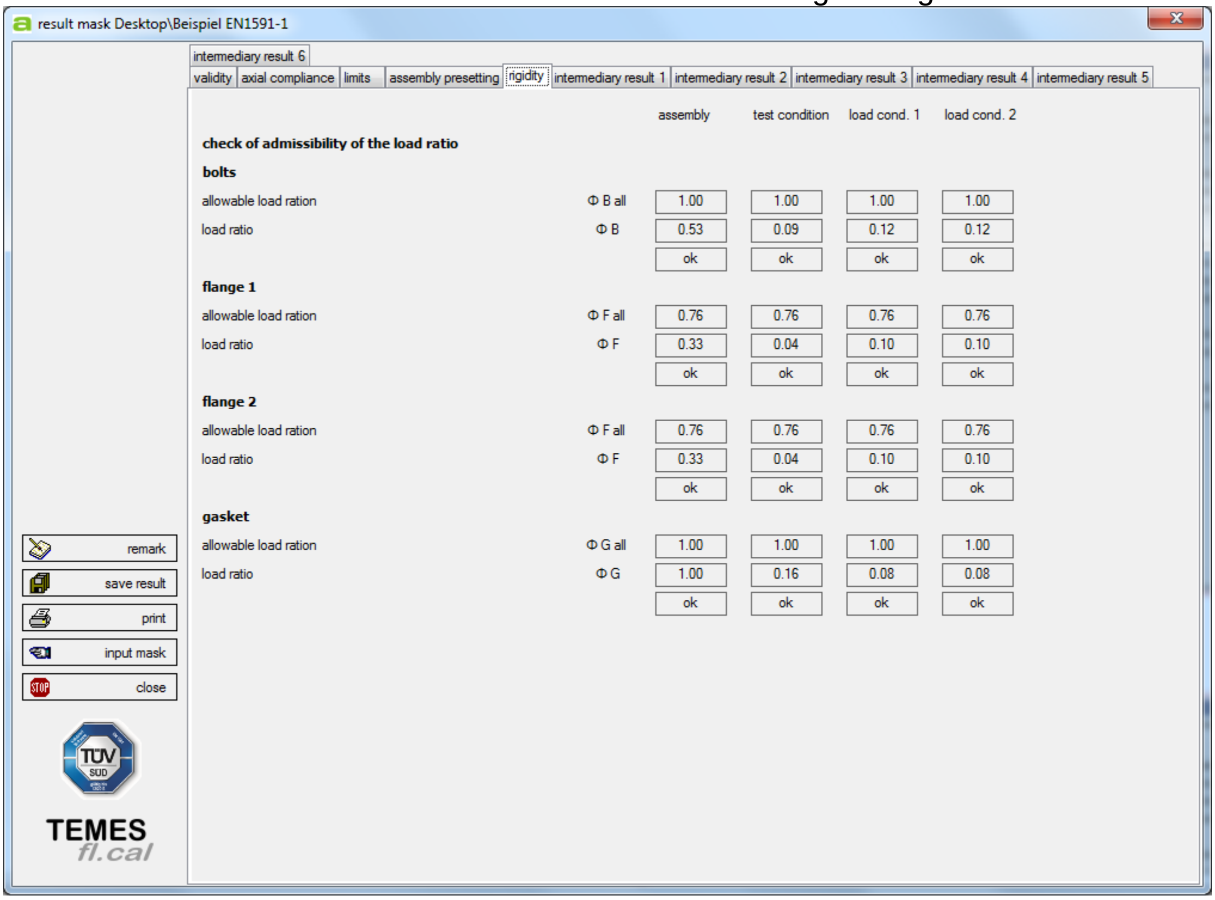
In this screen, first the required assembly bolt force to maintain the tightness requirements and the maximum force to meet the strength requirements are reported. The user can choose the assembly bolt force in “chosen assembly bolt force”.

Then the corresponding torque and the bolt elongation are shown as default for the assembly of these selected forces. Also the bolt force, the gasket force and the gasket stress are reported for all loads, in each case taking into account the scatter band of tightening.



3.9.4. Mask „load ratio“

In this mask, the load ratios of the individual components are shown for the selected bolt force under consideration of the scatter band of the tightening device.



Appendix

A.1. principles Norm KTA 3211.2

refer to:

KTA 3211.2
Draft rule change proposal
Version March 2003

A.2. priniciples Norm EN 1591

refer to:

EN 1591
Version Februar 2013

A.3. Rules and Standards

The calculation Software TEMES fl.cal accesses on a variety of standards:

- **A.3.1** geometry standards
  - **A.3.1.1** gaskets
  - **A.3.1.2** flanges
  - **A.3.1.3** bolts
- **A.3.2** material standards

Below those are listed in a table:

A.3.1.1 Standards for the gasket geometry

Standard	Typ
EN 1514-1:1997 - Form FF	Full Face Gasket
DIN 2690:1966	Flat gasket DIN flanges PN1-PN40
DIN 2691:1971	Flat gasket DIN flanges PN10-PN160
DIN 2692:1966	Flat gasket DIN flanges PN10-PN100 mit Vor- und Rücksprung
DIN 2697	Groove gasket
EN 1514-1:1997 - Form IBC	Flat gasket
EN 1514-1:1997 - Form TG	Flat gasket tongue / groove
EN 1514-1:1997 - Form SR	Flat gasket male-/female
EN 1514-2:2005	Spiral Wound gasket
EN 1514-3:1997	Sheet gasket with PTFE envelop
EN 1514-4:1997	Metallic gasket with flat or corrugated profile
EN 1514-6:2003	Kammprofile gasket
EN 1514-7:2004 - Form C/O oder C/IO	Metallic gasket
EN 1514-7:2004 - Form SC oder C/I	Metallic gasket
DIN EN 12560-6:2004	Kammprofile gasket
Werknorm 104 für DIN Flansche	Werknorm 104 für DIN flanges
Werknorm 188 für DIN Flansche	Werknorm 188 für DIN flanges
Werknorm 101 für DIN Flansche	Werknorm 101 für DIN flanges
Werknorm 145 für DIN Flansche	Werknorm 145 für DIN flanges
WN-41-32 für Wellringdichtung WD12 (Rev. 1)	WN-41-32 für Wellringdichtung WD12 (Rev. 1)

A.3.1.2 Standards for the flange geometry

Standard	Typ
DIN 2527:1972	Blank flange
DIN 2532:1976	weld-neck flange
DIN 2533:1976	weld-neck flange
DIN 2534:1967	weld-neck flange
DIN 2535:1967	weld-neck flange
DIN 2543:1977	Cast steel flanges
DIN 2544:1977	Cast steel flanges
DIN 2545:1977	Cast steel flanges
DIN 2546:1969	Cast steel flanges
DIN 2548:1969	Cast steel flanges
DIN 2549:1969	Cast steel flanges
DIN 2550:1969	Cast steel flanges
DIN 2551:1969	Cast steel flanges
DIN 2566:1975	Threaded flange with neck
DIN 2568	Threaded flange with neck
DIN 2569	Threaded flange with neck
DIN 2573:1975	Weld-on plate flange
DIN 2576:1975	Weld-on plate flange
DIN 2627:1975	weld-neck flange
DIN 2628:1975	weld-neck flange
DIN 2629:1975	weld-neck flange
DIN 2630:1975	weld-neck flange
DIN 2631:1975	weld-neck flange
DIN 2632:1975	weld-neck flange
DIN 2633:1975	weld-neck flange
DIN 2634:1975	weld-neck flange
DIN 2635:1975	weld-neck flange
DIN 2636:1975	weld-neck flange
DIN 2637:1975	weld-neck flange
DIN 2638:1975	weld-neck flange
DIN 2652	Loose flange, plain collars
DIN 2653	Loose flange, plain collars
DIN 2655	Loose flange, plain collars
DIN 2656	Lose Flansche, plain collars
DIN 2673:1962	Loose flange with welding end
DIN 2674:1974	Loose flange with welding end
DIN 2675:1979	Loose flange with welding end
DIN 2676:1978	Loose flange with welding end
DIN 28115:2003	Flange outlets
DIN 28117:1990	Block flange
DIN 86029:1987	Welding flange with neck

A.3.1.2 Standards for the flange geometry

Standard	Typ
DIN 86030:1987	Welding flange with neck
EN 1092-1:2008	Typ 01 flat welding flange
EN 1092-1:2008	Typ 05 blank flange
EN 1092-1:2008	Typ 11 weld-neck flange
EN 1092-1:2008	Typ 12 hubbed slip-on weleded flange
EN 1092-1:2008	Typ 13 hubbed threaded flange
EN 1092-1:2008	Typ 21
EN 1092-1:2008	Typen 02 und 32 Loose flange, plain collars
EN 1092-1:2008	Typen 02 und 33 Loose flange for beaded pipes
EN 1092-1:2008	Typen 02 und 35 Loose flange with welded ring
EN 1092-1:2008	Typen 02 und 36 Loose flange with long neck
EN 1092-1:2008	Typen 02 und 37 Loose flange für Pressbördel
EN 1092-1:2008	Typen 04 und 34 Loose flange for welded necks
EN 1092-2:1997	Typ 21 ductile cast iron (DG)
EN 1092-2:1997	Typ 21 gray cast iron (GG)
EN 1092-2:1997	Typ 21 malleable iron (TG)
prEN 1092-1:1994	Steel flange
prEN 1092-1:2005	Typ 01 welding plain flange
prEN 1092-1:2005	Typ 05 blank flange
prEN 1092-1:2005	Typ 11 weld-neck flange
prEN 1092-1:2005	Typen 02 und 35 Loose flange with welded ring
prEN 1092-1:2005	Typen 02 und 36 Loose flange with long neck
prEN 1092-1:2005	Typen 02 und 37 Loose flange für Pressbördel
prEN 1092-1:2005	Typen 04 und 34 loose flange for welded necks
prEN 1092-2:1993	Cast iron flanges
prEN 1092-3:1994	Flanges (copper alloy and compoiste materials)
prEN 1092-4:1995	Flanges (aluminium alloy)

A.3.1.2 Standards for the flange face geometry

Standard	Typ
DIN 2512:1975	Tongue / groobe
DIN 2513:1966	Male / female
DIN 2514:1975	Male / female
DIN 2527:1972	Blank flanges – nominal oressure 6 bis 100
DIN 2532:1976	Cast iron flanges, nominal pressure 10
DIN 2533:1976	Cast iron flanges, nominal pressure 16
DIN 2534:1967	Cast iron flanges, nominal pressure 25
DIN 2535:1967	Cast iron flanges, nominal pressure 40
DIN 2543:1977	Cast steel flanges, nominal pressure 16
DIN 2544:1977	Cast steel flanges, nominal pressure 25
DIN 2545:1977	Cast steel flanges, nominal pressure 40
DIN 2546:1969	Cast steel flanges, nominal pressure 64
DIN 2548:1969	Cast steel flanges, nominal pressure 160
DIN 2549:1969	Cast steel flanges, nominal pressure 250
DIN 2550:1969	Cast steel flanges, nominal pressure 320
DIN 2551:1969	Cast steel flanges, nominal pressure 400
DIN 2566:1975	Hubbed threaded flange PN 6, 10, 16, 25, 40
DIN 2627:1975	Weld-neck flanges, nominal pressure 400
DIN 2628:1975	Weld-neck flanges, nominal pressure 250
DIN 2629:1975	Weld-neck flanges, nominal pressure 320
DIN 2630:1975	Weld-neck flanges, nominal pressure 1 und 2.5
DIN 2631:1975	Weld-neck flanges, nominal pressure 6
DIN 2632:1975	Weld-neck flanges, nominal pressure 10
DIN 2633:1975	Weld-neck flanges, nominal pressure 16
DIN 2634:1975	Weld-neck flanges, nominal pressure 25
DIN 2635:1975	Weld-neck flanges, nominal pressure 40
DIN 2636:1975	Weld-neck flanges, nominal pressure 64
DIN 2637:1975	Weld-neck flanges, nominal pressure 100
DIN 2638:1975	Weld-neck flanges, nominal pressure 160
DIN 28115:2003	Flange connector, nominal pressure 10
EN 1092-1:2008	Round steel flanges
prEN 1092-1:2005	Round steel flanges

A.3.1.3 Standards for the bolt geometry

Typ	Standard
Anti-fatigue bolt	DIN 2510:1971, Bl. 3, Form K
Anti-fatigue bolt	DIN 2510:1971, Bl. 3, Form KU
Anti-fatigue bolt	DIN 2510:1971, Bl. 3, Form L
Anti-fatigue bolt	DIN 2510:1971, Bl. 3, Form Z
Anti-fatigue bolt	DIN 2510:1971, Bl. 4, Form G
Anti-fatigue bolt	DIN 2510:1971, Bl. 4, Form H
Anti-fatigue bolt	DIN 2510:1971, Bl. 4, Form P
Anti-fatigue bolt	DIN 2510:1971, Bl. 4, Form Q
Anti-fatigue bolt	DIN 2510:1971, Bl. 4, Form R
Anti-fatigue bolt	DIN 2510:1971, Bl. 4, Form S
Stud bolt	DIN 2509:1970
screw	DIN 931:1970
screw	DIN 933:1970
screw with shaft	EN ISO 4014:2001, Produktklasse A
screw with shaft	EN ISO 4014:2001, Produktklasse B
screw	DIN 938:1995
screw	DIN 939:1995
screw	DIN 940:1995

A.3.1.3 Standards for the thread geometry

Typ	Standard
Metrical thread with large match	DIN 2510:1971, Bl. 2
Metrical ISO-thread regular thread	DIN 13:1986

A.3.1.3 Standards for the extension sleeve geometry

Standard
DIN 126:1990
DIN 2510:1971 - Form D
DIN 2510:1971 - Form E

A.3.1.3 Standards for the nut geometry

Standard
ASME B18.2.2:2010
DIN 2510:1971, Bl. 5
EN ISO 4032:2000

A.3.2 material standards

Standard	material
AD W3/2	GG-25
AD W3/2	GGG-35.3
AD W3/2	GGG-40 (0.7040)
AD W3/2	GGG-40.3
AD W3/2	GGG-50 (0.7050)
AD W3/2	GGG-60 (0.7060)
AD W3/2	GGG-70 (0.7070)
AD W3/2:2000	EN-GJS-350-22
AD W3/2:2000	EN-GJS-400-15
AD W3/2:2000	EN-GJS-400-18
AD W3/2:2000	EN-GJS-500-3
AD W3/2:2000	EN-GJS-600-3
AD W3/2:2000	EN-GJS-700-2
DIN 1691:1985	GG-15
DIN 1691:1985	GG-20
DIN 1691:1985	GG-25
DIN 1691:1985	GG-30
DIN 1691:1985	GG-35
DIN 17100	RSt 37-2 (1.0038)
DIN 17100	ST 37.3 (1.0116)
DIN 17100	St 37-2 (1.0037)
DIN 17100	USt 37-2 (1.0036)
DIN 17100 ADW13:1980	St 52-3 (1.0570)
DIN 17103:1989	StE 355 (1.0562)
DIN 17103:1989	WStE 355 (1.0565)
DIN 17155:1983	10CrMo9-10 (1.7380)
DIN 17155:1983	13CrMo4-4 (1.7335)
DIN 17155:1983	15Mo3 (1.5415)
DIN 17155:1983	17Mn4 (1.0481)
DIN 17155:1983	19Mn6 (1.0473)
DIN 17155:1983	H I (1.0345)
DIN 17155:1983	H II (1.0425)
DIN 17155:1983	UH I (1.0348)
DIN 17173:1985	TTSt 35 N (1.0356)
DIN 17173:1985	TTSt 35 V (1.0356)
DIN 17175:1979	10CrMo9-10 (1.7380)
DIN 17175:1979	13CrMo4-4 (1.7335)
DIN 17175:1979	14MoV6-3 (1.7715)
DIN 17175:1979	15Mo3 (1.5415)
DIN 17175:1979	17Mn4 (1.0481)

A.3.2 material standards

Standard	material
DIN 17175:1979	19Mn5 (1.0482)
DIN 17175:1979	St 35.8 (1.0305)
DIN 17175:1979	St 45.8 (1.0405)
DIN 17175:1979	X20CrMoV12-1 (1.4922)
DIN 17177:1979	15Mo3 (1.5415)
DIN 17177:1979	St 37.8 (1.0315)
DIN 17177:1979	St 42.8 (1.0498)
DIN 17240	40CrMo5 (1.7711)
DIN 17240	C 35 (1.0501)
DIN 17240	Ck 35 (1.1181)
DIN 17240	Cq 35 (1.1172)
DIN 17240	NiCr20TiAl (2.4952)
DIN 17240	X19CrMoVNbN11-1 (1.4913)
DIN 17240	X8CrNiMoBNb16-16 (1.4986)
DIN 17240:1959	24 CrMoV 5 5 (1.7733)
DIN 17240:1976	21CrMoV5-7 (1.7709)
DIN 17240:1976	24CrMo5 (1.7258)
DIN 17240:1976	34CrNiMo6S (1.6589)
DIN 17240:1976	X22CrMoV12-1 (1.4923)
DIN 17243:1979	10CrMo9-10 (1.7380)
DIN 17243:1979	14MoV6-3 (1.7715)
DIN 17243:1979	15Mo3 (1.5415)
DIN 17243:1979	17Mn4 (1.0481)
DIN 17243:1979	20Mn5 N (1.1133)
DIN 17243:1979	20Mn5 V (1.1133)
DIN 17243:1979	C 22.8 (1.0460)
DIN 17243:1979	X20CrMoV12-1 (1.4922)
DIN 17243:1987	13CrMo4-4 (1.7335)
DIN 17440:1985	X10Cr13 (1.4006)
DIN 17440:1985	X15Cr13 (1.4024)
DIN 17440:1985	X2CrNi19-11 (1.4306)
DIN 17440:1985	X2CrNiMo17-13-2 (1.4404)
DIN 17440:1985	X2CrNiMo18-14-3 (1.4435)
DIN 17440:1985	X2CrNiMo18-16-4 (1.4438)
DIN 17440:1985	X2CrNiMoN17-12-2 (1.4406)
DIN 17440:1985	X2CrNiMoN17-13-3 (1.4429)
DIN 17440:1985	X2CrNiMoN17-13-5 (1.4439)
DIN 17440:1985	X2CrNiN18-10 (1.4311)
DIN 17440:1985	X5CrNi18-10 (1.4301)
DIN 17440:1985	X5CrNi18-12 (1.4303)

A.3.2 material standards

Standard	material
DIN 17440:1985	X5CrNiMo17-12-2 (1.4401)
DIN 17440:1985	X5CrNiMo17-13-3 (1.4436)
DIN 17440:1985	X6Cr13 (1.4000)
DIN 17440:1985	X6CrAl13 (1.4002)
DIN 17440:1985	X6CrNiTi18-10 (1.4541)
DIN 17440:1996	X17CrNi16-2 (1.4057, X20CrNi17-2)
DIN 17440:1996	X20Cr13 (1.4021)
DIN 17440:1996	X6CrNiMoNb17-12-2 (1.4580)
DIN 17440:1996	X6CrNiMoTi17-12-2 (1.4571)
DIN 17440:1996	X6CrNiNb18-10 (1.4550)
DIN 17440:1996	X6CrNiTi18-10 (1.4541)
DIN 17441:1997	X6CrNiMoTi17-12-2 (1.4571)
DIN 17441:1997	X6CrNiNb18-10 (1.4550)
DIN 17441:1997	X6CrNiTi18-10 (1.4541)
DIN 17445:1984	GX20Cr14 (1.4027)
DIN 17445:1984	GX22CrNi17 (1.4059)
DIN 17445:1984	GX3CrNiMoN17-13-5 (1.4439)
DIN 17445:1984	GX5CrNi13-4 (1.4313)
DIN 17445:1984	GX5CrNiMoNb18-10 (1.4581)
DIN 17445:1984	GX5CrNiNb18-9S (1.4552)
DIN 17445:1984	GX6CrNi18-9 (1.4308)
DIN 17445:1984	GX6CrNiMo18-10 (1.4408)
DIN 17445:1984	GX8CrNi13 (1.4008)
DIN 17457:1985	X6CrNiMoTi17-12-2 (1.4571)
DIN 17457:1985	X6CrNiNb18-10 (1.4550)
DIN 17457:1985	X6CrNiTi18-10 (1.4541)
DIN 17458:1985	X6CrNiMoNb17-12-2 (1.4580)
DIN 17458:1985	X6CrNiMoTi17-12-2 (1.4571)
DIN 17458:1985	X6CrNiNb18-10 (1.4550)
DIN 17458:1985	X6CrNiTi18-10 (1.4541)
DIN 2528	15Mo3 (1.5415)
DIN 2528	C 22.8 (1.0460)
DIN EN 10025 & AD W13:1994	S235J2G4 (1.0117)
DIN EN 10025 & AD W13:1994	S235JRG1 (1.0116)
DIN EN 10025 & AD W13:1994	S235JRG2 (1.0038)
DIN EN 10025 & AD W13:1994	S355J2G4 (1.0577)
DIN EN 10025 ADW1:1994	S235J2G3 (1.0116, St37.3)
DIN EN 10025 ADW1:1994	S235JRG2 (1.0038, RSt 37-2)
DIN EN 10028-2:1993	10CrMo9-10 (1.7380)
DIN EN 10028-2:1993	13CrMo4-5 (1.7335, 13CrMo4-4)

A.3.2 material standards

Standard	material
DIN EN 10028-2:1993	16Mo3 (1.5415, 15Mo3)
DIN EN 10028-2:2003	10CrMo9-10 (1.7380)
DIN EN 10028-2:2003	12CrMo9-10 (1.7375)
DIN EN 10028-2:2003	12CrMoV12-10 +NT (1.7767)
DIN EN 10028-2:2003	12CrMoV12-10 +QT (1.7767)
DIN EN 10028-2:2003	13CrMo4-5 (1.7335)
DIN EN 10028-2:2003	13CrMoSi5-5 +NT (1.7336)
DIN EN 10028-2:2003	13CrMoSi5-5 +QT (1.7336)
DIN EN 10028-2:2003	13CrMoV9-10 +NT (1.7703)
DIN EN 10028-2:2003	13CrMoV9-10 +QT (1.7703)
DIN EN 10028-2:2003	15NiCuMoNb5-6-4 (1.6368)
DIN EN 10028-2:2003	16Mo3 (1.5415)
DIN EN 10028-2:2003	18MnMo4-5 (1.5414)
DIN EN 10028-2:2003	20MnMoNi4-5 (1.6311)
DIN EN 10028-2:2003	P235GH (1.0345)
DIN EN 10028-2:2003	P265GH (1.0425)
DIN EN 10028-2:2003	P265GH (1.0425, H II)
DIN EN 10028-2:2003	P295GH (1.0481)
DIN EN 10028-2:2003	P355GH (1.0473)
DIN EN 10028-2:2003	X10CrMoVNb9-1 (1.4903)
DIN EN 10028-2:2003	X12CrMo5 +NT (1.7362)
DIN EN 10028-2:2003	X12CrMo5 +QT (1.7362)
DIN EN 10028-2:2009	10CrMo9-10 (1.7380)
DIN EN 10028-2:2009	12CrMo9-10 (1.7375)
DIN EN 10028-2:2009	12CrMoV12-10 (1.7767)
DIN EN 10028-2:2009	13CrMo4-5 (1.7335)
DIN EN 10028-2:2009	13CrMoSi5-5 + NT (1.7336 + NT)
DIN EN 10028-2:2009	13CrMoSi5-5 + QT (1.7336 + QT)
DIN EN 10028-2:2009	13CrMoV9-10 (1.7703)
DIN EN 10028-2:2009	15NiCuMoNb5-6-4 (1.6368)
DIN EN 10028-2:2009	16Mo3 (1.5415)
DIN EN 10028-2:2009	18MnMo4-5 (1.5414)
DIN EN 10028-2:2009	20MnMoNi4-5 (1.6311)
DIN EN 10028-2:2009	P235GH (1.0345)
DIN EN 10028-2:2009	P265GH (1.0425)
DIN EN 10028-2:2009	P295GH (1.0481)
DIN EN 10028-2:2009	P355GH (1.0473)
DIN EN 10028-2:2009	X10CrMoVNb9-1 (1.4903)
DIN EN 10028-2:2009	X12CrMo5 (1.7362)
DIN EN 10028-3:1993	P275NH (1.0487, WStE 285)

A.3.2 material standards

Standard	material
DIN EN 10028-3:1993	P355N (1.0562, StE355)
DIN EN 10028-3:1993	P355NH (1.0565 WStE 355)
DIN EN 10028-3:2003	P275NH (1.0487)
DIN EN 10028-3:2003	P275NL1 (1.0488)
DIN EN 10028-3:2003	P275NL2 (1.1104)
DIN EN 10028-3:2003	P355N (1.0562)
DIN EN 10028-3:2003	P355NH (1.0565)
DIN EN 10028-3:2003	P355NL1 (1.0566)
DIN EN 10028-3:2003	P355NL1 (1.8915)
DIN EN 10028-3:2003	P355NL2 (1.1106)
DIN EN 10028-3:2003	P460NH (1.8935)
DIN EN 10028-3:2003	P460NL2 (1.8918)
DIN EN 10028-3:2009	P275NH (1.0487)
DIN EN 10028-3:2009	P275NL1 (1.0488)
DIN EN 10028-3:2009	P275NL2 (1.1104)
DIN EN 10028-3:2009	P355N (1.0562)
DIN EN 10028-3:2009	P355NH (1.0565)
DIN EN 10028-3:2009	P355NL1 (1.0566)
DIN EN 10028-3:2009	P355NL2 (1.1106)
DIN EN 10028-3:2009	P460NH (1.8935)
DIN EN 10028-3:2009	P460NL1 (1.8915)
DIN EN 10028-3:2009	P460NL2 (1.8918)
DIN EN 10028-4:2003	11MnNi5-3 (1.6212)
DIN EN 10028-4:2003	12Ni14 (1.5637)
DIN EN 10028-4:2003	13MnNi6-3 (1.6217)
DIN EN 10028-4:2003	15NiMn6 (1.6228)
DIN EN 10028-4:2003	X12Ni5 (1.5680)
DIN EN 10028-4:2003	X7Ni9 (1.5663)
DIN EN 10028-4:2003	X8Ni9 +NT640 (1.5662)
DIN EN 10028-4:2003	X8Ni9 +QT640 (1.5662)
DIN EN 10028-4:2003	X8Ni9 +QT680 (1.5662)
DIN EN 10028-4:2009	11MnNi5-3 (1.6212)
DIN EN 10028-4:2009	12Ni14 (1.5637)
DIN EN 10028-4:2009	13MnNi6-3 (1.6217)
DIN EN 10028-4:2009	15NiMn6 (1.6228)
DIN EN 10028-4:2009	X12Ni5 (1.5680)
DIN EN 10028-4:2009	X7Ni9 (1.5663)
DIN EN 10028-4:2009	X8Ni9 +NT640 (1.5662)
DIN EN 10028-4:2009	X8Ni9 +QT640 (1.5662)
DIN EN 10028-4:2009	X8Ni9 +QT680 (1.5662)

A.3.2 material standards

Standard	material
DIN EN 10028-5:2009	P355M (1.8821)
DIN EN 10028-5:2009	P355ML1 (1.8832)
DIN EN 10028-5:2009	P355ML2 (1.8833)
DIN EN 10028-5:2009	P420M (1.8824)
DIN EN 10028-5:2009	P420ML1 (1.8835)
DIN EN 10028-5:2009	P420ML2 (1.8828)
DIN EN 10028-5:2009	P460M (1.8826)
DIN EN 10028-5:2009	P460ML1 (1.8837)
DIN EN 10028-5:2009	P460ML2 (1.8831)
DIN EN 10028-7:2000	X1CrNi25-21 (1.4335)
DIN EN 10028-7:2000	X1CrNiMoCuN20-18-7 (1.4547)
DIN EN 10028-7:2000	X1CrNiMoCuN25-20-7 (1.4529)
DIN EN 10028-7:2000	X1CrNiMoCuN25-25-5 (1.4537)
DIN EN 10028-7:2000	X1CrNiMoN25-22-2 (1.4466)
DIN EN 10028-7:2000	X1NiCrMoCu25-20-5 (1.4539)
DIN EN 10028-7:2000	X1NiCrMoCu31-27-4 (1.4563)
DIN EN 10028-7:2000	X2CrNi18-9 (1.4307)
DIN EN 10028-7:2000	X2CrNi19-11 (1.4306)
DIN EN 10028-7:2000	X2CrNiMo17-12-2 (1.4404)
DIN EN 10028-7:2000	X2CrNiMo17-12-3 (1.4432)
DIN EN 10028-7:2000	X2CrNiMo18-14-3 (1.4435)
DIN EN 10028-7:2000	X2CrNiMoCuN25-6-3 (1.4507)
DIN EN 10028-7:2000	X2CrNiMoN17-11-2 (1.4406)
DIN EN 10028-7:2000	X2CrNiMoN17-13-3 (1.4429)
DIN EN 10028-7:2000	X2CrNiMoN17-13-5 (1.4439)
DIN EN 10028-7:2000	X2CrNiMoN18-12-4 (1.4434)
DIN EN 10028-7:2000	X2CrNiMoN18-15-4 (1.4438)
DIN EN 10028-7:2000	X2CrNiMoN22-5-3 (1.4462)
DIN EN 10028-7:2000	X2CrNiMoN25-7-4 (1.4410)
DIN EN 10028-7:2000	X2CrNiN18-10 (1.4311)
DIN EN 10028-7:2000	X2CrNiN18-7 (1.4318)
DIN EN 10028-7:2000	X2CrNiN23-4 (1.4362)
DIN EN 10028-7:2000	X2NiCrMoCuWN25-7-4 (1.4501)
DIN EN 10028-7:2000	X3CrNiMo17-13-3 (1.4436)
DIN EN 10028-7:2000	X3CrNiMoBN17-13-3 (1.4910)
DIN EN 10028-7:2000	X5CrNi18-10 (1.4301)
DIN EN 10028-7:2000	X5CrNiMo17-12-2 (1.4401)
DIN EN 10028-7:2000	X5CrNiN19-9 (1.4315)
DIN EN 10028-7:2000	X5NiCrAlTi31-20 (1.4958)
DIN EN 10028-7:2000	X5NiCrAlTi31-20 +RA (1.4958)

A.3.2 material standards

Standard	material
DIN EN 10028-7:2000	X6CrNi18-10 (1.4948)
DIN EN 10028-7:2000	X6CrNi23-13 (1.4950)
DIN EN 10028-7:2000	X6CrNi25-20 (1.4951)
DIN EN 10028-7:2000	X6CrNiMoNb17-12-2 (1.4580)
DIN EN 10028-7:2000	X6CrNiMoTi17-12-2 (1.4571)
DIN EN 10028-7:2000	X6CrNiNb18-10 (1.4550)
DIN EN 10028-7:2000	X6CrNiTi18-10 (1.4541)
DIN EN 10028-7:2000	X7CrNiTiB18-10 (1.4941)
DIN EN 10028-7:2000	X8CrNiNb16-13 (1.4961)
DIN EN 10028-7:2000	X8NiCrAlTi32-21 (1.4959)
DIN EN 10028-7:2003	X2CrNi18-9 (1.4307)
DIN EN 10028-7:2008	X1CrNi25-21 (1.4335)
DIN EN 10028-7:2008	X1CrNiMoCuN20-18-7 (1.4547)
DIN EN 10028-7:2008	X1CrNiMoCuN25-20-7 (1.4529)
DIN EN 10028-7:2008	X1CrNiMoCuN25-25-5 (1.4537)
DIN EN 10028-7:2008	X1CrNiMoN25-22-2 (1.4466)
DIN EN 10028-7:2008	X1NiCrMoCu25-20-5 (1.4539)
DIN EN 10028-7:2008	X1NiCrMoCu31-27-4 (1.4563)
DIN EN 10028-7:2008	X2CrMoTi17-1 (1.4513)
DIN EN 10028-7:2008	X2CrMoTi18-2 (1.4521)
DIN EN 10028-7:2008	X2CrNi12 (1.4003)
DIN EN 10028-7:2008	X2CrNi18-9 (1.4307)
DIN EN 10028-7:2008	X2CrNi19-11 (1.4306)
DIN EN 10028-7:2008	X2CrNiMo17-12-2 (1.4404)
DIN EN 10028-7:2008	X2CrNiMo17-12-3 (1.4432)
DIN EN 10028-7:2008	X2CrNiMo18-14-3 (1.4435)
DIN EN 10028-7:2008	X2CrNiMoCuN25-6-3 (1.4507)
DIN EN 10028-7:2008	X2CrNiMoCuWN25-7-4 (1.4501)
DIN EN 10028-7:2008	X2CrNiMoN17-11-2 (1.4406)
DIN EN 10028-7:2008	X2CrNiMoN17-13-3 (1.4429)
DIN EN 10028-7:2008	X2CrNiMoN17-13-5 (1.4439)
DIN EN 10028-7:2008	X2CrNiMoN18-12-4 (1.4434)
DIN EN 10028-7:2008	X2CrNiMoN18-15-4 (1.4438)
DIN EN 10028-7:2008	X2CrNiMoN22-5-3 (1.4462)
DIN EN 10028-7:2008	X2CrNiMoN25-7-4 (1.4410)
DIN EN 10028-7:2008	X2CrNiN18-10 (1.4311)
DIN EN 10028-7:2008	X2CrNiN18-7 (1.4318)
DIN EN 10028-7:2008	X2CrNiN23-4 (1.4362)
DIN EN 10028-7:2008	X2CrTi17 (1.4520)
DIN EN 10028-7:2008	X2CrTiNb18 (1.4509)

A.3.2 material standards

Standard	material
DIN EN 10028-7:2008	X3CrNiMo13-4 (1.4313)
DIN EN 10028-7:2008	X3CrNiMo17-13-3 (1.4436)
DIN EN 10028-7:2008	X3CrNiMoBN17-13-3 (1.4910)
DIN EN 10028-7:2008	X3CrTi17 (1.4510)
DIN EN 10028-7:2008	X4CrNiMo16-5-1 (1.4418)
DIN EN 10028-7:2008	X5CrNi18-10 (1.4301)
DIN EN 10028-7:2008	X5CrNiMo17-12-2 (1.4401)
DIN EN 10028-7:2008	X5CrNiN19-9 (1.4315)
DIN EN 10028-7:2008	X5NiCrAlTi31-20 (1.4958)
DIN EN 10028-7:2008	X5NiCrAlTi31-20 +RA (1.4958)
DIN EN 10028-7:2008	X6CrMoNb17-1 (1.4526)
DIN EN 10028-7:2008	X6CrNi18-10 (1.4948)
DIN EN 10028-7:2008	X6CrNi23-13 (1.4950)
DIN EN 10028-7:2008	X6CrNi25-20 (1.4951)
DIN EN 10028-7:2008	X6CrNiMoNb17-12-2 (1.4580)
DIN EN 10028-7:2008	X6CrNiMoTi17-12-2 (1.4571)
DIN EN 10028-7:2008	X6CrNiNb18-10 (1.4550)
DIN EN 10028-7:2008	X6CrNiTi12 (1.4516)
DIN EN 10028-7:2008	X6CrNiTi18-10 (1.4541)
DIN EN 10028-7:2008	X6CrNiTiB18-10 (1.4941)
DIN EN 10028-7:2008	X8CrNiNb16-13 (1.4961)
DIN EN 10028-7:2008	X8NiCrAlTi32-21 (1.4959)
DIN EN 10083-2:2006	C35E (1.1181, Ck 35)
DIN EN 10083-3:2006	34CrNiMo6 (1.6582)
DIN EN 10083-3:2006	42CrMo4 (1.7225)
DIN EN 10088-2:1995	X1NiCrMoCu25-20-5 (1.4539)
DIN EN 10088-2:2005	X1CrNiSi18-15-4 (1.4361)
DIN EN 10088-3:1995	X17CrNi16-2 (1.4057, X20CrNi17-2)
DIN EN 10088-3:1995	X5CrNiCuNb16-4 (1.4542)
DIN EN 10213-2:1996	G12MoCrV5-2 +QT (1.7720)
DIN EN 10213-2:1996	G15CrMo5 +QT (1.7365)
DIN EN 10213-2:1996	G17CrMo5-5 +QT (1.7357)
DIN EN 10213-2:1996	G17CrMo9-10 +QT (1.7379)
DIN EN 10213-2:1996	G17CrMoV5-10 +QT (1.7706)
DIN EN 10213-2:1996	G20Mo5 +QT (1.5419)
DIN EN 10213-2:1996	GP240GH +N (1.0619)
DIN EN 10213-2:1996	GP240GH +QT (1.0619)
DIN EN 10213-2:1996	GP240GR +N (1.0621)
DIN EN 10213-2:1996	GP280GH +N (1.0625)
DIN EN 10213-2:1996	GP280GH +QT (1.0625)

A.3.2 material standards

Standard	material
DIN EN 10213-2:1996	GS-C 25 (1.0619)
DIN EN 10213-2:1996	GX23CrMoV12-1 +QT (1.4931)
DIN EN 10213-2:1996	GX4CrNi13-4 +QT (1.4317)
DIN EN 10213-2:1996	GX4CrNiMo16-5-1 +QT (1.4405)
DIN EN 10213-2:1996	GX8CrNi12 +QT1 (1.4107)
DIN EN 10213-2:1996	GX8CrNi12 +QT2 (1.4107)
DIN EN 10213-3:1996	G17Mn5 +QT (1.1131)
DIN EN 10213-3:1996	G17NiCrMo13-6 +QT (1.6781)
DIN EN 10213-3:1996	G18Mo5 +QT (1.5422)
DIN EN 10213-3:1996	G20Mn5 +N (1.6220)
DIN EN 10213-3:1996	G20Mn5 +QT (1.6220)
DIN EN 10213-3:1996	G9Ni10 +QT (1.5636)
DIN EN 10213-3:1996	G9Ni14 +QT (1.5638)
DIN EN 10213-3:1996	GX3CrNi13-4 +QT (1.6982)
DIN EN 10213-4:1996	GX2CrNi19-11 (1.4309)
DIN EN 10213-4:1996	GX2CrNiMo19-11-2 (1.4409)
DIN EN 10213-4:1996	GX2CrNiMoCuN25-6-3-3 (1.4517)
DIN EN 10213-4:1996	GX2CrNiMoN22-5-3 (1.4470)
DIN EN 10213-4:1996	GX2CrNiMoN26-7-4 (1.4469)
DIN EN 10213-4:1996	GX2NiCrMo28-20-2 (1.4458)
DIN EN 10213-4:1996	GX5CrNi19-10 (1.4308)
DIN EN 10213-4:1996	GX5CrNiMo19-11-2 (1.4408)
DIN EN 10213-4:1996	GX5CrNiMoNb19-11-2 (1.4581)
DIN EN 10213-4:1996	GX5CrNiNb19-11 (1.4552)
DIN EN 10216-1 & AD W4:2002	P195TR2 (1.0108)
DIN EN 10216-1 & AD W4:2002	P235TR2 (1.0255)
DIN EN 10216-1 & AD W4:2002	P265TR2 (1.0259)
DIN EN 10216-2:2002	10CrMo5-5 (1.7338)
DIN EN 10216-2:2002	10CrMo9-10 (1.7380)
DIN EN 10216-2:2002	11CrMo9-10 (1.7383)
DIN EN 10216-2:2002	13CrMo4-5 (1.7335)
DIN EN 10216-2:2002	14MoV6-3 (1.7715)
DIN EN 10216-2:2002	15NiCuMoNb5-6-4 (1.6368)
DIN EN 10216-2:2002	16Mo3 (1.5415)
DIN EN 10216-2:2002	20CrMoV13-5-5 (1.7779)
DIN EN 10216-2:2002	20MnNb6 (1.0471)
DIN EN 10216-2:2002	25CrMo4 (1.7218)
DIN EN 10216-2:2002	8MoB5-4 (1.5450)
DIN EN 10216-2:2002	P195GH (1.0348)
DIN EN 10216-2:2002	P235GH (1.0345)

A.3.2 material standards

Standard	material
DIN EN 10216-2:2002	P265GH (1.0425)
DIN EN 10216-2:2002	X10CrMoVNb9-1 (1.4903)
DIN EN 10216-2:2002	X11CrMo5+I (1.7362+I)
DIN EN 10216-2:2002	X11CrMo5+NT1 (1.7362+NT1)
DIN EN 10216-2:2002	X11CrMo5+NT2 (1.7362+NT2)
DIN EN 10216-2:2002	X11CrMo9-1+I (1.7386+I)
DIN EN 10216-2:2002	X11CrMo9-1+NT (1.7386+NT)
DIN EN 10216-2:2002	X20CrMoV11-1 (1.4922)
DIN EN 10216-2:2004	10CrMo5-5 (1.7338)
DIN EN 10216-2:2004	10CrMo9-10 (1.7380)
DIN EN 10216-2:2004	11CrMo9-10 (1.7383)
DIN EN 10216-2:2004	13CrMo4-5 (1.7335)
DIN EN 10216-2:2004	14MoV6-3 (1.7715)
DIN EN 10216-2:2004	15NiCuMoNb5-6-4 (1.6368)
DIN EN 10216-2:2004	16Mo3 (1.5415)
DIN EN 10216-2:2004	20CrMoV13-5-5 (1.7779)
DIN EN 10216-2:2004	20MnNb6 (1.0471)
DIN EN 10216-2:2004	25CrMo4 (1.7218)
DIN EN 10216-2:2004	8MoB5-4 (1.5450)
DIN EN 10216-2:2004	P195GH (1.0348)
DIN EN 10216-2:2004	P235GH (1.0345)
DIN EN 10216-2:2004	P265GH (1.0425)
DIN EN 10216-2:2004	X10CrMoVnb9-1 (1.4903)
DIN EN 10216-2:2004	X11CrMo5 +I (1.7362)
DIN EN 10216-2:2004	X11CrMo5 +NT1 (1.7362)
DIN EN 10216-2:2004	X11CrMo5 +NT2 (1.7362)
DIN EN 10216-2:2004	X11CrMo9-1 +I (1.7386)
DIN EN 10216-2:2004	X11CrMo9-1 +NT (1.7386)
DIN EN 10216-2:2004	X20CrMoV11-1 (1.4922)
DIN EN 10216-2:2007	10CrMo5-5 (1.7338)
DIN EN 10216-2:2007	10CrMo9-10 (1.7380)
DIN EN 10216-2:2007	11CrMo9-10 (1.7383)
DIN EN 10216-2:2007	13CrMo4-5 (1.7335)
DIN EN 10216-2:2007	14MoV6-3 (1.7715)
DIN EN 10216-2:2007	15NiCuMoNb5-6-4 (1.6368)
DIN EN 10216-2:2007	16Mo3 (1.5415)
DIN EN 10216-2:2007	20CrMoV13-5-5 (1.7779)
DIN EN 10216-2:2007	20MnNb6 (1.0471)
DIN EN 10216-2:2007	25CrMo4 (1.7218)
DIN EN 10216-2:2007	7CrMoVTiB10-10 (1.7378)

A.3.2 material standards

Standard	material
DIN EN 10216-2:2007	7CrWVMoNb9-6 (1.8201)
DIN EN 10216-2:2007	8MoB5-4 (1.5450)
DIN EN 10216-2:2007	P195GH (1.0348)
DIN EN 10216-2:2007	P235GH (1.0345)
DIN EN 10216-2:2007	P265GH (1.0425)
DIN EN 10216-2:2007	X10CrMoVNb9-1 (1.4903)
DIN EN 10216-2:2007	X10CrWMoVNb9-2 (1.4901)
DIN EN 10216-2:2007	X11CrMo5+I (1.7362+I)
DIN EN 10216-2:2007	X11CrMo5+NT1 (1.7362+NT1)
DIN EN 10216-2:2007	X11CrMo5+NT2 (1.7362+NT2)
DIN EN 10216-2:2007	X11CrMo9-1+I (1.7386+I)
DIN EN 10216-2:2007	X11CrMo9-1+NT (1.7386+NT)
DIN EN 10216-2:2007	X11CrMoWVNb9-1-1 (1.4905)
DIN EN 10216-2:2007	X20CrMoV11-1 (1.4922)
DIN EN 10216-3:2004	P275NL1 (1.0488)
DIN EN 10216-3:2004	P275NL2 (1.1104)
DIN EN 10216-3:2004	P355N (1.0562)
DIN EN 10216-3:2004	P355NH (1.0565)
DIN EN 10216-3:2004	P355NL1 (1.0566)
DIN EN 10216-3:2004	P355NL2 (1.1106)
DIN EN 10216-3:2004	P460N (1.8905)
DIN EN 10216-3:2004	P460NH (1.8935)
DIN EN 10216-3:2004	P460NL1 (1.8915)
DIN EN 10216-3:2004	P460NL2 (1.8918)
DIN EN 10216-3:2004	P620Q (1.8876)
DIN EN 10216-3:2004	P620QH (1.8877)
DIN EN 10216-3:2004	P620QL (1.8890)
DIN EN 10216-3:2004	P690Q (1.8879)
DIN EN 10216-3:2004	P690QH (1.8880)
DIN EN 10216-3:2004	P690QL1 (1.8881)
DIN EN 10216-3:2004	P690QL2 (1.8888)
DIN EN 10216-3:2008	P275NL1 (1.0488)
DIN EN 10216-3:2008	P275NL2 (1.1104)
DIN EN 10216-3:2008	P355N (1.0562)
DIN EN 10216-3:2008	P355NH (1.0565)
DIN EN 10216-3:2008	P355NL1 (1.0566)
DIN EN 10216-3:2008	P355NL2 (1.1106)
DIN EN 10216-3:2008	P460N (1.8905)
DIN EN 10216-3:2008	P460NH (1.8935)
DIN EN 10216-3:2008	P460NL1 (1.8915)

A.3.2 material standards

Standard	material
DIN EN 10216-3:2008	P460NL2 (1.8918)
DIN EN 10216-3:2008	P620Q (1.8876)
DIN EN 10216-3:2008	P620QH (1.8877)
DIN EN 10216-3:2008	P620QL (1.8890)
DIN EN 10216-3:2008	P690Q (1.8879)
DIN EN 10216-3:2008	P690QH (1.8880)
DIN EN 10216-3:2008	P690QL1 (1.8881)
DIN EN 10216-3:2008	P690QL2 (1.8888)
DIN EN 10216-4:2004	11MnNi5-3 (1.6212)
DIN EN 10216-4:2004	12Ni14 (1.5637)
DIN EN 10216-4:2004	13MnNi6-3 (1.6217)
DIN EN 10216-4:2004	26CrMo4-2 (1.7219)
DIN EN 10216-4:2004	P215NL (1.0451)
DIN EN 10216-4:2004	P255QL (1.0452)
DIN EN 10216-4:2004	P265NL (1.0453)
DIN EN 10216-4:2004	X10Ni9 (1.5682)
DIN EN 10216-4:2004	X12Ni5 (1.5680)
DIN EN 10216-5:2004	X10CrNiMoMnNbVB15-10-1 (1.4982)
DIN EN 10216-5:2004	X1CrNi25-21 (1.4335)
DIN EN 10216-5:2004	X1CrNiMoCuN20-18-7 (1.4547)
DIN EN 10216-5:2004	X1CrNiMoN25-22-2 (1.4466)
DIN EN 10216-5:2004	X1NiCrMoCu25-20-5 (1.4539)
DIN EN 10216-5:2004	X1NiCrMoCu31-27-4 (1.4563)
DIN EN 10216-5:2004	X1NiCrMoCuN25-20-7 (1.4529)
DIN EN 10216-5:2004	X2CrNi18-9 (1.4307)
DIN EN 10216-5:2004	X2CrNi19-11 (1.4306)
DIN EN 10216-5:2004	X2CrNiMo17-12-2 (1.4404)
DIN EN 10216-5:2004	X2CrNiMo18-14-3 (1.4435)
DIN EN 10216-5:2004	X2CrNiMoCuN25-6-3 (1.4507)
DIN EN 10216-5:2004	X2CrNiMoCuWN25-7-4 (1.4501)
DIN EN 10216-5:2004	X2CrNiMoN17-13-3 (1.4429)
DIN EN 10216-5:2004	X2CrNiMoN17-13-5 (1.4439)
DIN EN 10216-5:2004	X2CrNiMoN22-5-3 (1.4462)
DIN EN 10216-5:2004	X2CrNiMoN25-7-4 (1.4410)
DIN EN 10216-5:2004	X2CrNiMoSi18-5-3 (1.4424)
DIN EN 10216-5:2004	X2CrNiN18-10 (1.4311)
DIN EN 10216-5:2004	X2CrNiN23-4 (1.4362)
DIN EN 10216-5:2004	X2NiCrAlTi32-20 (1.4558)
DIN EN 10216-5:2004	X3CrNiMo17-13-3 (1.4436)
DIN EN 10216-5:2004	X3CrNiMoBN17-13-3 (1.4910)

A.3.2 material standards

Standard	material
DIN EN 10216-5:2004	X5CrNi18-10 (1.4301)
DIN EN 10216-5:2004	X5CrNiMo17-12-2 (1.4401)
DIN EN 10216-5:2004	X5NiCrAlTi31-20 (1.4958)
DIN EN 10216-5:2004	X5NiCrAlTi31-20 +RA (1.4958)
DIN EN 10216-5:2004	X6CrNi18-10 (1.4948)
DIN EN 10216-5:2004	X6CrNiMo17-13-2 (1.4918)
DIN EN 10216-5:2004	X6CrNiMoNb17-12-2 (1.4580)
DIN EN 10216-5:2004	X6CrNiMoTi17-12-2 (1.4571)
DIN EN 10216-5:2004	X6CrNiNb18-10 (1.4550)
DIN EN 10216-5:2004	X6CrNiTi18-10 (1.4541)
DIN EN 10216-5:2004	X6CrNiTiB18-10 (1.4941)
DIN EN 10216-5:2004	X7CrNiNb18-10 (1.4912)
DIN EN 10216-5:2004	X7CrNiTi18-10 (1.4940)
DIN EN 10216-5:2004	X8CrNiMoNb16-16 (1.4981)
DIN EN 10216-5:2004	X8CrNiMoVNb16-13 (1.4988)
DIN EN 10216-5:2004	X8CrNiNb16-13 (1.4961)
DIN EN 10216-5:2004	X8NiCrAlTi32-21 (1.4959)
DIN EN 10217-1:2005	P195TR1 (1.0107)
DIN EN 10217-1:2005	P195TR2 (1.0108)
DIN EN 10217-1:2005	P235TR1 (1.0254)
DIN EN 10217-1:2005	P235TR2 (1.0255)
DIN EN 10217-1:2005	P265TR1 (1.0258)
DIN EN 10217-1:2005	P265TR2 (1.0259)
DIN EN 10217-2:2005	16Mo3 (1.5415)
DIN EN 10217-2:2005	P195GH (1.0348)
DIN EN 10217-2:2005	P235GH (1.0345)
DIN EN 10217-2:2005	P265GH (1.0425)
DIN EN 10217-3:2002	P275NL1 (1.0488)
DIN EN 10217-3:2002	P275NL2 (1.1104)
DIN EN 10217-3:2002	P355N (1.0562)
DIN EN 10217-3:2002	P355NH (1.0565)
DIN EN 10217-3:2002	P355NL1 (1.0566)
DIN EN 10217-3:2002	P355NL2 (1.1106)
DIN EN 10217-3:2002	P460N (1.8905)
DIN EN 10217-3:2002	P460NH (1.8935)
DIN EN 10217-3:2002	P460NL1 (1.8915)
DIN EN 10217-3:2002	P460NL2 (1.8918)
DIN EN 10217-4:2005	P215NL (1.0451)
DIN EN 10217-4:2005	P265NL (1.0453)
DIN EN 10217-5:2005	16Mo3 (1.5415)

A.3.2 material standards

Standard	material
DIN EN 10217-5:2005	P235GH (1.0345)
DIN EN 10217-5:2005	P265GH (1.0425)
DIN EN 10217-6:2005	P215NL (1.0451)
DIN EN 10217-6:2005	P265NL (1.0453)
DIN EN 10217-7:2005	X1CrNiMoCuN20-18-7 (1.4547)
DIN EN 10217-7:2005	X1NiCrMoCu25-20-5 (1.4539)
DIN EN 10217-7:2005	X1NiCrMoCu31-27-4 (1.4563)
DIN EN 10217-7:2005	X1NiCrMoCuN25-20-7 (1.4529)
DIN EN 10217-7:2005	X2CrNi18-9 (1.4307)
DIN EN 10217-7:2005	X2CrNi19-11 (1.4306)
DIN EN 10217-7:2005	X2CrNiMo17-12-2 (1.4404)
DIN EN 10217-7:2005	X2CrNiMo17-12-3 (1.4432)
DIN EN 10217-7:2005	X2CrNiMo18-14-3 (1.4435)
DIN EN 10217-7:2005	X2CrNiMoCuWN25-7-4 (1.4501)
DIN EN 10217-7:2005	X2CrNiMoN17-13-3 (1.4429)
DIN EN 10217-7:2005	X2CrNiMoN17-13-5 (1.4439)
DIN EN 10217-7:2005	X2CrNiMoN18-15-4 (1.4438)
DIN EN 10217-7:2005	X2CrNiMoN22-5-3 (1.4462)
DIN EN 10217-7:2005	X2CrNiMoN22-7-4 (1.4410)
DIN EN 10217-7:2005	X2CrNiN18-10 (1.4311)
DIN EN 10217-7:2005	X2CrNiN23-4 (1.4362)
DIN EN 10217-7:2005	X3CrNiMo17-13-3 (1.4436)
DIN EN 10217-7:2005	X5CrNi18-10 (1.4301)
DIN EN 10217-7:2005	X5CrNiMo17-12-2 (1.4401)
DIN EN 10217-7:2005	X6CrNiMoTi17-12-2 (1.4571)
DIN EN 10217-7:2005	X6CrNiNb18-10 (1.4550)
DIN EN 10217-7:2005	X6CrNiTi18-10 (1.4541)
DIN EN 10222-2:2000	11CrMo9-10 (1.7383)
DIN EN 10222-2:2000	13CrMo4-5 (1.7335)
DIN EN 10222-2:2000	14MoV6-3 (1.7715)
DIN EN 10222-2:2000	15MnCrMoNiV5-3 (1.6920)
DIN EN 10222-2:2000	15MnMoV4-5 (1.5402)
DIN EN 10222-2:2000	16Mo3 (1.5415)
DIN EN 10222-2:2000	18MnMoNi5-5 (1.6308)
DIN EN 10222-2:2000	P245GH (1.0352)
DIN EN 10222-2:2000	P250GH (1.0460)
DIN EN 10222-2:2000	P280GH (1.0426)
DIN EN 10222-2:2000	P305GH (1.0436)
DIN EN 10222-2:2000	P305GH +QT (1.0436)
DIN EN 10222-2:2000	X10CrMoVNb9-1 (1.4903)

A.3.2 material standards

Standard	material
DIN EN 10222-2:2000	X16CrMo5-1 +A (1.7366)
DIN EN 10222-2:2000	X16CrMo5-1 +NT (1.7366)
DIN EN 10222-2:2000	X20CrMoV11-1 (1.4922)
DIN EN 10222-3:1999	12Ni14 (1.5637)
DIN EN 10222-3:1999	13MnNi6-3 (1.6217)
DIN EN 10222-3:1999	15NiMn6 (1.6228)
DIN EN 10222-3:1999	X12Ni5 (1.5680)
DIN EN 10222-3:1999	X8Ni9 (1.5662)
DIN EN 10222-4:2001	P285NH (1.0477)
DIN EN 10222-4:2001	P285QH (1.0478)
DIN EN 10222-4:2001	P355NH (1.0565)
DIN EN 10222-4:2001	P355QH1 (1.0571)
DIN EN 10222-4:2001	P420NH (1.8932)
DIN EN 10222-4:2001	P420QH (1.8936)
DIN EN 10222-5:2000	X1CrNiMoCuN20-18-7 (1.4547)
DIN EN 10222-5:2000	X1CrNiMoCuN25-20-7 (1.4529)
DIN EN 10222-5:2000	X1NiCrMoCu25-20-5 (1.4539)
DIN EN 10222-5:2000	X2CrNi18-9 (1.4307)
DIN EN 10222-5:2000	X2CrNiCu19-10 (1.4650)
DIN EN 10222-5:2000	X2CrNiMo17-12-2 (1.4404)
DIN EN 10222-5:2000	X2CrNiMo17-12-3 (1.4432)
DIN EN 10222-5:2000	X2CrNiMo18-14-3 (1.4435)
DIN EN 10222-5:2000	X2CrNiMoN17-11-2 (1.4406)
DIN EN 10222-5:2000	X2CrNiMoN17-13-3 (1.4429)
DIN EN 10222-5:2000	X2CrNiMoN17-13-5 (1.4439)
DIN EN 10222-5:2000	X2CrNiMoN22-5-3 (1.4462)
DIN EN 10222-5:2000	X2CrNiMoN25-7-4 (1.4410)
DIN EN 10222-5:2000	X2CrNiN18-10 (1.4311)
DIN EN 10222-5:2000	X3CrNiMo13-4 (1.4313)
DIN EN 10222-5:2000	X3CrNiMo17-13-3 (1.4436)
DIN EN 10222-5:2000	X3CrNiMo18-12-3 (1.4449)
DIN EN 10222-5:2000	X3CrNiMoBN17-13-3 (1.4910)
DIN EN 10222-5:2000	X5CrNi18-10 (1.4301)
DIN EN 10222-5:2000	X5CrNiMo17-12-2 (1.4401)
DIN EN 10222-5:2000	X6CrNi18-10 (1.4948)
DIN EN 10222-5:2000	X6CrNiMoTi17-12-2 (1.4571)
DIN EN 10222-5:2000	X6CrNiNb18-10 (1.4550)
DIN EN 10222-5:2000	X6CrNiTi18-10 (1.4541)
DIN EN 10222-5:2000	X6CrNiTiB18-10 (1.4941)
DIN EN 10222-5:2000	X7CrNiNb18-10 (1.4912)

A.3.2 material standards

Standard	material
DIN EN 10250-2 & AD W13:1999	S235J2G3 (1.0116)
DIN EN 10250-2 & AD W13:1999	S235JRG2 (1.0038)
DIN EN 10250-2 & AD W13:1999	S355J2G3 (1.0570)
DIN EN 10269:1999	19MnB4 +QT(1.5523)
DIN EN 10269:1999	20CrMoVTiB4-10 +QT (1.7729)
DIN EN 10269:1999	20Mn5 +N (1.1133)
DIN EN 10269:1999	21CrMoV5-7 +QT (1.7709)
DIN EN 10269:1999	25CrMo4 +QT (1.7218)
DIN EN 10269:1999	30CrNiMo8 +QT (1.6580)
DIN EN 10269:1999	34CrNiMo6 +QT (1.6582)
DIN EN 10269:1999	35B2 +QT (1.5511)
DIN EN 10269:1999	40CrMoV4-6 +QT (1.7711)
DIN EN 10269:1999	41NiCrMo7-3-2 +QT (1.6563)
DIN EN 10269:1999	42CrMo4 +QT (1.7225)
DIN EN 10269:1999	42CrMo5-6 +QT (1.7233)
DIN EN 10269:1999	C35E +N (1.1181)
DIN EN 10269:1999	C35E +QT (1.1181)
DIN EN 10269:1999	C45E +N (1.1191)
DIN EN 10269:1999	C45E +QT (1.1191)
DIN EN 10269:1999	NiCr15Fe7tiAl +AT +P (2.4669)
DIN EN 10269:1999	NiCr20TiAl +AT +P (2.4952)
DIN EN 10269:1999	X10CrNiMoMnNbVB15-10-1 +AT +WW (1.4982)
DIN EN 10269:1999	X12CrNiMoV12-3 +QT (1.4938)
DIN EN 10269:1999	X12Ni5 +NT (1.5680)
DIN EN 10269:1999	X12Ni5 +QT (1.5680)
DIN EN 10269:1999	X15CrMo5-1 +NT (1.7390)
DIN EN 10269:1999	X15CrMo5-1 +QT (1.7390)
DIN EN 10269:1999	X19CrMoNbVN11-1 +QT (1.4913)
DIN EN 10269:1999	X22CrMoV12-1 +QT1 (1.4923)
DIN EN 10269:1999	X22CrMoV12-1 +QT2 (1.4923)
DIN EN 10269:1999	X2CrNi18-9 +AT (1.4307)
DIN EN 10269:1999	X2CrNi18-9 +C700 (1.4307)
DIN EN 10269:1999	X2CrNi18-9 +C800 (1.4307)
DIN EN 10269:1999	X2CrNiMo17-12-2 +AT (1.4404)
DIN EN 10269:1999	X2CrNiMo17-12-2 +C700 (1.4404)
DIN EN 10269:1999	X2CrNiMo17-12-2 +C800 (1.4404)
DIN EN 10269:1999	X2CrNiMoN17-13-3 +AT (1.4429)
DIN EN 10269:1999	X3CrNiCu18-9-4 +AT (1.4567)
DIN EN 10269:1999	X3CrNiCu18-9-4 +C700 (1.4567)
DIN EN 10269:1999	X3CrNiMoBN17-13-3 +AT (1.4910)

A.3.2 material standards

Standard	material
DIN EN 10269:1999	X4CrNi18-12 +AT (1.4303)
DIN EN 10269:1999	X4CrNi18-12 +C700 (1.4303)
DIN EN 10269:1999	X4CrNi18-12 +C800 (1.4303)
DIN EN 10269:1999	X5CrNi18-10 +AT (1.4301)
DIN EN 10269:1999	X5CrNi18-10 +C700 (1.4301)
DIN EN 10269:1999	X5CrNiMo17-12-2 +AT (1.4401)
DIN EN 10269:1999	X5CrNiMo17-12-2 +C700 (1.4401)
DIN EN 10269:1999	X5CrNiMo17-12-2 +C800 (1.4401)
DIN EN 10269:1999	X6CrNi18-10 +AT (1.4948)
DIN EN 10269:1999	X6CrNiMoB17-12-2 +AT (1.4919)
DIN EN 10269:1999	X6CrNiTiB18-10 +AT (1.4941)
DIN EN 10269:1999	X6NiCrTiMoVB25-15-2 +AT +P (1.4980)
DIN EN 10269:1999	X7CrNiMoBNb16-16 +WW +P (1.4986)
DIN EN 10269:1999	X8Ni9 +NT (1.5662)
DIN EN 10269:1999	X8Ni9 +QT (1.5662)
DIN EN 10269:2006	C35E +QT (1.1181)
DIN EN 10269:2014	20CrMoVTiB4-10 (1.7729)
DIN EN 10269:2014	20Mn5 (1.1133)
DIN EN 10269:2014	20MnB4 (1.5525)
DIN EN 10269:2014	21CrMoV5-7 (1.7709)
DIN EN 10269:2014	23MnB3 (1.5507)
DIN EN 10269:2014	23MnB4 (1.5535)
DIN EN 10269:2014	25CrMo4 (1.7218)
DIN EN 10269:2014	26NiCrMo14-6 (1.6958)
DIN EN 10269:2014	27NiCrMoV15-6 (1.6957)
DIN EN 10269:2014	30CrNiMo8 (1.6580)
DIN EN 10269:2014	34CrNiMo6 (1.6582)
DIN EN 10269:2014	35B2 +QT (1.5511)
DIN EN 10269:2014	40CrMoV4-6 (1.7711)
DIN EN 10269:2014	42CrMo4 (1.7225)
DIN EN 10269:2014	42CrMo5-6 (1.7233)
DIN EN 10269:2014	C35E +N (1.1181)
DIN EN 10269:2014	C35E +QT (1.1181)
DIN EN 10269:2014	C45E +N (1.1191)
DIN EN 10269:2014	C45E +QT (1.1191)
DIN EN 10269:2014	NiCr15Fe7tiAl (2.4669)
DIN EN 10269:2014	NiCr19Fe19Nb5Mo3 (2.4668)
DIN EN 10269:2014	NiCr20TiAl (2.4952)
DIN EN 10269:2014	X10CrNiMoMnNbVB15-10-1 (1.4982)
DIN EN 10269:2014	X12CrNiMoV12-3 (1.4938)

A.3.2 material standards

Standard	material
DIN EN 10269:2014	X12Ni5 (1.5680)
DIN EN 10269:2014	X15CrMo5-1 (1.7390)
DIN EN 10269:2014	X19CrMoNbVN11-1 (1.4913)
DIN EN 10269:2014	X22CrMoV12-1 +QT1 (1.4923)
DIN EN 10269:2014	X22CrMoV12-1 +QT2 (1.4923)
DIN EN 10269:2014	X2CrNi18-9 +AT (1.4307)
DIN EN 10269:2014	X2CrNi18-9 +C700 (1.4307)
DIN EN 10269:2014	X2CrNi18-9 +C800 (1.4307)
DIN EN 10269:2014	X2CrNiMo17-12-2 +AT (1.4404)
DIN EN 10269:2014	X2CrNiMo17-12-2 +C700 (1.4404)
DIN EN 10269:2014	X2CrNiMo17-12-2 +C800 (1.4404)
DIN EN 10269:2014	X2CrNiMoN17-13-3 (1.4429)
DIN EN 10269:2014	X2CrNiN18-10 (1.4311)
DIN EN 10269:2014	X3CrNiCu18-9-4 +AT (1.4567)
DIN EN 10269:2014	X3CrNiCu18-9-4 +C700 (1.4567)
DIN EN 10269:2014	X3CrNiMoBN17-13-3 (1.4910)
DIN EN 10269:2014	X4CrNi18-12 +AT (1.4303)
DIN EN 10269:2014	X4CrNi18-12 +C700 (1.4303)
DIN EN 10269:2014	X4CrNi18-12 +C800 (1.4303)
DIN EN 10269:2014	X5CrNi18-10 +AT (1.4301)
DIN EN 10269:2014	X5CrNi18-10 +C700 (1.4301)
DIN EN 10269:2014	X5CrNiMo17-12-2 +AT (1.4401)
DIN EN 10269:2014	X5CrNiMo17-12-2 +C700 (1.4401)
DIN EN 10269:2014	X5CrNiMo17-12-2 +C800 (1.4401)
DIN EN 10269:2014	X6CrNi18-10 (1.4948)
DIN EN 10269:2014	X6CrNi25-20 (1.4951)
DIN EN 10269:2014	X6CrNiMoB17-12-2 (1.4919)
DIN EN 10269:2014	X6CrNiTiB18-10 (1.4941)
DIN EN 10269:2014	X6NiCrTiMoVB25-15-2 (1.4980)
DIN EN 10269:2014	X7CrNiMoBNb16-16 (1.4986)
DIN EN 10269:2014	X8Ni9 +NT (1.5662)
DIN EN 10269:2014	X8Ni9 +QT (1.5662)
DIN EN 10272:2001	X12Cr13 (1.4006)
DIN EN 10272:2001	X17CrNi16-2 +QT800 (1.4057)
DIN EN 10272:2001	X17CrNi16-2 +QT900 (1.4057)
DIN EN 10272:2001	X1CrNiMoCu25-20-5 (1.4539)
DIN EN 10272:2001	X1CrNiMoCuN20-18-7 (1.4547)
DIN EN 10272:2001	X1NiCrMoCu25-20-5 (1.4539)
DIN EN 10272:2001	X1NiCrMoCu31-27-4 (1.4563)
DIN EN 10272:2001	X1NiCrMoCuN20-18-7 (1.4547)

A.3.2 material standards

Standard	material
DIN EN 10272:2001	X1NiCrMoCuN25-20-7 (1.4529)
DIN EN 10272:2001	X2CrNi12 (1.4003)
DIN EN 10272:2001	X2CrNi18-11 (1.4306)
DIN EN 10272:2001	X2CrNi18-9 (1.4307)
DIN EN 10272:2001	X2CrNi19-11 (1.4306)
DIN EN 10272:2001	X2CrNiMo17-12-2 (1.4404)
DIN EN 10272:2001	X2CrNiMo17-12-3 (1.4432)
DIN EN 10272:2001	X2CrNiMo18-14-3 (1.4435)
DIN EN 10272:2001	X2CrNiMoCuN25-6-3 (1.4507)
DIN EN 10272:2001	X2CrNiMoCuWN25-7-4 (1.4501)
DIN EN 10272:2001	X2CrNiMoN17-11-2 (1.4406)
DIN EN 10272:2001	X2CrNiMoN17-13-3 (1.4429)
DIN EN 10272:2001	X2CrNiMoN17-13-5 (1.4439)
DIN EN 10272:2001	X2CrNiMoN22-5-3 (1.4462)
DIN EN 10272:2001	X2CrNiMoN25-7-4 (1.4410)
DIN EN 10272:2001	X2CrNiN18-10 (1.4311)
DIN EN 10272:2001	X2CrNiN23-4 (1.4362)
DIN EN 10272:2001	X2NiCrMoCuWN25-7-4 (1.4501)
DIN EN 10272:2001	X3CrNiMo13-4 +QT650 (1.4313)
DIN EN 10272:2001	X3CrNiMo13-4 +QT780 (1.4313)
DIN EN 10272:2001	X3CrNiMo13-4 +QT900 (1.4313)
DIN EN 10272:2001	X3CrNiMo17-13-3 (1.4436)
DIN EN 10272:2001	X4CrNiMo16-5-1 +QT760 (1.4418)
DIN EN 10272:2001	X4CrNiMo16-5-1 +QT900 (1.4418)
DIN EN 10272:2001	X5CrNi18-10 (1.4301)
DIN EN 10272:2001	X5CrNiMo17-12-2 (1.4401)
DIN EN 10272:2001	X6CrNiMoNb17-12-2 (1.4580)
DIN EN 10272:2001	X6CrNiMoTi17-12-2 (1.4571)
DIN EN 10272:2001	X6CrNiNb18-10 (1.4550)
DIN EN 10272:2001	X6CrNiTi18-10 (1.4541)
DIN EN 10272:2008	X12Cr13 (1.4006)
DIN EN 10272:2008	X17CrNi16-2 +QT800 (1.4057)
DIN EN 10272:2008	X17CrNi16-2 +QT900 (1.4057)
DIN EN 10272:2008	X1CrNiMoCu25-20-5 (1.4539)
DIN EN 10272:2008	X1NiCrMoCu31-27-4 (1.4563)
DIN EN 10272:2008	X1NiCrMoCuN20-18-7 (1.4547)
DIN EN 10272:2008	X1NiCrMoCuN25-20-7 (1.4529)
DIN EN 10272:2008	X2CrNi12 (1.4003)
DIN EN 10272:2008	X2CrNi18-11 (1.4306)
DIN EN 10272:2008	X2CrNi18-9 (1.4307)

A.3.2 material standards

Standard	material
DIN EN 10272:2008	X2CrNiMo17-12-2 (1.4404)
DIN EN 10272:2008	X2CrNiMo17-12-3 (1.4432)
DIN EN 10272:2008	X2CrNiMo18-14-3 (1.4435)
DIN EN 10272:2008	X2CrNiMoCuN25-6-3 (1.4507)
DIN EN 10272:2008	X2CrNiMoCuWN25-7-4 (1.4501)
DIN EN 10272:2008	X2CrNiMoN17-11-2 (1.4406)
DIN EN 10272:2008	X2CrNiMoN17-13-3 (1.4429)
DIN EN 10272:2008	X2CrNiMoN17-13-5 (1.4439)
DIN EN 10272:2008	X2CrNiMoN22-5-3 (1.4462)
DIN EN 10272:2008	X2CrNiMoN25-7-4 (1.4410)
DIN EN 10272:2008	X2CrNiN18-10 (1.4311)
DIN EN 10272:2008	X2CrNiN23-4 (1.4362)
DIN EN 10272:2008	X3CrNiMo13-4 +QT650 (1.4313)
DIN EN 10272:2008	X3CrNiMo13-4 +QT780 (1.4313)
DIN EN 10272:2008	X3CrNiMo13-4 +QT900 (1.4313)
DIN EN 10272:2008	X3CrNiMo17-13-3 (1.4436)
DIN EN 10272:2008	X4CrNiMo16-5-1 +QT760 (1.4418)
DIN EN 10272:2008	X4CrNiMo16-5-1 +QT900 (1.4418)
DIN EN 10272:2008	X5CrNi18-10 (1.4301)
DIN EN 10272:2008	X5CrNiMo17-12-2 (1.4401)
DIN EN 10272:2008	X6CrNi25-20 (1.4951)
DIN EN 10272:2008	X6CrNiMoNb17-12-2 (1.4580)
DIN EN 10272:2008	X6CrNiMoTi17-12-2 (1.4571)
DIN EN 10272:2008	X6CrNiNb18-10 (1.4550)
DIN EN 10272:2008	X6CrNiTi18-10 (1.4541)
DIN EN 10273:2000	10CrMo9-10 (1.7380)
DIN EN 10273:2000	11CrMo9-10 (1.7383)
DIN EN 10273:2000	13CrMo4-5 (1.7335)
DIN EN 10273:2000	16Mo3 (1.5415)
DIN EN 10273:2000	P235GH (1.0345)
DIN EN 10273:2000	P250GH (1.0460)
DIN EN 10273:2000	P265GH (1.0425)
DIN EN 10273:2000	P275NH (1.0487)
DIN EN 10273:2000	P295GH (1.0481)
DIN EN 10273:2000	P355GH (1.0473)
DIN EN 10273:2000	P355NH (1.0565)
DIN EN 10273:2000	P355QH (1.8867)
DIN EN 10273:2000	P460NH (1.8935)
DIN EN 10273:2000	P460QH (1.8871)
DIN EN 10273:2000	P500QH (1.8874)

A.3.2 material standards

Standard	material
DIN EN 10273:2000	P690QH (1.8880)
DIN EN 10273:2008	10CrMo9-10 (1.7380)
DIN EN 10273:2008	11CrMo9-10 (1.7383)
DIN EN 10273:2008	13CrMo4-5 (1.7335)
DIN EN 10273:2008	16Mo3 (1.5415)
DIN EN 10273:2008	P235GH (1.0345)
DIN EN 10273:2008	P250GH (1.0460)
DIN EN 10273:2008	P265GH (1.0425)
DIN EN 10273:2008	P275NH (1.0487)
DIN EN 10273:2008	P295GH (1.0481)
DIN EN 10273:2008	P355GH (1.0473)
DIN EN 10273:2008	P355NH (1.0565)
DIN EN 10273:2008	P355QH (1.8867)
DIN EN 10273:2008	P460NH (1.8935)
DIN EN 10273:2008	P460QH (1.8871)
DIN EN 10273:2008	P500QH (1.8874)
DIN EN 10273:2008	P690QH (1.8880)
DIN EN 1561:1997	EN-GJL-150
DIN EN 1561:1997	EN-GJL-200
DIN EN 1561:1997	EN-GJL-250
DIN EN 1561:1997	EN-GJL-300
DIN EN 1561:1997	EN-GJL-350
DIN EN ISO 3506-1:1998	A2-50
DIN EN ISO 3506-1:1998	A2-70
DIN EN ISO 3506-1:1998	A2-80
DIN EN ISO 3506-1:1998	A4-50
DIN EN ISO 3506-1:1998	A4-70
DIN EN ISO 3506-1:1998	A4-80
DIN EN ISO 3506-1:2010-04	A1-50
DIN EN ISO 3506-1:2010-04	A1-70
DIN EN ISO 3506-1:2010-04	A1-80
DIN EN ISO 3506-1:2010-04	A2-50
DIN EN ISO 3506-1:2010-04	A2-70
DIN EN ISO 3506-1:2010-04	A2-80
DIN EN ISO 3506-1:2010-04	A3-50
DIN EN ISO 3506-1:2010-04	A3-70
DIN EN ISO 3506-1:2010-04	A3-80
DIN EN ISO 3506-1:2010-04	A4-50
DIN EN ISO 3506-1:2010-04	A4-70
DIN EN ISO 3506-1:2010-04	A4-80

A.3.2 material standards

Standard	material
DIN EN ISO 3506-1:2010-04	A5-50
DIN EN ISO 3506-1:2010-04	A5-70
DIN EN ISO 3506-1:2010-04	A5-80
DIN EN ISO 3506-1:2010-04	C1-110
DIN EN ISO 3506-1:2010-04	C1-50
DIN EN ISO 3506-1:2010-04	C1-70
DIN EN ISO 3506-1:2010-04	C3-80
DIN EN ISO 3506-1:2010-04	C4-50
DIN EN ISO 3506-1:2010-04	C4-70
DIN EN ISO 3506-1:2010-04	F1-45
DIN EN ISO 3506-1:2010-04	F1-60
DIN EN ISO 898	10.9
DIN EN ISO 898	12.9
DIN EN ISO 898	5.6
DIN EN ISO 898	8.8
DIN EN ISO 898:1999	4.6
EN 10028-5:2003	P355M (1.8821)
EN 10028-5:2003	P355ML1 (1.8832)
EN 10028-5:2003	P355ML2 (1.8833)
EN 10028-5:2003	P420M (1.8824)
EN 10028-5:2003	P420ML1 (1.8835)
EN 10028-5:2003	P420ML2 (1.8828)
EN 10028-5:2003	P460M (1.8826)
EN 10028-5:2003	P460ML1 (1.8837)
EN 10028-5:2003	P460ML2 (1.8831)
KTA 3201.1:1990	20NiCrMo14-5 II (1.6772)
KTA 3201.1:1990	X6CrNiTi18-10S (1.4533)
KTA 3201.1:1998	10MnMoNi5-5
KTA 3201.1:1998	20MnMoNi5-5 (1.6310)
KTA 3201.1:1998	21CrMoV5-7 (1.7709)
KTA 3201.1:1998	26NiCrMo14-6 (1.6958)
KTA 3201.1:1998	34CrNiMo6S (1.6589)
KTA 3201.1:1998	8MnMoNi5-5
KTA 3201.1:1998	GS-18NiMoCr3-7 (1.6761)
KTA 3201.1:1998	GS-C 25 S (1.1339)
KTA 3201.1:1998	GX5CrNiNb18-9S (1.4552)
KTA 3201.1:1998	Inconel 600 (2.4816, NiCr 15 Fe)
KTA 3201.1:1998	X2NiCrAlTi32-20 (1.4558)
KTA 3201.1:1998	X5CrNi13-4 (1.4313)
KTA 3201.1:1998	X6CrNiMoTi17-12-2S (1.4579)

A.3.2 material standards

Standard	material
KTA 3201.1:1998	X6CrNiNb18-10S (1.4553)
KTA 3201.1:1998	X6CrNiTi18-10S (1.4533)
KTA 3211.1:1991	15NiCuMoNb5 (1.6368)
KTA 3211.1:1991	20MnMoNi5-5 (1.6310)
KTA 3211.1:1991	20NiCrMo14-5 I (1.6772)
KTA 3211.1:1991	20NiCrMo14-5 II (1.6772)
KTA 3211.1:1991	21CrMoV5-7 (1.7709)
KTA 3211.1:1991	C 22.8 S (1.1338)
KTA 3211.1:1991	X8CrNiMoBNb16-16 (1.4986)
KTA 3211.1:2000	15NiCuMoNb5S (1.6369, WB36)
KTA3211.1:1991	15MnNi6-3 (1.6210)
SEW 400	X20CrMo13 (1.4120)
SEW 620:1951	C 22 (1.0402)
SEW 620:1951	C 35 (1.1181)
ThyssenKrupp	X2CrNiMoN22-5-3 (1.4462)
ThyssenKrupp	X2CrNiMoN25-7-4 (1.4410)
VdTÜV 007/3:1984	12 CrMo 19 5 G (1.7362)
VdTÜV 12-238 (6.71)	Altherm 35 (H I; 1.0345)
VdTÜV 12-238 (6.71)	Altherm 41 (H II; 1.0425)
VdTÜV 12-238 (6.71)	Altherm 44 (H IV)
VdTÜV 12-238 (6.71)	Altherm 44 (H IV)
VdTÜV 12-238 (6.71)	Altherm 47 (17Mn4; 1.0481)
VdTÜV 12-238 (6.71)	Altherm 50 (19Mn6; 1.0473)
VdTÜV 12-238 (6.71)	Altherm 55
VdTÜV 12-238 (6.71)	Altherm CrMo (13CrMo4-4; 1.7335)
VdTÜV 12-238 (6.71)	Altherm Mo (15Mo3; 1.5415)
VdTÜV 277/2:1986	X5 CrMnNiN 18 9 (1.6909)
VdTÜV 314	Altherm NiMoV (1.6918)
VdTÜV 337:1997	20NiCrMo14-5 (1.6772)
VdTÜV 341:1985	GS-45 R
VdTÜV 351/1:1994	StE 255 (1.0461)
VdTÜV 351/1:1994	WStE 255 (1.0462)
VdTÜV 353/1:2000	StE 315 (1.0505)
VdTÜV 353/1:2000	WStE 315 (1.0506)
VdTÜV 364	C 22.3 (1.0427)
VdTÜV 376:1984	17MnMoV6-4 (1.5403)
VdTÜV 377/1:1986	15NiCuMoNb5 (1.6368)
VdTÜV 377/2:1986	15NiCuMoNb5 (1.6368)
VdTÜV 390:1997	26NiCrMo14-6 (1.6958)
VdTÜV 395/1 - 3	X5CrNi13-4 (1.4313)

A.3.2 material standards

Standard	material
VdTÜV 395/3:1999	X4CrNi13-4 (1.4313)
VdTÜV 399/1:1996	A 105 (1.0432)
VdTÜV 399/1:1996	C 21 (1.0432)
VdTÜV 399/3:1996	A 105 (1.0432)
VdTÜV 399/3:1996	C 21 (1.0432)
VdTÜV 400:2007	NiMo16Cr15W (2.4819)
VdTÜV 401/1:2000	20MnMoNi5-5 (1.6310)
VdTÜV 401/2:1983	20MnMoNi5-5 (1.6310)
VdTÜV 401/3:1983	20MnMoNi5-5 (1.6310)
VdTÜV 401/3:1986	20MnMoNi5-5 (1.6310)
VdTÜV 405:1999	X2CrNiMoN17-13-5 (1.4439)
VdTÜV 412:1995	X10NiCrAlTi32-20 (1.4876)
VdTÜV 418:1999	X2CrNiMoN22-5-3 (1.4462)
VdTÜV 424:1995	NiMo 16 Cr 16 Ti (2.4610)
VdTÜV 427/1:2000	15MnNi6-3 (1.6210)
VdTÜV 427/2:1981	15MnNi6-3 (1.6210)
VdTÜV 427/3:1982	15MnNi6-3 (1.6210)
VdTÜV 432/1:1999	NiCr 21 Mo (2.4858)
VdTÜV 432/2:1999	NiCr 21 Mo (2.4858)
VdTÜV 432/3	NiCr 21 Mo (2.4858)
VdTÜV 435/3:1997	X5NiCrTi26-15 (1.4980)
VdTÜV 451:2000	X6CrNiMoTi17-12-2S (1.4579)
VdTÜV 451:2000	X6CrNiNb18-10S (1.4553)
VdTÜV 451:2000	X6CrNiTi18-10S (1.4533)
VdTÜV 452:1999	GX5CrNi13-4 (1.4313)
VdTÜV 453:1984	C 22.8 S 1 (1.1338)
VdTÜV 459/2:1983	15NiCuMoNb5S1 (1.6369, WB36 S1)
VdTÜV 459/3:1995	15NiCuMoNb5S1 (1.6369, WB36 S1)
VdTÜV WB 305:2012	NiCr15Fe (2.4816)
VdTÜV WB 395/3:1995	X5CrNi13-4 (1.4313)
VdTÜV WB 405:1995	X2CrNiMoN17-13-5 (1.4439)
VdTÜV WB 427/3:1982	15MnNi6-3 (1.6210)
VdTÜV-WB 505	Alloy 59 (2.4605 NiCr23Mo16Al)
WB 424 RS:1973	22NiMoCr3-7 (1.6751)
WB-091/08/EG2:1999	GX8CrNi26-7 (1.4347)
WB-100/20/B:1999	34CrNiMo6S (1.6589)