winLIFE 4.0 2017

FE INTERFACE

STZ-Verkehrstechnik / Germany



Inhalt

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Interface for ANSYS

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1. Interface for ANSYS

Note: If you use the V4W then you can perform easily the datatransfer between winLIFE 4.0 2017 and ANSYS to watch stress and fatigue results. Instead of the V4W you can use ANSYS macros and the use is described following. Using ANSYS macros is a more flexible solution and it may be in some special cases more convenient.

1.1. Interface winLIFE to ANSYS (V4.0)

This special interface has been developed by AWOTEC GmbH and Steinbeis.

The ANSYS interface is a collection of APDL (ANSYS Parametric Design Language) macros making the export of the FE results and the import of the winLIFE 4.0 2017 results possible. You can also then view these results.

The pre-processing and post-processing can be carried out in the classic ANSYS user surface "Mechanical APDL" and also in the work platform "ANSYS Workbench".

Below are the individual menus for interactive working followed by the enter sizes of the macros used. The macros can be integrated in an automatic program carried out by APDL Script.

1.1.1.Improvements compared to Version V3.2

- Now includes the export of element stresses for shell elements
- Error corrected in export of node stresses for shell elements

1.1.2. Runtime environment for the macros

The interface has been tested under the following conditions:

ANSYS Release V17.0

Supported element types: Solid: 45, 92, 95, 185, 186, 187, 190 Plane: 42, 182, 183 Shell: 41, 43, 63, 93, 181, 281

Supported calculation types:

Uniaxial and multiaxial; welded seams for solids and shells.

1.1.3.Installation

The file for the interface macros "ANSYS to winLIFE" has to be via the system variable ANSYS_macrolib defined in the environment variables of the Windows control system. The macros can be found on the winLIFE 4.0 2017 -CD.

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ANS	5YS110_DIR 5YS110_PRO	C:\Program Files\ANSYS Inc\v110\ANSYS	~	
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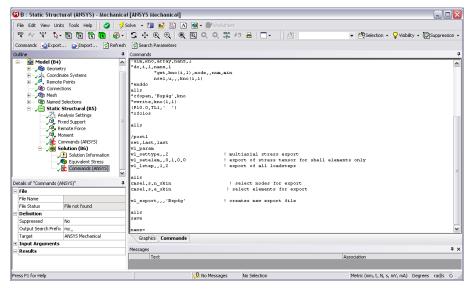
1.1.4. Preprocessing in ANSYS Workbench

1.1.4.1. Project Schematic Workflow

For the interactive use of the interface it is necessary to link an object from the *Mechanical APDL* with the solution from the *Mechanical* Object (Simulation). It is best if this link is added <u>before</u> the start of the solution!

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The data export can also be carried out, however, via the interface macros directly into *Commands* Objects in the *Mechanical* Structure tree. *Mechanical* APDL is then only necessary to show the results.



Before starting the equation solver with the command "SOLVE" in the *Mechanical* surface, it is necessary to make the following settings in the ANSYS settings in the detail window:

save ANSYS db: YES

Delete Unneeded Files: NO

If the winLIFE Viewer is used subsequently, the data basis in the *.cdb format has to be saved in a Command Snippet using the command "cdwrite,db,"

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1.1.4.2. Named Selections

All nodes and elements, for which an evaluation is to be carried out, must be defined by Named Selections (Components). When doing this it is important to set the definition "Send to Solver" in the detail window to YES.

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1.1.4.3. Starting the Interface

To start the interface, the *Mechanical APDL* window must be opened using the RMB-menu with the command "Edit in Mechanical APDL".

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Then enter the following commands in the command line.

RESUME

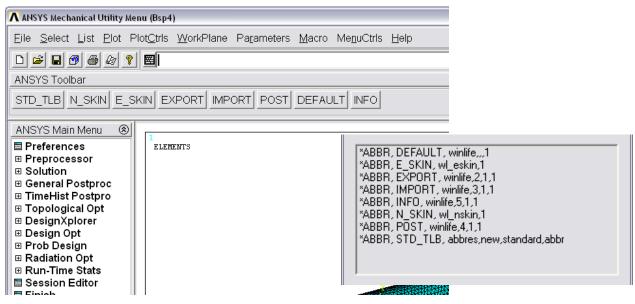
WINLIFE,1

1.1.5. The winLIFE Toolbar

For interactive use there are several command lines in the *Mechanical APDL*. These can be activated with the command **WINLIFE,1**.

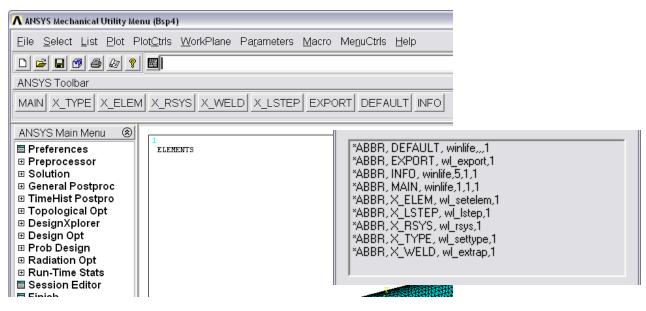
1.1.5.1. winLIFE MAIN Toolbar - winLIFE_main.abbr

Main menu for using the interface:



1.1.5.2. winLIFE EXPORT Toolbar - winLIFE_exp.abbr

Definition of the parameters, file names and settings for the export of stresses from the FE-Calculation.



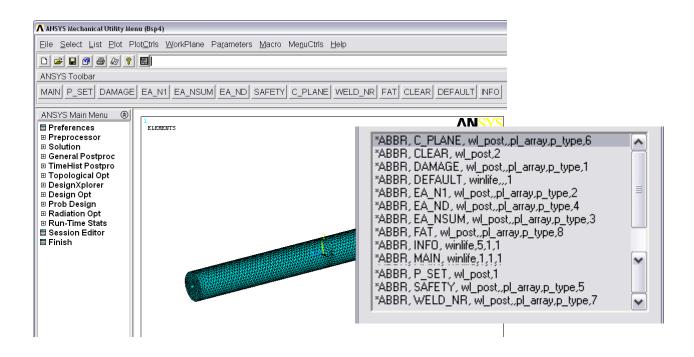
1.1.5.3. winLIFE IMPORT Toolbar - winLIFE_imp.abbr

Definition of the file names and parameters for the import of winLIFE 4.0 2017 result file.

Eile Select List Plot PlotCtrls WorkPlane Parameters Macro MenuCtrls						
	s <u>H</u> elp					
ANSYS Toolbar						
	R, DEFAULT, winlife,,,1 R, I_FILE, wl_import,2 R, IMPORT, wl_import,1 R, INFO, winlife,5,1,1 R, MAIN, winlife,1,1,1					

1.1.5.4. winLIFE POST Toolbar - winLIFE_post.abbr

With the commands of the POST-Toolbar the results from winLIFE 4.0 2017 such as damage or safety factor can be shown in ANSYS as contour plots.



1.1.6. winLIFE to ANSYS Interface Macros

1.1.6.1. winlife.mac

WINLIFE,TLB_KEY,PAR_KEY,STD_KEY

Activates winLIFE to ANSYS Toolbar

TLB_KEY	activates winLIFE menu bars
	1 = Standard Toolbar
	2 = Export Toolbar
	3 = Import Toolbar
	4 = Post Toolbar
	5 = INFO Text
PAR_KEY	0 = Default Parameter values are set ((wl_param.mac)
	$\neq 0$ no action
STD_KEY	0 = Default Parameter values are set ((wl_param.mac)
	$\neq 0$ no action

Note:

For the use of the interface macros using the command line or in a program script, it is not necessary to carry out this command. If, however, the default values of parameters are to be used, it is recommended that these are set at the beginning of the export using the command "wl_param".

1.1.6.2. wl_nskin.mac

WL_NSKIN,XMODE,CMN_NAME

WL_NSKIN creates a node component 'cmn_name' with the "external" nodes of the selected elements. ("External" nodes are nodes on free element surfaces.)

XMODE	Selection of the type of interactive mode
	0 = Execution by command line or script
	1 = activates the display of input menus
CMN_NAME	Name of the node component [Character Parameter]

Note:

When defining the component name with the command, this must be placed between two single inverted commas. (e.g. wl_nskin,,'notch')

For the interactive definition via the dialogue field, however, you must not use these!

1.1.6.3. wl_eskin.mac

WL_ESKIN,XMODE,CMN_NAME,CME_NAME

WL_ESKIN creates shell elements for evaluating the stresses on the surface of solid elements. This technique is also called "skinning". The nodes of the components 'cmn_name' describs the "skin" area. The elements created are grouped in the components 'cme_name'.

XMODE	Selection of the type of interactive mode
	0 = Execution by an command line or script
	1 = activates the display of input menus
CMN_NAME	Name of the node component [Character Parameter]
CME_NAME	Name of the element component [Character Parameter]

Note:

When defining the component name with the command, this must be placed between two single inverted commas. (e.g. wl_eskin,,'notch','skin')

For the interactive definition via the dialogue field, however, you must not use these!

1.1.6.4. wl_settype.mac

WL_SETTYPE,XMODE,WET

WL_SETTYPE defines the export type

XMODE	Selection of the type of interactive modus
	0 = Execution by a command line or script
	1 = activates the display of input menus
WET	Export type
	1 = UNIAXIAL

2 = MULTIAXIAL
3 = Weld seam extrapolation
4 = Weld seam Multiplier
5= non-linear / transient export

Note:

The export type WET=3 is currently only supported for solid elements

1.1.6.5. wl_setelem.mac

WL_SETELEM,XMODE,ESOLID,ESHELL,EBEAM,ELINK,SKINKEY

WL_SETELEM defines the element type for export

XMODE	Selection of the type of interactive modus
	0 = Execution by an command line or script
	1 = activates the display of input menus
ESOLID	0/1 = No/Yes - solid elements
ESHELL	0/1 = No/Yes - shell elements
EBEAM	0/1 = No/Yes - beam elements (at present not yet supported)
ELINK	0/1 = No/Yes - bar elements (at present not yet supported)
SKINKEY	0/1 = No / Yes - use skinning technique for solids
GRDKEY	0/1=No/Yes - node information for stress gradient

Note:

To use the skinning technique it is necessary to pre-define the required nodes and elements using the macros wl_nskin.mac and wl_eskin.mac

1.1.6.6. wl_rsys.mac

WL_RSYS,XMODE,CS_EXP

WL_RSYS defines the output coordinate system for the export

ctive modus
l line or script
out menus
oordinate system)
ordinate system

Note:

When exporting unstructured meshed shell elements it is particularly important to check the result coordinate system, because the averaged node results do not automatically take into account the different orientations of the coordinate systems. After automatic meshing but before starting the solver it is strongly recommended to orientate the element coordinate systems correctly!

1.1.6.7. wl_extrap.mac

wl_extrap,xmode,xtype,xf_0,hstyp,hsthk,wlfat,hstoe,hspath,hsplo

WL_EXTRAP defines the parameter for extrapolation for the export of weldings

	0 = Execution by an command line or script
	1 = activates the display of input menus
XTYPE	Method of extrapolation
	0 = automatic classification according to IIW
	1 = linear extrapolation (2 reference points)
	2 = quadratic extrapolation (3 reference points)
	3 = rough extrapolation for coarse meshes
XF_0	Multiplier for multiplier method
HSTYP	$1 = ,,a^{"} / 2 = ,,b^{"} HotSpot$
HSTHK	thickness of sheet at hot spot
WLFAT	FAT class (only for documentation)
HSTOE	line of the foot point
HSPATH	path of extrapolation perpendicular to the weld
HSPLO	0/1 = No / Yes - create a path-plot of the extrapolation

Note:

The multipliers according to the IIW recommendations are implemented within the macro. Changes of these multipliers are only possible in the programming code.

1.1.6.8. wl_lstep.mac

WL_LSTEP,XMODE,LSSTART,LSEND

WL_LSTEP defines the area of the load cases to be exported.

XMODE	Selection of the type of interactive modus
	0 = execution by a command line or script
	1 = activates the display of input menus
LSSTART	first load case
LSEND	last load case

Note:

With the two parameters LSSTART and LSEND all available load cases between these will be exported. If this is not required, the load cases must be exported individually one after the other.

1.1.6.9. wl_export.mac

 $wl_export, xmode, f_append, e_filnam, cme_name, wlstart, wlend$

WL_EXPORT writes the stress tensors of the selected nodes taking into account the settings previously selected into the winLIFE 4.0 2017 input files *.lst

XMODE	Selection of the type of interactive modus
	0 = Execution by a command line or script
	1 = activates the display of input menus
F_APPEND	Activates writing of data into existing files
	0 = any existing data is overwritten
	1 = any existing data is amended
E_FILNAM	File name of the export file [Character Parameter]
CME_NAME	Name of the skin - element component [Character Parameter]
WLSTART	Number of the first weld or hot-spot for export
WLEND	Number of the last weld or hot spot for the export

Note:

When defining the file name with the command, this must be placed between two single inverted commas. (e.g. wl_import,,,'example').

For the interactive definition via the dialogue window, however, you must not use these!

WARNING! The length of the file name should be limited to 8 characters!

All existing welds in between WLSTART und WLEND are exported. If this is not wished, the welds must be exported one after the other with separate commands.

The macros eu_solid.mac, eu_shell.mac, em_solid.mac, em_shell.mac, ewm_solid.mac, ewm_shell.mac, ewx_solid.mac, enl_solid.mac, enl_shell.mac, ewmu_shell.mac und eme_shell.mac are sub-routines for the export and can only be used in this context.

1.1.6.10. wl_import.mac

WL_IMPORT,XMODE,I_FILNAM,I_ARRAY

WL_IMPORT reads the winLIFE 4.0 2017 result values out of the file *.exp into a user defined ARRAY-parameter.

XMODE	Selection of the type of interactive modus
	0 = Execution by a command line or script
	1 = interactive import start
	2 = activates the display of the input menu
I_FILNAM	File name of the import file [Character Parameter]
I_ARRAY	Name of the result - ARRAYS [Character Parameter]

Note:

When defining the file name with the command, this must be placed between two single inverted commas. (e.g. wl_import,,,'example')

For the interactive definition via the dialogue window, however, you must not use these!

WARNING! The length of the file name should be limited to 8 characters!

1.1.6.11. wl_post.mac

WL_POST,XMODE,PL_ARRAY,P_TYPE,R_TYPE

WL_POST reads the winLIFE 4.0 2017 result values out of a defined ARRAY-Parameter and creates a plot or a list of the user requested results.

XMODE	Selection of the type of interactive modus
	0 = Execution by an command line or script
	1 = activates the display of input menus
	2 = Reset the display to ANSYS results
PL_ARRAY	Name of the result - ARRAYS [Character Parameter]
P_TYPE	Type of result presentation
	0 = Data only read in
	1 = Contour plots are created
	2 = Results are listed in output window
R_TYPE	Result value
R_TYPE	Result value 1 = Damage [D]
R_TYPE	
К_ТҮРЕ	1 = Damage [D]
К_ТҮРЕ	1 = Damage [D] 2 = Equivalent Amplitude for one cycle [EA_1]
К_ТҮРЕ	 1 = Damage [D] 2 = Equivalent Amplitude for one cycle [EA_1] 3 = Equiv. Amplitude for the sum cycle number [EA_nsum]
К_ТҮРЕ	 1 = Damage [D] 2 = Equivalent Amplitude for one cycle [EA_1] 3 = Equiv. Amplitude for the sum cycle number [EA_nsum] 4 = Equiv. Amplitude for the endurance limit [EA_ND]
К_ТҮРЕ	 1 = Damage [D] 2 = Equivalent Amplitude for one cycle [EA_1] 3 = Equiv. Amplitude for the sum cycle number [EA_nsum] 4 = Equiv. Amplitude for the endurance limit [EA_ND] 5 = Utilisation rate
К_ТҮРЕ	 1 = Damage [D] 2 = Equivalent Amplitude for one cycle [EA_1] 3 = Equiv. Amplitude for the sum cycle number [EA_nsum] 4 = Equiv. Amplitude for the endurance limit [EA_ND] 5 = Utilisation rate 6 = critical plane

Note:

The presentation of the contour plot occurs in the graphic mode /Graphics,Full The mode /Graphics,Power cannot used for the presentation of the results!

1.1.6.12. wl_param.mac

This file contains the default values for the parameters "Standard" file-names of winLIFE 4.0 2017 to ANSYS interface macros. These values can be changed and adapted by the user. The parameters and the standard values delivered are shown below:

Parameter	Default
e_filnam	active jobname
i_filnam	active jobname
wet	1
esolid	1

eshell	1
ebeam	0
elink	0
Skinkey	0
cs_exp	0
hstype	1
xsthk	1
xtype	1
xf_0	1.00
wlfat	100
hsplo	0
hstoe	1
hspath	1
wlstart	1
wlend	1
lsstart	1
lsend	1
f_append	0
cmn_name	n_skin
cme_name	e_skin
i_array	wl_res
pl_array	%i_array%
p_type	1
r_type	1

Note:

1.1.7. File Summary (V4.0)

Term	File	Version
Menu bars	winLIFE_main.abbr	1.0
	winLIFE_exp.abbr	1.0
	winLIFE_imp.abbr	1.0
	winLIFE_post.abbr	2.0
0) General	winLIFE.mac	4.0
1) Pre-processing	wl_nskin.mac	2.0
	wl_eskin.mac	2.0
2) Export of results	wl_settype.mac	4.0
	wl_setelem.mac	4.0
	wl_rsys.mac	2.0
	wl_extrap.mac	2.2
	wl_lstep.mac	2.0
	wl_export.mac	4.0
	eu_solid.mac	3.1
	eu_shell.mac	3.1
	em_solid.mac	3.1
	em_shell.mac	4.0
	ewm_solid.mac	3.1
	ewm_shell.mac	4.0
	ewx_solid.mac	3.1
	enl_solid.mac	3.1
	enl_shell.mac	3.1
	ewmu_shell.mac	3.2
	eme_shell.mac	4.0
3) Import of results	wl_import.mac	2.1
4) Presentation of results in the Post- processor	wl_post.mac	2.0
5) Parameter	wl_param.mac	2.3

2. FEMAP Installation notes and Interface

All existing modules of winLIFE 4.0 2017 :

- winLIFE FKM QUICKCHECK
- winLIFE 4.0 2017
- winLIFE GEARWHEEL&BEARING
- winLIFE MULTIAXIAL
- winLIFE MULTIAXIAL MULTICORE
- VIEWER4WINLIFE
- winLIFE CRACKGROWTH
- winLIFE RANDOM FATIQUE

are all on the installation-CD and are installed during the installation process. They are inaccessible, however, until you buy a license and register with winLIFE 4.0 2017 .

winLIFE 4.0 2017 can be used with

- NX NASTRAN
- NEi NASTRAN

The two programs use FEMAP as a pre and postprocessor. This leads to a totally identical data structure. Other programs which use FEMAP can be connected to winLIFE 4.0 2017 without problems.

The installation process of winLIFE 4.0 2017 itself has been described before. In this chapter the interface to FEMAP is described.

2.1. Standard Interface (recommended)

Execute the file

winLIFE_interface_to_FEMAP.exe

which is on the winLIFE 4.0 2017 CD while FEMAP is open. This performs that the winLIFE 4.0 2017 menu will be included in the FEMAP menu. After executing this file an additional menu point "winLIFE" appears in the FEMAP menu.

Delete	Group	View	Window	winLIFE	Help

In the case that the winLIFE 4.0 2017 menu is not automatically integrated in FEMAP the user has to customize the menu manually. In the document *Installation_Interface_Femap_winLIFE.pdf* describes how to do this.

2.2. High-Speed interface (only in special cases)

The standard interface is user friendly but slow. If more than 10 000 nodes shall be transferred from FEMAP to the winLIFE 4.0 2017 export file the time for data transfer may be no more acceptable. For this case an alternative solution is available using FEMAP macro language.

The macro must be installed by copying the file LIFE_FMT.esp and the *.PRG files into the FEMAP installation directory (e.g. C:\FEMAPv102).

The use is recommended for users who are familiar with FEMAP and the FEMAP macros.

2.3. Using FEMAP

After successful installation the menu option winLIFE 4.0 2017 is shown in the top line.

If you click on it, the options for the data export/import are shown like

	winLIFE	Help	
	Create surface group		
	Create surface plate		
1	Create weld groups		
	Star	Start data export for winLIFE	
	Data import from winLIFE		
	Export node list		

Figure 2-1: winLIFE-Button and sub-menus in the user-interface of FEMAP (is created while the installation process of winLIFE)

2.3.1. Create Surface Group

In most cases, a fatigue calculation only has to be carried out for surface nodes. To do this you select

Create Surface group

and the following mask will appear:

Create Surface group from ¥9.3					
Creates a node surface group with the ID 9999					
and the title Surfa	ce group				
A temporary property and a temporary group with an ID 9999 will be compiled and then deleted.					
Start Cancel					

Figure 2-2: Creating a group of nodes located on the surface

Click on *start* and this mask will appear:



Figure 2-3: Inquiry if a new database shall be created

Click on Yes

2.3.2. Create Surface Plate and Group

If very thin plate elements are located on the surface, the only state possible is a plane stress. Then the stress tensor is simpler because it contains only 3 different elements. The post processing may be simpler (if you use beside FEMAP further postprocessors). You do not need to use plate elements on the surface but some users prefer this procedure.

Create surface plates from ¥9.3	X
Create plates on the surface with a thickness of and save in the surface group with ID 9998 and the title Surface plate group A temporary property and a temporary group with an ID 9999 will be compiled and then deleted.	
Ok Cancel	

Figure 2-4: Inquiry to create thin plate elements on the surface

The number and the name of the group and the thickness of the new plates on the surface can be changed as the user requires. The Young's modulus should be low compared to the basic material of the structure. It should have no mechanical influence. For steel basic material you can define a separate material specification or you can use aluminium alloy.

Create surface plates from ¥9.3		
Select material		
1 ISOTROPIC Material		
Ok	Cancel	

Figure 2-5: Selection of material for the plates of the surface

Now select the material for the plate elements.

Entity Selection - Oberflächenelemente auswählen	? 🛛
	Select All Reset Pick ^ Hilfe
	Previous Delete DK
Group 9999PlotPlanar	More Method Cancel

Figure 2-6: Selection of the plate elements on the surface

Select the elements you are interested in.



Figure 2-7: Inquiry if a new database shall be created

Click on Yes to continue.

2.3.3. Create Weld Groups

The various properties of the sheet metal make it possible to identify the welds. Sheets are looked for which are joined together with nodes. The nodes found are where the sheets meet and show the welds. All elements which lie on these seam nodes are grouped together in weld groups.

Create weld groups	(V3.5) 📧
Create weld groups with the start ID and the title weld	99000
Weld elements are identified by the different element-properties.	connection of
Start	Cancel

Figure 2-8: Selection to create a weld group

In the following window, the group you wish to create is given a starting number and a title. Click on *Start* to continue.

2.3.4.Export of stresses for the uniaxial case The fatigue calculation differs between the uniaxial and the multiaxial case. Resulting from this the data export is different. The following table shows the possible selections available. The grey marked line gives the possibility for the uniaxial case (it is only one!!)

Selection	Necessarity of the module	Suitable for calculation of	Limits	Afford
Uniaxial export	winLIFE 4.0 2017	Proportional fatigue for only 1 loading history	Equivalent stress only from principal stress	small
Multiaxial export and QUICK CHECK	winLIFE MULTIAXIAL	Critical plane approach	Max. 200 loading histories	High
Multiaxial Export and Quick CHECK	winLIFE FKM QUICKCHECK	Static and fatigue proof according to FKM or	Only load spectrum / no loading history possible.	small
Multiaxial Export or Quick CHECK marked	winLIFE FKM QUICKCHECK	Endurance limit proof (not accord. FKM	Only worst case scenario	Very small
Nonlinear export	winLIFE MULTIAXIAL	Geometrically and/or physically nonlinear	Ma. 20 000 nodes	Mean
Welding structural stress concept	winLIFE MULTIAXIAL	Seam weldings / according well known standards	Node lines must be located exactly in strongly defined matter relative to the weld toe	High (mesh creation)
Weld hot spots	winLIFE MULTIAXIAL	Seam weldings, only plate elements useable but normal direction vector used	Acceptable accuracy	Small
Weld hot spots for QUICK CHECK	winLIFE FKM QUICKCHECK	Seam weldings, only plate elements, no direction vector used	Only for hot spot search recommended, only for endurance limit proof	Very small
Create file for the regression analysis of the stress gradient	winLIFE MULTIAXIAL	Creating the related stress gradient to modify S-N curve locally	Only surface nodes	High
Create file for the regression analysis of the stress gradient for some nodes only	winLIFE MULTIAXIAL	Creating the related stress gradient to modify S-N curve locally only for some selected nodes	Only surface nodes	Mean
User defined	winLIFE MULTIAXIAL	User can define selection according to his needs		high

Table: Menu options of the FEMAP data export

Interface program winLIFE-FEMAP V11.0.0 (V3.7.2)	X
Export	
uniaxial export	
C multiaxial export and Quick Check	
C nonlinear export	
O weld structural stress concept	
○ weld hot spots	
C create file for the regression analysis of the stress gradient	
C stress gradient for few Solids	
C user defined	
C user defined	
Export quantity	
✓ principal stress	
🗖 stress tensor 🗖 surface index	
node coordinates 🗖 stress gradient	
normal vector	
next Cancel	

Figure 2-9: Selection to create an export-file for winLIFE

It is possible to export node stresses or element stresses. In case of element stress only plate-elements can be exported at the moment.

The Calculation Method `Average` means that the average stress of the nodes is exported. In the case of Max, the maximum stress on the nodes is exported. We recommend you to use Average.

Export of Stress, static designation of stress Kind of stress Standard (linear) Nonlinear Export of stress for following elements Solids Beam Rod Image: Solids Beam Rod Image: Solids Beam Rod Max Calculationsmethod Average Max Transform Plate Material Axes Image: Solids Solids Solids<th>Interface program winLIFE-FEMAP VI</th><th>1.2.0 (V4.0.2) 🗵</th>	Interface program winLIFE-FEMAP VI	1.2.0 (V4.0.2) 🗵
Kind of stress Image: Standard (linear) Image: Node Image: Element Image: Element of Stress for following elements Image: Solids Image: Element of Stress for following elements Image: Solids Image: Element of Stress for following elements Image: Solids Image:	- French of Shares, shalls	designation of stores
Image: Node C Element C Nonlinear Export of stress for following elements Image: Solids Beam Rod Image: Solids Beam Rod Image: Solids Beam Rod Image: Solids Beam Rod Image: Solids Image: Solids<		
Export of stress for following elements		
Solids Beam Rod Plates Bar Calculationsmethod	Node C Element	O Nonlinear
Image: Plates □ Bar Calculationsmethod Image: C_Max Image: C_Max Transform Plate Material Axes Image: Transform Image: C_Max Image: C_Max Image: C_Max <td>Export of stress for following e</td> <td>elements</td>	Export of stress for following e	elements
Calculationsmethod	Solids Bear	n 🗖 Rod
 Average C Max Transform Plate Material Axes ✓ Transform Element Orientation Vector in Basic Rectangular X 1,0 Y 0,0 Z 0,0 Extrapolation factor hot spots Inear extr. C quadratic extr. 	Plates 🗌 Bar	
Transform Plate Material Axes Transform Element Orientation Vector in Basic Rectangular X 1,0 Y 0,0 Z 0,0 Extrapolation factor hot spots © linear extr. © quadratic extr.	Calculationsmethod	
✓ Transform Element Orientation Vector in Basic Rectangular × 1.0 Y 0.0 Z 0.0 Extrapolation factor hot spots © linear extr. C quadratic extr.	Average C Max	
Element Orientation Vector in Basic Rectangular X 1.0 Y 0.0 Z 0.0 Extrapolation factor hot spots © linear extr. O quadratic extr.	Transform Plate Material Axes	
X 1.0 Y 0.0 Z 0.0 Extrapolation factor hot spots Inear extr. C quadratic extr.	✓ Transform	
Extrapolation factor hot spots	Element Orientation Vector in	Basic Rectangular
Iinear extr. C quadratic extr.	X 1.0 Y 0.0	Z 0,0
	Extrapolation factor hot spots —	
F,inside 1,67 F 0,67 F,outside 0,72	C linear extr. C quadra	atic extr.
,	F,inside 1.67 F 0.67	F,outside 0,72
Create export-group of the nodes / elements 9999	Create export-group of the nod	es / elements 9999
start export Cancel	start export	Cancel

Figure 2-10: Selection to create an export-file for winLIFE

Only the element type you select will be exported

FEMAP - winLI	E Export Datei	auswählen			? 🔀
Spejchern in:	🗀 test_gw		•	+ 🗈 💣 💷]-
Zuletzt verwendete D Desktop	test_gw2.LST test_gw23.LST test_gw.LST				
igene Dateien					
Arbeitsplatz					
S					
Netzwerkumgeb ung	Datei <u>n</u> ame:	test_gw3 LST		•	<u>S</u> peichern
	Datei <u>t</u> yp:	Export files (*.LST)		•	Abbrechen

Figure 2-11: Defining the file-name

The filename and the directory are chosen by the user. Keep the name in your mind, because you have to select the file later.

The selection of the load case you can do in the following mask.

Interface program winLIFE-FEMAP V11.0.0	(V3.7.2)	X
Choose OutputSet		
1 NX NASTRAN Case 1		
	1	
next > Cancel		

Figure 2-12: Selection of the output set

To select the nodes to be shown you can select single nodes or - in most cases - you will select all.

Entity Selection - Select nodes		? 🗙
Add <u>Remove</u> Exclude ID <u>Iso</u> by 1 or <u>G</u> roup	+114,16115,1	Select All Rgset Pick^ Previous Delete DK More Method^ Cancel

Figure 2-13: Node selection

2.3.5. Export of stresses for the multiaxial case

In the case of multiaxial calculation more data are exported and more information is needed. The grey marked lines are possible for multiaxial export. You can see that only the case for uniaxial export is not possible!

Table: Menu options of the FEMAP data export

Selection	Necessarity of	Suitable for		
	the module	calculation of		
Uniaxial export	winLIFE 4.0 2017	Proportional fatigue for only 1 loading history	Equivalent stress only from principal stress	small
Multiaxial export and QUICK CHECK	winLIFE MULTIAXIAL	Critical plane approach	Max. 200 loading histories	High
Multiaxial export and QUICK CHECK	winLIFE FKM QUICKCHECK	Static and fatigue proof according to FKM or	Only load spectrum / no loading history possible.	small
Multiaxial Export and Quick CHECK	winLIFE FKM QUICKCHECK	Endurance limit proof (not accord. FKM	Only worst case scenario	Very small
Nonlinear export	winLIFE MULTIAXIAL	Geometrically and/or physically nonlinear	Ma. 20 000 nodes	Mean
Welding structural stress concept	winLIFE MULTIAXIAL	Seam weldings / according well known standards	Node lines must be located exactly in strongly defined matter relative to the weld toe	High (mesh creation)
Weld hot spots	winLIFE MULTIAXIAL	Seam weldings, only plate elements useable but normal direction vector used	Acceptable accuracy	Small
Weld hot spots for QUICK CHECK	winLIFE FKM QUICKCHECK	Seam weldings, only plate elements, no direction vector used	Only for hot spot search recommended, only for endurance limit proof	Very small
Create file for the regression analysis of the stress gradient	winLIFE MULTIAXIAL	Creating the related stress gradient to modify S-N curve locally	Only surface nodes	High
Create file for the regression analysis of the stress gradient for some nodes only	winLIFE MULTIAXIAL	Creating the related stress gradient to modify S-N curve locally only for some selected nodes	Only surface nodes	Mean
User defined	winLIFE MULTIAXIAL	User can define selection according to his needs		high

Interface program winLIFE-FEMAP V11.0.0 (V3.7.2) 🗵
Export	_
C uniaxial export	
 multiaxial export and Quick Check 	
C nonlinear export	
O weld structural stress concept	
O weld hot spots □ for QUICK CHECK	
C create file for the regression analysis of the stress gradient	
C stress gradient for few Solids	
C user defined	
Export quantity	
🗖 principal stress 🗖 surface roughness	
🔽 stress tensor 🗌 surface index	
🗖 node coordinates 🗖 stress gradient	
normal vector temperature	
next Cancel	

Figure 2-14: Selection to create an export-file for winLIFE

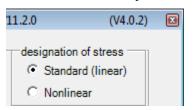
If all selected plate elements don't have the same direction at the material axes FEMAP cannot build the correct node stress-tensor. So you have to transform all material axes into the same direction. This direction should not be perpendicular to the surface.

If you select a vector, which is perpendicular to any plate element, then you will get an error message.

Interface program winLIFE-FEMAP V11.2.0 (V4.0.2)				
Export of Stress, static	designation of stress			
Kind of stress	Standard (linear)			
 Node C Element 	C Nonlinear			
Export of stress for following e	elements			
Solids 🗖 Bear	m 🗖 Rod			
Plates 🗌 Bar				
Calculationsmethod				
Average C Max				
Transform Plate Material Axes Transform Element Orientation Vector in X 1.0 Y 0.0	n Basic Rectangular Z 0,0			
Extrapolation factor hot spots —				
Iinear extr. C quadra	atic extr.			
F,inside 1,67 F 0,67	F,outside 0,72			
Create export-group of the nod	es / elements 9999			
start export	Cancel			

Figure 2-15: Selection to create an export-file for winLIFE

Remarks to the stress export



Selecting *Standard linear* in a multiaxial export the following vectors are exported:

Solid-Elements	Shell elements	
60010Solid X Normal Stress	7020Plate Top X Normal Stress	
60011Solid Y Normal Stress	7021Plate Top Y Normal Stress	
60012Solid Z Normal Stress	7023Plate Top XY Shear Stress	
60013Solid XY Shear Stress	7420Plate Bot X Normal Stress	
60014Solid YZ Shear Stress	7421Plate Bot Y Normal Stress	
60015Solid ZX Shear Stress	7423Plate Bot XY Shear Stress	

If the kind of stress is *Nonlinear* the following vectors are exported::

Solid-Element type	Shell elements	
60160Nonlinear Solid X Normal Stress	7142Nonlinear Plate Top X Normal Stress	
60161Nonlinear Solid Y Normal Stress	7143Nonlinear Plate Top Y Normal Stress	
60162Nonlinear Solid Z Normal Stress	7145Nonlinear Plate Top XY Shear Stress	
60163Nonlinear Solid XY Shear Stress	7542Nonlinear Plate Bot X Normal Stress	
60164Nonlinear Solid YZ Shear Stress	7543Nonlinear Plate Bot Y Normal Stress	
60165Nonlinear Solid ZX Shear Stress	7545Nonlinear Plate Bot XY Shear Stress	

In the case of uniaxial export the principal stresses (linear, nonlinear) are exported.

Note: Results from ADINA are listed as nonlinear stresses in Femap

After a winLIFE 4.0 2017 fatigue calculation is done the results can be read from FEMAP to present the results in a contour plot. To export the results of FEA an export file name has to be created by the user:

FEMAP - winLIF	E Export Datei a	auswählen			? 🗙
Spejchern in:	🗀 test_gw		•	+ 🗈 💣 🎟+	
Zuletzt verwendete D	test_gw2.LST test_gw23.LST test_gw.LST				
Desktop					
igene Dateien					
Arbeitsplatz					
Netzwerkumgeb ung	Datei <u>n</u> ame:	test_gw33.LST		•	<u>S</u> peichern
-	Datei <u>t</u> yp:	Export files (*.LST)		-	Abbrechen

Figure 2-16: Defining the file-name

Next step is to select the load case.

Interface program winLIFE-FEMAP V11.0.0	(V3.7.2)	
Choose OutputSet		
1 NX NASTRAN Case 1		
next > Cancel		

Figure 2-17: Selection of the output set

You can select the nodes of interest. In most cases you will select the nodes of the surface which are included in the group you have created.

Entity Selection - Select nodes			? 🗙
Add <u>Permove</u> Exclude ID Ya to by 1 or Group	+114,16115,1	Select All Reset Previous Delete More Method ^	Pi <u>ck</u> ^ 💦

Figure 2-18: Selection of the nodes

Consult your analysis program's documentation concerning the original coordinate system definition. The new component forces, stresses, and strains will be placed in the user defined output vector numbers (300000+).

2.3.6. Import the fatigue results from winLIFE into FEMAP

The fatigue results – the damage sum – is written from winLIFE 4.0 2017 into a file. You can import these results and show them in FEMAP by choosing from the menu

winLIFE / data import from winLIFE

It is the same procedure for uniaxial and multiaxial case. You have to select the filename as shown in the following mask:

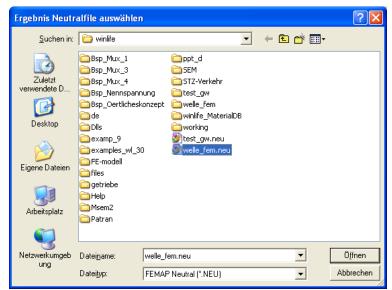


Figure 2-19: Selection of winLIFE result file containing the fatigue results

You select the file name which you created in winLIFE 4.0 2017 to store the results.

The following message will occur if just a result file exists in FEMAP. Press OK and rename in FEMAP the existing Output-Set. Or delete the existing Output-Set. Then repeat the import of the winLIFE 4.0 2017 result file.



Figure 2-20: Message appears if the file name just exists

To show the results in FEMAP choose

View / Select / Deformed and Contour Data

and the following mask will appear. You have to select the output set 200005 by clicking the drop down button and choose the Output Vectors.

Select PostP	rocessing Data			×
View 1	Rahmenecke		[Dynamic Max/Min
-Output Set	s 200005winLIFE Result SET	• 🕅 🕷	Program : Unknown Analysis Type : Unknown Set Value : 0,	
Output Vec	tors			
Deform	1Damaging Parameter	- 🏹 😿	Transform	Vector Info
Contour	1Damaging Parameter	- 👔 😿	Transform	Vector Info
	✓ Double-Sided Planar Contours		Multiple Contou	r Vectors
	r Options Contour Vectors e Options Section Cut	Trace Locations Streamline Options]	OK Cancel

Figure 2-21: Selection of the winLIFE result set

After clicking

OK

The following graphic containing your fatigue results will appear.

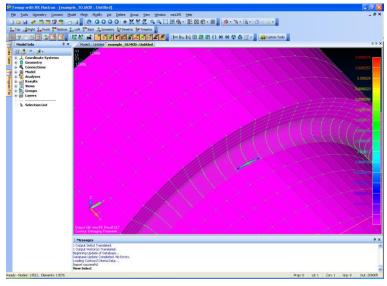


Figure 2-22: Visualisation of the result in FEMAP

To improve the presentation you can change the colour range. Select

View / Options

And the following mask will appear where you can change the minimum and maximum value of the damage presented in the graph.

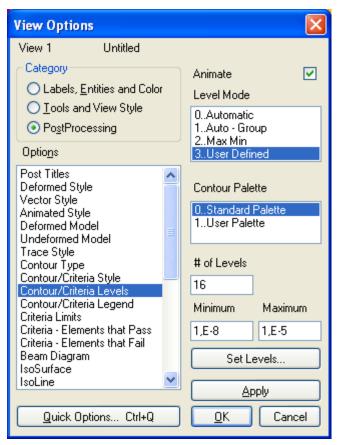


Figure 2-23: Options for result presentation

The result is shown in the following picture. In this way this you can show all other results such as safety factor, equivalent stress etc.

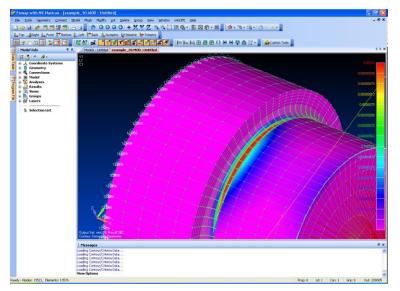


Figure 2-24: Modified view after changing the colour range

In case of exporting element-stresses from FEMAP to winLIFE 4.0 2017 the following FEMAP options are reasonable.

View Options	- • •
View 1 Rahmenecke	
Category Cabels, Entities and Color	Double-Sided
 <u>T</u>ools and View Style PostProcessing 	0Nodal Contour 1Elemental Contour
Optio <u>n</u> s	2Match Output
Post Titles Deformed Style Vector Style Animated Style Deformed Model Undeformed Model Trace Style	Contour Fill Mode
Contour Type	1Level Colors
Contour/Criteria Style Contour/Criteria Levels Contour/Criteria Legend Criteria - Elements that Pass Criteria - Elements that Pasi Beam Diagram IsoSurface IsoLine Streamline Contour Vector Style Freebody	
Freebody Node Markers Freebody Vectors Freebody Total Force Freebody Total Moment Freebody Nodal Force Freebody Nodal Moment	Contour Options Apply OK Cancel

Figure 2-25: Settings for export of element stresses

2.3.7. Description of the winLIFE import file *.LST

A file *.lst is created by the FEA program as transfer file to winLIFE 4.0 2017. All data which shall be used for a fatigue calculation (e.g. the nodes) must be in this file. The structure is defined in the chapter "Data transfer between FEA and winLIFE".

2.3.8. Export node list

The command Export node list exports nodes in a file with the extension *.kno.

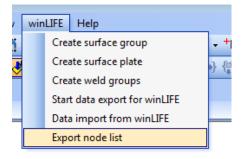


Figure 2-26: Selection to create a node list

To do this the user selects nodes of interest and specifies a file in which the node numbers are written.

2.4. Using the original FEMAP commands

The winLIFE 4.0 2017 standard interface based on FEMAP APIs is comfortable and tested. If the number of nodes is very large (> 10 000) the time for the data transfer can be long and it is recommended to export directly from the FEMAP user interface. For this purpose the winLIFE 4.0 2017 CD has a file LIFE_FMT.esp which provides the data structure. This has to be copied into the FEMAP installation directory e.g. into: C:\FEMAPv102\.

In FEMAP under File -> Preferences in the tab "Library/Startup" enter the file LIFE_FMT.esp as the format file (instead of e.g. format.esp). The macros are subsequently carried out as program file in FEMAP.

Because this method is more complicated that using the API-interface, it is only recommended for experienced users.

In FEMAP changes are often made to the APIs. Therefore we only use an example here to describe the basic procedure. Version 10.2.0 of FEMAP is used.

The example represents a uniaxial load using plate elements.

The commands can be recorded with the help of the FEMAP macro recorder and a program file is created. The following diagrams show the process. The order of the commands is labelled with the numbers 1, 2 etc.

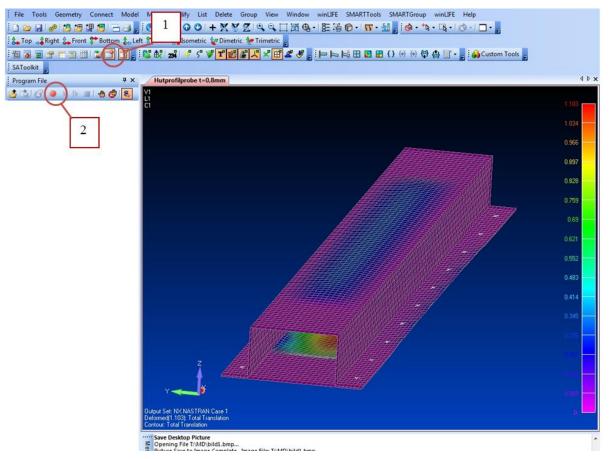


Figure 2-27: order of actions using original FEMPA commands

To copy the output vectors into a new output set. Command: Model \rightarrow Output \rightarrow Process

What to	Process	Complete Out	put Sets	One or More Selected	Output Vectors	
Process	ing Opera	ations				
Сору	Merge	Linear Combination	RSS Combinati	on Envelope Error E	stimate Convert	
		No Options	Required - Just	1 Press "Select Output T	o Process"	
		ct Output To Process		Store Output in Set	0New Output Se	et
peratio		ct Output To Process Will Be Processed - Re			0New Output Se	
peratio					0New Output Se	Reset
peratio					0New Output Se	Reset
peratio					0New Output Se	Reset

Figure 2-28: order of actions using original FEMPA commands

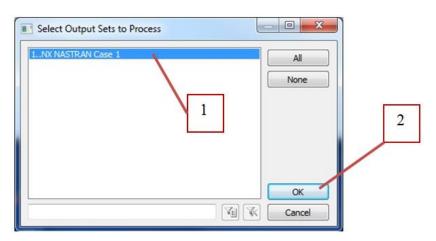


Figure 2-29: order of actions using original FEMPA commands

Process Output Data What to Process				
Ocomplete Output Sets	One or More Selected	Output Vectors		
Processing Operations				
Copy Merge Linear Combination RSS Combinati	on Envelope Error E	stimate Convert		
1 No Options Required - Just	Press "Select Output To	Process*		
Select Output To Process	Store Output in Set	0New Output S	et 💌	
Operations That Will Be Processed - Review Before Pre 1NX NASTRAN Case 1 -> New Set	using OK		Reset Delete	2
			Cancel	

Figure 2-30: order of actions using original FEMPA commands

Command: Model \rightarrow Output \rightarrow Process

Proce	ss Outpu	t Data					
What to	Process	_					
		Complete Ou	tput Sets (@) On	e or More S	Selected Output 1	Vectors	1
rocess	ing Opera	tions				/	
Сору	Merge	Linear Combination	RSS Combination	Envelope	Error Estimate	Convert	
Conv	version Ap	oproach			Use Output or	n Elements Fro	m
	Aver	age Values) Maximum Values		0Full Mod	el	w
	S	et Conversion Appro	ach and Elements	2 Pres	s "Select Output	To Process	•
	Selec	ct Output To Process			Store Output	in Original Set	(s)
peratio	ns That W	/ill Be Processed - Re	eview Before Pressing	ок			Reset Delete
							OK Cancel



For the uniaxial case: Select the vectors 7026, 7027, 7426, 7427

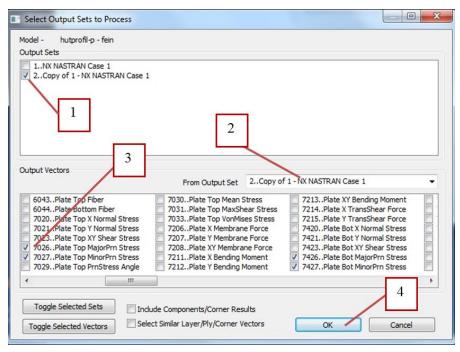


Figure 2-32: order of actions using original FEMAP commands

1000351	ng Oper			1				
Сору	Merge	Linear Combination	RSS Combination	Envelope	Error Estimate	Convert		
Conv	ersion A	pproach			Use Output or	Elements	From	
	Ave	rage Values 🔊 🔘	Maximum Values		0Full Mode	el		-
	S	Set Conversion Approa	ch and Elements .	Then Pre	ss "Select Output	To Process	·*	
	Sele	ect Output To Process.			Store Output	in Original S	Set(s)	
vg Full vg Full vg Full	Model Model Model	Will Be Processed - Rev 2Copy of 1 - NX NAS 2Copy of 1 - NX NAS 2Copy of 1 - NX NAS 2Copy of 1 - NX NAS	TRAN Case 1 [702/ TRAN Case 1 [702] TRAN Case 1 [742/	6Plate Top 7Plate Top 6Plate Bot	MinorPrn Stress] MajorPrn Stress]			set

Figure 2-33: order of actions using original FEMPA commands

Output of the stresses List \rightarrow Output \rightarrow Use Format Select the output sets

Entity Selection - Select Output Set(s) to List	
	Select All Reset Pick ^ 🛞
ID to by 1	Previous Delete OK
Group	More Method ^ Cancel

Figure 2-34: order of actions using original FEMPA commands

litle Sorting Sort Field		✓ Ø Ascending Absolute Value
Top N All Bottom Top Jumber 0	Limits None Above Maximum Below Minimum Between Outside Absol	Options Full Report Summaries Only Octails Only Skip Empty Ute Value Entity List
Format ID		Modify Format New Format OK Cancel

Figure 2-35: order of actions using original FEMPA commands

Format Title	1					
Page Title Fo	mats					
					Center	🔲 Blank
					Center	🔲 Blank
Column Title	ormat					
Data Formats	(Include Da	ta Vectors as	<vectorid,digits,< td=""><td>EFormat,LeftJustify</td><td>(0)</td><td></td></vectorid,digits,<>	EFormat,LeftJustify	(0)	
Data Formats	(Include Da	ita Vectors as	<vectorid,digits,< td=""><td>EFormat,LeftJustify</td><td>(>)</td><td></td></vectorid,digits,<>	EFormat,LeftJustify	(>)	
Data Formats	(Include Da	ata Vectors as	<vectorid,digits,< td=""><td>EFormat , Left Justify</td><td>0)</td><td></td></vectorid,digits,<>	EFormat , Left Justify	0)	
Data Formats	(Include Da		<vectorid,digits,< td=""><td>EFormat , Left Justify</td><td>0)</td><td></td></vectorid,digits,<>	EFormat , Left Justify	0)	
Data Formats	(Include Da		<vectorid,digits,< td=""><td>EFormat, Left Justify</td><td>0)</td><td></td></vectorid,digits,<>	EFormat, Left Justify	0)	

Figure 2-36: order of actions using original FEMPA commands

brary Entry	Choose Library	
IASTRAN Displacement		
ASTRAN Eigenvector		
ASTRAN Load Vector		
ASTRAN Constraint Forces		
ASTRAN MPC Forces	E	
ASTRAN CBAR Forces		
ASTRAN CBEAM Forces		
ASTRAN CBEND Forces		
ASTRAN CELAS2 Forces		
ASTRAN CBUSH Forces		
IASTRAN QUAD4 Forces IASTRAN QUAD8 Forces		
ASTRAN QUADO FOICES		
ASTRAN CTRIA3 Forces		
ASTRAN CTRIAG Forces		
ASTRAN CTUBE Forces		
ASTRAN CBAR Stresses		
ASTRAN CBEAM Stresses		
ASTRAN CBEND Stresses		
ASTRAN CELAS2 Stresses		
ASTRAN CBUSH Stresses		
IASTRAN CHEXA Stresses		
ASTRAN CPENTA Stresses		
IASTRAN CQUAD4 Stresses	-	

Figure 2-37: order of actions using original FEMPA commands

Organisieren 🔻 Neuer Ordner				iii 🔹 🔲 🧯
Name	Änderungsdatum	Тур	Größe	
BASICHDR.ESP	18.10.2011 07:55	ESP-Datei	62 KB	
format.esp	18.10.2011 07:55	ESP-Datei	43 KB	
FUNCTION.ESP	18.10.2011 07:55	ESP-Datei	1 KB	
🖻 LIFE_FMT.ESP 🔪	28.04.2011 12:54	ESP-Datei	44 KB	
mat_eng_in-lbf-psi-degF-BTU.esp	18.10.2011 07:55	ESP-Datei	373 KB	
mat_eng_mm-N-tonne-deg	18.10.2011 07:55	ESP-Datei	370 KB	
🖃 mat_eng_SI.esp 🔹 📘	18.10.2011 07:55	ESP-Datei	376 KB	
i material.esp	18.10.2011 07:55	ESP-Datei	14 KB	
LIFE_FMT.ESP Änderungsdate ESP-Datei Grö	um: 28.04.2011 12:54 iBe: 43,6 KB	Erstelldatum: 20	0.02.2014 08:30	2
Dateiname: LIFE FM	AT ECD		- Library	(* ere)

Figure 2-38: order of actions using original FEMPA commands

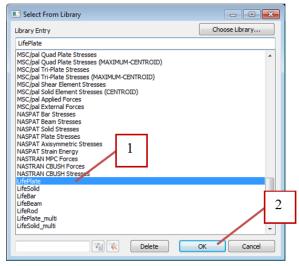


Figure 2-39: order of actions using original FEMPA commands

Define Ou	tput Forma	t				
Format Title	LifePlate					
Page Title For	mats					
					Center	🗸 Blank
					Center	🗸 Blank
Column Title F	ormat					
Data Formats	(Include	Data Vectors as	<vectorid.digits< td=""><td>.EFormat.LeftJustify</td><td>o)</td><td></td></vectorid.digits<>	.EFormat.LeftJustify	o)	
		Data Vectors as > < 9000001,6		,EFormat,LeftJustify	>)	
< 0 > <	9000000,6	> < 9000001,6	; >	,EFormat,LeftJustify	»)	
< 0 > <	9000000,6		; >	,EFormat,LeftJustify	>)	
< 0 > <	9000000,6	> < 9000001,6	; >	,EFormat , Left Justify	>)	1
< 0 > <	9000000,6	> < 9000001,6	; >	,EFormat , Left Justify	>)	1
< 0 > <	9000000,6	> < 9000001,6	; >	EFormat.LeftJustify		1 ncel

Figure 2-40: order of actions using original FEMPA commands

Selection of the output nodes

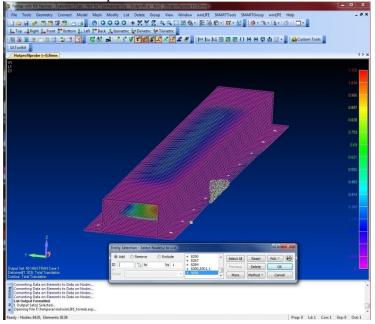


Figure 2-41: order of actions using original FEMPA commands

The output of the node stresses occurs in the message window. The values can now be copied to create a *.LST file.

Messages				
	t 2 - Copy of 1 - NX NAS t 200003 - WinLIFE-SET-F			
			1	
56	4.469395E+1	-2.566965E+1		
56	1.989908E+1	-5.185170E+1		
57	6.933349E+1	6.511211E+0		
57	-7.537208E+0	-8.499605E+1		
58	6.889610E+1	7.605387E+0		
58	-8.520838E+0	-8.321851E+1		
59	4.265100E+1	-2.179063E+1		
59	1.767709E+1	-4.710468E+1		
60	1.792053E+1	-5.032185E+1		
60	4.866585E+1	-1.752563E+1		
61	4.365424E+0	-4.105468E+1		
61	4.329025E+1	-3.407243E+0		
62	-2.673627E+0	-2.944841E+1		1
•				۴.,

Figure 2-42: result file

3. ADINA Data export to winLIFE

3.1. Using CDI

Data conversion is performed by help of the CDI (Custom designable Data Interface). The user has to create an ADINAresult file including the data in ASCII. This we show here for plate elements and solids.

3.1.1. Creating an ASCII-file for plates

For the following model of a notched plate shown in figure below the output-file shall be created. The ADINA-user should be able to create such a file himself as it is shown in the following.

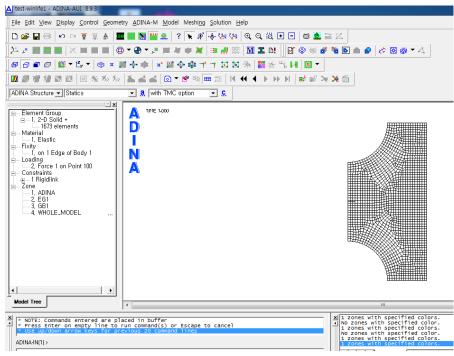


Figure 3-1: Model of a tension bar in ADINA (the symmetric properties were used to reduce the size of the model). Only the right part of the model is shown.

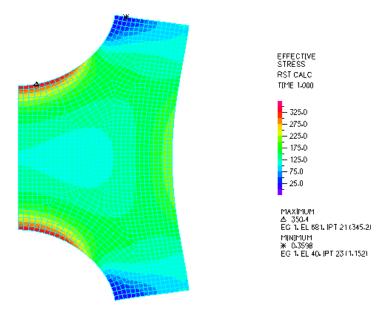


Figure 3-2: Model of a tension bar with stress results

Define Result Grid
Add Delete Copy Save Discard
Result Grid Name: DEFAULT
Results Computed at: Node Points
Number of Grids OK r: 1 s: 1 Cancel

Figure 3-3: Selection of parameters for output

Define Smoothing Technique	×
Add Delete Copy Save Discard	ОК
Smoothing Name: DEFAULT	Cancel
Type: Averaged Error Reference Value:	1
Zone: WHOLE_MODEL 🗾	

Figure 3-4: Selection of methode for mean values.

List Zone Values				
Zone Name: WHOLE_MODEL	Variable	es to List		
Result Grid: DEFAULT	I 1	Stress	▼ STRESS-YY	-
	2	Stress	▼ STRESS-ZZ	•
Result Control: DEFAULT 💌	□ 3	Displacement	▼ 1-DISPLACEMENT	v
Smoothing Technique: DEFAULT		, Displacement	▼ 1-DISPLACEMENT	_
Response Option		Displacement	☐].DISPLACEMENT	
C Single Response • Range of Responses		Displacement		
Response: DEFAULT		Joispideement		
Response Range: DEFAULT			Apply Export	. Close
POINT STRESS-YY	STRESS-ZZ			•
Time 1.00000E+00				
Node 3 -4.95764E-01 -3.	86867E-01 04635E+00			
	91195E+00 36262E+00			
	02561E+01 95841E+01			
	09968E+01			
	23417E+01			
Node 10 2.88203E+01 1. Node 11 4.40215E+01 1.	01778E+02 17861E+02			
	29590E+02			
Node 13 8.47456E+01 1.	36413E+02			
	38205E+02 35216E+02			
Node 15 1.35900E+02 1.	28006E+02			
Node 17 1.91121E+02 1.	17350E+02			
	04158E+02			
Node 19 2.43340E+02 8.	93866E+01			Ψ.
				4

Figure 3-5: Result of the output in ASCII-format

The so created file can be read in with the winLIFE 4.0 2017 CDI.

3.1.2. Creating an ASCII-file for solids

The model is a simple cylinder built by solids, which are under tension stresses. How to create the ASCII file is shown in the next figures. By help of CDI it is read into winLIFE 4.0 2017 and the fatigue calculation is done. The results of winLIFE 4.0 2017 can be read in back to ADINA.

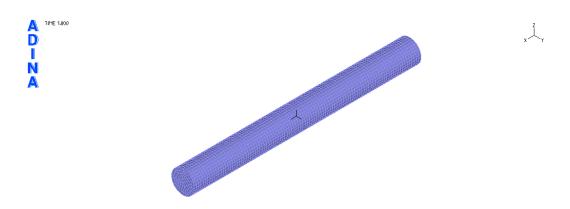


Figure 3-6: Model of the cylinder



Figure 3-7: result of stress calculation

one Name:	PULL 🔻	· · · · ·	Variable	s to List				
			☑ 1	Stress	•	STRESS-XX		-
Result Grid:	DEFAULT		▼ 2	Stress	Ţ	STRESS-YY		-
esult Control:	DEFAULT -	·						
moothing Technique	E DEFAULT		▼ 3	Stress	-	STRESS-ZZ		-
			▼ 4	Stress	•	STRESS-XY		-
Response Option —			▼ 5	Stress	•	STRESS-YZ		-
C Single Response	se 🛛 🖲 Range of Respo	onses						
Response: DEFAL	JLT	T	₽ 6	Stress	-	STRESS-XZ		•
ADINA: AUI ver	sion 8.9.3, 17 Oc	tober 2013	: ***	NO HEADI	NG DEFI	[NED ***		[
Licensed from Finite element Listing for zo Element field	ADINA R&D, Inc. program ADINA, r	esponse ra luated usi	nge ty ng RST evalua	pe load-s interpol ted on th	tep: ation a	and smoothed with	h nodal avera 1.00 STRESS-	[ige v
Licensed from Finite element Listing for zo Element field On shell secti POINT	ADINA R&D, Inc. program ADINA, r ne PULL: variables are eva ons, element vari STRESS-XX	esponse ra luated usi ables are	nge ty ng RST evalua	pe load-s interpol ted on th	tep: ation a e shell	and smoothed with top layer, t =	1.00	[ige v
Licensed from Finite element Listing for zc Element field On shell secti POINT Time 1.00000E+ Node 20772 Node 20773 Node 20774	ADINA R&D, Inc. : program ADINA, r one PULL: variables are eva ions, element vari STRESS-XX -00 1.28141E-02 1.28129E-02 1.2869E-02	esponse ra luated usi ables are STRES -1.64454 -2.91841 -3.57956	nge ty ng RST evalua S-YY E-06 E-06 E-06	pe load-s interpol ted on th STRE -2.6885 -1.8470 -2.4395	tep: ation a e shell SS-ZZ 8E-06 0E-06 8E-06	and smoothed with top layer, t = STRESS-XY 3.81406E-06 1.48961E-06 6.53670E-07	1.00 STRESS- -4.60769E- -6.54643E- 1.55509E-	uge v YZ 07 07 06
Licensed from Finite element Listing for zc Element field On shell secti POINT Time 1.00000E4 Node 20772 Node 20774 Node 20776	ADINA R&D, Inc. : program ADINA, r yariables are eva ons, element vari STRESS-XX -00 1.28141E-02 1.28129E-02 1.281069E-02 1.28100E-02 1.28111E-02	esponse ra luated usi ables are STRES -1.64454 -2.91841 -3.57956 3.81941 -4.43305	nge ty evalua S-YY E-06 E-06 E-06 E-06 E-06 E-06	pe load-s interpol ted on th STRE -2.6885 -1.8470 -2.4395 1.2484 3.0737	tep: ation a e sheli SS-ZZ 8E-06 0E-06 8E-06 0E-06 1E-06	and smoothed with top layer, t = STRESS-XY 3.81406E-06 1.48961E-06 6.53670E-07 -9.86969E-07 5.59068E-06	1.00 STRESS- -4.60769E- -6.54643E- 1.55509E- 2.47407E- -9.41664E-	•YZ •07 •07 •06 •07 •07
Licensed from Finite element Listing for zo Element field On shell secti	ADINA R&D, Inc. : program ADINA, r ne PULL: variables are eva ons, element vari STRESS-XX -00 1.28141E-02 1.28129E-02 1.28069E-02 1.2800E-02	esponse ra luated usi ables are STRES -1.64454 -2.91841 -3.57956 3.81941	nge ty ng RST evalua S-YY E-06 E-06 E-06 E-06 E-06 E-06 E-05	pe load-s interpol ted on th STRE -2.6885 -1.84705 -2.4345 1.2484	tep: ation a e shell SS-ZZ 8E-06 0E-06 8E-06 0E-06 1E-05	and smoothed wit top layer, t = STRESS-XY 3.81406E-06 1.48961E-06 6.53670E-07 -9.86369E-07	1.00 STRESS- -4.60769E- -6.54643E- 1.55509E- 2.47407E-	uge v YZ 07 07 06 07 07 07 07 07
Licensed from Finite element Listing for zc Element field On shell secti POINT Time 1.00000E+ Node 20772 Node 20773 Node 20775 Node 20776 Node 20776	ADINA R&D, Inc. : program ADINA, r nne PULL: variables are eva ons, element vari STRESS-XX -00 1.28141E-02 1.28129E-02 1.28069E-02 1.28110E-02 1.28111E-02 1.28128E-02	esponse ra luated usi ables are STRES -1.64454 -2.91841 -3.57956 3.81941 -4.43305 1.31704	nge ty ng RST evalua S-YY E-06 E-06 E-06 E-06 E-05 E-05 E-05 E-05	pe load-s interpol ted on th STRE -2.6885 -1.8470 -2.4395 1.2484 3.0737 1.6718	tep: ation a e sheli SS-ZZ 8E-06 0E-06 8E-06 0E-06 1E-06 1E-06 2E-07 2E-07 2E-06	and smoothed witi top layer, t = STRESS-XY 3.81406E-06 1.48961E-06 6.53670E-07 -9.86965E-07 5.59068E-06 -4.46047E-07	-4.60769E -6.54643E 1.55509E 2.47407E -9.41664E -7.26792E	07 07 06 07 07 07 07 07 07 07

Figure 3-8: Settings to create the here discussed ASCII-file.

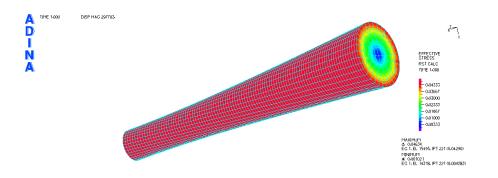


Figure 3-9: Result of the winLIFE fatigue calculation reimported to ADINA and shown there

4. ABAQUS Data export to winLIFE

Note: If you use the VIEWER4WINLIFE then you can perform easily the datatransfer between winLIFE 4.0 2017 and ABAQUS to watch stress and fatigue results. Instead of the VIEWER4WINLIFE you can use the winLIFE CDI and the use is described following.

4.1. Using CDI

The data is transferred with the aid of CDI (Custom designable Data Interface). To do this, an ASCII-File has to be created in ABAQUS. This can be seen in the following SOLID-Elements diagram.

4.1.1. Creating an ASCII-file for solids

The necessary winLIFE 4.0 2017 output file is created for the ABAQUS-Model of a beam. An experienced ABAQUS user will be able to adapt this briefly explained procedure to create output files for any other model or element type.

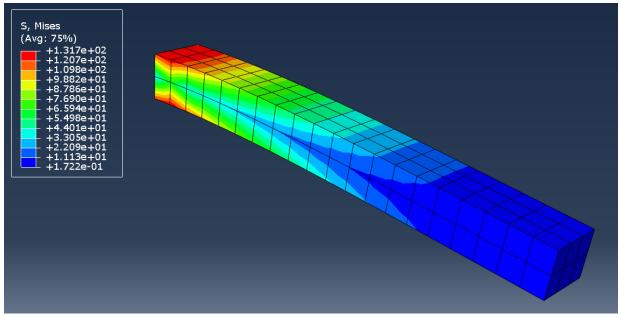


Figure 4-1: Model of a Beam in ABAQUS

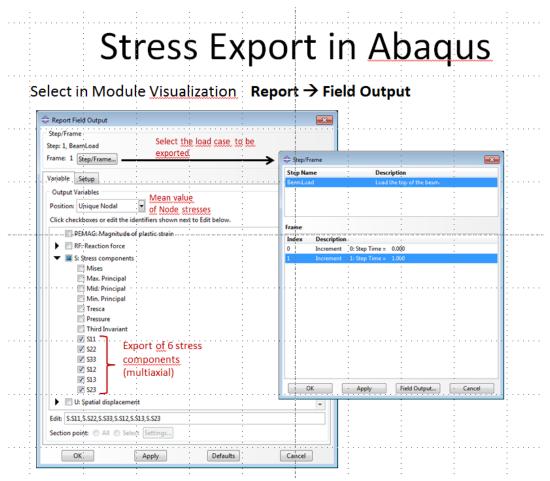


Figure 4-2: Dialogue Report Field Output

+ Report Field Output
Step/Frame
Step: 1, BeamLoad
Frame: 1 Step/Frame
Variable Setup
File
Name: D:/Abaqus-winLIFE Schnittstelle/abaqus-export.rpt Select
Append to file
Output Format
Layout: Single table for all field output variables
Separate table for each field output variable
Sort by: Node Label
Ascending Descending
Page width (characters): No limit Specify: 80
Number of significant digits: 6
Number format: Engineering 💌
Data
Write: 📝 Field output 🔲 Column totals 📄 Column min/max
OK Apply Defaults Cancel
Cancer Cancer

Figure 4-3: Defining the Output Format in ABAQUS

When the file has been created, go to winLIFE 4.0 2017 and open the CDI (see next diagram). The file created in ABAQUS will be shown.

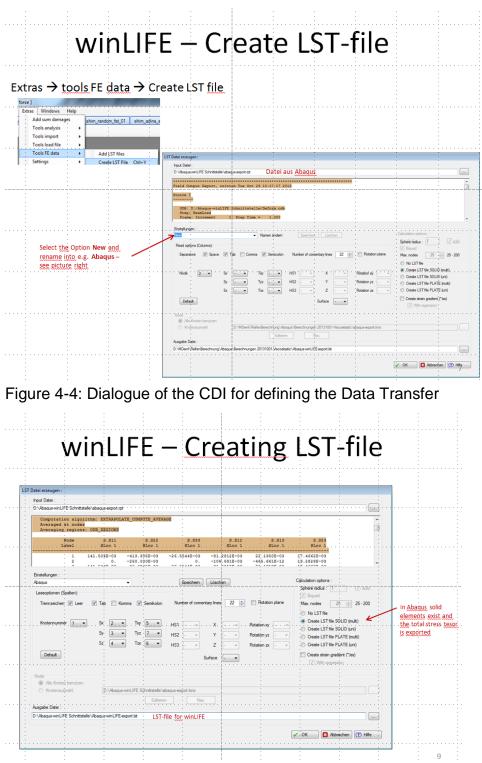


Figure 4-5: All Entries in the Dialogue for Data Transfer

Note that this structure of data transfer is saved under a name defined by the user - in this example Abaqus. For future data transfers you only have to enter this name.

The result of this operation is the following file which can now be read into winLIFE $4.0\ 2017$.

Abaqus-winLl	FE-export.lst - Editor							×
Datei Bearbeite	n Format Ansicht	?		1			1	i.
winLIFE_vers	ion 3.6.3 (32Bi	t)	10			()	· · · · · · · · · · · · · · · · · · ·	1.4
Number_of_he	adlines 5	123		1	i :			
kind_of_deli	miter '. '.							
Number of co							•	1
		num to	SX SV S	Z TXV TVZ TXZ	Meaning_of_para	meters end	-	
1 4	1.41504e-01	-4.1330		-2.65544e-02	-8.12812e-02		2.21350e-02	
2 4	0.00000e+00	-2.5000		0.00000e+00	-1.06581e-01	1.92828e-02	-4.65661e-10	2
3 4	-1.41504e-01	-8,6694		2.65544e-02	-8.12812e-02		-2.21350e-02	1 A 1
2 4	1.29974e-01	-4.0908		-2.97319e-02	-5. 34285e-02	3.71615e-03	5.39027e-03	
5 4		-2.5000		-2.32831e-10	-7.83848e-02		-2.91038e-11	
	-1.39698e-09							1
64	-1.29974e-01	-9.0911		2.97319e-02	-5.34285e-02	3.71615e-03	-5.39028e-03	
. 7 4	1.29974e-01	-4.0908		-2.97319e-02	-5. 34285e-02		-5.39028e-03	1
8 4 9 4	-4.65661e-10	-2.5000		0.00000e+00	-7.83848e-02	-4.62447e-03	5.82077e-11	
	-1.29974e-01	-9.0911		2.97319e-02	-5.34285e-02		5.39028e-03	
10 4	1.41504e-01	-4.1330		-2.65544e-02	-8.12812e-02	-1.74662e-02	-2.21350e-02	1.1
11.4	0.00000e+00		0e-01	0.00000e+00	-1.06581e-01	-1,92828e-02	0.00000e+00	
12 4	-1.41504e-01	-8.6694	5e-02	2.65544e-02	-8-12812e-02	-1.74662e-02	2.21350e-02	
13 4	4.43614e-01	-4.5250	0e-01	-7.20299e-02	-1,89225e-01	9.331926-04	4.36713e-02	1 a -

Figure 4-6: Result of the Data Transfer

Sources

5. Literature and references

5.1. General fatigue

[1] DIN 45667 Klassierverfahren für das Erfassen regelloser Schwingungen

[2] Haibach, E.: Betriebsfestigkeit, VDI-Verlag; Düsseldorf 1989

[3] Buxbaum, O.: Betriebsfestigkeit, Verlag Stahl Eisen; Düsseldorf 1986

[4] Westermann-Friedrich: Sonderereigniskollektive, kennzeichnende Zeitfunktionen und Kollektive für Anlagen und Arbeitsprozesse. Forschungsvereinigung Antriebstechnik Heft 274, 1988

[5] Verein deutscher Eisenhüttenleute: Leitfaden für eine Betriebsfestigkeitsrechnung, 2. Auflage; Düsseldorf 1985

[6] Hück, Thrainer, Schütz: Berechnung von Wöhlerlinien für Bauteile aus Stahl, Stahlguß und Grauguß, Synthetische Wöhlerlinien, Verein deutscher Eisenhüttenleute Arbeitsgemeinschaft Betriebsfestigkeit, Mai 1981

[7] Zammert, W.-U.: Betriebsfestigkeitsberechnung, Vieweg-Verlag; Braunschweig-Wiesbaden 1985, ISBN 3-528-03350-9

[8] Munz, D.: Ermüdungsverhalten metallischer Werkstoffe, Vortragstexte eines Symposiums der Deutschen Gesellschaft für Metallkunde, 1984, Deutsche Gesellschaft für Metallkunde e.V., Adenauerallee 21, Oberursel

[9] Hertel, H.: Ermüdungsfestigkeit der Konstruktion, Springer-Verlag 1969

[10] Gumpert, W.: Höhere Festigkeitslehre, Betriebsfestigkeit, 3. Lehrbrief; Lehrbriefe für das Hochschulfernstudium Nr.: 02 1205 03 0; Herausgeber: Zentralstelle für das Hochschulfernstudium Dresden

[11] Heuler, P.: Anrißlebensdauer bei zufallsartiger Belastung auf der Grundlage örtlicher Beanspruchungen; Institut für Stahlbau und Werkstoffmechanik der TH Darmstadt, Heft 40, 1983

[12] Bergmann, J.: Zur Betriebsfestigkeit gekerbter Bauteile auf der Grundlage der örtlichen Beanspruchungen; Dissertation TH-Darmstadt 1983

[13] Krüger, Petersen: Simulation und Extrapolation von Rainflow-Matrizen; Bericht Nr. 8 der Arbeitsgruppe Technomathematik des Fachbereichs Mathematik der Universität Kaiserslautern, Mai 1988

[14] Chlormann, U. H., Seeger, T: Rainflow-HCM - Ein Zählverfahren für Betriebsfestigkeitsnachweise auf werkstoffmechanischer Grundlage. Stahlbau, 55[3], S. 65 - 71, 1986

[15] Masing, G.: Eigenspannung und Verfestigung beim Messing. In: Proc. of the 2nd Int. Congress of Applied Mechanics, S. 332-335, 1926

[16] Smith, K. N., Watson, P., Topper, T. H.: A Stress-Strain Function for the Fatigue of Metals. Journal of Materials, 5 [4], S. 767 - 768, 1970

[17] Boller, Chr., Seeger, T.: Materials Data for Cyclic Loading, Part A: Unalloyed Steels, Elsevier Science Publishers B.V.1987, ISBN 0-444-42870-4

[18] Schön, M., Seeger, T.: Lebensdauerberechnung auf der Basic der Rainflow-Matrix, Technische Hochschule Darmstadt, Fachgebiet Werkstoffmechanik, Vortrag im Haus der Technik 1993

[19] Radaj, D.: Ermüdungsfestigkeit, Springer-Verlag Berlin Heidelberg New York, ISBN 3-540-58348-3

[20] Haibach, E.: Betriebsfeste Bauteile, Konstruktionsbücher Band 38, Springer-Verlag Berlin Heidelberg New York, ISBN 3-540-54815-7

[21] Boller, Chr., Seeger, T.: Materials Data for Cyclic Loading, Part B: Low Alloy Steels, Elsevier Science Publishers B.V.1987, ISBN 0-444-42871-2

[22] Boller, Chr., Seeger, T.: Materials Data for Cyclic Loading, Part C: High Alloy Steels, Elsevier Science Publishers B.V.1987, ISBN 0-444-42871-0

[23] Boller, Chr., Seeger, T.: Materials Data for Cyclic Loading, Part D:\\WINLITEX\\ENGLISCH Aluminium and Titanium Alloys, Elsevier Science Publishers B.V.1987, ISBN 0-444-42873-9

[24] Boller, Chr., Seeger, T.: Materials Data for Cyclic Loading, Part E: Cast and Welded Metals, Elsevier Science Publishers B.V.1987, ISBN 0-444-42874-7

[25] Boller, Chr., Seeger, T.: Materials Data for Cyclic Loading, Part E: Unalloyed Steels, Elsevier Science Publishers B.V.1987, ISBN 0-444-42874-7

[26] Issler, L., Ruoß, H., Häfele, P.: Festigkeitslehre Grundlagen, Springer-Verlag Berlin 1995, ISBN 3-540-57995-8

[27] Haibach, E., Berger, C., Hänel, B., Wirthgen, G., Zenner, H., Seeger, T.: Rechnerischer Festigkeitsnachweis für Maschinenbauteile, Heft Nr. 183-1, 1994, Forschungskuratorium Maschinenbau, Lyonerstr. 18, Frankfurt/M.

[28] Dorn, S.: Rechnerische Lebensdauerermittlung nach verschiedenen Rechenkonzepten im Vergleich mit Meßdaten und Bestimmung von Formzahlen mit Hilfe von FE-Rechnungen, Diplomarbeit an der FH-Coburg im Studienschwerpunkt Maschinenbau, April 1996

[29] Zenner H. und Liu J.: Vorschlag zur Verbesserung der Lebensdauerabschätzung nach dem Nennspannungskonzept, Konstruktion 44 [1992] Seite 9-17

[30] Bäumel A. ; Seeger, T.: Materials Data for Cyclic Loading, supplement 1, Elsevier Science Publishers B.V.1987, ISBN 0-444-88603 6

[31] Manson S.S.: Fatigue: A Complex Subject - Some Simple Approximations. Experimental Mechanics, 5:193-226, 1965

[32] Muralidharan, U; Manson, S.S.: A Modified Universal Slopes Equation for Estimation of Fatigue Characteristics of Metals. Journal of Engineering Materials and Technology, 110:55-58, 1988

[33] Gudehus, Zenner: Leitfaden für eine Betriebsfestigkeitsrechnung, Empfehlung zur Lebensdauerabschätzung von Maschinebauteilen. 3. Auflage, ISBN 3-514-00445-5, Verlag Stahleisen, Düsseldorf.

[34] Störzel, K.; Sonsino C.M.: Verfahren zur Lebensdauerabschätzung auf der Basic von Rainflow-Matrizen örtlicher Dehnungen; Fraunhofer - Institut für Betriebsfestigkeit [LBF], Darmstadt, LBF-Nr. 7662 [1994], unveröffentlichter Eigenforschungsbericht.

[35] FKM Richtlinie: Rechnerischer Festigkeitsnachweis für Maschinenbauteile, 4. erweiterte Ausgabe 2002, Forschungskuratorium Maschinenbau, 1998

[36] Häckh, J; Willmerding, G; Kley, M; Binz, H; Körner, T.: rechnerische Lebensdauerabschätzung von Getriebegehäusen unter Einbeziehung relaer multiaxialer Belastungen, DVM-Tagung Fulda vom 5. bis 6.6. 2002, VDI-Berichte N2. 1689, 2002 Seite 303 - 317

[37] Körner, T; Depping, H; Häckh, J; Willmerding, G; Klos, W.: Rechenrische Lebensdauerabschätzung unter Berücksichtigung realer Belastungskollektive für die Hauptwelle eines Nutzfahrzeuggetriebes, DVM-Tagung Fulda vom 5. bis 6.6. 2002, VDI-Berichte N2. 1689, 2002 Seite 275 - 285

[38] Körner, T; Depping, H; Häckh, J; Willmerding, G.: Fatigue Life Prognosis for Transmissions based on critical Component Spectrum, World Automotive Congress FISITA 2002, Helsinki, Paper Nr. F02V091

[39] Eichsleder W. Unger B.: Lebensdauerberechnung auf der Basis von Finite Element Ergebnissen; 19. Vortragsveranstaltung des DVM Arbeitskreises Betriebsfestigkeit München 1993

[40] Köttgen V.B.; Anthes R.J.; Seeger T.: Implementation des Werkstoffmodells von Mroz in das Finite Element Programm Abaqus Teil 1; Bericht aus dem Fachgebiet Werkstoffmechanik der Universität Darmstadt

[41] Köttgen V.B.; Anthes R.J; Seeger T.: Implementation des Werkstoffmodells von Mroz in das Finite Element Programm Abaqus Teil 2: Quelltext und Beispiele; Bericht aus dem Fachgebiet Werkstoffmechanik der Universität Darmstadt

[42,] Chu Chin-Chan; Conle F; Albrecht Bonnen; John J. F.: Multiaxial Stress-Strain Modeling and Fatigue Life Prediction of SAE Axle Shafts; American Society for Testing and Materials, Philadelphia 1993

[43,] Mayer, Kötzle: Lebensdauerabschätzung von Fahrwerksteilen unter Berücksichtigung der sich drehenden Hauptspannungen; VDI-Berichte 1283, 1996 Seite 349

[44] Steinwender, Greald; Gaier, Christian; Unger, Bernhard: Simulationder Betriebsfestigkeit von mehrachsig belasteten Fahrwerksbauteilen; 7. Aachener Kolloquium vom 5.-7. Oktober 1998, Aachen, Seite 1141

[45] Issler, Ruoß, Häfele: Festigkeitslehre Grundlagen

[46] Yousefi F.; Küppers, M.: Lebensdauerberechnung mehraxial, Vorhaben Nr. 235, Forschungskuratorium Maschinenbau

[47] Radaj, D.; Sonsiono, C.M.; Fricke, W.: Fatigue assessment of welded joints by local approaches, 2. Auflage, Woodhead publishing limited, ISBN-13: 978-1-85573-948-2

[48] Fricke, W.: Recommended hot spot analysis procedure for structural details of ships and FPSOs based on round-robin FE analyses, Int J Offshore Polar Engng, 20020 12 [1], 40-47

[49] Bäckström, M.; Marquis, G.: A review of multiaxial fatigue of weldments: experimental results, design code and critical plane approaches, Fatigue Fracture Egnng Mater Struct 24, 279-291

[50] Hobbacher, A.: Recommendations for fatigue design of welded joints and components, Inernational Institute of welding, IIW document IIW-1823-07 december 2008

[51] Germanischer Lloyd: Guideline for the Certification of Offshore Wind Turbines, Edition 2005

[52] Gaier, C; Dannbauer, H.: An efficient critical plane method for ductile, semiductile and brittle materials, Fatigue 2006: 9th International Fatigue Congress Atlanta, 14.5-19.5.2006, Vortrag Nr. FT 436

[53] N.N.:Qualitätsmanagement in der Automobilindustrie; Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten; Teil 2;. ISSN 0943-9412, VDA, Frankfurt am Main, 2000

[54] Richard, H. A.; Sander, M.: Ermüdungsrisse, ISBN 978-3-8348-0292-7

[55] Rennert, R; Kullig, E; Vormwald, M; Esderts, A; Siegele, D: Rechnerischer Festigkeitsnachweis für Maschinenbauteile; 6. Auflage 2012; ISBN 978-3-8163-0605-4

[56] Berger, C; Blauel. G; Hodulak, L; Pyttel, B; Varfolomeyev, I; Gerdes, C.P.: Bruchmechansciher Festigkeitsnachweis für Maschinenbauteile; 3. Ausgabe, Stand 2009, ISBN 978-3-8163-0514-9

5.2. Gearwheel and Bearing

[1] DIN 3990 Teil 1: Tragfähigkeitsberechnung von Stirnrädern: Einführung und allgemeine Einflußfaktoren

[2] DIN 3990 Teil 2: Tragfähigkeitsberechnung von Stirnrädern: Berechnung der Grübchentragfähigkeit

[3] DIN 3990 Teil 2: Tragfähigkeitsberechnung von Stirnrädern: Dauerfestigkeit und Werkstoffqualitäten

[4] Forschungsvereinigung Antriebstechnik E.V.: Zahnfuß-Betriebsfestigkeit, Forschungsvorhaben Nr. 188/I und II, 1993 Heft 408 und 1996 Heft 502

[5] Forschungsvereinigung Antriebstechnik E.V.: Zahnflankenlebensdauer, Forschungsvorhaben Nr. 125/III, 1995 Heft 457

[5] Forschungsvereinigung Antriebstechnik E.V.: Zahnflankenlebensdauer, Forschungsvorhaben Nr. 125/III, 1995 Heft 457

[6] Forschungsvereinigung Antriebstechnik E.V.: Zahnrad-Lebensdauerprüfung mit Lastkollektiven, Forschungsvorhaben Nr. 125/I Heft 290 1989

[7] Forschungsvereinigung Antriebstechnik E.V.: Zahnrad-Lebensdauerprüfung: Betriebsfestigkeitsuntersuchungen zur Grübchenbildung an einsatzgehärteten Stirnradflanken, Heft 320 1991

[7] Forschungsvereinigung Antriebstechnik E.V.: Zahnrad-Lebensdauerprüfung: Betriebsfestigkeitsuntersuchungen zur Grübchenbildung an einsatzgehärteten Stirnradflanken, Heft 320 1991

[8] G. Niemann; H. Winter: Maschinenelemente Band II; Getrieb3e allgemein, Zahnradgetriebe-Grundlagen, Stirnradgetriebe, Zweite Auflage, Springer-Verlag, ISBN 3-540-11149-2

[9] Hexagon, Ein Programm zur Zahnradberechnung

Statistics

[1] Gramlich, Günter.: Skript zur Stochastik, Eine Einführung in die Mathematik der Daten des Zufalls, <u>www.hs-ulm.de/gramlich</u>

[2] Kleppmann, Wilhelm: Taschenbuch Versuchsplanung, Hanser-Verlag, 2009, ISBN 978-3-446-420335-5

[3] wikipedia: http://en.wikipedia.org/wiki/Latin_square

[4] M.D. McKay ; R. J. Beckmann ; W.J. Conover: A comparison of three methods for selecting values of input variables in the analysis of output from a computer code, Zeitschrift Technometrics, Vol. 21, No, 2, May 1979

[5] Aleksandar Trifkovi: Multi-objective and Risk-based Modelling Methodology for Planning, Design and Operation of Water Supply Systems, Dissertation Universität Stuttgart, Institut für Wasserbau, 2007

[6] Haibach: Betriebsfestigkeit, VDI-Verlag

[7] Willmerding, G.:Opti: ein Programm zur Multiplen, nichtlinearen Regressionsanalyse. Handbuch zur Software. Steinbeis TZ-Verkehrstechnik 1986

Conditions of use

6. Legal Liability

6.1. § 1 Subject of this Agreement

1.1 The buyer purchases the winLIFE Software from

Steinbeis GmbH & Co. KG for Technology Transfer

Represented by

Steinbeis Transfer Centre

New Technologies in Traffic Engineering

Prittwitzstrasse 10, 89075 Ulm, Germany

- hereinafter referred to as the "seller" -

under the terms of use agreed to in this contract.

1.2 The source code for the software is not part of the subject of this agreement.

1.3 The nature of the software delivered by the seller is subject to the service description valid at the time of the software being despatched and which was available to the buyer at the time of the contract being finalised. The service provided by the seller is not expected to exceed this.

1.4 The general business terms & conditions of the buyer are not a subject of this contract, not even when an offer request, order or declaration of acceptance is attached and/or not contradicted.

6.2. § 2 Conditions of Use

2.1 Once the buyer has paid the total amount, the seller grants him use of the **winLIFE** software. The conditions of use are for a single licence, valid for an unlimited length of time, and not sub-licensable.

2.2 The buyer may only use the **winLIFE** software for internal business purposes or for other companies within the same concern, according to paragraph 15 of the AktG. Commercial sub-leasing of the software is not permitted.

2.3 The buyer is only permitted to copy the **winLIFE** software if this is necessary for use according to the contract. The buyer may make safety backup copies of the **winLIFE** software as necessary according to technical standards. Backup copies on mobile data storage media must be labelled as such and endorsed with the copyright of the original data storage medium.

2.4 The buyer is only permitted to make changes, extensions and other alterations to the **winLIFE** software as allowed by law according to paragraph 69c No.2 of the UrhG. The buyer is not permitted to execute his own rights and conditions of use other than stated in this contract.

2.6 Should the seller permit the buyer to make improvements or carry out maintenance on alterations (eg patches, alterations in the user instructions) or create a new version of the winLIFE software (eg update, upgrade, new user instructions) which replace former objects of the contract, then these alterations or new versions will also be subject to the rules of this contract.

2.7 If the seller produces a new version of the winLIFE Software then the seller's authorisation regarding the old winLIFE software in this contract becomes invalid as soon as the buyer uses the new winLIFE software. This is the case even when the seller does not explicitly demand the return of the old software. However, the seller allows the buyer a changeover period of three months in which both versions of the software can be used simultaneously.

6.3. § 3 Sales Price, Terms of Payment

3.1 The buyer purchases the rights of use as stated in the offer for the sales price also stated in the offer. The sales price complies with the offer on which this software sales contract is based. The buyer is only permitted to use the software according to the rights of use stated in this contract. Any other use requires prior consent in writing from the seller. In the case of multiple use without consent (in particular when the software is used simultaneously by a more users than agreed to) the seller has the right to invoice the additional use according to the seller's price list valid at that particular time unless the buyer can prove a lower sum of damage. This does not have any effect on other non-contractual compensation claims.

3.2 The sales price is due and must be paid in full when the software is delivered or provided.

3.3 In addition to the given price, VAT at the current rate must be paid.

3.4 The delivery prices include transport and packing for posted deliveries. For goods which are to be transferred on the net, the seller bears the costs of making the software accessible; the buyer bears the costs of the retrieval.

3.5 The ownership of surrendered copies remains subject to alteration until the payment has been made in full.

6.4. § 4 Installation, Training, Maintenance

4.1 When installing the **winLIFE** software, please read the installation notes included in the user documentation, in particular those regarding the hardware and software environment needed by the buyer. By installing the program onto his computer, the buyer commits himself to the terms of this contract. If the buyer does not agree to the terms, then the CDs and all other documentation is to be returned immediately. The purchase price will then be reimbursed from where it was purchased.

4.2 At the buyer's request the seller will assume the training and maintenance of the **winLIFE** software based on a separate contractual agreement and applicable price list. The seller is prepared to maintain the software based on the terms of a separate maintenance contract

6.5. § 5 Protection of Software and user documentation

5.1 Unless the buyer is granted specific rights within this contract then all rights regarding the **winLIFE** software (and all copies made by the buyer) – in particular the copyright, the patent rights and the technical protection rights – apply to the seller.

6.6. § 6 Transfer

6.1 The buyer is only permitted to pass the **winLIFE** software on to a third party provided he transfers the total product and renounces his own use of the software completely and finally.

6.2 A temporary transfer of the **winLIFE** software to a third party is not permitted either as a hard copy or otherwise.

6.3 If the buyer passes on data storage media, memory or other hardware on which objects of the contract (complete or partial, altered or edited) have been saved,

6.3.1 to third parties without being subject to a transfer according to paragraph 6 or

6.3.2 renounces his direct ownership hereof

then he carries the responsibility that the winLIFE software is completely deleted.

6.7. § 7 User Cooperation and Information Obligations

7.1 The buyer has informed himself of the essential function characteristics of the **winLIFE** software and carries the risk whether these are in accordance with his needs and wishes. If there is any doubt he should obtain qualified information from the seller.

7.2 It is the sole responsibility of the buyer to ensure that he has a working and – bearing in mind the additional storage requirements of the **winLIFE** software - sufficiently dimensioned hardware and software environment.

7.3 Before using it, the buyer is to test the **winLIFE** software extensively for its usage in the existing hardware and software configuration. This is also the case for software acquired within the framework of the guarantee.

7.4 The buyer is to make sufficient provisions for the case that the **winLIFE** software does not work properly, either wholly or partially (for example by making daily backups, error diagnoses, regular controls of the data results).

6.8. § 8 Time of Delivery and Performance, Acts of God

8.1 Unless otherwise agreed upon, the current version of the software will be delivered.

8.2 The seller delivers the goods according to his choice as follows:

8.2.1 He provides the buyer with (1) a copy of the software program on a computer-legible data storage medium, together with user documentation for each user according to section 2.1.

8.2.2 He makes the software available in a network where it can be retrieved and informs the buyer accordingly and provides user documentation for each user according to section 2.1.

8.3 The time of delivery and the passing of risk for material despatch are considered to be the time when the seller hands over the software and user documentation to the transport company. Otherwise it is the time when the software is made available in a network where it can be retrieved and the buyer is informed accordingly.

8.4 As long as the seller

8.4.1 is still waiting for cooperation or information from the buyer or

8.4.2 is delayed in his performance due to strikes or lock-outs in third-party companies or in the seller's company (in the latter case, however, only if the industrial action is legal), intervention through the authorities, legal bans or other circumstances that are no fault of his own (act of God).

then the times of delivery and performance are considered extended for the length of the hindrance ("time of non-use") and no breach of duty is regarded for the time of non-use. The seller is to immediately inform the buyer of such hindrances and their anticipated length. If an "act of God" continues continually for longer than three months then both parties are freed of their delivery duties.

6.9. § 9 Material and Warranty Defects, other Performance Failures, Statute of Limitations

9.1 The seller is liable for any material and warranty defects of the subject of agreement as in section 1.3 according to the terms and conditions of sale and for the fact that the buyer does not conflict the rights of third parties regarding the use of the subject of agreement to the extent of the contract.

The liability for the freedom of the subject of agreement by rightful third parties is, however, only valid for the country in which the subject of agreement is to be used, as agreed upon by the parties. Unless otherwise agreed upon, the country of liability is The Federal Republic of Germany.

9.2 In the case of material defect, the seller firstly provides supplementary performance. As decided by the seller, the buyer either receives new faultless software or the defect is corrected. A valid method of correction is also if the seller shows the buyer a reasonable possibility of correcting the failure.

In the case of legal defects the seller firstly provides supplementary performance. As decided by the seller, the buyer either receives a legally faultless possibility of use for the delivered subject of agreement or replaces it with an exchanged or altered subject of agreement of the same value.

9.3 The buyer is obliged to accept new software as long as its function remains the same and its acceptance does not lead to any considerable disadvantage.

9.4 If two attempts to provide supplementary performance fail, then the buyer is entitled to insist on an acceptable date for removal of defects. In doing so he must clearly and in writing state that he has the right, should the supplementary performance again be unsuccessful, to withdraw from the contract and/or demand compensation.

If the error cannot be corrected even in the period of grace, the buyer can withdraw from the contract or reduce the payment unless the failure is a "petit" failure. The seller is liable for compensation or replacement of correction measures carried out in vain within the limits stated in section 10.

9.5 If there are claims made by third parties which deter the buyer from assuming his rights of use as stated in the contract then the buyer is to inform the seller immediately and completely in writing. Herewith he authorises the buyer to dispute the matter with the third party either in court or out of court.

The seller is obliged to defend the claims at his own cost and to release the buyer from all costs and damages relating to the defence of the claims as long as these are not caused by his lack of duty.

9.6 The limitation period for all guarantee claims is one year beginning with the delivery or moment when the subject of agreement is made available. The same period is valid for other claims, of whatever manner, against the seller.

9.7 In the case of malice intent or gross negligence on the part of the seller, or in the case of fraudulent concealment regarding a fault, in cases of personal injury or legal faults as in § 438 Abs. 1 a BGB, and in guarantees (§ 444 BGB) the legal limitation period is valid. This also applies for claims according to the Product Liability Law.

6.10. § 10 Reliability

10.1 For all cases of contractual and ex-contractual reliability, the seller provides compensation only within the following limits:

10.1.1 In cases of intent totally, also if there are errors in the configuration guaranteed by the seller.

10.1.2 in cases of negligence only for the amount of the foreseeable damage caused by the negligence.

10.1.3 in other cases only to the extent of the typically foreseeable damage. If the typically foreseeable damage is higher than the purchase price of the **winLIFE** software for one damage case, then the buyer is obliged to inform the seller within 2 weeks of finalising the contract. In this case the seller has the right to withdraw from the contract unless a liability limit has otherwise been agreed to.

10.2 The liability limitation according to paragraph 10.1 does not apply to the liability for personal damage and for the liability according to the product liability law.

10.3 The seller is at liberty to raise objection to the contributory negligence (e.g. as in paragraph 7).

10.4 The statute of limitations is according to paragraph 9.6. The legal statutes of limitations apply to claims according to paragraphs 10.1.1 and 10.2. The statute of limitations for Part 1 begins at the time stated in paragraph 199 No.1 of the BGB. This comes into account at the latest at the event of the statutory period stated in paragraph 199 Nos.3 and 4 of the BGB.

10.5 As long as the liability according to these terms is excluded or limited, then this also applies for the personal liability of the organisation, the staff, representatives and sub-agents of the seller.

6.11. § 11 Secrecy, Data Protection

11.1 The parties of the contract are obliged to treat all the other party's confidential information and company trade secrets which come to knowledge during the initiation and implementation of the contract confidentially for an unlimited period of time. These are only to be used for the implementation of this contract. The subject(s) of agreement and the performance agreed to in the contract are also matters which are included in the seller's company trade secrets.

11.2 The buyer may only allow staff and other third parties access to the subject of agreement as long as this is necessary for the execution of the authorisation of use agreed to.

11.3 The above mentioned obligations are not valid for company trade secrets which

11.3.1 were already obvious or known to the other party at the time of conveyance.

11.3.2 became obvious after the time of conveyance through the contractual partner through no fault of the other contractual party.

11.3.3 became known to the other contractual party after conveyance by the contractual partner by a third person in a manner which is not illegal and without limitation in regard to secrecy or usage.

11.3.4 which have been developed by one of the contractual partners independently without using the trade secrets of the contractual partner.

11.3.5 which must be made public according to the law, authoritative decision or court order – providing the party releasing the information informs the contractual partner hereof immediately and supports him in the defence of such decisions or orders; or

11.3.6 as long as the contractual partner is permitted to use or pass on the trade secret due to urgent legal conditions or as a result of this contract.

11.4 The seller is to adhere to the rules of data protection, in particular when he is granted access to the buyer's company or to his hardware/software

6.12. § 12 Final Clause

12.1 Exclusive Place of Jurisdiction for all disputes relating to or resulting from this contract is the seller's business location. If the seller has a claim, he is also entitled to choose the Place of Jurisdiction and the buyer's business location. The right for both parties to apply for preliminary injunction legal protection from a court legally responsible remains untouched.

12.2 Only German law applies excluding UN-purchase laws (CISG).

12.3 The completion of the contract as well as any later alterations and additions must be in writing to be effective. That is also the case for changing this clause. It does not apply to verbal subsidiary agreements. All declarations by the parties are to be in writing.

12.4 Should a condition of this contract be or become invalid, or if there is an invalid time period or a gap, then the legality of the other conditions remains untouched hereby. As long as the invalidity does not violate §§ 305ff. BGB (Validity of General Business Terms and Conditions) then instead of the invalid condition, a valid condition is agreed to which is nearest to that intended by the parties in a commercial sense. The same applies in the case of a gap. In the case of an unacceptable period, the legally acceptable period becomes valid. If there is a violation to §§ 305ff. BGB then the parties shall find an amicable solution in terms of paragraph 2.

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