

Material entries using MatTool II program

Because Bellows Master II is updated regularly due to specification additions and changes the material entering has become more and more critical and sometimes difficult to understand. Entering a material requires data, time and accuracy. Number of entries is not small. Typical material like 304 has over 220 separate entries. Current additional database, 2019 edition, for ASME related designs has over 40 000 entries of which the program enters small part automatically. All entries have to be correct.

To clarify some issues we like to point out issues, which are valid for the program:

- Material entry is critical. Mistakes results in difficult to detect errors in design calculations
- You can enter unlimited number of materials. Program comes with limited number of sample materials. Add on material databases are available from the program supplier jouko@jatsa.biz. Alternatively they will enter the required materials for a small fee.
- Use the short code to separate different material types. Each material must have own short code. If you try to use same code as before you get Key violation error
- If your allowable stress is different for different material thicknesses enter each thickness range as a separate material. Use codes like Grade 70 >40 mm. Remember that the database is used not only for Bellows Master II but for FlangeTool, RodMaster etc.
- In the program you have to separate materials for ASME VIII Div 1 appendix 26 and EJMA/ASME B31.3 calculations. Note that before ASME B31.3 2016 edition it had different fatigue values to EJMA. Use material short code to do this. For instance 304 2001 ed and 304 2002 ASME. Main reason are the differences in fatigue factors and sometimes allowable stresses. If you do not use correct fatigue values for each of the codes your bellows cycle calculation results are totally wrong.
- ASME VIII Division 2 Class 2 uses different allowable stresses to other ASME VIII design calculations. Programs like BMII cannot differentiate if the material is for Class 2 or for something else. It is advisable to use coding and/or totally separate databases.
- ASME B31.1 since 2018 edition has mandatory Appendix P for the bellows design. BMII has this calculation. B31.1 has own allowable stresses, which are same or similar than other ASME material listings. However there can be additional limitations. There are two possibilities: Use coding and enter dedicated B31.1 materials or use those entered for EJMA or B31.3 and verify that the values are the same.
- EJMA, B31.1 and B31.3 use the same fatigue factors. ASME VIII and EN 14917 use different factors. EJMA doesn't state from where the allowable stress, Yield, UTS and

similar are taken. Values should be from the main code of the pipe line or vessel where the bellows element is designed to EJMA.

- EN 14917 calculations using Bellows Master II EN requires different material database. EN has a different calculation system compared to ASME standards. MatTool II Help file has detailed information.
- RecBel can use any of the ASME based material databases. It is recommended to use EJMA fatigue factors for austenitic and nickle based materials. RecBel has a possibility to use ferritic materials also. No factors are used for those. Enter 1 for the factors.
- MatTool II have entries "Bellows material", RecBel Bellows material" and "Hide material in RecBel". Use them to limit errors by the user. Not easy to make a bellows element from a round bar material.
- Entries marked "EN 14917 Related" are not used in any one of the ASME related calculations and can be ignored for ASME related data entries.
- **Help file has a lot of information. Please use it. Use F1 key to activate help file!** Content page has general information to read. Each form has its own help page. Images in the help file have "Hot Spots" Use your mouse to click the image to get more information. Nobody likes help files. This time you have to look at it. Even we do so each time we enter new material.
- How to add new material is done using the General info form. On top is a set of buttons. Please use help file and attached pages to get more information.
- Back ups are important. We have had no corruptions in the last 10 plus years. Be safe and not sorry. Computers fail, they are stolen etc. If you are uncertain how and what to back up please ask. (We lost in one year two hard drives within 6 months! Without back ups we would have been in trouble. Hard drives were under 2 years old.)
- If you are not sure how to enter materials please ask our support. Let us know your most common material and if possible we will send you data to enter with answers to your queries.
- You have to enter all the information required. There are several different forms: General, Allowable, Yield, UTS, Poisson and E. We do not enter always all the information but we know when this can be done. We do not recommend this method as sooner or later it gives serious problems. The trick is to limit the maximum temperature on the main form.
- Each entry form Allowable, Yield, UTS, Poisson and E has to have as an absolute minimum 2 entries. Lower temperature has to be same temperature or lower as main form Limit Temperature. For Poisson factor the lower temperature must be lowest you will ever use the material for. Highest temperature value and material entry has to be

same or higher than Max Temp entry on the main form. Between these two temperatures you can enter as many values as required - entry for each value change.

- Never change material values except if you find a clear mistake. This way you can recalculate old saved designs and you will get same result. Note that sometimes customer specified material specification edition. This is common especially for ASME designs. ASME edition is decided in the beginning of the project and is used for the lifetime of the plant. Any replacement is therefore ordered to the old material values.
- Material standards change with time. ASME has major changes every 2 years. Sometimes changes are substantial in allowable stress values.
- Use note field to record where you have taken the values etc
- Never enter a material and think that "I am too busy, I will only enter some information I need now". Sooner or later you will use that material without remembering what you did. BM II will most probably calculate but the results are rubbish.
- MatTool II is a database program. Most users have not used this type of program before. There are couple issues, which are important. You do not "Save" or "Save as". Saving is called "Posting". There are two ways to post the entries. You can click the button Post or you can just move to an other record. Moving is automatically posting the entries. This can be very dangerous. If you for instance just look, which entries are possible for Fatigue Type and accidentally change the entry and then move to an other material the change is posted without any warning. Result is that you messed up that material totally.
- We generally recommend that the entry to MatTool II program is limited to authorized people only. There are couple reasons. One is that the program requires training, untrained person can accidentally change the values. Second reason is that unfortunately there are people who will change material values to get a design acceptable. Such changes are nearly impossible to detect except if the customer makes check calculation or the bellows fails.
- Where to get values is sometimes problematic. Here are some pointers: Materials for EJMA calculations can be from any standard. Most common is ASME II D. From this standard you can find allowable stress, UTS and Yield. Creep limit is in the allowable stress notes. Poisson values are also now in the latest edition of ASME II D. Density is also available from the same place. Max elongation you should enter the specified minimum elongation from the applicable material standard. Moduli of elasticity values are available from EJMA and ASME II D standards. Note that they were changed at least one time - use EJMA 7 or later. Max fatigue temperature is either from the applicable design code or from your fatigue tests. ASME B31.3 allowable values are from that code. Other values as for EJMA. ASME VIII Div 1 Appendix 26 values are from ASME

II D and other values as per EJMA. Fatigue factors are from each code and your fatigue tests. **Make sure you do not mix these up!**

- 2012 June new program VesselTool was launched. As a result the material database had to be extended substantially. New entry forms and numerical data were added. Such changes are only visible in the additional material databases starting from EJMA_2019_Mat_R13_5.adb. Material values are used to calculate ASME VIII Div 1 UG 28 external pressure designs. Entries are not used for any other purpose. Help file has the entry details.
- See attachment pages for more information.

General Properties



Material code

304 2001ASME

Bellows material

To add material click this button. Pls see help file for other buttons.

Material description

ASME SA-240 Grade 304 2001 ed

Note the coding. 304 gives grade, 2001 edition and ASME identifies this material for ASME calculations

General | Fatigue

Max temp

1500

Limit temp E

-325

Yield cold

30

Max stress temp

1000

E cold

30.4

Limit temp Yield

100

Creep limit temp

800

E room temp

28.3

Limit temp Allow

200

Max Elongation

43

Limit temp UTS

100

Allow stress cold

20

Density

8000

UTS cold

75

Max fatigue temp

800

Cm Annealed

1.5

Cm not Annealed

3

Fatigue type

ASME

This entry is critical for which code material can be used. Press F1 key and in the help file image click this entry to get more information

It is critical to understand how entries are "saved". In a database program like MatTool you Post the entries. This is done in 2 ways. Either clicking Post button OR moving to another entry. This can be extremely dangerous. If you by accident change some entry and then move to another material your changed entry is automatically saved without any warning! Therefore if you just "look" what entry is possible for Fatigue type and then select wrong type you have a serious problem.

Notes:

Yield and UTS are calculated above 1000 F. Yield $1.2 * \text{allowable}$ and UTS $3.5 * \text{Yield}$

General Properties



Material code

304 2001ASME

Material description

ASME SA-240 Grade 304 2001 ed

All these factors are different in various codes. They are the reason why you need different materials for different codes

General Fatigue

Base and low values - EN as formed

Unreinforced

Fatigue A	Fatigue B	Fatigue C	Fatigue D	Fatigue cycles
2	30600	6700000	1	100000

Reinforced

Fatigue A	Fatigue B	Fatigue C	Fatigue D	Fatigue cycles
2	38800	8500000	1	100000

ANSI/ASME Fatigue high values. EN as formed high values

Unreinforced

High limit	Fatigue A	Fatigue B	Fatigue C	Fatigue D
65000	2	38300	5200000	1

Reinforced

High limit	Fatigue A	Fatigue B	Fatigue C	Fatigue D
82200	2	48500	6600000	1

EN annealed unreinforced

Low end values

Fatigue A	Fatigue B	Fatigue C	Fatigue D	Fatigue cycles
1	1	1		1

High end values

Stress limit	Fatigue A	Fatigue B	Fatigue C	Fatigue D
1	1	1	1	1

Notes:

Yield and UTS are calculated above 1000 F. Yield $1.2 \times$ allowable and UTS $3.5 \times$ Yield

This area is used to make notes about the material



Allowable Stress



Material code

304 2001ASME



Material description

ASME SA-240 Grade 304 2001 ed

Temperature in F

Allowable stress in ksi

Note F and
ksi!!!

You cannot change these
here. You enter and
change them in General
properties!

After clicking in the bottom
this button becomes active.
Click this and you can select
material from which the
values are copied from.

Allowable stress values for
EJMA and ASME VIII
calculations are often same.
Therefore you can "borrow"
or copy them from an other
material.

To start copying
click this button



1200

7.7

6.1

