

### Fixed & Tilting-Pad Fluid-Film Lubricated Thrust Bearings

14-Pad       Shroud         Shroud       Midth         90       Taper         Height       Taper	Tilting-Pad Bearing
Rotor Bearing Technology & Software 1041 West Bridge Street Phoenixville, PA 19460, USA	Tel: 610-415-0412 Fax: 610-415-0413 Email: info@rbts.com Web: www.rbts.com

Rev:20230101



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 Inner Pad #1 Advantage	Rotation	Pad Pad Pad Pad Pad
b.	Multi-groove	Radius	Υ	Inner Radius
c.	Step pad	Outer Radius	Shaft Thrust Collar	Outer Radius Part Grand Part $Z_{a_x}$
d.	Step pocket	Angio Y	$\begin{array}{c} & & \\ & & \\ \hline \hline & & \\ \hline \hline & & \\ \hline \\ \hline$	est Clearance Rotation Shaft 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 Packing Pad Step Angle Pad Angle
f.	Tapered pocket	◆ - Shrouded Step-Pad Configuration	• - Tapered-Land Configuration	◆ - Shrouded Tapered-Land Configuration
g.	Tilting pad	Pad	Pad Pad Patrong	Pad Plat
h.	Compound taper	Inner Radius	Inner Radius Outer	Inner Radius Outer
i.	Any configurable	Pad Concernent Pad	Radius Pad #3 Golom Pad #4	Pad #3 Radius Pad #4
	pad surfaces	Rotation and Part Angle State Angle Angle Angle Angle Angle State State Angle State State Angle State	Clearance Rotation Shart Payney, Taper Height Besting Pad	Rotation Batt Rotation Batt Parking Park Spering Park
		Pad Angle Bit Pad Angle Angle Angle Angle Angle Angle Angle Bit Pad Angle Bit Revealed Angle Ang	Section A-A	Section A-A
		◆ - Tilting-Pad Configuration	◆ - Compound Taper	◆ - Any Configurations utilizing
		a Y	Northern Learning of a second law data determined and the second law of the second l	et togen de, toe de finiste de Chanice & Clanice & Clanice - 1 (1997-20)
		AV Star		5.7KM
				a set of
				50000 1000
		as a large and a large		9.400 04 2.000 04
		o Jax		1196.97
		Shaft Rotation (Runner)		D Sine C
		Clearance Pad Tilt		Name:
		Section A-A, Tilt about R	Television Constant Descriptions	
	l			Colouro Generalitykai, Bornellon Generalitykai (Scherken Generalitykai)

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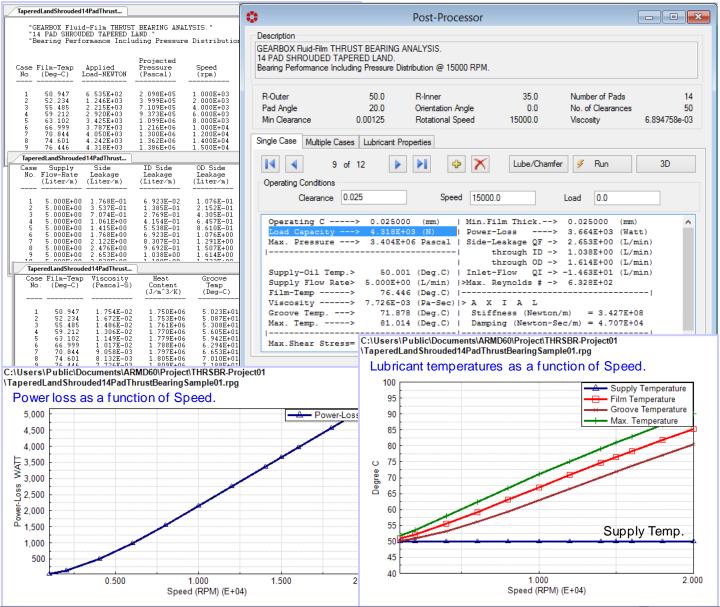
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Simulation capabilities with **THRSBR** include such effects as misalignment, pressurized boundaries or grooves, structural deformation/surface deviation, lubricant feed circuitry with specified pressures and feed orifices/nozzles, groove geometry 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





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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.

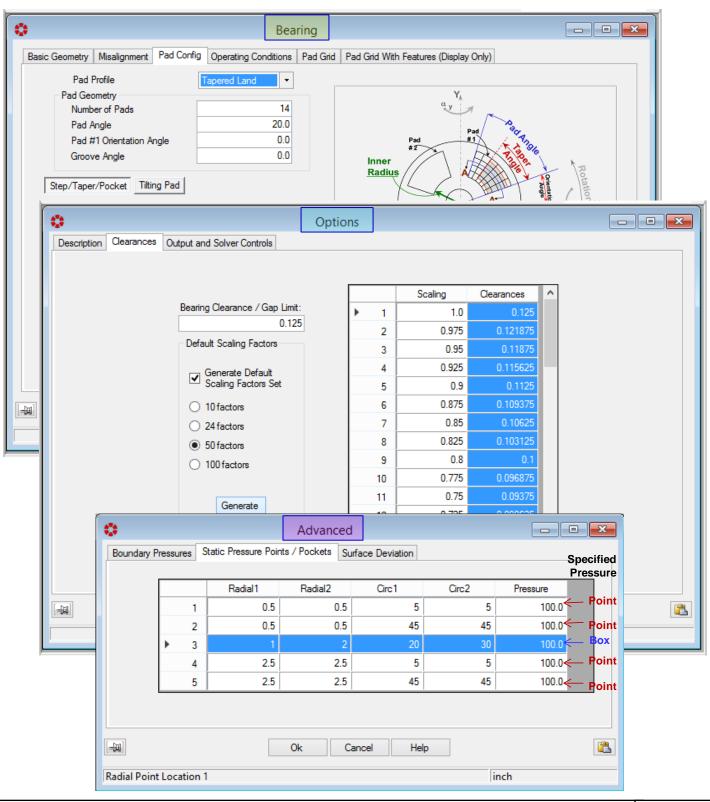
Version 6 THRSBR users need only pick an overall grid density or design, and the user interface built-in analytical routines will generate the required grid network for the overall design, automatically modified as needed to add additional grid points at feature locations. Previous versions required 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.

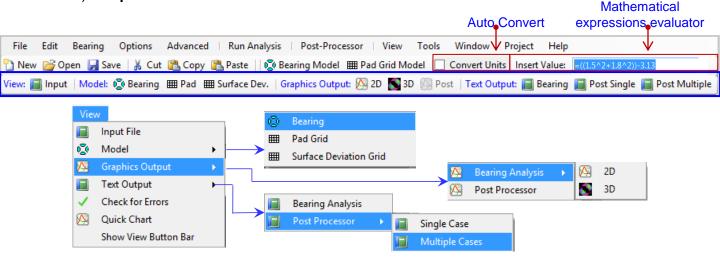


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> Multiple instances of THRSBR. The newly developed package can now open simultaneous

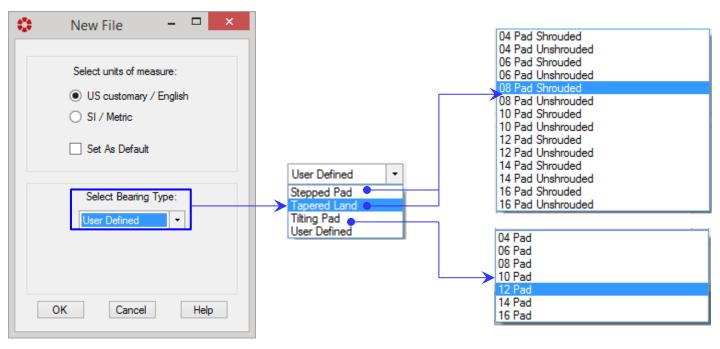
multiple instances of THRSBR, so side-by-X THRSBR (C:\Users\Public\Documents\ARMD58\TH... side comparison of bearings model Bearing File Edit Options Run View Project Window Help variations and analysis results are easy and 01218 % **₽**∎| хI 1日 efficient. This functionality permits multiple THRSBR V5.8 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 🖺 Copy 隆 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 Li nale 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 Tape	red Land Thrust Bear	ing With Shroud.	- • <mark>× ·</mark>		
	🔅 14 Pad Taper	red Land Thrust Bearing	g With Shroud		
Please enter Outer Radi		14 Pad Tapere	ed Land Thrust Bearing	With Shroud. – 🗆	×
(mm)	Please enter Inner Radiu:		🔅 14 Pad Tapere	ed Land Thrust Bearing With	n Shroud. – 🗆 🗙
	35.0	Please enter Bearing Clearance / Gap Limit (mm)		14 Pad Tapered La	nd Thrust Bearing With Shroud. 🛛 🗖 🗙
		0.125	Please enter Taper Height (mm)	Please enter Operating Speed	Shrouded Tapered-Land Configuration – 14 Pads
< Back	< Back		0.050	(RPM)	
l		< Back	< Back		Clarance Relation Taper Angle
				< Back	Finish Cancel Help

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						

Basic Geometry       Misalignment       Pad Corrfig       Operating Conditions       Pad Grid       Pad Grid <t< th=""><th>0</th><th>Bea</th><th>ring</th><th></th></t<>	0	Bea	ring	
Pad Geometry Number of Pads Pad Angle Pad Angle Pad Angle Pad #1 Orientation Angle Groove Angle Step/Taper/Pocket Titing Pad Side 1 Land / Step Side 2 Land / Step Step / Taper Height Outer Redius Step / Taper Height Outer Redius Step / Taper Height Outer Step / Taper Height Outer Step / Taper Height Outer Step	Basic Geometry Misalignment Pad Con	fig Operating Conditions	Pad Grid Pad Grid With Features (Display	y Only)
Section A-A Inner Side Land  Shrouded Tapered-Land Configuration	Pad Profile         Pad Geometry         Number of Pads         Pad Angle         Pad #1 Orientation Angle         Groove Angle         Step/Taper/Pocket       Tilting Pad         Side 1 Land / Step         Side 2 Land / Step         Step / Taper Height         Include         Step Angle         Taper Angle	Tapered Land       ▼         14       20.0         0.0       0.0         0.0       0.0         13.0       0.05         Step       Taper         16.5       16.5	Pad Pad Pad Pad Pad Pad Pad Pad	Pad Pad Pad Pad Pad Pad Pad Pad
Ok Cancel Help		Ok	Cancel Help	<u>a</u>

#### > 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 Tilting Pad			
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	tilt of tilting pad onstant for tilt angle ns 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.

\$	Bearing								
	Basic Geometry Misalignment	Pad Config	Operating Conditions	Pad Grid P	ad Grid With Fe	atures (Dis	play Only)		
		Radial Grid P	oints		Cir	rcumferenti	al Grid Points		
	Grid point 1 at location		Increment	Location	<u>^</u>		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	V L	41	0.5	20.0	~
	-620		Ok	Cancel	Help				
R	Radial Point Increment						mm		
			🔅 Ge	enerate Grid	- 🗆 ×		🕽 Ge	enerate Grid	- 🗆 🗙
			Grid Type Default     O User Specified			Grid Type     O Default     O Default     O Default     O Low     O Medium     O High     26X27     37X37     73X73			
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		ר   Set	26X27	Medium 37X37	<ul> <li>⊖ High</li> <li>73X73</li> </ul>		26X27	Medium 37X37	<ul> <li>High</li> <li>73X73</li> </ul>
		, <mark>ј</mark>	User Specified Grid Number of Radial Point 31 If you click Generate, a I discarded. If you have d pressure regions, the grid to include those location Generate	new grid will be built efined recesses, pur d you specified here	41 and any old grid mps, or static will be expanded	User S	User Specified Grid Number of Radial Points 31 If you click Generate, a r discarded. If you have de pressure regions, the grid to include those locations Generate	new grid will be built and efined recesses, pumps I you specified here will	41 d any old grid s, or static

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.

•	Opt	ions				- 0	×
Description Clearances	Output and Solver Controls						
	Bearing Clearance / Gap Limit:		Scaling	Clearances	^		
	0.125	▶ 1	1.0	0.125			
	Default Scaling Factors	2	0.975	0.121875			
	Default Scaling Pactors	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	ן ר
	0.0000000	10	0.775	0.09	Сору	Ctrl+C	
		11	0.75	0.0 🚘	Paste	Ctrl+V	
	Generate	12	0.725	0.09	Clear	Carrie	
	LJ	13	0.7	0			
	0.08 •	Insert Row	F3				
	Append Row						
	Delete Row	F4					
		Consel	Ulala	1	Duplicate Row	F5	
	Ok	Cancel	Help				<u></u>

#### 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.

0	Options	
Description Clearances Output	t and Solver Controls	
	Output Files Ondensed Intermediate De Generate non-dimensional text output file	taled
Dynamic Perturbations Spring Coefficients X-axis Displacement	0.003 Y-axis Displacement 0.005	Z-axis Displacement -0.005
Damping Coefficients X-axis Velocity	0.005 Y-axis Velocity 0.005	Z-axis Velocity -0.005
<ul> <li>Tilting Pad Angular Displacem</li> <li>About radial axis</li> </ul>	ents 0.005 About tangential axis 0.005	
	Restore Defaults For These Values	
	Ok Cancel Help	
Incremental Displacement		dimensionless

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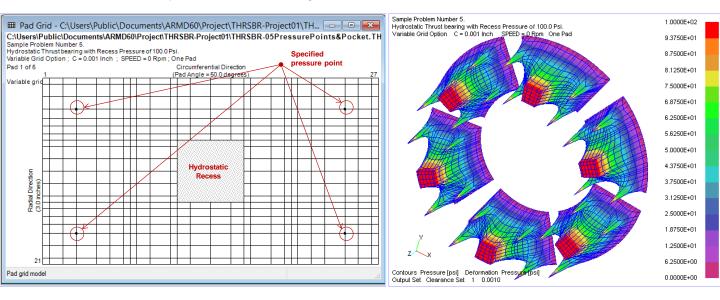
Static Pressure Points / Lines / Pockets – Advanced Form. New features implemented in version 6 provide the user with means to specify pressure conditions, some of which include:

- 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.

;	0				Advanced				
	Boundary Pressures Static Pressure Points / Pockets Surface 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	Specified pressure box
			4	2.5	2.5	5	5	100.0	Specified pressure point
			5	2.5	2.5	45	45	100.0	— Specified pressure point
Ľ									
	Ok Cancel Help								
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.

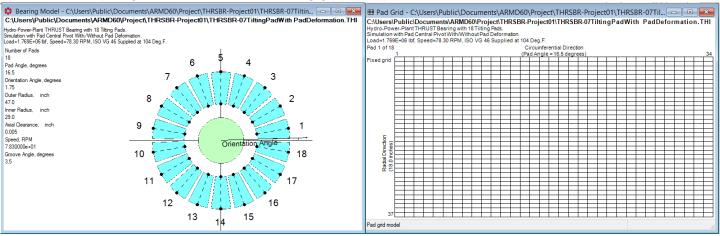
When surface deviation feature is enabled by checking the "Enable Surface Deviation" box (shown below), the form expands allowing grid network size to be specified and grid intervals in the radial and circumferential directions computed. Surface deviation may also be imported from external comma-separated-files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

🔅 Surface Deviation – 🗆 🗙	🗘 Advanced 🗖 🗖
Build Default Matrix from Pad Grids       Clear existing surface deviations       Grid Dimensions       Number of Points:       Radial Direction:       3       29.0       47.0       Circumferential Direction:       5       1.75       18.25	Boundary Pressures Static Pressure Points / Pockets       Surface Deviation         Image: Boundary Pressures       Static Pressure Points / Pockets       Surface Deviation       Current and a static Pressure Points / Pockets       Radial a static Pressure Points / Pockets       Surface Deviation       Current and a static Pressure Points / Pockets       Surface Deviation       Set Size       Import Magnitudes       Repair Grid       Current and Size: Circumferential       Set Size       Current and a static Pressure Points / Pockets       Set Size       Current and Size: Circumferential       Set Size       Current and a static Pressure Points / Pockets       Set Size       Current and Size: Circumferential       Set Size       Current and a static Pressure Points / Pockets       Set Size       Current and Size: Circumferential       Set Size       Current and Size: Circumferential       Set Size       Set
Boundary Pressures       Static Pressure Points / Pockets       Surface Deviation         Image: Static Pressure Points / Pockets       Import Magnitudes       Repart Office         Image: Static Pressure Points / Pockets       Import Magnitudes       Repart Office         Image: Static Pressure Points / Pockets       Surface Deviation       Repart Office         Image: Static Pressure Points / Pockets       Surface Deviation       Repart Office         Image: Static Pressure Points / Pockets       Surface Deviation       Repart Office         Image: Static Points       C001       C002       C003       C004         Image: Static Points       C001       C002       C003       C004         Image: Static Points       C001       C002       C003       C004         Image: Static Points       Ok       Cancel       Ok       Cancel	Count     Circumferential     Divide-Foree-Rear THRUST Bearing with 18 Timp Pads.     Hydro-Power       to the whole bearing.     Sinded out with Pad Certel Row With With Wath Data Deformation. Load-1755E-v65M. Speed-78.30 RPM. ISO VS 46 Suppled at 104 Dep.F.     Hydro-Power       Number of pade:     1     Croumferential length-16.5 degrees Grid Model     5       C0005     Mm. Circum. Location:     1.     Croumferential length-16.5 degrees Grid Model     5       Mm. Circum. Location:     1.35 degrees     Mm. Circum. Location:     1.     1.       1.25 degrees     Mm. Corum. Location:     1.32 degrees     Mm. Circum. Location:     1.       1.25 degrees     Mm. Rodel Location:     1.     1.     1.
<ul> <li>Two options are available for defining the deviation in version 6 of the thrust bearing</li> <li>1- By default (shown above) the surface specified in the global bearing coord "Global Grid" and not the individual period of the deviation grid is a Global Grid</li> <li>2- Surface deviations may be specified</li> </ul>	ring Module: ce deviations are dinate system pad grid network.

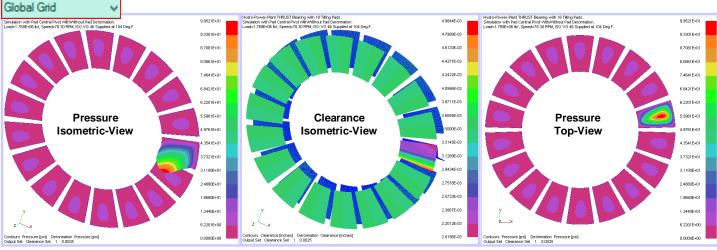
and applied to all pads in the bearing when selecting the "Single Pad" option.

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

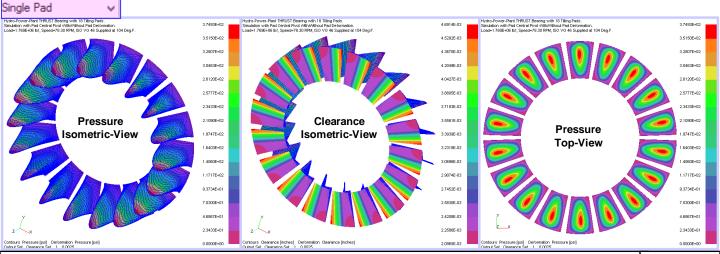
#### A view of the pad grid network and the bearing graphical presentation are shown below.



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

Auto Convert

Convert Units Insert Value:

Mathematical Expressions

evaluator

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

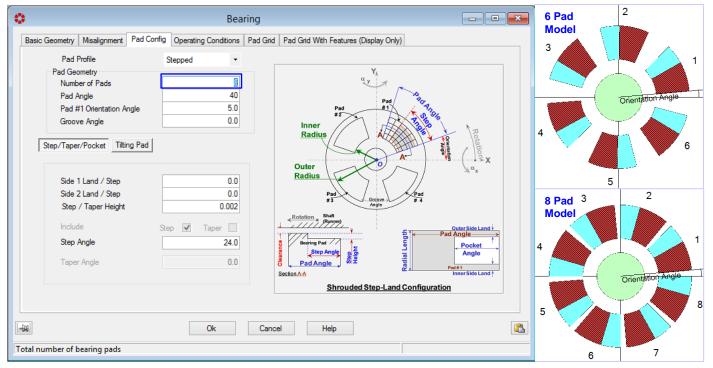
•			lic\Documents\ARMD60\Project\THRSBR-Project	01\Taper	edLandShrouded	14PadThrustBe	earingSample01.thi	SI)			×
	2 1	dvanced   Run Analysis   Post-Pro 🖁 Copy 🌇 Paste    🔯 Bearing Mode	ocessor   View Tools Window Project Help								
New 2	gopen 🛃 Save   💑 Cut 📺	Bearing	a m Pad Grid Model   Insert Value:	8	•		Post-Processor				3
Desire	Country Musicanat Pad Co	offin Occurring Conditions Red Cid R	d Crid With Fasture (Disalar Only)		Description						
Basic Geometry         Misalignment         Pad Config         Operating Conditions         Pad Grid         Pad           Pad Profile         Stepped         •         •         •         •         •					GEARBOX Fluid-Film TH 14 PAD SHROUDED T Bearing Performance In	APERED LAND.	ANALYSIS. stribution @ 15000 RPM.				
	Pad Geometry Number of Pads	14	Y <sub>A</sub>								
	Pad Angle	20.0			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	50	
	Groove Angle	0.0	*2 X X Y Y Y Y		Min Clearance	0.00125	Rotational Speed	15000.0	Viscosity	6.894758e-03	
	Step/Taper/Pocket Tilting Pad		Inner Radius		Single Case Multiple C	Cases Lubricant Pr					
					Operating Conditions	of 12 🕨	M 4 🗙	Lube/Chamfe	er 🕖 Run	3D	
	Side 1 Land / Step Side 2 Land / Step	2.0	Pad		Clearance	0.025	Speed 15000.	D	Load 0.0		
	Step / Taper Height	0.05	# 5 Genove A # 4		Operating C			lm Thick>			
			Rotation Shaft		Load Capacity		-03 (N)   Power- -06 Pascal   Side-L		3.708E+03 (Wat		
Include Step 🗹 Taper			Outer Side Land				t	hrough ID ->	9.591E-01 (L/m	min)	
	Step Angle	0.0	Beining Pad		Supply-Oil Ten		t )1 (Deg.C)   Inlet-		1.431E+00 (L/m		
	Taper Angle	16.5	Pad Angle		Supply Flow Ra	ate> 5.000E+0	00 (L/min)  >Max. R	eynolds # ->			
		Sect	ion A-A Inner Side Land *		Film-Temp		1 (Deg.C)   (1 (Deg.C)   (1 (Deg.C)  > A X			1	
			Shrouded Step-Land Configuration		Groove Temp		38 (Deg.C)   Stiff		/m) = 1.894E+	08	
					Max. Temp		)4 (Deg.C)   Dampi				
		Ok Cancel	Help	r 🔊	1		BRGVU - [thrpo				×
							rmations Display Zo	om Rotate C	olors Window H	lelp _ 🗗	×
Ļ			1		¥ <u>8 6 6 6</u>	2					
🛟 Bea	aring Model - C:\Users\Pu	ıblic\Docum 🗖 🗉 🖾	I Pad Grid - C:\Users\Public\Docu 🗖							2.9357E+06	
C:\Use	ers\Public\Documents\Al	RMD60\Project\THRSBR-Pr	C:\Users\Public\Documents\ARMD60\Project\THRSE GEARBOX Fluid-Film THRUST BEARING ANALYSIS.	BR-Pro			ributon @ 1-000 RPM			2.7522E+06	
GEARBO	X Fluid-Film THRUST BEARING AN HROUDED TAPERED LAND.	NALYSIS.	14 PAD SHROUDED TAPERED LAND.			<b>1</b>					
	erformance Including Pressure Distr	ribution @ 15000 RPM.	Bearing Performance Including Pressure Distribution @ 15000 R Pad 1 of 14 Circumferential Direction	PM.							
Number	-		1 (Pad Angle = 20.0 degrees)	41			<u>۶</u>				
14		- 4	Fixed grid								
	e, degrees	5 <u> </u>									
20.0 Orientatio	on Angle, degrees	$\mathbb{S}$									
0.0	in Angle, degrees								-		
Outer Ra	dius, mm 🛛 🖊								<b>T</b>	1.1009E+06	
50.0		//	Direction							9.1741E+05	
Inner Rac	dius, mm 🛛 🕺	Orientation Angl							/	7.3393E+05	
	35.0 8 14		12 aad							5.5045E+05	
0.125	a a		α Ξ	##						3.6696E+05	
Speed, R		Y\Y_13								1.8348E+05	
15000.0		10 11 12	31				- <u>u</u>	Wewton him 2		0.0000E+00	
Groove A 5.714286	Angle, degrees	· · · -	Pad grid model	. C:\	Users\Public\Docume	ents\ARMD60\Thr	sbr\thrpost.thv			NUM	
							THRSBR-F	Project01			-

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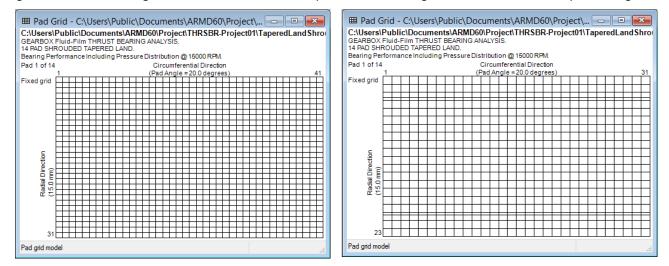
- Data Entry Menus. All data entry menus are visible at the Grid input page. Grids now feature selection check boxes and editing buttons where appropriate.
- Quick Chart. This feature rapidly displays an X-Y graph of entered tabular data for visual verification of correctness. ARMD Graph software is 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         1.300000e-06
User Specified Case(s) &	Single Case       Multiple Cases       Lubricant Properties         Image: Case       10 of 70       Image: Case       Image: Case
Operating Conditions	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.

							C Lubricant Library								
	Lubricant Properties						<u>+</u>	Insert	💠 Арре	end	× Delete	<b>E</b> Duplicate			
		Supplier	Typical			Supplier	BrandN	lame	ISO Grade	API Gravity	1st Kinematic Viscosity Point	1st Kinematic Viscosity Temp.	2nd Kinematic Viscosity Point	2nd Kinematic Viscosity Temp.	^
						TEXACO	REGAL R&O 220	)	220	26.7	220.0	104.0	18.1	212.0	
	Choose Lubricant	Brand Name	ISO Grade 32 Oil			TEXACO	REGAL R&O 320	D	320	26.1	320.0	104.0	23.1	212.0	
L		ISO Grade	32			TEXACO	REGAL R&O 460	0	460	25.0	460.0	104.0	29.1	212.0	
		API Gravity	31.0			TEXACO	REGAL R&O N-1	100	100	22.0	100.0	104.0	9.0	212.0	
- Kinomatia Magazi	ties (for interpolation)					TEXACO	REGAL R&O N-6	58	68	22.9	67.0	104.0	7.2	212.0	
	32.0			04.0		TOTAL	PRESLIA 100		100	28.206	99.3	104.0	11.4	212.0	
1st Point	32.0	Ist	Temperature 1	04.0		TOTAL	PRESLIA 32		32	31.144	32.3	104.0	5.4	212.0	
2nd Point	5.36	2-4	Temperature 2	12.0		TOTAL	PRESLIA 46		46	30.214	46.3	104.0	6.8	212.0	
2riu Poirit	3.30	210	remperature 2	12.0		TOTAL	PRESLIA 68		68	28.568	67.4	104.0	8.7	212.0	
		Reset				Typical	ISO Grade 10	Oil	10	33.4	10.0	104.0	2.66	212.0	
					3/	Typical	ISO Grade 15	Oil	15	32.6	15.0	104.0	3.41	212.0	
					98	Typical	ISO Grade 22	Oil	22	31.8	22.0	104.0	4.29	212.0	
					99	Typical	ISO Grade 32	Oil	32	31.0	32.0	104.0	5.36	212.0	
					100	Typical	ISO Grade 46	Oil	46	30.3	46.0	104.0	6.76	212.0	~
								Save	Sele	ct	Cancel	Help			
				Supp	plier										

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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 Viscosit	y and Heat Content			
Film Temperature 160.0	Viscosity / Heat Content			Cham	fer Geometries
Supply Temperature	Viscosity	0.0		Nor ▲	e-No Chamfer
Flow Type Grooved -	Heat Content	0.0	$\langle \langle \rangle$	O I O Pria	ngular
Supply Flow Rate 3.0				<ul> <li>Nor</li> <li>Nor</li></ul>	tangular cular
Feeding System				<b>↓</b> <sup>®</sup>	
Fixed Geometry Pads	_			$\omega$ – Direction	of Rotation
Groove Feeding System					
Chamfer Type Triangular 🔻					→ X
Chamfer Depth 0.125	Supply Pressure	20.0	<u>Triangular</u>	<u>Rectangular</u>	<u>Circular</u>
Chamfer Angle 90.0 Groove Length 0.4	Orifice Diameter	0.075		$\langle \rangle$	
Groove Length 0.4	_				Radius
Ok	ancel Help		Angle	Width	$\rangle$
Lube Supply Temperature	•F		Depth	Depth	Depth
	,.				
	Triangular 🗸 🗸	Fixed Geometry Pads			
Grooved V	None	Groove Feeding Sys	tem Triangular ✓		
Classical	Triangular Circular	Chamfer Depth	3.0	Supply Pressure 1500	00.0
Grooved Non-Grooved	Rectangular	Chamfer Angle	90.0	Orifice Diameter	10.0
Non-Grooved		Groove Length	10.0		_
Fixed Geometry Pads Groove Feeding System		Fixed Geometry Pads Groove Feeding Sys	tem		
Chamfer Type Rectangular V	L	Chamfer Type	Circular V		
Chamfer Depth 4.0 Supply Pres Chamfer Width 4.0 Orifice Diam		Chamfer Depth Chamfer Radius	3.0	Supply Pressure 1500 Orifice Diameter	00.0
Chamfer Width 4.0 Onfice Diam Groove Length 10.0	10.0	Chamfer Radius Groove Length	45.0		10.0

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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		7	
Solve For	Film Temp -	User Specified Vis	cosity and Heat Content
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 Neg Consumed Exactling	Destaura -	1	
	System		
Non - Grooved	System 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		
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.

		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       Analysis         Image: A state of the state of th	3D
<b>Complete Bearing</b> <b>Performance Results</b> including bearing system heat balance and supply pressure considerations.	Load Capacity> 2.200E+03 (Lbf) Power-Loss> 7.202E+00 ( Max. Pressure> 1.439E+03 (Psi) Side-Leakage QF -> 3.574E-01 ( 	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.

		metric lation o	of	0					Pos	st-Pro	cessor					-		×
bearing performance is accomplished efficiently.																		
childrenkiy.				F	-Outer ad Angle Iin Clearar		H	50.0 20.0 00125	Orie Rot	nner entation tational S	-		5.0 0.0 0.0		of Pads Clearances Y	6.89	4758e	14 50 -03
Expand button if				Sir	igle Case	Multiple Ca		Lubricant	Proper	ties						<i>4</i> 1	Run	
pressed will expand the window to the full width of the parent window which provides a quick view of all the columns		idth w Jick				Clearance		Speed		Load		Use Lube Specified Viscosity Viscosity / Heat Content		Specified Heat Content		Tem	F	
	efficient modific	data ent	try	ין ו	• 1		0.025		1000.0		0.0			0.0		0.0		_
unu	mound				2		).025 ).025		2000.0		0.0			0.0		0.0		-
[	Restore		١	Use													[	🖋 Run
	Clearance	Speed	Load	Lube Viscosity / Heat Content	Specified Viscosity	Specified Heat Content	Film Temperati	Supp ure Tempera	ly F ature F	low Rate	Row Type	Chamfer Type	Supply Pressure	Orfice Diameter	Groove Length (Grooved)	Chamfer (Groo		Chamfer Size (Grooved)
1	0.025 0.025	1000.0 2000.0	0.0		0.0	0.0		0.0	50.0 50.0	5.0 5.0	Grooved ¥ Grooved ¥	Triangular Y Triangular Y	100000.0		3.0 10.0 3.0 10.0		1.25 1.25	90.0 90.0
3	0.025 0.025	4000.0 6000.0	0.0		0.0	0.0		0.0	50.0 50.0	5.0 5.0	Grooved ♥ Grooved ♥	Triangular 🗡 Triangular 🗸	100000.0		3.0 10.0 3.0 10.0		1.25 1.25	90.0 90.0
5	0.025	8000.0 10000.0	0.0		0.0	0.0		0.0	50.0 50.0	5.0 5.0	Grooved V	Triangular V	100000.0		3.0 10.0 3.0 10.0		1.25 1.25	90.0 90.0
7	0.025	12000.0	0.0		0.0	0.0		0.0	50.0	5.0	Grooved 💙	Triangular 🗸	100000.0		3.0 10.0		1.25	90.0
8 ▶ 9	0.025 0.025	14000.0 15000.0	0.0 0.0		0.0 0.0	0.0		0.0	50.0 50.0	5.0 5.0	Grooved V Grooved V	Triangular Y	100000.0 100000.0		3.0 10.0 3.0 10.0		1.25 1.25	90.0 90.0
10 11	0.025	16000.0 18000.0	0.0		0.0			0.0	50.0 50.0	5.0 5.0	Grooved ¥	Triangular V	100000.0	-	3.0 10.0 3.0 10.0		1.25	90.0 90.0
≦ Mu be	ultiple ca low. Th	ase bear ne ARME	ring pe D grap	erforn hics	nance r utility ca	esults ai an be us	ed to	tomatic	son cally ( y X-1	display f plots	/ed in te of any	Triangular Y	at as ill enerate	ustrate ed resi	an 100 ed		1.25	90.0
Case No.	Film-Temp (Deg-C)	Applied Load-NEWTON	Projec Press (Pasca	ire	Speed (rpm)	Surface Velocity (m/sec)		nolds Number		80							y Tempera	
1 2 3 4 5 6 7 8 9 10 11 12	50.803 51.658 53.427 55.236 57.055 58.864 60.653 62.409 63.277 64.135 65.823 67.479	$\begin{array}{c} 5.376E\!+\!02\\ 1.041E\!+\!03\\ 1.951E\!+\!03\\ 2.742E\!+\!03\\ 3.430E\!+\!03\\ 4.553E\!+\!03\\ 5.015E\!+\!03\\ 5.015E\!+\!03\\ 5.224E\!+\!03\\ 5.224E\!+\!03\\ 5.784E\!+\!03\\ 6.107E\!+\!03 \end{array}$	1.725 3.342 6.263 8.802 1.101 1.293 1.462 1.610 1.677 1.740 1.857 1.960	2+05 2+05 2+05 2+06 2+06 2+06 2+06 2+06 2+06 2+06 2+06	$\begin{array}{c} 1.000 \pm +03\\ 2.000 \pm +03\\ 4.000 \pm +03\\ 6.000 \pm +03\\ 1.000 \pm +03\\ 1.200 \pm +04\\ 1.200 \pm +04\\ 1.500 \pm +04\\ 1.500 \pm +04\\ 1.600 \pm +04\\ 1.800 \pm +04\\ 2.000 \pm +04\\ \end{array}$	5.236E+00 1.047E+01 2.094E+01 3.142E+01 5.236E+01 6.283E+01 7.330E+01 7.330E+01 8.378E+01 9.425E+01 1.047E+02	3.8 8.3 1.3 2.5 3.2 3.9 4.3 4.7 5.6	87E+01 19E+01 32E+02 93E+02 18E+02 08E+02 65E+02 69E+02 90E+02 83E+02 83E+02 45E+02	0	76 74 72 70 68 66 64 62			_			- Groov	emperatur e Tempera <u>Femperatu</u>	ature _
Case No.	Clearance (mm)	Minimum-C (mm)	Shear-S Max.(Pas	cress S scal) <i>i</i>	Sommerfeld Avg.Number	Power Loss (watt)	Pre	ssure scal)	and	60 58 56			-					
1 2 3 4 5 6 7 8 9 10 11 12 2 2	2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02	2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02 2.500E-02	4.1521 8.043 1.5071 2.1181 2.6501 3.1121 3.5171 3.8731 4.1881 4.4681 4.7171	E+04 E+04 E+04 E+04 E+04 E+04 E+04 E+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 4.4 4.5	51E+05 14E+05 52E+06 21E+06 04E+06 55E+06 45E+06 90E+06 90E+06 90E+06 90E+06 90E+06 •		54 52 50 48 46 44 42 40			1.000 Sneed (2)	• PM) (E+04)	-			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 Market		
configuration form consists of two panels. The left panel contains a tree view of the	Graph - Default Charts Chart - 1 ⊖ Output Files (1) TaperedLand3Pads.psg Sl	File Contents Units Speed (RPM) TaperedLand3Pads.psg S1 Eccentricity Ratio	Chart Type Line X Axis Unit Speed (RPM) Speed (RPM) -Y Lines Units mm	<ul> <li>Image: Construction</li> </ul>
graphs, charts, and graphic output files. The right panel contains all chart and graph settings.		Min. Film Eccentricity - Att. Angle - Power-Loss	Units mm     Line File     Clearance (1) TaperedLand     Min. Film (1) TaperedLand     Eccentricity (1) TaperedLand	d3Pad 🔶
	Save Workspace     Use Current Files       Open Workspace     Show/Update Graphs	Replace File		

ARMDGraph features include:

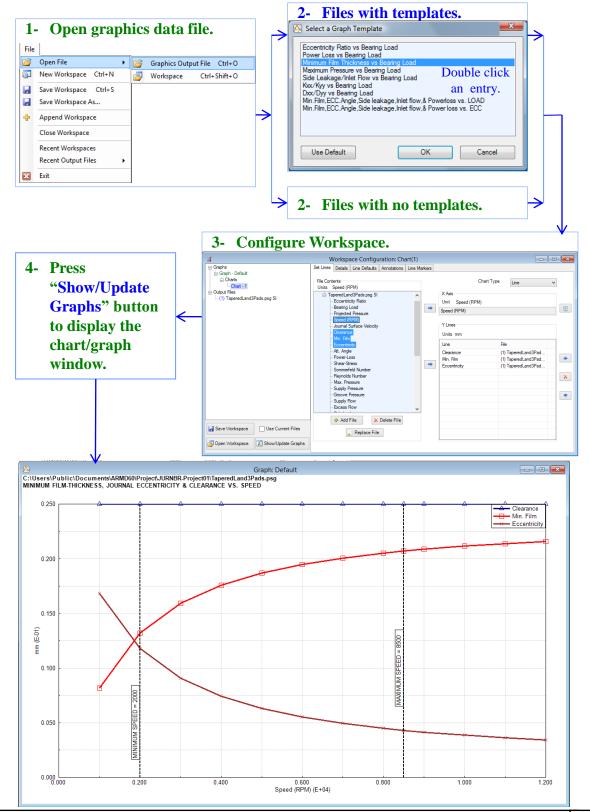
- Workspace concept that contains all graph settings and linked graphics output files in one form customized by the user.
- > Existing workspace can be easily applied to newly generated graphics output files.
- > New graphical user interface to access and customize graphs.
- > New file format (\*.usrx) 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.
    - N or OFF).
- 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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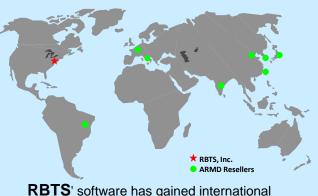
## **ARMD**<sup>-</sup> The Worldwide Leading Software For Rotating Machinery Analysis

#### Advanced Rotating Machinery Dynamics

**ARMD** is a well established software package used worldwide to perform complete rotating machinery dynamic analysis. ARMD employs a user-friendly interface and window environment with pulldown menus and context-sensitive help. ARMD integrates the most advanced and complete rotor dynamics, torsional vibration, and bearing analysis programs under one environment in a seamless fashion to give you the power to model your rotating machinery with ease, efficiency, and above all accuracy. Some applications in which ARMD has been utilized include rotating machinery such as a miniature air turbine for a dental drill, a large turbine generator set for a power plant, a small compressor for an air conditioner, a pump for an artificial heart, a fuel pump for a jet engine, an electric motor and spindle for a miniature computer hard disk, a canned pump for petrochemical processing plant, synchronous motor driven drivetrains, and a gear box for an Uranium enrichment plant.



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**RBTS**' software has gained international reputation for its:

- Technical Capabilities
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- Completeness
- User Friendliness
- Support & Service