

Fixed & Tilting-Pad Fluid-Film Lubricated Thrust Bearings



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The fluid-film bearing module **THRSBR** provides a full-scale computerized analysis that incorporates state-of-the-art numerical and modeling features. It is an advanced program designed to handle complex bearing geometries of the fixed and tilting pad configuration. Complete performance predictions of **hydrodynamic**, **hydrostatic**, and **hybrid** lubricated thrust bearings operating in the laminar and/or turbulent regimes can be generated. Analysis starts with subdividing the bearing/pad surface area into grid pattern in two dimensions (circumferential & radial) and establishing the lubrication system of equations. Boundary conditions (pressurized boundaries, pockets, lines, recesses with specified pressures, surface deviation, etc.) are incorporated to the system of equations. An advanced variable-grid finite-difference numerical method is employed for obtaining a solution, thus eliminating any approximation typically associated with one dimensional analysis or look-up table methods.

A wide variety of fixed and tilting pad geometries thrust bearings that can be analyzed include but not limited to:

	Right Hand ay Y Coordinate	Misalirnment with Bearing Surface	◆ - Step-Pad Configuration		
a. Plain surface	System Pad Inner #2	Rotation	Pad		
b. Multi-groove	Cuter Contracting	Δ. A A A A A A A A A A A A A A A A A A A	Inner Radius		
c. Step pad	Outer Radius Pad Forone Pad	Shafty Thrust Collar	Outer Radius Per Grow Per d		
d. Step pocket	Angie Y	h=C+AMISY*Ro h=C-AMISY*Ro	Clearance Rotation Shaft Step Height		
e. Tapered land	Rotation Shaft Thrust Collar	Misalignment is about coordinate system origin (AMISY = Misalignment about Y-axis)	Section A-A		
f. Tapered pocket	◆ - Shrouded Step-Pad Configuration	◆ - Tapered-Land Configuration	♦ - Shrouded Tapered-Land Configuration Y _h		
g. Tilting pad	Pad	Pad	Pad		
h. Compound taper	Inner Radius Outer	Inner Radius	Inner Radius Outer		
i. Any configurable	Padius Pad Pad Door Pad Poge Pad	Radius Pad #3 Golom Pad #4	Pac Groom Pad #3 Groom #4		
pad surfaces	Rotation shat Rotation shat 1997	Clearance Rotation Shart	Rotation Batt		
	Section A-A Section A-A	Section A-A Pad Angle	Section AA		
	◆ - Tilting-Pad Configuration	♦ - Compound Taper			
	a YA	Na Alama Agene Anama Alama Agene Anama Manaman, Yi Maya at Alama Manama Agene	1.1900		
	AY ARR		3762		
			6.07%.04		
			50050		
	A B C Crientation	1004	3.070.04		
	ο \[\]α _x		1108.04		
	Shaft Rotation (Runner)		No Series C		
	Clearance Pad Tilt		Name L Notecco		
	Section A-A, Tilt about R				
l	Section ArA, The about N		Datary Generalized Datarian Generalized States		

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Simulation capabilities with **THRSBR** include such effects as misalignment, pressurized boundaries or grooves, structural deformation/surface deviation, lubricant feed circuitry with specified pressures and feed orifices/nozzles, groove geometry and chamfers to mention a few. Performance results include the following.

- Load capacity
- Runner position
- Viscous power loss
- Righting moments

- Flow requirements
- Stiffness and damping (dynamic) coefficients
- Clearance and pressure distribution
- Heat balance and temperature rises







The release of RBTS' **ARMD Version 6 THRSBR** module is a major milestone in the product's development history, rolling out a **completely new and improved** graphical user interface for the package with enhanced numerical capabilities and new technical features. THRSBR software's front end was redesigned with our customers' and industry's input to incorporate the most logical, efficient, and productive techniques to model and analyze common, as well as, complex bearing configurations with ease.

ARMD THRSBR users will immediately see the improvements as bearing design data are presented in a flatter, more accessible format, with key fields and analysis options readily visible from the main data entry screens. Fluid-film bearing design and performance evaluation productivity is vastly improved as a wide selection of templates accompanied by a "wizard" style sequence of dialogs allows the user to setup and evaluate most of the commonly used bearings in industry with few key strokes. Tab selected grids and input forms allow the user to see all of the data on screen at the same time. Furthermore, the ability to simultaneously run multiple instances of the program permits rapid side-by-side comparison of results.

A vastly improved pad configuration tab, on the basic bearing design input data form, allows the user to select from many standard bearing types (Plain, Multi-groove, Rayleigh Step or Pocket, Tapered Land or Pocket, Tilting Pad, etc.), restricting input to only those fields pertinent to that type, along with a user-defined selection that allows the user complete freedom in configuring pad attributes.

By identifying new trends from industry, along with RBTS' involvement in bearings design, performance evaluation and troubleshooting, new technical capabilities were added to the software including the ability to define any bearing pad surface configuration and apply it to all pads in the bearing. This capability provides means for the user to model any pad surfaces they desire or would like to experiment with.

Version 6 THRSBR users need only pick an overall grid density or design, and the user interface built-in analytical routines will generate the required grid network for the overall design, automatically modified as needed to add additional grid points at feature locations. Previous versions required the user to carefully design the fluid-film grid network in order to place design feature locations (like steps, tapers, specified pressure regions, tec.) at existing grid points.

The grid design form now allows the user to specify grid locations by their physical positions instead of their incremental distance from their neighboring grid points. If a grid point increment is changed resulting in a mismatch between the size of the grid and the size of the bearing, a single button click will proportionately resize the grid to fit the bearing.

Surface deviation for customized and unique bearing internal clearances (compound tapers, special grooving, structural deflection/deformation, tilting pad deflection, full or partial radially tapered surfaces, etc.) incorporates import function of CSV (comma separated variables) files containing clearance deviations for the custom bearing design.

Enhanced Modeling, Usability and Technical Features Include:

TAB layout. Redesigned for more direct and faster access to data input locations, and results. Important functionality is brought forward into the TAB structure, thereby eliminating the need to select from drop down menu lists or mouse right-click pop-up menu lists.



> Multiple instances of THRSBR. The newly developed package can now open simultaneous

multiple instances of THRSBR, so side-by-X THRSBR (C:\Users\Public\Documents\ARMD58\TH... side comparison of bearings model Bearing File Edit Options Run View Project Window Help variations and analysis results are easy and 01218 % **₽**∎| хI 1日 efficient. This functionality permits multiple THRSBR V5.8 - - - X instances of THRSBR Version 6 or Version Pad Radial Grid Intervals Gearbox 14-Pad 5.8 to be accessible on your display, from Length Tapered Land which portions of a model (grid layout, 1.075765e+001 surface deviation, etc.) can easily be moved 1.075765e±001 from one instance to another. 🛟 Thrsbr (C:\Users\Public\Documents\ARMD60\Project\THRSBR-Project01\TaperedLandShrouded14Pa... 🗕 🗖 💌 Edit Bearing Options Advanced | Run Analysis | Post-Processor View Tools Window Project 🛅 New 쯜 Open 🚽 Save 🛛 😹 Cut 鶅 Copy 鶅 Paste 🗏 😨 Bearing Model 🖽 Pad Grid Model 🛛 Insert Value: Thrsbr (C:\Users\Public\Documents\ARMD60\Project\THRSBR-Projec ٢ - • × Bearing File Edit Bearing Options Advanced Run Analysis Post-Processor THRSBR V6 Instance #2 🎦 New 📄 Open 🚽 Save | 👗 Cut 🌊 Copy 🖺 Paste || 😨 Bearing Model 🏼 Pad Basic Geometry Misalignment Pad Config Operating Conditions Pad Grid Pad Grid With Features (Display Only) Gearbox 14-Pad Tapered Land Pad Profile ٢ Advanced Pad Geometry Boundary Pressures Static Pressure Points / Pockets Surface Deviation Number of Pads 14 20.0 Pad Angle Enable Surface Deviation Set Size Import Magnitudes Pad #1 Orientation Angle 0.0 0.0 Groove Angle [C001: 1.75, R001: 29.0] The deviation grid is a Inner Radi Radial and Circumferential Locations Deviation Magnitudes Step/Taper/Pocket Tilting Pad Radial Locations View Increments Outer Radius Locations Side 1 Land / Step 20 Side 2 Land / Step 13.0 38.0 Step / Taper Height 0.05 2 47.0 3 THRSBR V6 Instance # 1 Step 📃 Taper 🗸 ter Side La Step Angle 18-Pad Tilting Pad with Pad Pocket Taper Ang Anale Taper Angle Deflection/Deformation 16.5 Pad Angle Shrouded Tapered-Land Configuration Cancel -10 Ok Cancel Help No License No License THRSBR-Project01

User Configurable Expanded Toolbar. The main toolbar contains controls used to access frequently used functions (these functions are usually accessible from a menu as well). When a function is not available, its control on the toolbar will be disabled and displayed in a faded gray color. A user configurable expanded Toolbar has been added (second row of the toolbar shown below) for quick access to all of the View menu functions.



Many of the improvements incorporated into ARMD THRSBR Version 6 are specifically directed towards simplicity, increasing usability and productivity as illustrated bellow:

Pre-Configured Bearing and Types. The newly developed package incorporates a significant number of preconfigured bearing types (templates) used in industry. When creating a new bearing model the built-in wizard and templates expedite the creation of bearing models and provide bearing performance results in few keystrokes. Users can create additional templates of their specific bearing configurations and utilize them during their normal work flow.



As an illustration (shown below) it takes only five steps utilizing templates/wizard to model a bearing with its geometry and operating speed and provide a complete solution of bearing performance.

 14 Pad Tapered Land Thrust Bearing With Shroud. 14 Pad Tapered Land Thrust Bearing With Shroud. 	- - ×
Please enter Outer Radiu (mm) Please enter Inner Radiu (mm) (mm) (mm) (mm) (mm) (mm) (mm) (mm) Please enter Bearing (carance / Gap Limit (mm) (mm) <th>ered Land Thrust Bearing With Shroud. – – – ×</th>	ered Land Thrust Bearing With Shroud. – – – ×

Bearing Pad Configuration. A vastly improved pad configuration tab allows the user to select from many standard bearing types, including special options, while restricting input to only those fields/cells pertinent to that type. To assist the user when a pad profile has been selected, various fields/cells in the form will appear and be accessible or grayed out as shown below for the tapered land profile. When a "User Defined" pad profile is selected, the user has complete freedom in configuring pad attributes.

User Defined	•
Stepped Pad	
Tapered Land	
Tilting Pad	
User Defined	

¢			Bea	ring			x
Ba	asic Geometry Misalignment	Pad Config	Operating Conditions	Pad Grid	Pad Grid With Features (Display Only)		
	Pad Profile Pad Geometry Number of Pads Pad Angle Pad #1 Orientation Ang Groove Angle Step/Taper/Pocket Tilting Side 1 Land / Step Side 2 Land / Step Side 2 Land / Step Step / Taper Height Include Step Angle Taper Angle	gle	Tapered Land • 14 20.0 0.0 0.0 0.0 0.0 13.0 0.05		Pad #2 Pad #1 Pad #1 #2 Outer Radius	ad A A A A A A A A A A A A A	
-9			Ok	Cance	el Help		2

> Features Defined by Geometry.

The newly developed package incorporates built-in analytical routines to accommodate bearing pad design **feature locations** (like steps, tapers, and lube feed specified pressure regions) locations by their physical location in normal design length units (**millimeter**, **inch**, **degree**, etc.), not by grid point index as in previous versions. This significantly enhances bearing/pad model development and provides the user with an efficient means to incorporate bearing/pad design features of interest.

Step/Taper/Pocket			
Side 1 Land / Step Side 2 Land / Step Step / Taper Height	2.0 13.0 0.05	Tilting Pad	
Include Step Angle Taper Angle	Step Taper 0.0 16.5	gle dius dial ngential	8.25 0.0 0.0 0.0
	Truncation co	ilt of tilting pad nstant for tilt angle is to solve for tilt	0.001

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Bearing Pad Grid. The pad grid network is utilized for formation and solution of the lubrication equations resulting in the overall bearing performance results. In previous versions of the software the grid network was defined by the user. The new version, by default, automatically generates the grid network with user option of low, medium, or high density gridding. User Specified grid network can be selected to override default setting. As illustrated below, the new version allows the user to specify grid locations by their physical positions instead of just their incremental distance from their neighboring grid points.

\$	>		Bea	aring					• •
	Basic Geometry Misalignment	Pad Config	Operating Conditions	Pad Grid Pa	ad Grid With Fea	itures (Dis	play Only)		
		-Radial Grid P	oints		Circ	cumferenti	al Grid Points		
	Grid point 1 at location		Increment	Location	^		Increment	Location	^
	0 is not alterable and is not shown.	2	0.5	0.5		28	0.5	13.5	
		3	0.5	1.0		29	0.5	14.0	
	Show Increments	4	0.5	1.5		30	0.5	14.5	
		▶ 5	0.5	2.0		31	0.5	15.0	
	Current Grid Size	6	0.5	2.5		32	0.5	15.5	
	Pad Grid:	7	0.5	3.0		33	0.5	16.0	
	Radial: Circ:	8	0.5	3.5		34	0.5	16.5	
	31 41 With Features:	9	0.5	4.0		35	0.5	17.0	
	Radial: Circ:	10	0.5	4.5		36	0.5	17.5	
	31 41	11	0.5	5.0		37	0.5	18.0	
		12	0.5	5.5		38	0.5	18.5	
		13	0.5	6.0		39	0.5	19.0	
	Generate Grid	14	0.5	6.5	•	40	0.5	19.5	
	Validate/Repair Grid	15	0.5	7.0	• L	41	0.5	20.0	~
[-14		Ok	Cancel	Help				2
R	adial Point Increment						mm		
			🔅 Ge	enerate Grid	- 🗆 🗙	<	🕽 Ge	nerate Grid	- 🗆 🗙
			Grid Type				Grid Type	-	
Г			 Default 	O Use	er Specified		O Default	User	Specified
	If a grid point increme		Default Grid Density	<u></u>	0.000	ecified	Default Grid Density		
	is changed resulting i	n 👿	C Low 26X27	Medium 37X37	 High 73X73 	ec.	C Low (Medium 37X37	 High 73X73
	a mismatch between the size of the grid and		User Specified Grid	0,7,0,7	,,,,,,	S	User Specified Grid	57767	70770
	the size of the bearin		Number of Radial Points	s Number of Circur	mferential Points	User	Number of Radial Points	Number of Circumfe	erential Points
	a single button click will proportionately resize		31		41		31		41
			lf you click Generate, a				lf you click Generate, a n		
	the grid to fit the		discarded. If you have d pressure regions, the grid to include those location	d you specified here v			discarded. If you have de pressure regions, the grid to include those locations	you specified here will	
	bearing		Generate	Is as needed.	al			s as needed.	
-			Generate	Cance			Generate	Cancel	

Clearances – Options Form. Thrust runner to bearing surface clearances/gaps for bearing performance simulation is specified in the Options form shown below. Clearances are automatically generated (10, 24, 50 default, 100 clearances, or can be specified by the user) for user specified axial clearance/gap limit and pressing the Generate button. Modified axial gaps can simply be entered and clearances for simulation updated with the Generate button at any time.

0	O	ptions					×
Description Clearances O	utput and Solver Controls						
					_		
	Bearing Clearance / Gap Limit:		Scaling	Clearances	^		
	0.125	▶ 1	1.0	0.125			
	Default Scaling Factors	2	0.975	0.121875			
	Deradit Scaling Factors	3	0.95	0.11875			
	Generate Default Scaling Factors Set	4	0.925	0.115625			
	Scaling Factors Set	5	0.9	0.1125			
	10 factors	6	0.875	0.109375			
	24 factors	7	0.85	0.10625			
	50 factors	8	0.825	0.103125			
	100 factors	9	0.8	*	Cut	Ctrl+X	
		10	0.775	0.09	Сору	Ctrl+C	
	Generate	11	0.75	0.0 💦	Paste	Ctrl+V	
		12	0.725	<u>0.09</u> ක	Clear		
		13	0.7	0.	Insert Row	F3	1
		14	0.675	0.08	Append Row	Ctrl+F3	
				×	Delete Row	F4	
					Duplicate Row	F5	
	Ok	Cancel	Help				1

Output and Solver Controls – Options

Form. Version 6 provides the user with condensed, intermediate and detailed output results of the solution with simply selecting the appropriate radio button. Additionally and unlike previous version **restore default button** provides default settings on increments for stiffness and damping coefficients to be generated.

)	Options	
Description Clearances Output	t and Solver Controls	
	Output Files Oundensed Intermediate Generate non-dimensional text output fil	O Detailed
Dynamic Perturbations Spring Coefficients X-axis Displacement	0.00E Y-axis Displacement 0	0.005 Z-axis Displacement -0.005
Damping Coefficients X-axis Velocity	0.005 Y-axis Velocity 0	0.005 Z-axis Velocity -0.005
Tilting Pad Angular Displacem About radial axis		0.005
-fai	Restore Defaults For These Values	Helo
ncremental Displacement	UK Cancel	Help

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Static Pressure Points / Lines / Pockets – Advanced Form. New features implemented in version 6 provide the user with means to specify pressure conditions, some of which include:

- Pressure point at a intersection of a radial and circumferential location in the pad surface area.
- Pressure line in either radial or circumferential direction in the pad surface area.
- Pressure pocket/box in the pad surface area.

Pressurized points, lines, or pockets are specified by their physical geometry (of radial and circumferential positions) in the bearing pad surface area, unlike previous versions which permitted only the specification of pressures at already established grid points.

	•				Advanced				
ļ	Boundary P	ressu	res S	itatic Pressure Poin	ts / Pockets Su	rface Deviation			
				Radial 1	Radial2	Circ1	Circ2	Pressure	
			1	0.5	0.5	5	5	100.0	Specified pressure point
			2	0.5	0.5	45	45	100.0	— Specified pressure point
		•	3	1	2	20	30	100.0	
			4	2.5	2.5	5	5	100.0	Specified pressure point
			5	2.5	2.5	45	45	100.0	Specified pressure point
L									
6					Ok Ca	ancel Hel	p		2
F	Radial Point	t Loca	ation 1				i	nch	

The above specified conditions illustrate (shown pictorially below with the display of the pad grid layout) the specification of points pressure at a radial location of 0.50 inches and located at 5 and 45 degrees circumferentially, points pressure at a radial location of 2.5 inches and located at 5 and 45 degree circumferentially, as well as pressurized pocket/box bounded radially at 1.0 and 2.0 inches, and circumferentially at 20.0 and 30.0 degrees.



Surface Deviation – Advanced Form. Surface deviation is defined as modification to the bearing fluid-film clearance distribution. The surface deviation magnitudes are superimposed clearances to the geometrical clearance distribution of the bearing surface. This surface deviation is a fixed magnitude of superimposed clearances to the geometrical clearance distribution of the bearing or pad surfaces regardless of shaft/runner position in the bearing clearance due to applied load, speed, viscosity, etc. With this capability and in addition to standard configuration bearings such as step, step pocket, tapered-land, tapered-pocket, tilting pad, etc., practically any bearing/pad surface geometry imagined (compound taper, full or partial radial/circumferential tapered or wavy surfaces, structural deformation or deflection, etc.) can be modeled and evaluated with the software.

When surface deviation feature is enabled by checking the "Enable Surface Deviation" box (shown below), the form expands allowing grid network size to be specified and grid intervals in the radial and circumferential directions computed. Surface deviation may also be imported from external comma-separated-files (.CSV files).

۰.	Surface Deviation 🛛 🗕 🗖 🗙	Advanced
	Surface Deviation	Boundary Pressures Static Pressure Points / Pockets Surface Deviation
	Build Default Matrix from Pad Grids	Enable Surface Deviation Set Size Import Magnitudes Repair Grid Current Radial 3 Grid Size: Circumferential 5
	Clear existing surface deviations	[C001: 1.75, R001: 29.0] The deviation grid is a Global Grid v and applies to the whole bearing
	Grid Dimensions	Radial and Circumferential Locations Deviation Magnitudes
	Number of Starting Ending Points: Location: Location:	Radial Locations 📝 View Increments Circumferential Locations
	Radial Direction: 3 29.0 47.0	Increments Locations Increments Locations
	Circumferential Direction: 5 1.75 18.25	
		2 9.0 38.0 2 4.125 5.875 3 9.0 47.0 3 4.125 10.0
0	Hydro-Power Tilting Pad Deflection Advanced	
Bo	Indary Pressures Static Pressure Points / Pockets Surface Deviation	5 4.125 18.25
	P Enable Surface Deviation Set Size Import Magnitudes Repair [C001: 1.75, R001: 29.0] The deviation grid is a Global Grid v and applies to adial and Circumferential Locations Deviation Magnitudes	Current Grid Current Grid Radial Circumferential IIII Surface Deviation Grid - CAUsers/bubic/Documents/ARMD600/Project/THRSBR IIII Surface Deviation Grid - CAUsers/bubic/Documents/ARMD600/Project/THRSBR-07/ling/Pad/thrsbc00/ling/Pad/thrsbc00/ling/ling/thrsbc00/ling/Pad/thrsbc00/ling/thrsbc00/ling/ling/thrsbc00/l
	C001 C002 C003 C004	C005 Mn. Circum. Location: 1.75 degrees
	▶ R001 -0.001 -5.000000e-04 0.0 -5.000000e-04	
	R002 -0.001 -5.000000e-04 0.0 -5.000000e-04	4 -0.001 Mn. Radial Location:
	R003 -0.001 -5.000000e-04 0.0 -5.000000e-04	4 -0.001 Max. Radial Location:
		47.0 inches
	Ok Cancel	Help 16.5 degrees Radial Length:
Devi	ations	inch
	Two options are available for defining the deviation in version 6 of the thrust bear 1- By default (shown above) the surfact specified in the global bearing coord "Global Grid" and not the individual product the deviation grid is a Global Grid	the surface ring Module: ce deviations are dinate system pad grid network.
	The deviation gird is a Global Gird	 and applies to the whole beaming.
	, , , , , , , , , , , , , , , , , , ,	d over one pad surface area (1 st pad closest to the X-axis)

applied to all pads in the bearing when selecting the "Single

Single Pad The deviation grid is a and will be duplicated to all pads

A view of the pad grid network and the bearing graphical presentation are shown below.



Specified surface deviations/deformation applied in the global coordinate system (Global Grid) and the actual surface deviation extended in the circumferential direction to cover one pad only. Performing the bearing solution, generating the bearing performance results, and viewing the fluid-film pressure/clearance distributions, the surface deviations will be considered in the 1st bearing pad only as shown below.



If the specified surface deviations (pad deformation) is used on all pads by simply selecting the "Single Pad" option, performing the bearing solution will consider the deviations in each of the pads and produce the bearing performance results with the fluid-film pressure and clearance distributions shown below.



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- Evaluate Mathematical Expressions. When entering data to cells, this data entry field has the ability to evaluate mathematical expressions, without having to launch a calculator app.
- Whole Number. Display for improved legibility, defaulting to scientific notation when required. Trailing zeros are implied out to seven significant digits.
- Auto Convert Units. Automatically computes the units conversion when modeling a system with different components using mixed SI and English units. Example: You have a few inch dimensions to enter amongst hundreds of mm values, just check the box for auto conversion.
- Data validation. Performed at Data Entry time. The program now reviews data grids for incomplete, invalid, or nonsensical entries, providing an Error Flag and correction recommendation.
- Error diagnostics. Quickly walks user through any model input errors. A mouse click navigates the user to the next error found.
- Round Function. Round function for data entry fields is accessible from the Tools menu, and can be declared for all data fields.

Enable Units Conversion from Expression Evaluator
 Enable Rounding Button
 Set Rounding Precision

Data Entry Grids. All data entry grids can be open simultaneously for ease of model building & analysis.

•		Thrsbr (C:\Users\Pub	olic\Documents\ARMD60\Project\THRSBR-Pr	oject01\Tap	peredLandShrouded14PadThrustBearingSample01.thi SI)	×
	2 1		ocessor View Tools Window Project Help	5		
🚹 New 📷	Open 🛃 Save 👗 Cut 🎬	🖁 Copy 🏦 Paste 🛛 😨 Bearing Mod	el 🏢 Pad Grid Model Insert Value:			
•		Bearing	-		Post-Processor	
Basic Ge	ometry Misalignment Pad Cor	nfig Operating Conditions Pad Grid P	ad Grid With Features (Display Only)		Description	
	Pad Profile				GEARBOX Fluid-Film THRUST BEARING ANALYSIS. 14 PAD SHROUDED TAPERED LAND.	
	Pad Profile Pad Geometry	Stepped •	Y.		Bearing Performance Including Pressure Distribution @ 15000 RPM.	
	Number of Pads	14	a y			
	Pad Angle	20.0	A A		R-Outer 50.0 R-Inner 35.0 Number of Pads	14
	Pad #1 Orientation Angle	0.0	Pad #1		Pad Angle 20.0 Orientation Angle 0.0 No. of Clearances Min Clearance 0.00125 Rotational Speed 15000.0 Viscosity 6.85	50 194758e-03
	Groove Angle	0.0	Inner "Z A REAL TO A			1047308-03
			Radius		Single Case Multiple Cases Lubricant Properties	
Ste	p/Taper/Pocket Tilting Pad				9 of 12 🕨 🔰 💠 🔀 Lube/Chamfer 🖋 Run	3D
			Outer O A 3	X	Operating Conditions	
	Side 1 Land / Step	2.0	Radius		Clearance 0.025 Speed 15000.0 Load 0.0	
	Side 2 Land / Step	13.0	Pad			
	Step / Taper Height	0.05	#3 Angle #4		Operating C> 0.025000 (mm) Min.Film Thick> 0.025000 (mm)	^
	Include	Step 🖌 Taper	Rotation Shaft		Load Capacity> 3.4682+03 (N) Power-Loss> 3.7082+03 (Watt) Max. Pressure> 2.9362+06 Pascal Side-Leakage QF -> 2.3912+00 (L/min)	
	Step Angle	0.0	Revite Pad Angle		through ID -> 9.591E-01 (L/min)	
	Step Aligie		Step Angle	→	through OD -> 1.431E+00 (L/min) Supply-Oil Temp.> 50.001 (Deg.C) Inlet-Flow QI -> -1.378E+01 (L/min)	
	Taper Angle	16.5	Pad Angle # Pad#1	+	Supply Flow Rate> 5.000E+00 (L/min) >Max. Reynolds # -> 6.443E+02	
		Sec	tion A-A Inner Side Lar	hd †	Film-Temp> 77.121 (Deg.C) Viscosity> 7.585E-03 (Pa-Sec) > A X I A L	
			Shrouded Step-Land Configuration		Groove Temp> 72.238 (Deg.C) Stiffness (Newton/m) = 1.894E+08	
					Max. Temp> 82.004 (Deg.C) Damping (Newton-Sec/m) = 3.456E+04	
-64		Ok Cancel	Help		BRGVU - [thrpost.thv] -	. 🗆 🗙
					S File Edit View Contours Deformations Display Zoom Rotate Colors Window Help	_ & ×
Ľ						
😫 Bearin	na Model - C:\Users\Pul	blic\Docum 📼 📼 🖾	🖩 Pad Grid - C:\Users\Public\Docu		GEARBOX Fluid-Film THRUST BEARING ANALYSIS. 2.9	9357E+06
		RMD60\Project\THRSBR-Pr	C:\Users\Public\Documents\ARMD60\Project\7	THRSBR-Pre	14 PAD SHROUDED TAPERED LAND. Bearing Performance Including Pressure Distribution @ 15000 RPM. 2.7	7522E+06
GEARBOX F	uid-Film THRUST BEARING AN	ALYSIS.	GEARBOX Fluid-Film THRUST BEARING ANALYSIS. 14 PAD SHROUDED TAPERED LAND.			5687E+06
	OUDED TAPERED LAND. mance Including Pressure Distri	ibution @ 15000 RPM	Bearing Performance Including Pressure Distribution @	15000 RPM.		3853E+06
Number of P	-		Pad 1 of 14 Circumferential Direction 1 (Pad Angle = 20.0 degrees)	41		2018E+06
14		F 4	Fixed grid			0183E+06
Pad Angle, o	legrees	5 <u> </u>				8348E+06 6513E+06
20.0 Orientation 4	ngle, degrees 6					4679E+06
0.0	i igic, degreca					2844E+06
Outer Radiu	s, mm 🛛 🎽		s			1009E+06
50.0	mm		e etto			1741E+05
Inner Radius 35.0	8	Orientation Angl		<u>₩₩₩</u> ₽∣	Y 73	3393E+05
Axial Clearar	ice, mm 🧹		(15.0 n			5045E+05
0.125	. 9					6696E+05
Speed, RPN 15000.0	I				Cultuurs Pressure (Pascal (Newton/mr.2)) Celumiation Pressure Pascal Newton/mr.2)	8348E+05
Groove Angl	e, degrees	¹⁰ 11 12	31			0000E+00
5.714286		. 1	Pad grid model		C:\Users\Public\Documents\ARMD60\Thrsbr\thrpost.thv	MUM //
					THRSBR-Project01	





- Data Entry Menus. All data entry menus are visible at the Grid input page. Grids now feature selection check boxes and editing buttons where appropriate.
- Quick Chart. This feature rapidly displays an X-Y graph of entered tabular data for visual verification of correctness. ARMD Graph software is still available for complete graphic analysis capabilities.

> Live 2-D GRAPHICS MODELS.

Real-time graphics update of the 2-D image corresponding to numeric data input in data grids provides visual confirmation of model correctness while building the bearing model. Changing the number of pads from 6 to 8 will automatically modify the graphics model as shown below.



Modifying pad grid network size from 31 X 41 to 23 X 31 (shown below for axially symmetric grid) displays new grid model, including its feature of shrouded tapered land configuration added to the specified grid size.



> Metafile enabled copy and paste of bearing and pad grid graphics models for better reporting.

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Post-Processor. Following a complete bearing modeling and performance map solution as a function of axial clearance/gap, the post processor illustrated below immediately provides bearing performance results when the Run button is pressed. The complete bearing performance results can be generated for a *Single-Case* or *Multiple-Cases* with user specified operating conditions of Clearance or Load, Speed, Viscosity, Flow Rate, Temperatures, Pressure, Chamfers geometry, etc.

	Thrsbr (C:\Users\Public\Documents\ARMD62\THRSBR\GEARBOX-Tapered-Land.THI US) - 🗆 🗙
	File Edit Bearing Options Advanced Run Analysis Post-Processor View Tools Window Project Help
	🎦 New 💕 Open 🚼 Save 🐰 Cut 🖺 Copy 🖺 Paste 👰 Bearing Model 🏾 🖽 Pad Grid Model Insert Value:
	Post-Processor
Modeled Bearing	Description GEARBOX Fluid-Film THRUST BEARING ANALYSIS. 14 PAD SHROUDED TAPERED LAND Pressure Distribution @ 15000 RPM.
Geometry	R-Outer 1.906 R-Inner 1.375 Number of Pads 14 Pad Angle 20.0 Orientation Angle 0.0 No. of Clearances 49 Min Clearance 5.000000e-05 Rotational Speed 15100.0 Viscosity 1.30000e-06
User Specified Case(s) &	Single Case Multiple Cases Lubricant Properties Image: A structure 10 of 70 Image: A structure Image: A
Operating Conditions	Solve For Load Clearance 0.0025 Speed 15100.0 Load 0.0
	Single Case results are displayed here after the Run button is pressed.
	Ok Cancel Help
	No project open

Lubricant Properties can be selected from the built-in lubricant database or specified by the user. User specific lubricants, not available in the database, can be added for later retrieval / use.

		<u></u>	👌 Lubricant Library – 🗆										×			
	Lubricant Properties								🛨 Insert	ф Ар	pend	🗙 Delete	Duplicate			
		Supplier	Typical				Supplier	Bra	ndName	ISO Grade	API Gravity	1st Kinematic Viscosity Point	1st Kinematic Viscosity Temp.	2nd Kinematic Viscosity Point	2nd Kinematic Viscosity Temp.	^
		-		4		TEX	ACO	REGAL R&C	220	220	26.7	220.0	104.0	18.1	212.0	
	Choose Lubricant	Brand Name	ISO Grade 32 Oil				TEXACO R		320	320	26.1	320.0	104.0	23.1	212.0	
		ISO Grade	32	2		TEX	ACO	REGAL R&C	REGAL R&O 460		25.0	460.0	104.0	29.1	212.0	
		API Gravity	31.0	0		TEX	ACO	REGAL R&C	N-100	100	22.0	100.0	104.0	9.0	212.0	
Karantia Maran	sities (for interpolation)					TEX	ACO	REGAL R&C	N-68	68	22.9	67.0	104.0	7.2	212.0	
				104.0		тот	AL	PRESLIA 10	10	100	28.206	99.3	104.0	11.4	212.0	
1st Point	32.0	Ist	Temperature	104.0		TOT	AL	PRESLIA 32	2	32	31.144	32.3	104.0	5.4	212.0	
2nd Point	5.36	24	Transmission	212.0		тот	AL	PRESLIA 46	;	46	30.214	46.3	104.0	6.8	212.0	
2nd Point	0.00	210	d Temperature	212.0		тот	AL	PRESLIA 68	1	68	28.568	67.4	104.0	8.7	212.0	
1		Reset				Турі	cal	ISO Grade	10 Oil	10	33.4	10.0	104.0	2.66	212.0	
						у Турі	cal	ISO Grade	15 Oil	15	32.6	15.0	104.0	3.41	212.0	
					9	98 Typi	cal	ISO Grade	22 Oil	22	31.8	22.0	104.0	4.29	212.0	
					▶ 9	99 Typi	cal	ISO Grade	32 Oil	32	31.0	32.0	104.0	5.36	212.0	
I					10	00 Typi	cal	ISO Grade	46 Oil	46	30.3	46.0	104.0	6.76	212.0	~
																- P
1									Save	S	elect	Cancel	Help			
				Su	pplier											_
1				1.00										1		

Lube / Chamfers / Feed-Nozzles: Both fixed geometry bearings oil grooves feeding-system and their geometrical chamfers as well as tilting pad bearings feed nozzles numbers and orifice geometry, may influence the bearing performance significantly. In the fixed geometry bearings the flow rate through the bearing is controlled by both the bearing internal clearances and groove's resistance to flow, while in the tilting pad feed nozzles the flow is controlled by the number of feed nozzles and their orifice diameter. Due to supply lubricant pressure, these flow rates impacts the heat balance and temperature rise through the bearing which in turn influences the oil film viscosity thus affecting bearing performance.

Simulation with the latest version can include the influence of either a pressurized grooved feeding system, pressurized nozzle feeding system, or classical flow assumption (flooded environment). By default, classical flow is simulated by assuming that the bearing's supply flow rate is equal to its side leakage flow rate (non-starved lubrication).

When the flow type is set to "**Grooved**" shown below, the supply pressure and groove details (including chamfer type and dimensions) are to be specified by the user. Depending on the chamfer type selected (triangular, rectangular and circular), the required data will be displayed as illustrated.

👌 Single Case Lube Details					
Lubricant Conditions			<u>Thrust Bearing</u>	Y	
Solve For Film Temp 🔻	User Specified Viscosity an	nd Heat Content		T	
Film Temperature 160.0	Viscosity / Heat Content			<u>Cham</u>	fer Geometries
Supply Temperature 120.0	Viscosity	0.0		T ▲ ◎ > Nor	ne – No Chamfer
Flow Type Grooved -	Heat Content	0.0	\leq		ngular
Supply Flow Rate 3.0				l l i i i i i i i i i i i i i i i i i i	ctangular cular
Feeding System				↓ [∞]	
Fixed Geometry Pads				- Direction	n of Rotation
Groove Feeding System Chamfer Type Triangular					> X
Chamfer Depth 0.125	Supply Pressure	20.0			
Chamfer Angle 90.0		0.075	<u>Triangular</u>	Rectangular	<u>Circular</u>
Groove Length 0.4		0.075	5 🔨	5	
			Angle	Width	Radius
Ok	Cancel Help			Depth	
Lube Supply Temperature	۴		Depth		Depth
	Triangular 🗸		-		
	None	Fixed Geometry Pads Groove Feeding Sy			
Grooved 🗸	Triangular	Chamfer Type	Triangular V		
Classical Grooved	Circular Rectangular	Chamfer Depth Chamfer Angle	3.0	Supply Pressure 1500 Orifice Diameter	10.0
Non-Grooved	nootangalar	Groove Length	10.0	L	
Fixed Geometry Pads		Fixed Geometry Pads	7		
Groove Feeding System		Groove Feeding Sys			
Chamfer Type Rectangular V Chamfer Depth 4.0 Supply F	ressure 150000.0	Chamfer Type Chamfer Depth	Circular V 3.0	Supply Pressure 1500	00.0
Chamfer Width 4.0 Onfice D	iameter 10.0	Chamfer Radius	45.0	Orifice Diameter	10.0
Groove Length 10.0		Groove Length	10.0		
	_				-

For flow type is set to "**Non-Grooved**" shown below, pressurized lubricant is supplied through sharp-edge orifices or nozzles (typically incorporated in tilting pad bearings) the supply pressure, number of orifices/nozzles per pad and orifice/nozzle geometry are to be specified by the user.

Lubricant Conditions			
Solve For	Film Temp 🔻	User Specified Vis	cosity and Heat Conter
Film Temperature	0.0	Viscosity / Heat Content	
Supply Temperature	50.0	Viscosity	0.0
Flow Type	Non-Grooved 💌	Heat Content	0.0
Supply Flow Rate	5.0		
Feeding System Non - Grooved	lystem]	
	ÿstem		
Non - Grooved	ystem 1	Supply Pressure	150000.0
Non - Grooved Non - Grooved Feeding S	1	Supply Pressure Onfice Diameter	150000.0
Non - Grooved Non - Grooved Feeding S # of Orifices per Pad	1		

Illustration of Three Feed Orifices/Nozzles per Pad



Single Case: Illustrated below, complete bearing performance results are generated when the *Run* button is pressed. The solution is performed for user specified operating conditions taking into consideration the pressurized feeding system. Heat balance is performed for the overall bearing system.

	Post-Processor Description GEARBOX Fluid-Film THRUST BEARING ANALYSIS. 14 PAD SHROUDED TAPERED LAND Bearing Performance Including Pressure Distribution @ 15000 RPM. 3	Pressure/ Clearance Distributions D View Button
Modeled Bearing Details	R-Outer 1.906 R-Inner 1.375 Number of Pads Pad Angle 20.0 Orientation Angle 0.0 No. of Clearance Min Clearance 5.000000e-05 Rotational Speed 15100.0 Viscosity	14 s 49 1.300000e-06
Scroll through cases.	Single Case Multiple Cases Lubricant Properties Run Image: A state of the sta	3D
Complete Bearing Performance Results including bearing system heat balance and supply pressure considerations.	Operating Conditions Solve For Clearance Operating C> 0.0005 Speed 15100.0 Load Operating C> 0.000557 (Inch) Min.Film Thick> 0.000557 (December 2000) Max. Pressure> 1.439E+03 (Def) Power-Loss> 7.202E+00 (Side-Leakage QF -> 3.574E-01 (December 2000) Supply-Lub Temp.> 119.992 (Deg.F) Side-Leakage QF -> 3.574E-01 (December 2000) Supply-Lub Temp.> 119.992 (Deg.F) Inlet-Flow QI -> 1.423E-01 (December 2000) Supply-Lub Temp.> 119.992 (Deg.F) Inlet-Flow QI -> 1.423E-01 (December 2000) Supply-Lub Temp.> 119.992 (Deg.F) Max. Reynolds # -> 5.306E+02 (December 2000) Film-Temp> 1.69.147 (Deg.F) Max. Reynolds # -> 5.306E+02 (December 2000) Viscosity> 1.128E-06 (Rens) > A X I A L Stiffness (Lbf/Inch) = 6.300E+0 (December 2000) Max. Temp> 192.896 (Deg.F) Damping (Lbf-Sec/Inch)= 6.971E+0 (December 2000) Sommerfeld Number = 2.994E+01 (December 2000) Projected Press.= 5.168E+02 (Psi) PV (1bf-ft/min/in^2) = Full Fi Image: December 2000 December 2000 Sommerfeld Number = 2.994E+01 (December 200)	Gpm) Gpm) Gpm) Gpm) 06 02

Multiple Cases / Parametric Evaluation : Multiple case bearing performance evaluation can be performed as a function of any combination of user defined operating conditions of Clearance, Speed, Load, Viscosity, Flow Rate, Temperatures, Pressure, Chamfers geometry, etc.

Parame evaluati			•					Pos	t-Pro	cessor							×
bearing perform accomp efficien	ance is blished	5	Description GEARBOX Fluid-Film THRUST BEARING ANALYSIS. 14 PAD SHROUDED TAPERED LAND. Bearing Performance Including Pressure Distribution @ 15000 RPM.														
emolen				50.0 R-Inner 20.0 Orientation Angle 0.00125 Rotational Speed							r of Pads Clearances ty 6.894758e			14 50 -03			
Expand button if			Single Case Multiple Cases L Expand		Lubricant Properties								4	Run			
pressed will expand the window to the full width of the parent window which provides a quick view of all the columns		1			Clearance		Speed		Load		Use Lube Viscosity / Heat Content	Specified Viscosity		Specified Heat Content		Tem	F
for efficient data			Þ	1		0.025		1000.0		0.0			0.0		0.0		
	5115.			2).025).025		2000.0 4000.0		0.0			0.0		0.0		-
Restore			Use														🖋 Run
Clearance Sp	oeed Load	d Vis /I	ube cosity Heat intent	Specified Viscosity	Specified Heat Content	Film Temperatu	Supph re Tempera		w Rate	Flow Type	Chamfer Type	Supply Pressure	Orifice Diameter	Groove Length (Grooved)		er Depth oved)	Chamfer Size (Grooved)
1 0.025 2 0.025	1000.0 2000.0	0.0 [0.0	0.0		0.0	50.0 50.0	5.0 5.0	Grooved ¥	Triangular V Triangular V	100000.0		3.0 10. 3.0 10.)	1.25 1.25	90.0 90.0
3 0.025 4 0.025	4000.0 6000.0			0.0 0.0	0.0		0.0	50.0 50.0	5.0 5.0	Grooved V Grooved V	Triangular V Triangular V	100000.0 100000.0	·	3.0 10. 3.0 10.	_	1.25 1.25	90.0 90.0
5 0.025 6 0.025	8000.0 10000.0			0.0	0.0		0.0	50.0 50.0	5.0 5.0	Grooved V Grooved V	Triangular V	100000.0 100000.0		3.0 10. 3.0 10.	_	1.25 1.25	90.0 90.0
7 0.025	12000.0			0.0	0.0		0.0	50.0 50.0	5.0 5.0	Grooved 💙	Triangular 🗸	100000.0		3.0 10. 3.0 10.	_	1.25 1.25	90.0 90.0
8 0.025 > 9 0.025	14000.0 15000.0	0.0		0.0			0.0	50.0	5.0	Grooved V Grooved V	Triangular V Triangular V	100000.0 100000.0		3.0 10.		1.25	90.0
10 0.025 11 0.025	16000.0 18000.0			0.0	0.0		0.0	50.0 50.0	5.0 5.0	Grooved V Grooved V	Triangular V	100000.0 100000.0		3.0 10. 3.0 10.	_	1.25 1.25	90.0 90.0
Multiple case below. The A "Bearing Performe	perfo aphic g Press	CS U	Jtility Ca	on @ 15000 R Surface	ed to ™."	displa	y X-Y		of any		enerate SBR-Project01				1.25	90.0	
Case Film-Temp App No. (Deg-C) Load		essure 'ascal)		Speed (rpm)	Velocity (m/sec)		nolds Number	7	8						Film	ly Tempera Temperatu ve Temper	re
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	041E+03 3. 951E+03 6. 951E+03 8. 130E+03 1. 129E+03 1. 129E+03 1. 125E+03 1. 224E+03 1. 224E+03 1. 122E+03 1. 84E+03 1.	725E+05 342E+05 263E+05 802E+05 101E+06 293E+06 462E+06 610E+06 677E+06 740E+06 857E+06 960E+06	2 4 8 1 1 1 1 1	L.000E+03 2.000E+03 3.000E+03 3.000E+03 3.000E+03 1.000E+04 4.200E+04 1.200E+04 1.500E+04 1.600E+04 2.000E+04	5.236E+00 1.047E+01 2.094E+01 3.142E+01 4.189E+01 5.236E+01 7.830E+01 7.830E+01 8.378E+01 9.425E+01 1.047E+02	3.8 8.3 1.3 2.5 3.2 3.2 4.3 4.3 4.3 5.6	37E+01 37E+01 19E+01 32E+02 33E+02 38E+02 55E+02 55E+02 30E+02 33E+02 33E+02 33E+02 45E+02						/				
	nimum-C Shea (mm) Max.	r-Stres (Pascal	s Sc .) Av	ommerfeld 7g.Number	Power Loss (watt)	Pres	imum ssure scal)	Degre	i0 i8 i6								
1 2.500E-02 2.5 2 5.00E-02 2.5 3 2.500E-02 2.5 4 2.500E-02 2.5 5 2.500E-02 2.5 6 2.500E-02 2.5 8 2.500E-02 2.5 9 2.500E-02 2.5 10 2.500E-02 2.5 11 2.500E-02 2.5 12	500E-02 4. 500E-02 8. 500E-02 1. 500E-02 2. 500E-02 2. 500E-02 3. 500E-02 3. 500E-02 3. 500E-02 4. 500E-02 4. 500E-02 4. 500E-02 4.	152E+03 043E+03 507E+04 118E+04 650E+04 112E+04 517E+04 873E+04 035E+04 188E+04 468E+04 717E+04		3.093E+01 3.093E+01 3.093E+01 3.093E+01 3.093E+01 3.093E+01 3.093E+01 3.093E+01 3.093E+01 3.093E+01 3.093E+01 3.093E+01	3.832E+01 1.485E+02 5.564E+02 1.173E+03 1.956E+03 3.895E+03 5.005E+03 5.587E+03 6.184E+03 7.422E+03 8.707E+03	8.8 1.6 2.3 2.9 3.4 3.8 4.2 4.2 4.5 4.8	51E+05 52E+06 52E+06 55E+06 55E+06 55E+06 52E+06 90E+06 90E+06 90E+06 •		6 4 2 2 8 8 6 6 4 2 0 0			1.000 Speed (RP	<u>د</u> ۱۸۱۰ (E + ۱۹۵۰)		<u>A</u>	*	2.000

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2-D Graphics Utility (ARMDGraph)

ARMDGraph is a graphics utility that employs a Workspace concept to manage multiple graphs with associations to single or multiple graphics output files. The workspace environment contains all user defined plot and chart configuration settings for graphics output files generated by

ARMD solvers.	1	Workspace Configuration: Chart(1)				
The workspace	Graphs	Set Lines Details Line Defaults Annotations Line Mark				
configuration form consists of two panels. The left panel contains a tree	Graph - Default ∴ Charts ↓ Chart - 1 ⊖ Output Files ↓ (1) TaperedLand3Pads.psg Sl	File Contents Units Speed (RPM) TaperedLand 3Pads.psg SI Eccentricity Ratio Bearing Load Projected Pressure <u>Speed (RPM)</u> Journal Surface Velocity [Cearance]	X Axis Unit Speed (R Speed (RPM) Y Lines	Unit Speed (RPM) Speed (RPM) Y Lines		
view of the graphs, charts, and graphic output files. The right panel contains all chart and graph settings.	Save Workspace	Version Loop Version Loop Version Ve	Units mm Line Clearance Min. Film Eccentricity	File (1) TaperedLand3Pad (1) TaperedLand3Pad (1) TaperedLand3Pad	* X *	
	Open Workspace Show/Update Graphs					

ARMDGraph features include:

- Workspace concept that contains all graph settings and linked graphics output files in one form customized by the user.
- > Existing workspace can be easily applied to newly generated graphics output files.
- > New graphical user interface to access and customize graphs.
- > New file format (*.usrx) allows more customization of graphics data than previous (*.usr) format.
- > Ability to create multiple graphs each of which may contain multiple charts.
- > Ability to plot from two or more graphics output files.
- > Backwards compatible with files generated by RBTSGRAF (*.usr) graphing utility.
- Customizable annotations and line markers.
- > Automatic detection of graphics data file changes and updates.
- > Plots can be rotated and copied to the clip board as bitmaps or enhanced metafiles.
- Utilizes GUI help system.
- > Accelerator keys (hot keys) for accessing menu items and switching between charts.
- ➤ Multiple plots per window (1, 2, 3 or 4) including line, polar, and FFT plots.
- Templates for automatic configuration of graphs.
- Save/restore user options (*.USRX), for custom graphs, including:
 - Log, semi-log or linear axis scaling.
- Automatic or manual axis scaling.
- Grid lines (ON or OFF).

- Legend position (hidden, inside or outside right).
- Draw curves with lines, symbols or both.
- Macro strings for flexible title assignment.

Graphics Utility (ARMDGraph)

With ARMDGraph, in few simple steps a workspace can be set up, saved and a graphical representation of simulation results from ARMD solvers can be generated as illustrated below.



Purchasing Options

ARMD is constructed from various solution modules. It can be tailored to suit your needs and budget. You may purchase any combination of programs/modules or all if you wish. Licensing is available as a single seat or multi-seat network configuration. With your purchase, the package includes the software (CD or download), quick start manual, electronic user's manual, technology transfer and training session (optional), updates, maintenance, and support.

System Requirements:

Personal computer with Microsoft Windows 8, 10, 11 or higher (32 or 64 bit).

Remember, with **RBTS**, you get more than just the programs, you get the company with more than 50 years of experience in the areas of tribology and machinery dynamics.

For further information, please contact us.



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