eAssistant
the engineering assistant

A calculation example
Roller bearing according to DIN ISO 281

Release January 2009

Rebenring 31 – 38106 Braunschweig – Germany – Tel.: +49 531 129 399-0
www.eassistant.de

Contents

1 Example: The roller bearing calculation according to DIN ISO 281

1.1 Start the calculation module

Please login with your user name and your password. Select the module through the tree structure of the Project Manager by double-clicking on the module or clicking on the button 'New calculation'.

The calculation module is opened in a new window.

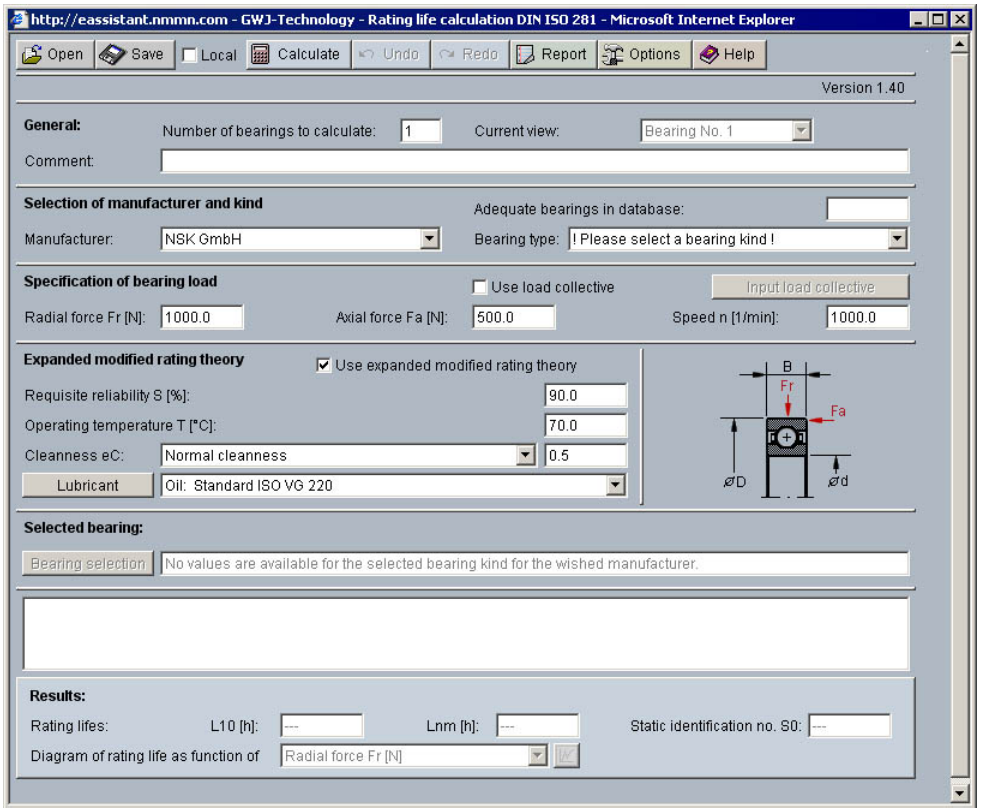

Figure 1: The calculation module

1.2 The first calculation example

The bearing of a sheave of a hook block

The arc of contact of the rope is 180° for the sheaves of hook blocks. Therefore, a double tensile load is acting on the bearing. The axial forces and the torque are small. When there is a diagonal tension of 5°, then axial forces have to be considered for the calculation of the rating life. Two rows of idler bearing units in one bearing or two bearings next to each other form the supporting base for taking up the torque. In the following example the rating life and expanded modified rating life are to be calculated.

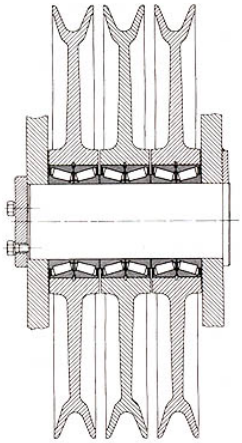

Figure 2: The sheave of a hook block

We have taken this example from: J. Brändlein: Die Wälzlagerpraxis: Handbuch zur Berechnung und Gestaltung von Wälzlagern (1995, p. 466-470). (The following figure: J. Brändlein: Die Wälzlagerpraxis, p.467).

The input values

Please enter the following input values:

Bearing load	65 kN
Type of bearing	Tapered roller bearing (single row)
Speed n	30 min^{-1}
Built-in bearing	A pair of tapered roller bearing (100 x 150 x 67)
For-life lubrication	Grease with EP-additive

1.3 The calculation

Define the number of bearings

In this example we would like to calculate one bearing of a tapered roller bearing pair. When you open the calculation module, usually one bearing is shown. So you need not to change the number of the bearings. Enter a description into the comment field, for example 'bearing of the sheave'.

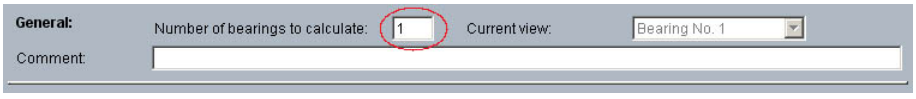

Figure 3: Number of bearings

Select the manufacturer and the bearing type

In the database about 20.000 bearings of different manufacturer are available. For our example please select the manufacturer 'SKF'.

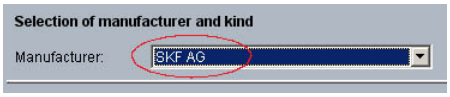

Figure 4: Select the manufacturer

Select the bearing type 'Tapered roller bearing (single row)'.

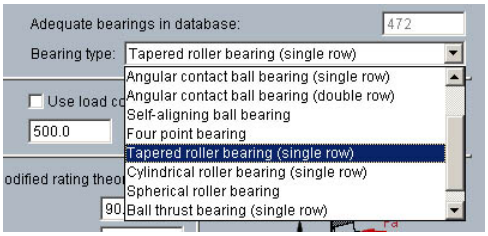

Figure 5: Tapered roller bearing (single row)

The specification of bearing load

Now enter the values for the bearing load. Please pay attention that the values will be entered in 'kN'. Change the unit of measurement by right-clicking.

Figure 6: Values for the bearing load in kN

Hinweis: The expanded modified rating life is deactivated.

The bearing selection

To get into the bearing database, click on the button 'Bearing selection'.

Figure 7: Button 'Bearing selection'

The bearing database is opened.

Right now there are '472' bearings in the database. But it is easy to refine the selection to get precisely the results you want, because you can use the value for the inner and outer diameter of the bearing.

Inner diameter of bearing = 100 mm
Outer diameter of bearing = 150 mm

Enter the values for the inner and outer diameter of the bearing and click on the button 'Search'.

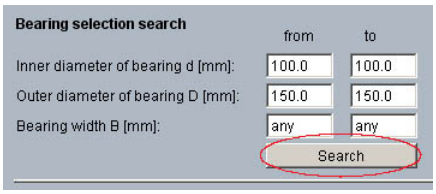

Figure 8: Input values

Finally the number of bearings reduces from 472 to two bearings.

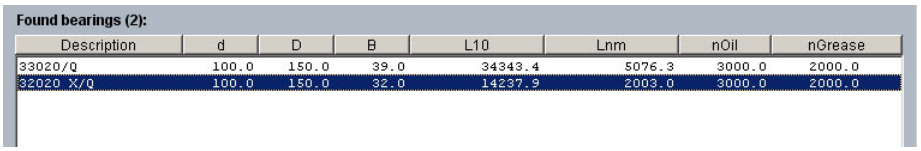

Figure 9: Found bearing

Select the bearing '32020 X/Q' and confirm with the button 'OK'.

The bearing is taken over to the main mask of the calculation module.

1.4 The results

The rating life

When you define the bearing, the calculation will be accomplished automatically and the results will be displayed immediately in the result panel. At first you get the result for the rating life as well as the static identification number.

Figure 10: The result for the rating life

The result of the rating life is $\underline{\underline{L_{10} = 14.237{,}9 \text{ h}}}$

For sheaves a rating life from 5.000 to 20.000 hours is required. The bearing is sufficiently dimensioned. For this example you will find a note in the message window.

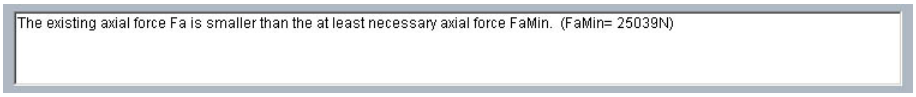

Figure 11: The message window

In this case you can ignore this message. When the pair is clamped, then the correct axial clearance and the necessary axial force for the tapered roller bearing occur.

The expanded modified rating theory

After you get the result for the rating life, please have a look at the expanded modified rating life L_{nm} in regard to the operating conditions (lubrication, clearance).

When you open the calculation module, the option 'Use expanded modified rating theory' is automatically activated.

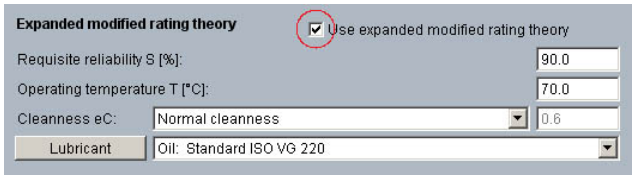

Figure 12: The expanded modified rating theory

Now you an define the requisite reliability and the cleanness as well as a lubricant.

Please select the grease 'Klüber Klübersynth BMQ 72-162 (094073)'. Select this lubricant directly from the listbox. If you need detailed information, please click on the button 'Lubricant'.

Figure 13: The lubricant selection

The lubricant database opens.

Now you can see that this grease contains active EP additive.

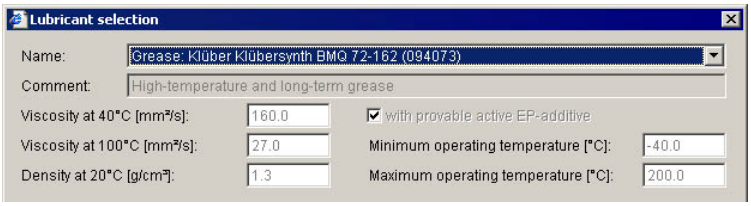

Figure 14: Lubricant search

Click on the button 'OK'.

The lubricant 'Klübersynth' is taken over to the main mask.

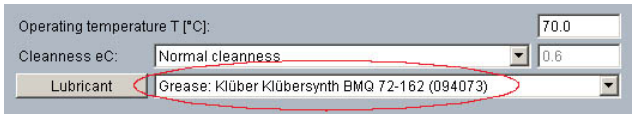

Figure 15: Lubricant 'Klüber'

Next you have to estimate the influence of possible impurities by using the cleanness factor. Actually it is assumed that the 'highest cleanness' is used for sealed and greased bearings (for-life-lubrication). But during the entire operating time, a certain wear of the seals could occur which can let light impurities into the bearing. In this case you can assume light impurities. Therefore, choose 'Light impurities' from the listbox.

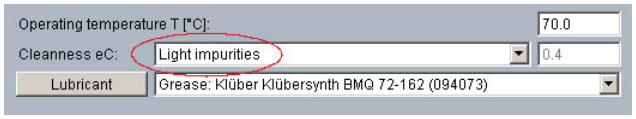

Figure 16: Light impurities

Now you get immediately the result for the expanded modified rating life.

Hinweis: The two arrow keys 'Up' and 'Down' of your keyboard allows you to search through the lubricant database, so you can compare the different values with each other.

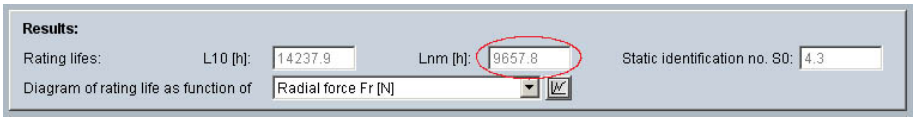

Figure 17: The expanded modified rating life

The result of the expanded modified rating life is $\underline{\underline{L_{nm} = 9.657{,}8 \text{ h}}}$.

Finally the expanded modified rating life L_{nm} is in the range of the rating life L_{10}.

1.5 The documentation: The calculation report

The diagrams

For a further illustration the following diagrams are available:

- Radial force
- Axial force
- Speed
- Cleanness
- Temperature
- Lubricant viscosity

Click on the button 'Diagram' next to the listbox.

Figure 18: Button 'Diagram'

The selected diagram opens. The diagram including the values for the rating life and for the expanded modified rating life is displayed immediately.

The calculation report

The button 'Options' allows you to define which diagrams are to be represented in the calculation report later. Afterwards click on the button 'Report'.

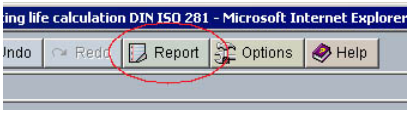

Figure 19: Button 'Report'

The calculation report is generated.

The calculation report contains a table of contents. You can navigate through the report via the table of contents that provides links to the input values, results and figures. The report is available in HTML and PDF format. Calculation reports, saved in HTML format, can be opened in a web browser or in Word for Windows.

Save the calculation

After accomplishment of your calculation, you can save the calculation. There you have the possibility to save either on the eAssistant server or on your own workstation locally. Click on the button 'Save'.

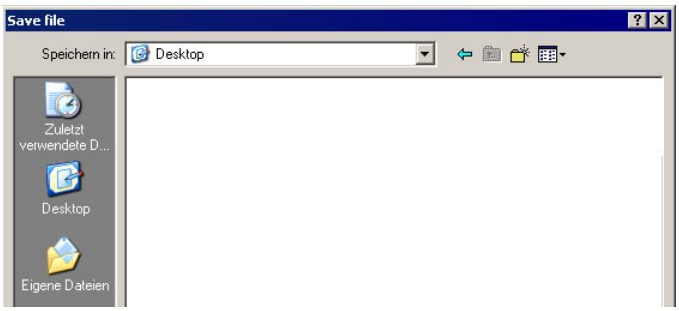

Figure 20: Windows dialog for saving the file

Please note: You must not forget that the calculation module has to be closed to activate the option 'Enable file save local.'

In case you have not activated this option, a new window is opened and you can save the calculation on the eAssistant server.

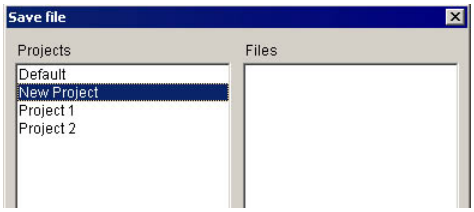

Figure 21: Save the calculation

Please enter a name into the input field 'Filename' and click on the button 'Save'. Then click on the button 'Refresh' in the Project Manager. Your saved calculation file is displayed in the window 'File'.

1.6 The second calculation example

Bearing of a ventilator

For the ventilator the impeller can be placed either centrically between two bearings or in an overhung position to the both bearing points. For small or medium ventilators the overhung bearing of the impeller is usual. Here a support for the fan drive shaft in two separated pillow block housings is possible.

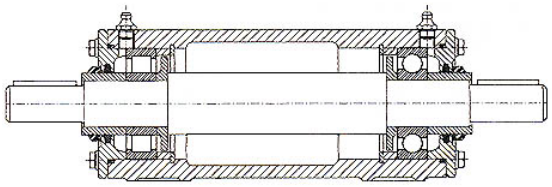

Figure 22: A bearing unit for ventilator

The unit (figure 22) contains a cylindrical roller bearing A and a deep groove ball bearing B in a shared casing (figure 23). The bearing diameter is 70 mm.

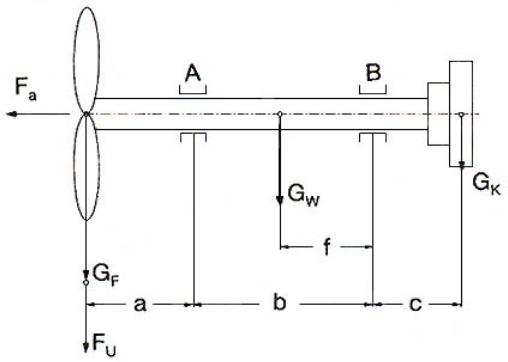

Figure 23: The bearing of a ventilator

This calculation example we have taken from: J. Brändlein: Die Wälzlagerpraxis: Handbuch zur Berechnung und Gestaltung von Wälzlagern (1995, p. 516-520). (The following figure: J. Brändlein: Die Wälzlagerpraxis, p.517)

The input values

The input values for bearing A (Cylindrical roller bearing NU 314 ECP)

Loading case no. 1		**Loading case no. 2**	
Time slice q_1	= 50%	Time slice q_2	= 50%
Speed n_1	= 3.000 min-1	Speed n_2	= 4.500 min-1
Radial force F_{r1}	= 8.500 N	Radial force F_{r2}	= 11.000 N
Axial force F_{a1}	= 0 N	Axial force F_{a2}	= 0 N
Temperature T_1	= 70 °C	Temperature T_2	= 70 °C

All input values for bearing B (deep groove ball bearing 6314)

Loading case no. 1		**Loading case no. 2**	
Time slice q_1	= 50%	Time slice q_2	= 50%
Speed n_1	= 3.000 min-1	Speed n_2	= 4.500 min-1
Radial force F_{r1}	= 2.000 N	Radial force F_{r2}	= 5.000 N
Axial force F_{a1}	= 5.000 N	Axial force F_{a2}	= 5.000 N
Temperature T_1	= 70 °C	Temperature T_2	= 70 °C

1.7 The calculation

Define the number of bearings

In this example we would like to calculate the rating life of the cylindrical roller bearing and the deep groove ball bearing. Here you find two bearings, that is why you have to change the number of bearings. So enter '2' into the input field 'Number of bearings to calculate'.

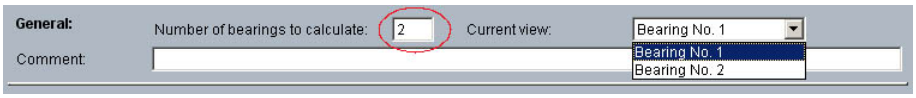

Figure 24: The number of bearings

Hinweis: Please calculate the bearings one after another separately. The listbox 'Current view' allows you to switch between the two bearings

Add a comment for the first bearing.

Figure 25: Add a comment

Select the manufacturer and the bearing type

Now select the manufacturer 'SKF'.

Figure 26: The selection of the manufacturer

Choose the cylindrical roller bearing.

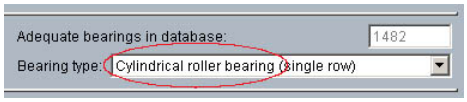

Figure 27: The cylindrical roller bearing

The specification of bearing load with load collective

Define the load collective for the first bearing. Activate the option 'Use load collective'. The input options for the radial and axial force as well as for the speed will be deactivated.

Figure 28: The bearing load

A new window is opened.

Define two loading cases for the bearing. For each individual loading case enter the time slice, the radial force, axial force, the temperature, and cleanness. When you have defined all inputs, then confirm with the button 'OK'.

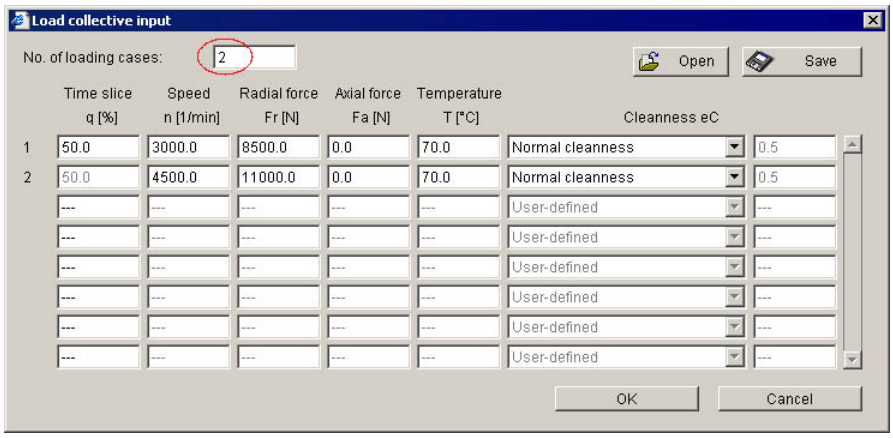

Figure 29: Define the load collective

The bearing selection

Click on the button 'Bearing selection'.

Figure 30: The bearing selection

The bearing database opens.

It is easy to filter the search to get precisely the results you want, because you can use the value for the inner diameter of the bearing. So please enter into the input field 'Inner diameter of bearing' the value '70 mm' and click on the button 'Search'. Finally 52 bearings remain. Please look for the cylindrical roller bearing 'NU 314 ECP' and confirm your input with the button 'OK'. The bearing is taken over to the main mask of the calculation module.

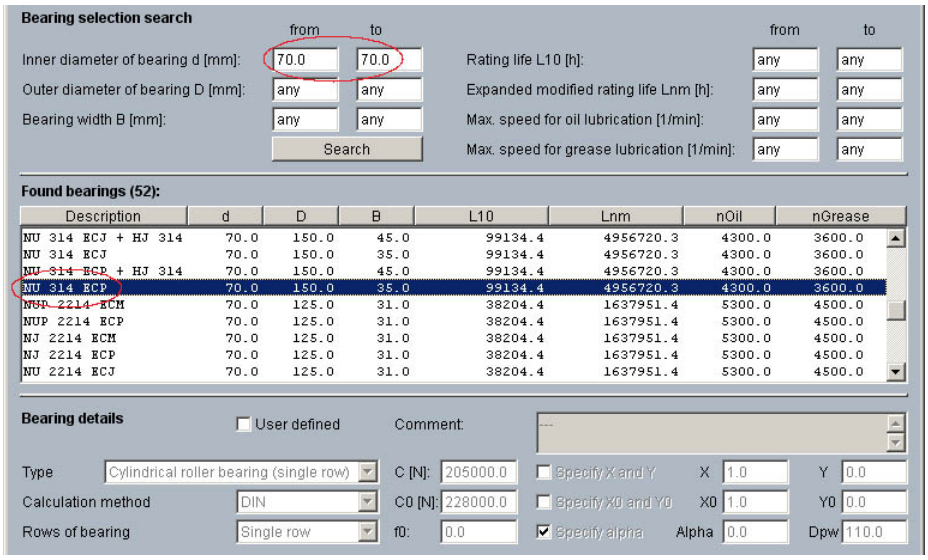

Figure 31: The bearing selection

1.8 The results

The rating life for the cylindrical roller bearing (the bearing point A)

When you define a bearing, the calculation will be accomplished automatically and the results will be displayed immediately in the result panel. This means that after every input of your data your results will be calculated again. At first, you get the result for the rating life.

Figure 32: The rating life

The result for the rating life is $\underline{L_{10} = 99.134{,}4 \text{ h}}$

With this the rating life is sufficiently dimensioned.

The rating life for the deep groove ball bearing (single row) (the bearing point B)

Calculate now the rating life for the deep groove ball bearing. Please pay attention that you select 'Bearing No. 2' from the listbox 'Current view'.

Figure 33: Deep groove ball bearing

Select the manufacturer 'SKF' and the bearing type 'deep groove ball bearing (single row)'. Then activate the option 'Use load collective'.

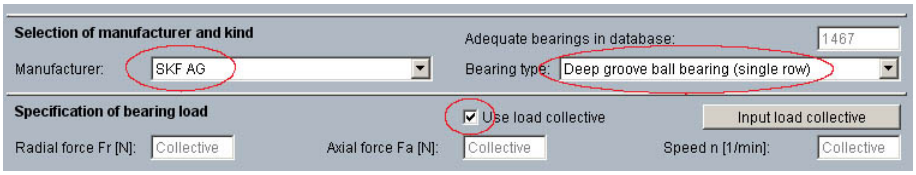

Figure 34: The bearing selection

Define the separate loading cases.

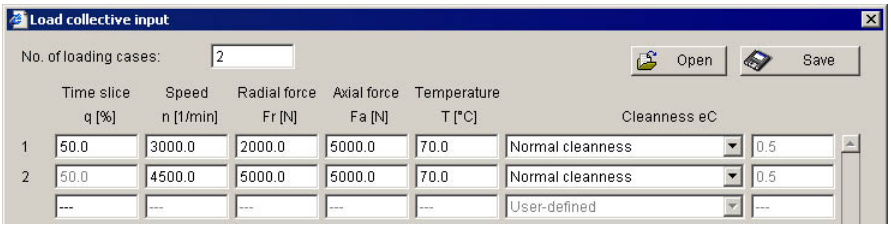

Figure 35: Define the load collective

Click on the button 'Bearing selection' and choose the bearing '6314' from the listbox. Filter your search and enter into the input field 'Inner diameter of bearing' the value '70 mm' and click on the button 'Search'. Then you can select the bearing '6314' from the list.

The result for the rating life is $L_{10} = 4.869{,}6$ h

Figure 36: The rating life

The rating life for the deep groove ball bearing B is lower than the rating life for the cylindrical roller bearing. This means that the load for bearing B is higher than for bearing A. At least 22.000 hours are required for the rating life of the deep groove ball bearing. With this the rating life is not sufficiently dimensioned. Next take a closer look at the expanded modified rating life L_{nm} for the bearing B.

The expanded modified rating life for the deep groove ball bearing

The next step is to calculate the expanded modified rating life for the deep groove ball bearing. Generally the expanded modified rating theory is activated.

Select the grease 'Lubcon Turmograse Highspeed L 252 (K HC P 2/3 K-50)' directly from the listbox or click on the button 'Lubricant' to open the lubricant selection. Accept the lubricant and confirm with the button 'OK'.

The lubricant is taken over to the main mask of the calculation module. The result for the expanded modified rating life is displayed automatically.

Figure 37: The expanded modified rating life

The result of the expanded modified rating life is $L_{nm} = 34.092{,}4$ h.

Because at least 22.000 hours are required, the bearing is sufficiently dimensioned.

1.9 The documentation: The calculation report

The button 'Options' allows you to define which diagrams are to be represented in the calculation report later. Afterwards click on the button 'Report'.

Hinweis: If you calculate the bearing with load collective, then not all diagrams can be displayed.

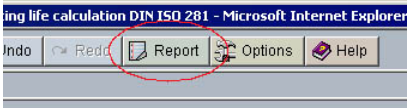

Figure 38: Button 'Report'

The calculation report is generated.

The calculation report contains a table of contents. You can navigate through the report via the table of contents that provides links to the input values, results and figures. The report is available in HTML and PDF format. Calculation reports, saved in HTML format, can be opened in a web browser or in Word for Windows.

Save the calculation

After accomplishment of your calculation, you can save the calculation. There you have the possibility to save either on the eAssistant server or on your own workstation locally. Click on the button 'Save'. If you have activated the option 'Enable file save local' in the Project Manager and the option 'Local' in the calculation module, a standard Windows dialog for saving the file on your workstation appears.

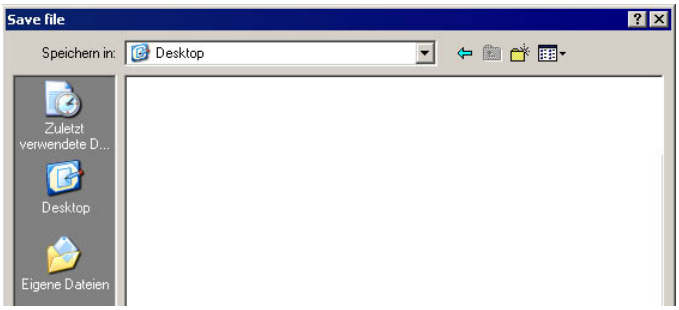

Figure 39: Windows dialog for saving the file

Please note: You must not forget that the calculation module has to be closed to activate the option 'Enable file save local.'

In case you have not activated this option, a new window is opened and you can save the calculation on the eAssistant server.

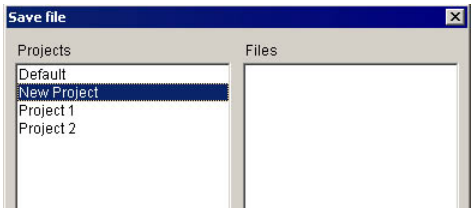

Figure 40: Save the calculation

Please enter a name into the input field 'Filename' and click on the button 'Save'. Then click on the button 'Refresh' in the Project Manager. Your saved calculation file is displayed in the window 'File'.

Our manual is improved continually. Of course we are always interested in your opinion, so we would like to know what you think. We appreciate your feedback and we are looking for ideas, suggestions or criticism. If you have anything to say or if you have any questions, please let us know via telephone *+49 (0) 531 129 399-0* or email *eAssistant@gwj.de*.