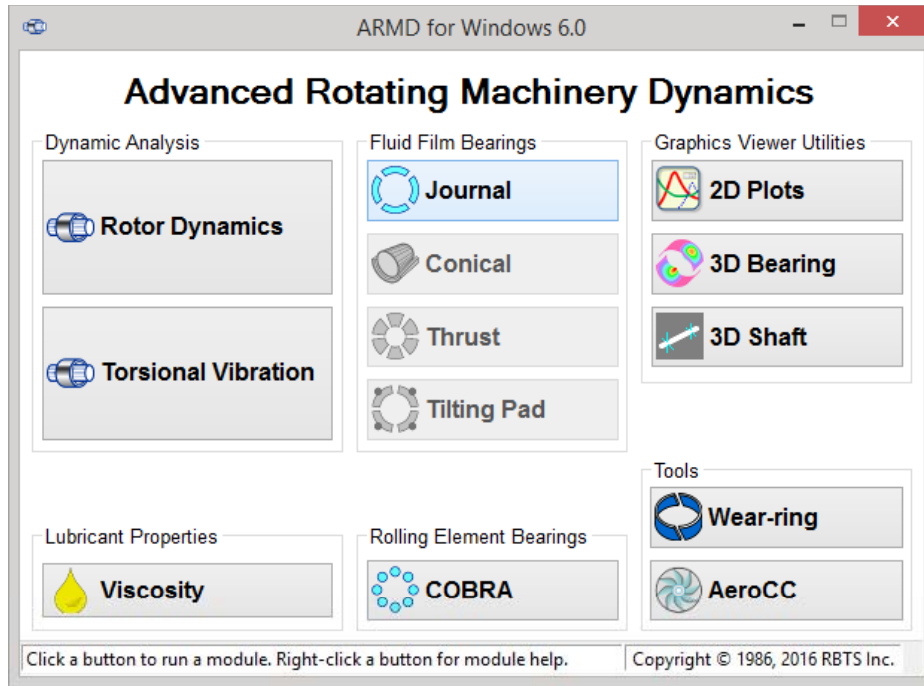


Advanced
Rotating
Machinery
Dynamics

JURNBR Version 6.0

**New
Release**



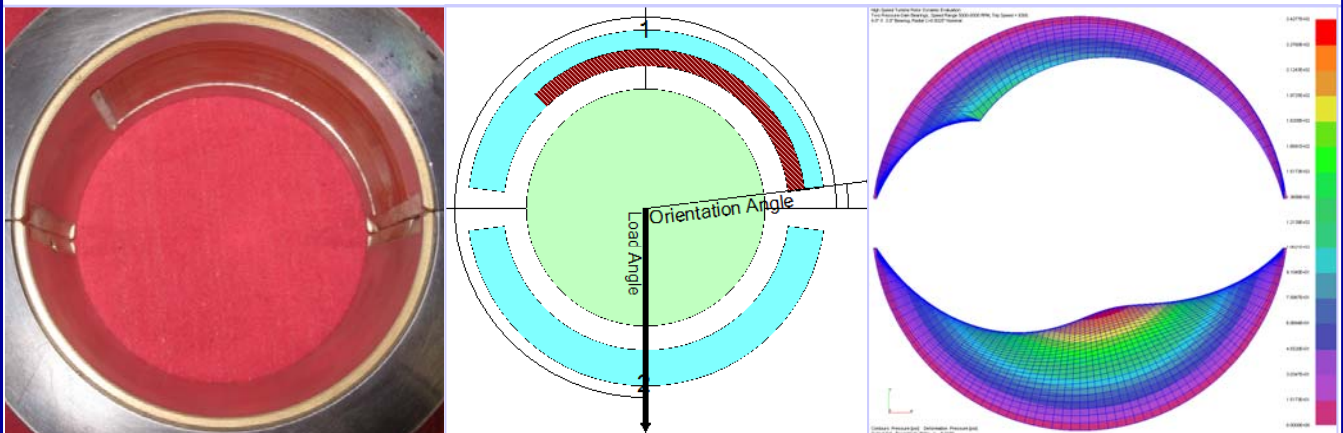
Cylindrical
Fixed Geometry
Journal Bearings
(JURNBR)

JURNBR
Solver

Post-Processor
Single Case

Post-Processor
Multiple
Case

Cylindrical Fluid-Film Lubricated Journal Bearings with Fixed Geometry



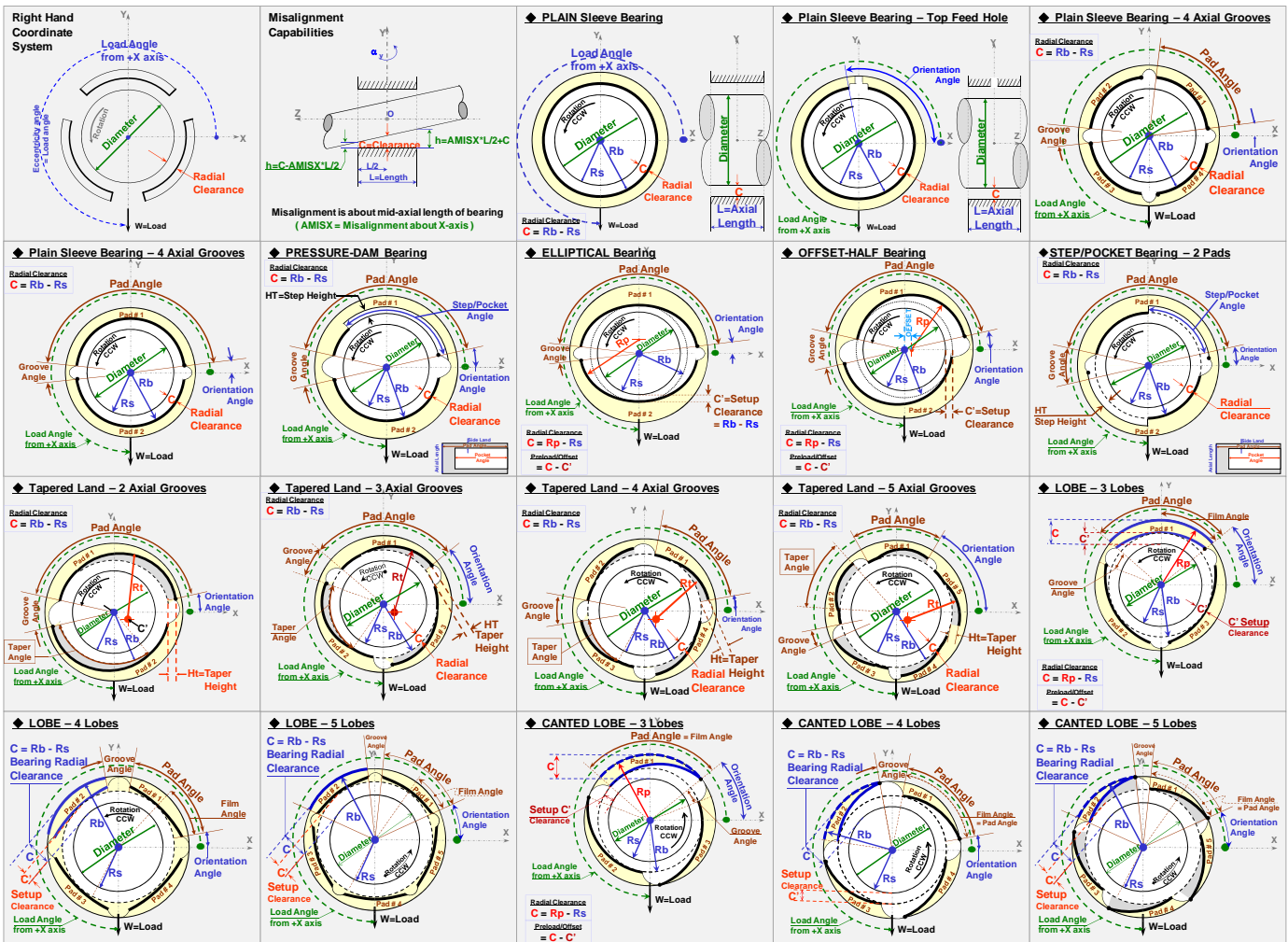
 **RBTS, Inc.**
Rotor Bearing Technology & Software
1041 West Bridge Street
Phoenixville, PA 19460, USA

Tel: 610-415-0412
Fax: 610-415-0413
Email: info@rbts.com
Web: www.rbts.com

The fluid-film bearing module **JURNBR** 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 and various feeding systems. Complete performance predictions of **hydrodynamic**, **hydrostatic**, and **hybrid** lubricated cylindrical journal bearings operating in the laminar and/or turbulent regimes can be generated. Analysis starts with subdividing the bearing surface area into a grid pattern in two dimensions (circumferential & axial) and establishing the lubrication system of equations. Boundary conditions (pressurized boundaries, pockets, lines, recesses with specified pressures or restrictors, 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 geometry journal bearings that can be analyzed include but not limited to:

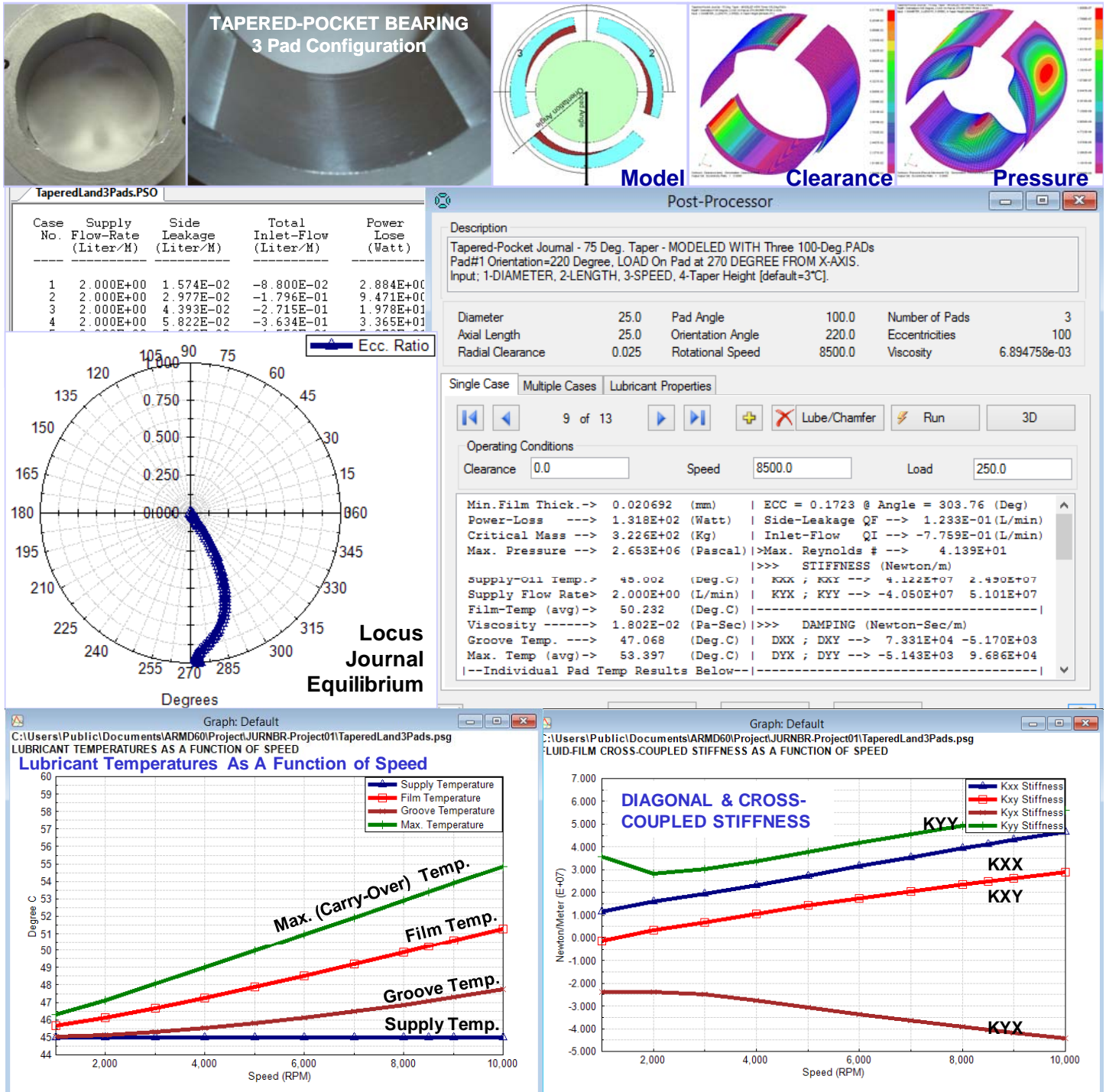
| | | | |
|----------------------|-----------------|---------------------|------------------------|
| a. Plain Cylindrical | b. Multi-groove | c. Pressure dam | d. Elliptical or Lemon |
| e. Step or Pocket | f. Tapered land | g. Lobe/Canted Lobe | h. Multi-recess |



ARMTM V6.0 – JURNBR Module

Simulation capabilities with **JURNBR** include such effects as misalignment, pressurized boundaries or grooves, cavitation, structural deformation/surface deviation, lubricant feed circuitry with specified pressures or restrictors (capillary, orifice, or flow control valve), groove geometry and chamfers to mention a few. Performance results include the following.

- Load capacity / journal position
- Attitude angle
- Viscous power loss
- Righting moments
- Flow requirements
- Stability (bearing whirl/whip)
- Stiffness and damping (dynamic) coefficients
- Clearance and pressure distribution
- Recess pressures and flows
- Heat balance and temperature rises



ARMD™ V6.0 – JURNBR Module

- *The release of RBTS' **ARMD Version 6 JURNBR** 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. JURNBR 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 JURNBR 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 Cylindrical, Multi-groove, Pressure-dam, Elliptical or Lemon, Rayleigh Step or Pocket, Tapered land, Lobe/Canted Lobe, 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 heat balance and temperature rise on a pad-per-pad basis in the bearing.

Version 6 JURNBR 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, 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, lube feed recesses and specified pressure regions) at existing grid points.

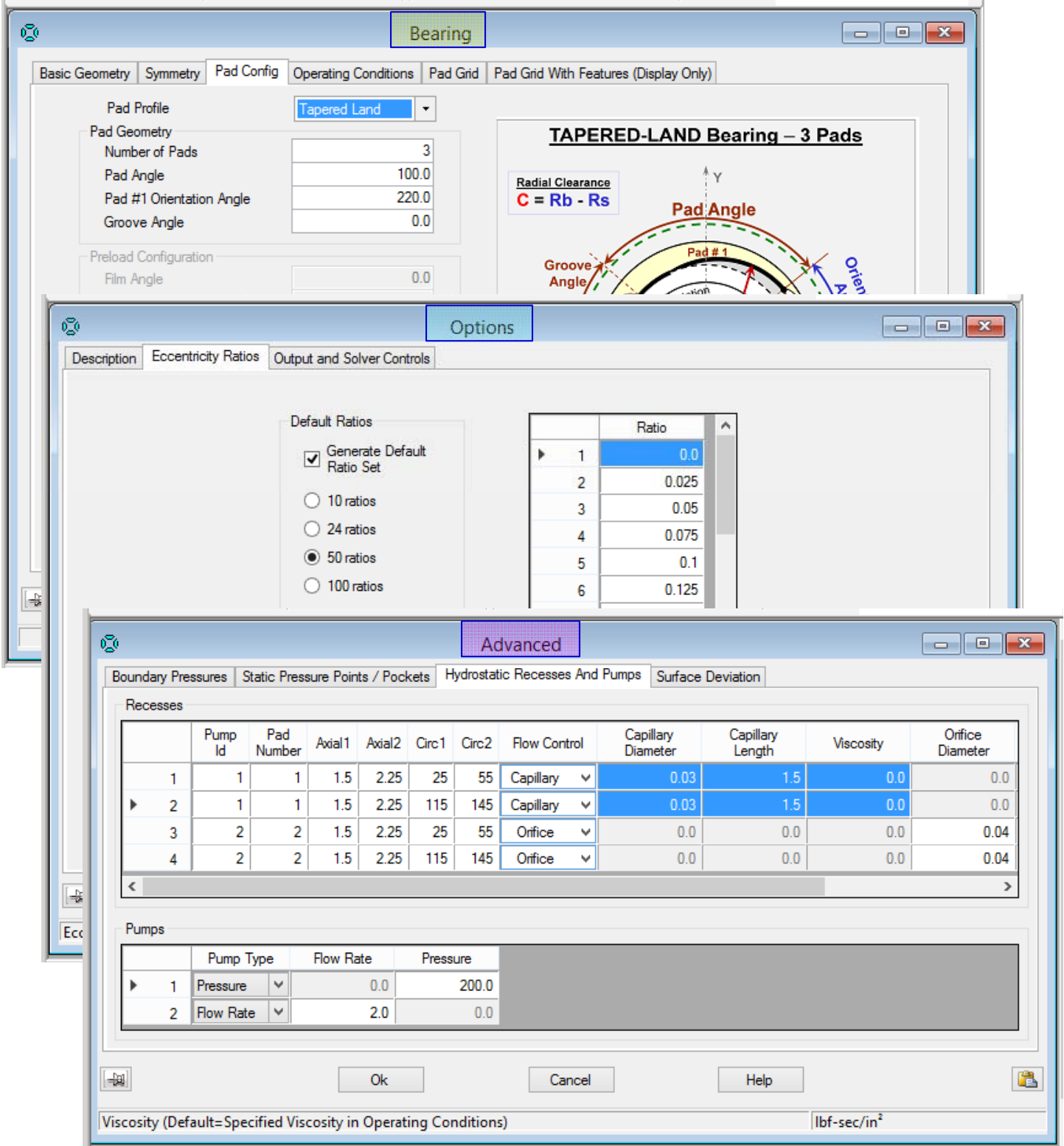
The grid design forms now allows the user to specify grid locations by their physical positions instead of their incremental distance from their neighboring grid points. If a grid point increment is changed resulting in a mismatch between the size of the grid and the size of the bearing, a single button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

Surface deviation for customized and unique bearing internal clearances (herringbone and spiral grooving, full or partial axially tapered bore, structural deformation, etc.) incorporates import function of CSV (comma separated variables) files containing clearance deviations for the custom bearing design.

ARMD™ V6.0 – JURNBR Module

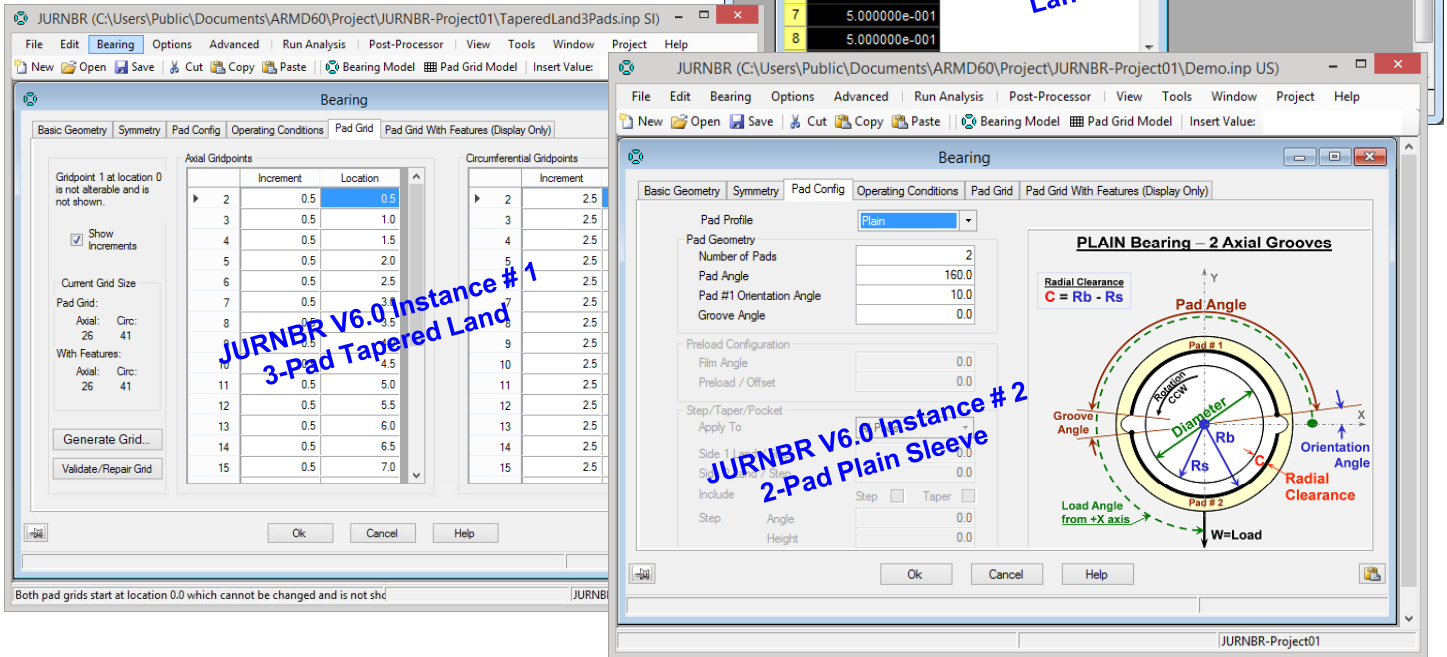
Enhanced Modeling, Usability and Technical Features Include:

- **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.

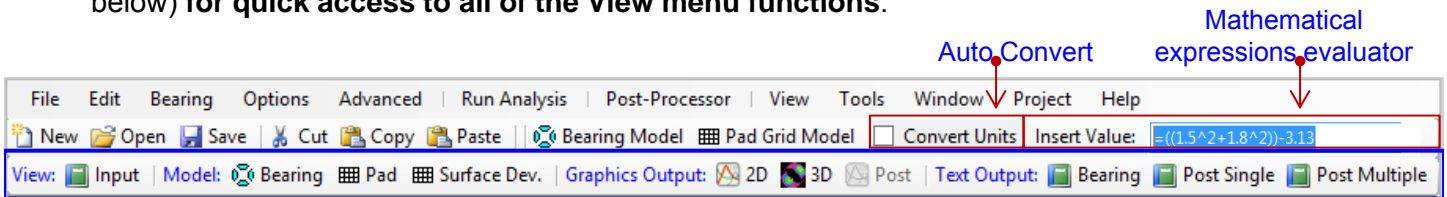


ARMD™ V6.0 – JURNBR Module

- **Multiple instances of JURNBR.** The newly developed package can now **open simultaneous multiple instances of JURNBR**, so side-by-side comparison of bearings model variations and analysis results are easy and efficient. This functionality permits multiple instances of JURNBR Version 6.0 or Version 5.8 to be accessible on your display, from which portions of a model (grid layout, surface deviation, etc.) can easily be moved from one instance to another.



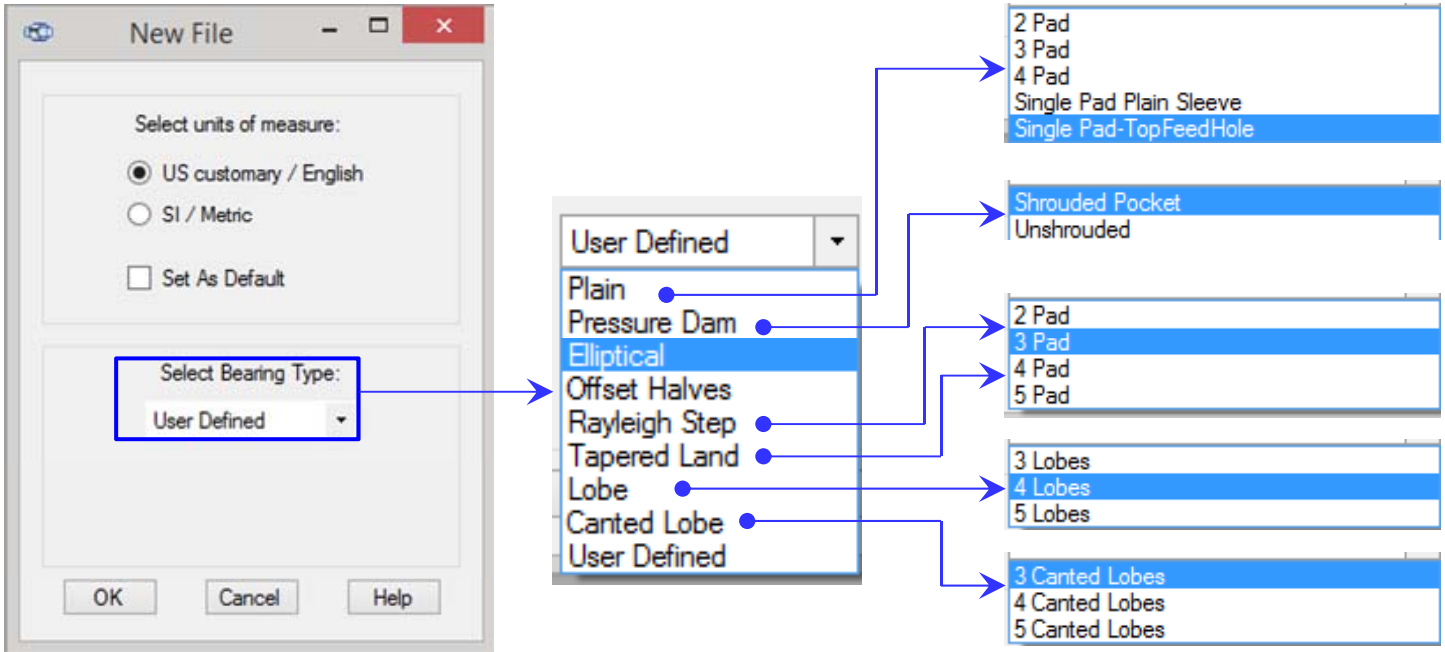
- **User Configurable Expanded Toolbar.** The main toolbar contains controls used to access frequently used functions (these functions are usually accessible from a menu as well). When a function is not available, its control on the toolbar will be disabled and displayed in a faded gray color. A user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



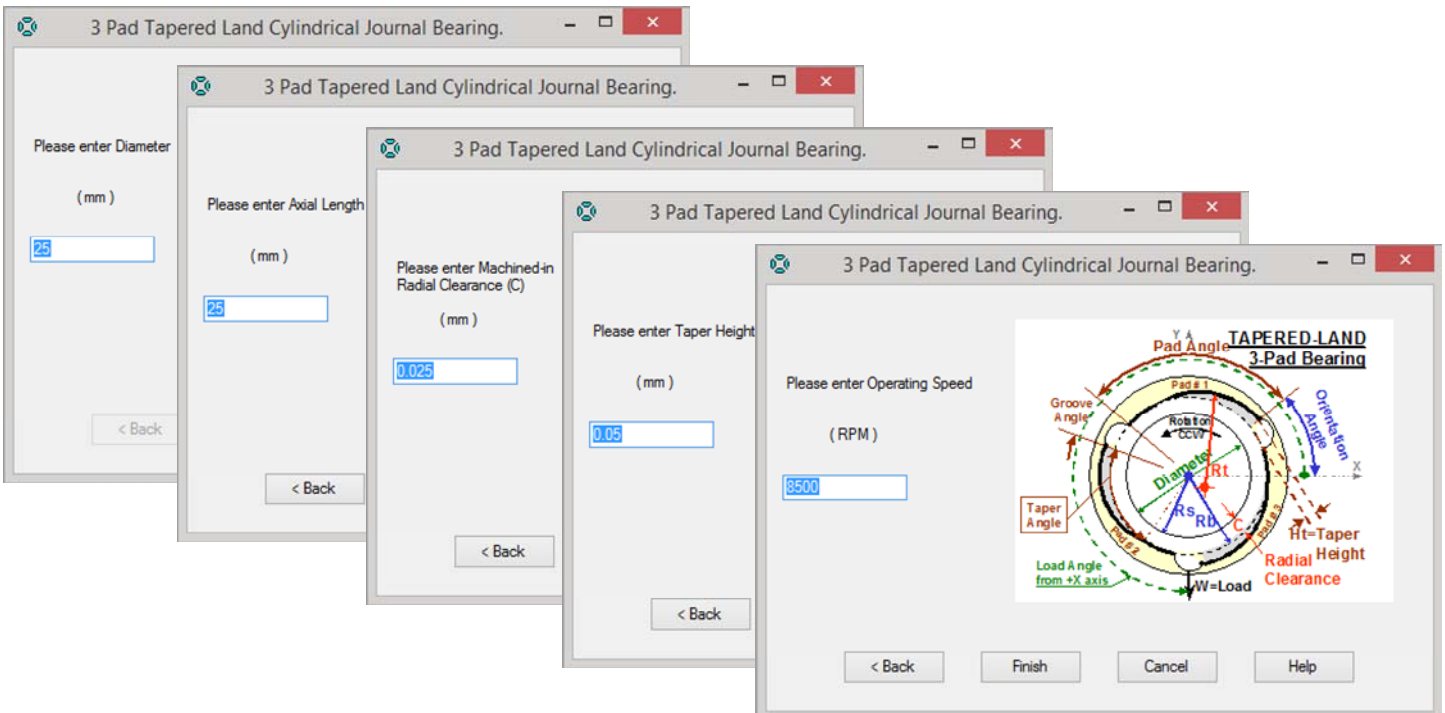
ARMD™ V6.0 – JURNBR Module

Many of the improvements incorporated into ARMD JURNBR Version 6.0, most are specifically directed towards simplicity, increasing usability and productivity as illustrated below:

- **Pre-Configured Bearing 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.

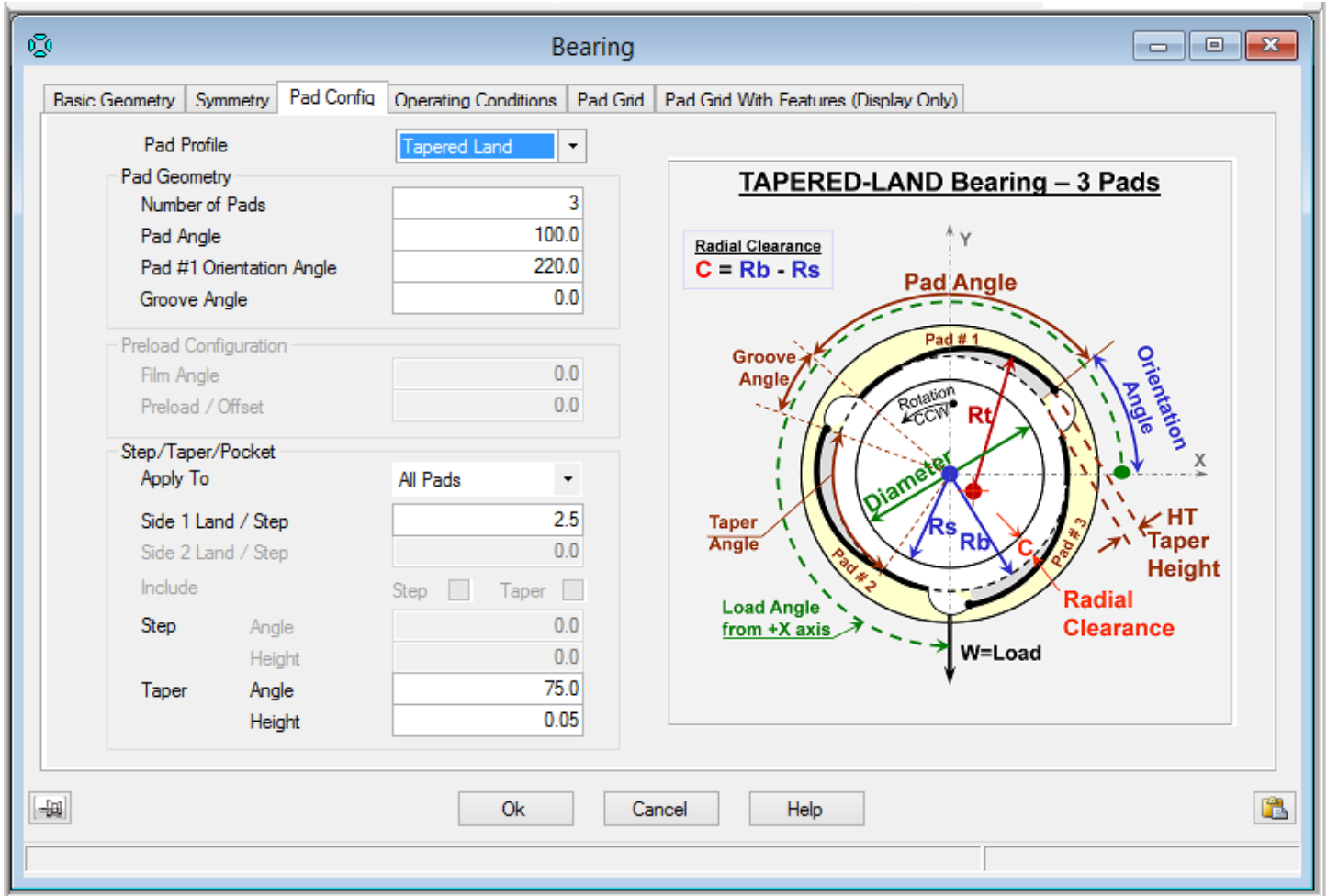
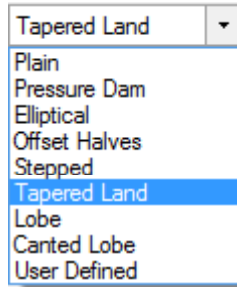


Five steps for bearing geometry and operating speed provides a complete solution of bearing performance.

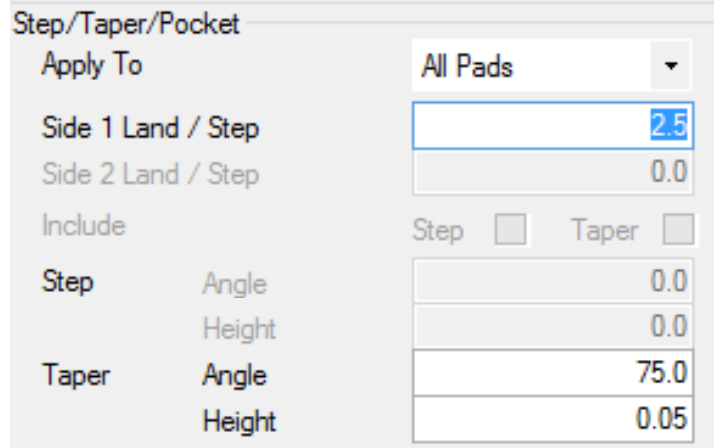


ARMD™ V6.0 – JURNBR Module

➤ **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.

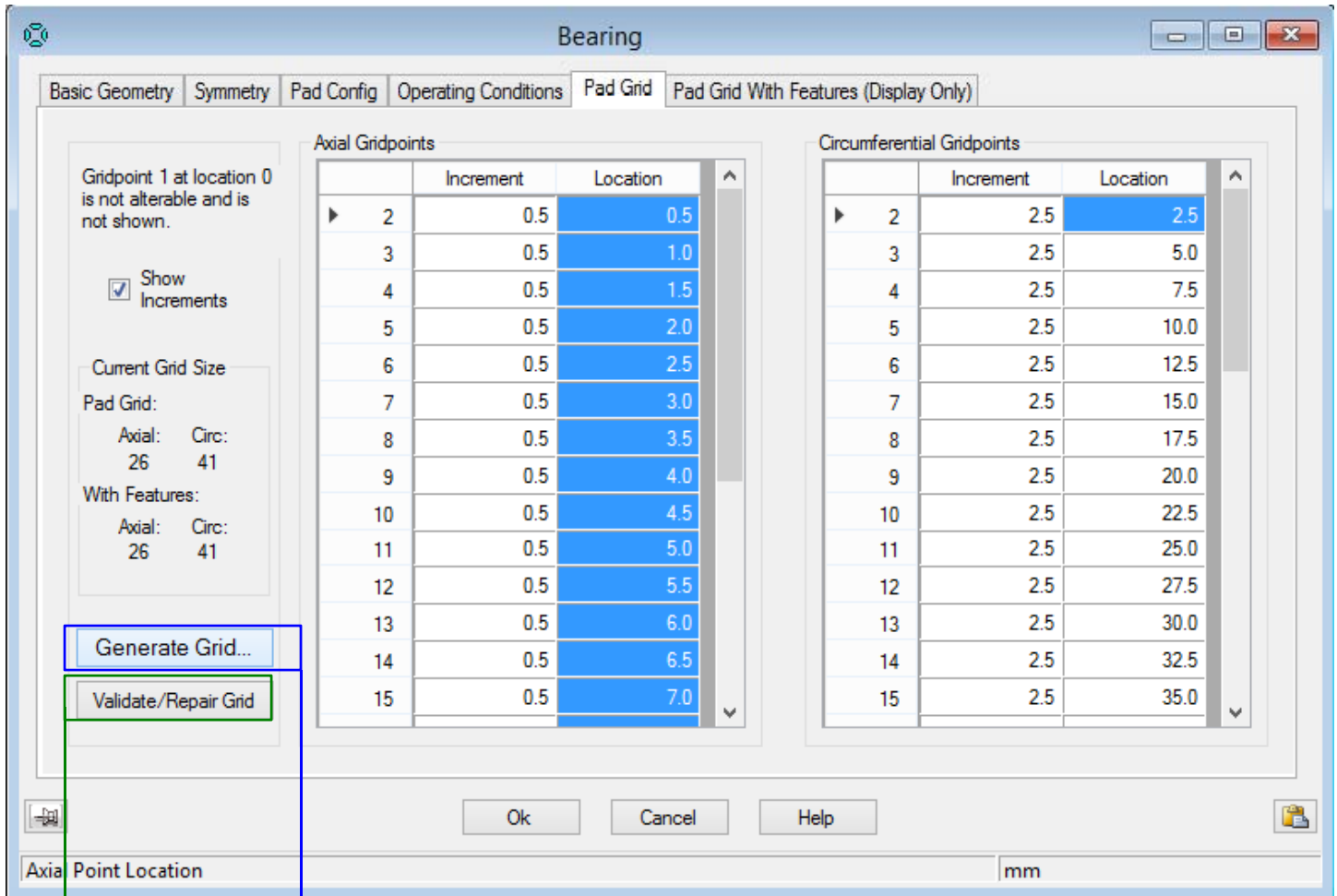


➤ **Features Defined by Geometry.** The newly developed package incorporates built-in analytical routines to accommodate bearing pad design **feature locations** (like steps, tapers, lube feed recesses and specified pressure regions) locations by their physical location in normal design length units (**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.



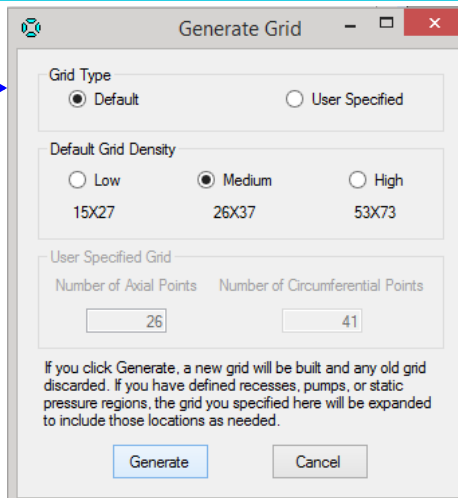
ARMD™ V6.0 – JURNBR Module

- **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.

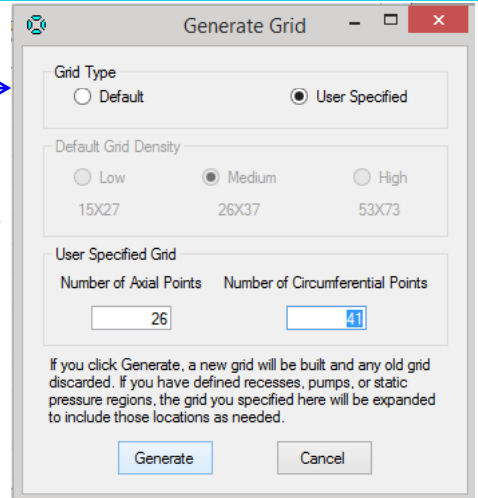


If a grid point increment is changed resulting in a mismatch between the size of the grid and the size of the bearing, a single button click will proportionately resize the grid to fit the bearing

Default Setting



User Specified



ARMD™ V6.0 – JURNBR Module

- **Eccentricity Ratios – Options Form.** Journal eccentricity in the bearing bore is defined as the ratio of journal position to bearing radial clearance. For a plain bore bearing, the eccentricity ratio ranges from 0.0 (concentric) to just below 1.0. Eccentricity ratios are automatically generated (10, 24, 50 default, 100 eccentricities, or can be specified by the user) as shown below.

The screenshot shows the 'Options' dialog box with the 'Eccentricity Ratios' tab selected. The 'Default Ratios' section is highlighted with a blue box. It contains the following options:

- Generate Default Ratio Set
- 10 ratios
- 24 ratios
- 50 ratios
- 100 ratios

Under the 'Adjustments' section:

- Adjust for Preload / Offset
- Multiplier:
-

To the right of these options is a table with the following data:

| | Ratio |
|-----|-------|
| ▶ 1 | 0.0 |
| 2 | 0.025 |
| 3 | 0.05 |
| 4 | 0.075 |
| 5 | 0.1 |
| 6 | 0.125 |
| / | 0.15 |
| 8 | 0.175 |
| 9 | 0.2 |
| 10 | 0.25 |
| 11 | 0.3 |
| 12 | 0.35 |
| 13 | 0.4 |
| 14 | 0.45 |

At the bottom of the dialog, the 'Eccentricity Ratio' is labeled as 'dimensionless'. The 'Generate' button is highlighted with a blue box.

The new version provides the user with means to exceed the maximum computed eccentricity ratio with the newly implemented "Adjustments" option. In previous versions, geometrically preloaded bearing types such as Elliptical, Offset Halves, Lobe, Canted Lobe, the computed journal position could not exceed the physical setup clearance. However, the influence of speed effects, attitude angle change, or load direction, can result in journal eccentricity ratios that exceed the maximum computed values that is based solely on the bearing's setup clearance.

In version 6.0 the adjustments option for preloaded bearings allows the user to extend the eccentricity ratio computation range by simply checking the "Adjust for Preload / Offset" box and entering a multiplier. The Generate button is then pressed to generate the desired range of eccentricity ratios.

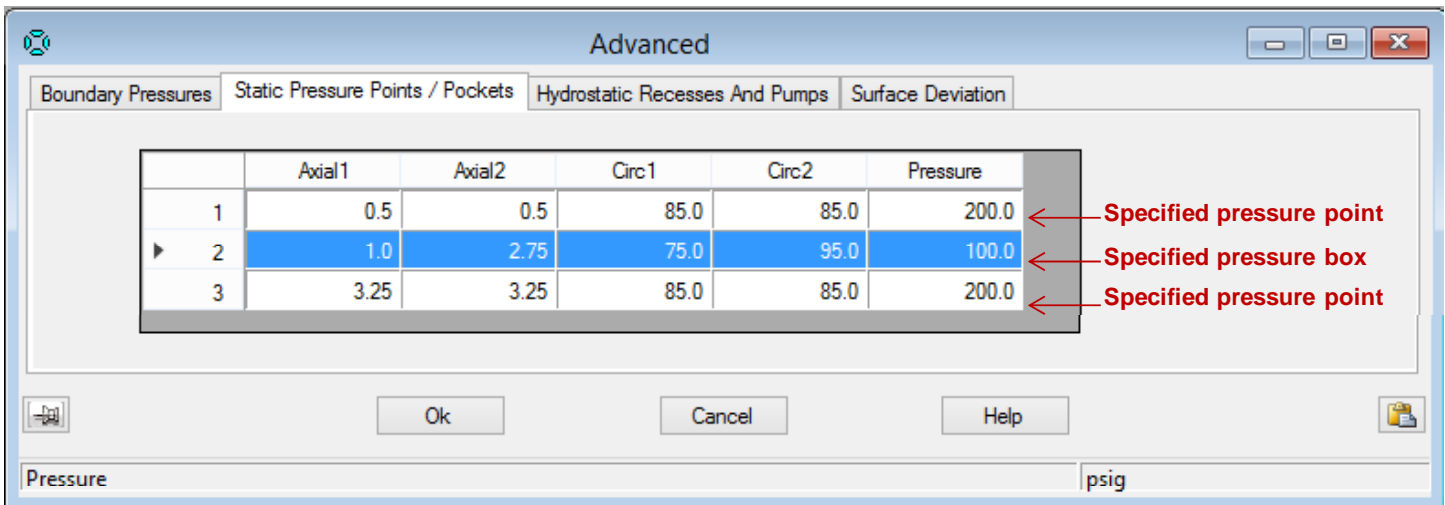
This close-up shows the 'Adjustments' section of the 'Options' dialog box. The 'Adjust for Preload / Offset' checkbox is checked, and the 'Multiplier' is set to 1.125. The 'Generate' button is highlighted with a blue box.

ARMD™ V6.0 – JURNBR Module

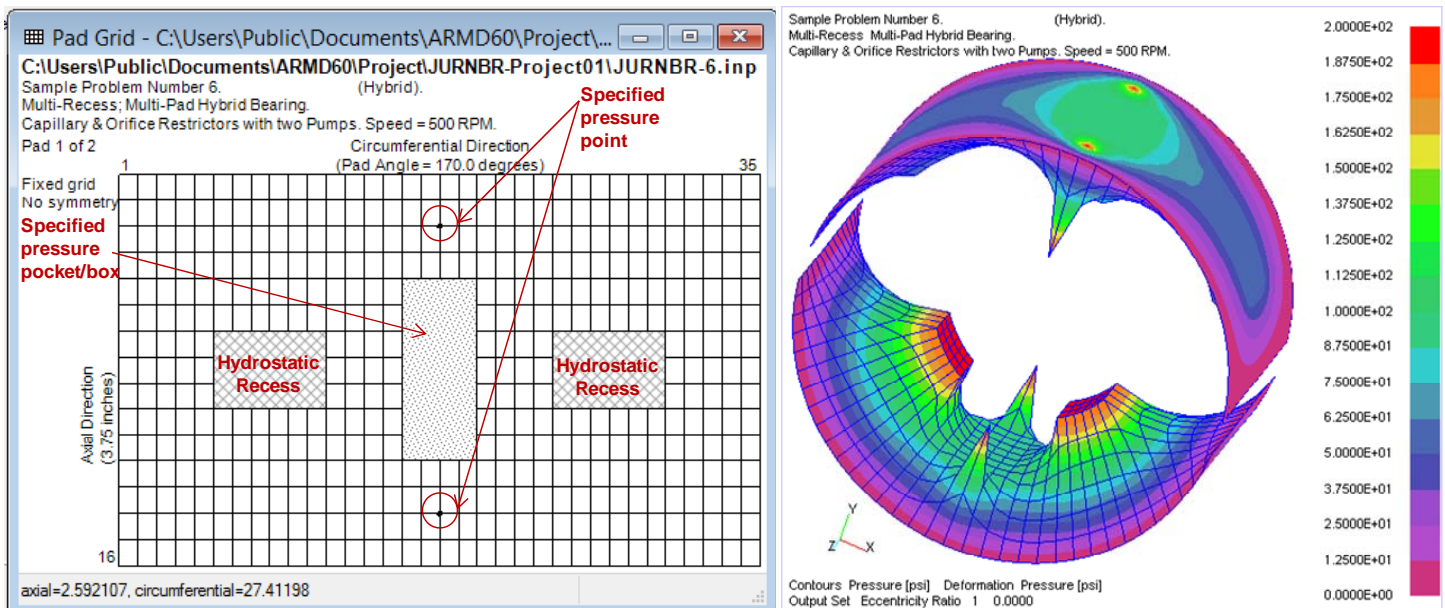
➤ **Static Pressure Points / Lines / Pockets – Advanced Form.** New features implemented in version 6.0 provide the user with means to specify pressure conditions some of which include:

- Pressure point at a intersection of an axial and circumferential location in the pad surface area.
- Pressure line in either axial 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 in the bearing pad surface area, unlike previous versions which permitted only the specification of pressures at already established grid points.



The above specified conditions illustrate (shown pictorially below with the display of the pad grid layout) the specification of point pressure at an axial location of 0.50 inches and located at 85 degree circumferentially, point pressure at an axial location of 3.25 inches and located at 85 degree circumferentially, as well as pressurized pocket/box bounded axially at 1.00 and 2.5 inches, and circumferentially at 75.0 and 95.0 degree



ARMD™ V6.0 – JURNBR Module

- **Hydrostatic Recesses And Pumps – Advanced Form.** Hydrostatic recesses can be specified in a pad or all pads. Each recess can be connected to its own pump or all recesses to one pump. Restrictors such as sharp-edge orifice or capillary tubes can be specified between the supply pump and the recesses. Recesses in a pad are specified by their **geometrical locations** (axial and circumferential) as illustrated in the below form with beginning and ending locations in both the axial and circumferential directions.

Recesses

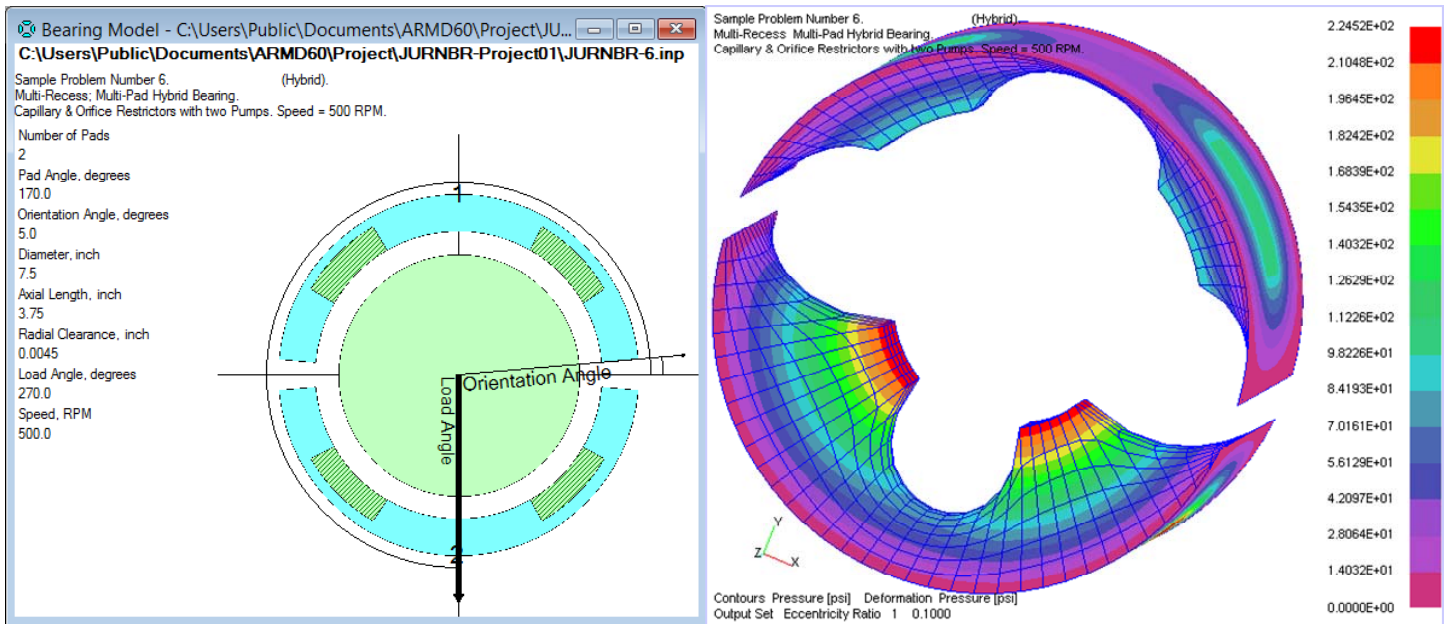
| | Pump Id | Pad Number | Axial1 | Axial2 | Circ1 | Circ2 | Flow Control | Capillary Diameter | Capillary Length | Viscosity | Orifice Diameter |
|---|---------|------------|--------|--------|-------|-------|--------------|--------------------|------------------|-----------|------------------|
| ▶ | 1 | 1 | 1.5 | 2.25 | 25 | 55 | Capillary | 0.03 | 1.5 | 0.0 | 0.0 |
| | 2 | 1 | 1.5 | 2.25 | 115 | 145 | Capillary | 0.03 | 1.5 | 0.0 | 0.0 |
| | 3 | 2 | 1.5 | 2.25 | 25.0 | 55 | Orifice | 0.0 | 0.0 | 0.0 | 0.04 |
| ▶ | 4 | 2 | 1.5 | 2.25 | 115.0 | 145 | Orifice | 0.0 | 0.0 | 0.0 | 0.04 |

Pumps

| | Pump Type | Flow Rate | Pressure |
|---|-----------|-----------|----------|
| ▶ | Pressure | 0.0 | 500.0 |
| | Flow Rate | 2.0 | 0.0 |

Circumferential Point Location 2: degrees

Hybrid bearing performance results are computed with each recess considered as having its own feeding system. The solution is bearing performance takes into account both the hydrostatic and hydrodynamic lubrication regimes, iteratively solving for flow and pressure in each recess.



ARMD™ V6.0 – JURNBR Module

➤ **Surface Deviation – Advanced Form.** Surface deviation is defined as modification to the bearing's nominal design geometry. With this capability, practically any bearing geometry imagined (herringbone and spiral grooving, full or partial axially tapered bore, structural deformation, etc.) can be modeled and evaluated with the software. The surface deviation magnitudes are superimposed clearances to the geometrical clearance distribution of the bearing for concentric shaft position. This surface deviation is a fixed magnitude of clearance modification regardless of shaft position in the bearing clearance due to applied load, speed, viscosity, attitude angle, etc.

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 axial and circumferential directions computed. Surface deviation may also be imported from external comma-separated-files (.CSV files).

The screenshot displays the ARMD V6.0 software interface, specifically the 'Surface Deviation' settings window. The 'Enable Surface Deviation' checkbox is checked. The 'Set Size' button is highlighted. The 'Current Grid Size' is set to Axial 15 and Circumferential 43. The 'Axial and Circumferential Locations' table is visible, showing increments and locations for both directions. Below the settings, a 'Surface Deviation Grid' window shows a grid of red and blue dots representing the bearing's geometry. The grid is labeled 'Mill Application Trunnion Deformation' and has a circumferential length of 140.0 degrees. The grid is overlaid on a 3D model of a bearing with a herringbone pattern. The grid is also overlaid on a 2D cross-section of the bearing, showing the 'Gearbox 3-Lobe with 50% Axially Tapered Bore' and a '3.0mm Drop' in the lower half. The grid is also overlaid on a 2D cross-section of the bearing, showing the 'Marine Application Tapered Bore Lower Half Only' and a '3.0mm Drop' in the lower half. The grid is also overlaid on a 2D cross-section of the bearing, showing the 'Mill Application Trunnion Deformation'.

| Axial Locations | | Circumferential Locations | |
|-----------------|-----------|---------------------------|-----------|
| Increments | Locations | Increments | Locations |
| 1 | 0.0 | 0.0 | 200.0 |
| 2 | 2.4016 | 2.4016 | 203.5 |
| 3 | 1.6929 | 4.0945 | 206.1 |
| 4 | 1.6929 | 5.7874 | 208.7 |
| 5 | 2.4016 | 8.189 | 211.3 |
| 6 | 2.6378 | 10.8268 | 213.9 |
| 7 | 1.9291 | 12.7559 | 216.5 |
| 8 | 1.9291 | 14.685 | 220.0 |
| 9 | 1.9292 | 16.6142 | 225.6 |
| | | 18.5433 | 230.3 |
| | | 21.1611 | 235.0 |

| | C001 | C002 | C003 |
|------|---------------|---------------|---------------|
| A001 | -1.500200e-03 | -1.795300e-03 | -2.006500e-03 |
| A002 | -1.365500e-03 | -1.786700e-03 | -2.103400e-03 |
| A003 | -1.267200e-03 | -1.781400e-03 | -2.174500e-03 |
| A004 | -1.162600e-03 | -1.767600e-03 | -0.002235 |
| A005 | -1.002600e-03 | -1.732300e-03 | -0.002303 |
| A006 | -7.968300e-04 | -1.650700e-03 | -2.322900e-03 |
| A007 | -6.290500e-04 | -1.559900e-03 | -2.293900e-03 |
| A008 | -4.406500e-04 | -1.423800e-03 | -2.200900e-03 |
| A009 | -2.380200e-04 | -1.276500e-03 | -2.092200e-03 |
| A010 | -1.629700e-05 | -1.090600e-03 | -1.930200e-03 |
| A011 | 3.136100e-04 | -7.829200e-04 | -1.632300e-03 |
| A012 | 6.404800e-04 | -4.609400e-04 | -1.306200e-03 |

ARMD™ V6.0 – JURNBR Module

Mathematical Expressions evaluator

Auto Convert

➤ **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.



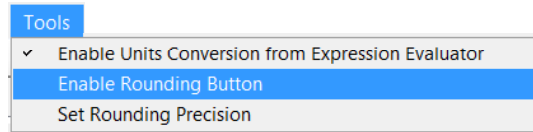
➤ **Whole Number.** Display for improved legibility, defaulting to scientific notation when required. Trailing zeros are implied out to seven significant digits.

➤ **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.



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

The screenshot displays the ARMD V6.0 JURNBR software interface. The main window is titled 'JURNBR (C:\Users\Public\Documents\ARMD60\Project\JURNBR-Project01\TaperedLand3Pads.inp SI)'. It features a menu bar (File, Edit, Bearing, Options, Advanced, Run Analysis, Post-Processor, View, Tools, Window, Project, Help) and a toolbar. The interface is divided into several panes:

- Bearing Model:** Shows 'Basic Geometry' and 'Symmetry' tabs. The 'Pad Profile' is set to 'Tapered Land'. Parameters include: Number of Pads (3), Pad Angle (100.0), Pad #1 Orientation Angle (220.0), Groove Angle (0.0), Preload Configuration (Film Angle: 0.0, Preload / Offset: 0.0), Step/Taper/Pocket (Apply To: All Pads, Side 1 Land / Step: 2.5, Side 2 Land / Step: 0.0), and Taper (Step: 0.0, Angle: 0.0, Height: 75.0, Taper: 0.05).
- Post-Processor:** Displays simulation results for 'Tapered-Pocket Journal - 75 Deg. Taper - MODELED WITH Three 100-Deg PADS'. Key parameters include: Diameter (25.0), Axial Length (25.0), Pad Angle (100.0), Orientation Angle (220.0), Number of Pads (3), Radial Clearance (0.025), Rotational Speed (8500.0), and Viscosity (6.894758E-03). It also shows operating conditions (Clearance: 0.0, Speed: 8500.0, Load: 250.0) and a table of results for Min. Film Thick., Power-Loss, Critical Mass, Max. Pressure, Supply Oil Temp., Supply Flow Rate, Film-Temp (avg), Viscosity, Groove Temp., and Max. Temp (avg).
- Bearing Model - C:\Users\Public\Documents\ARMD60\Project\JURNBR-Project01:** Shows a 3D model of the tapered-land bearing with three pads. Labels include: Radial Clearance (C = Rb - Rs), Pad Angle, Orientation Angle, Groove Angle, Taper Angle, Load Angle from X-axis, Radial Clearance, HT Taper Height, and W=Load.
- Pad Grid - C:\Users\Public\Documents\ARMD60\Project\JURNBR-Project01:** Shows a grid for the tapered-land bearing with three pads. Parameters include: Pad #1 of 3, Fixed grid, Axial symmetry, Circumferential Direction, Axial Direction (12.5 mm), and Pad grid model.
- BRGVU - [inter.juv]:** Shows a contour plot of pressure (Pascal) and deformation (Pascal) for the tapered-land bearing. The color scale ranges from 0.0000E+00 to 2.8535E+06.

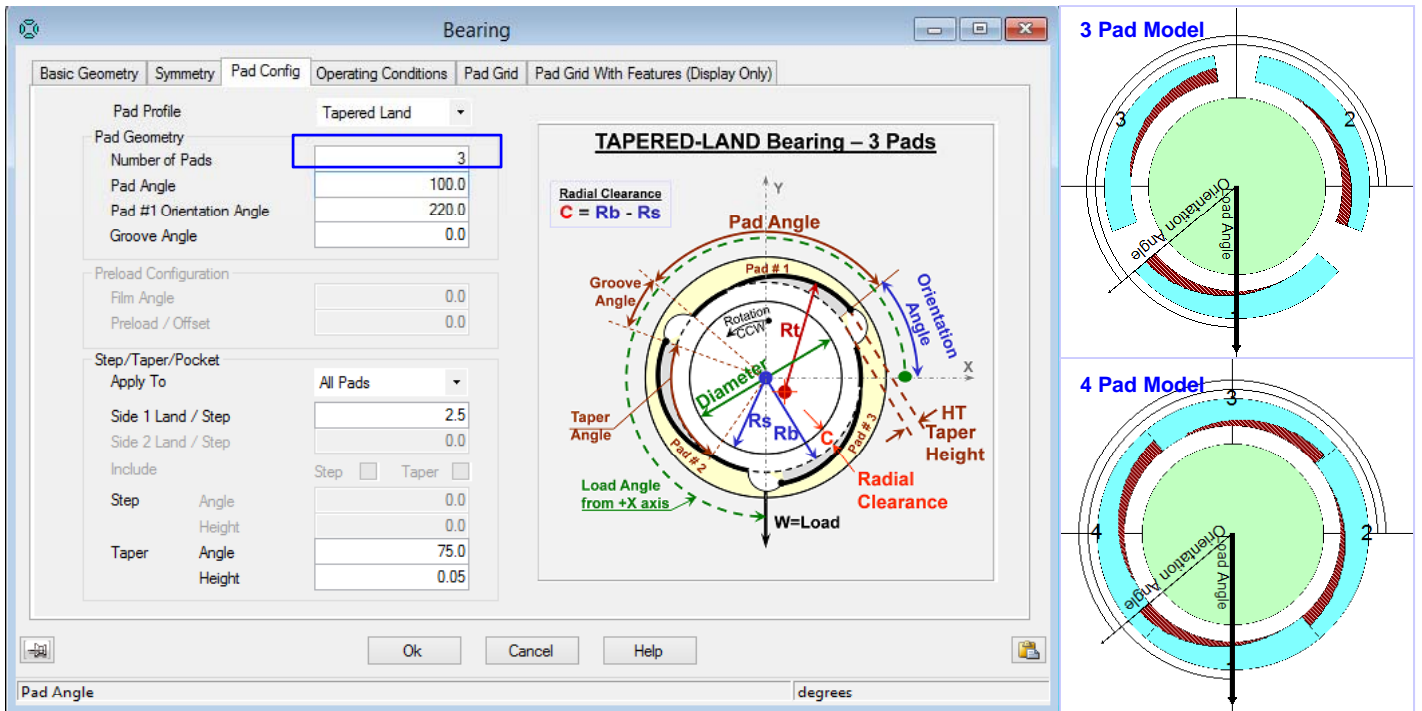
ARMD™ V6.0 – JURNBR Module

➤ **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.

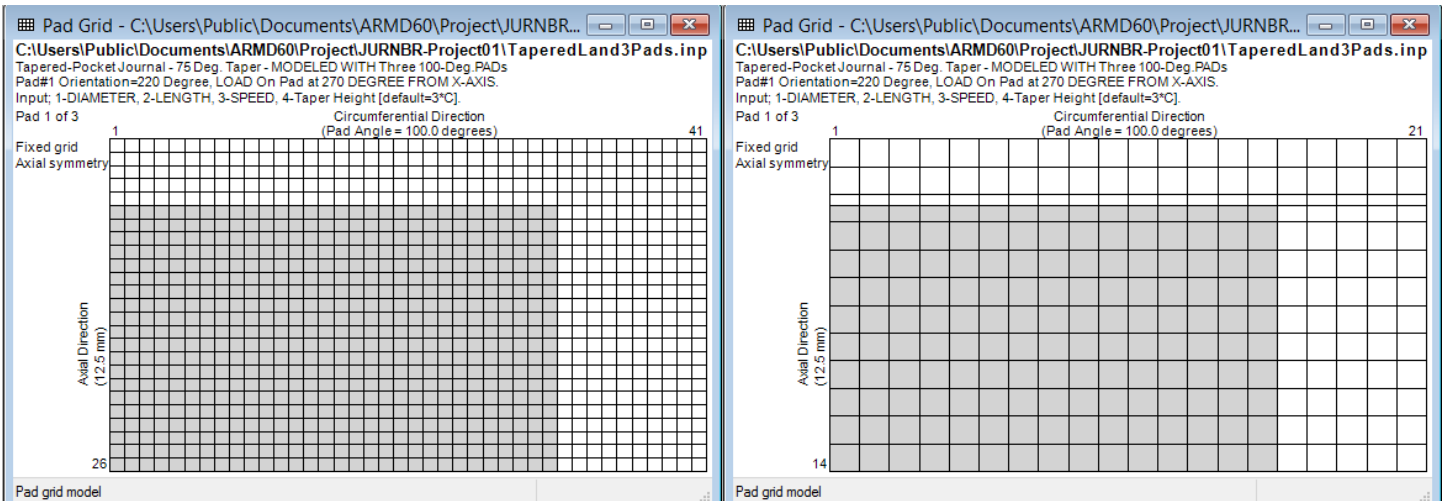
➤ **Quick Chart.** This feature rapidly displays an X-Y graph of entered tabular data for visual verification of correctness. ARMD Graph software is still available for complete graphic analysis capabilities.

➤ **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 3 to 4 will automatically modify the graphics model as shown below.



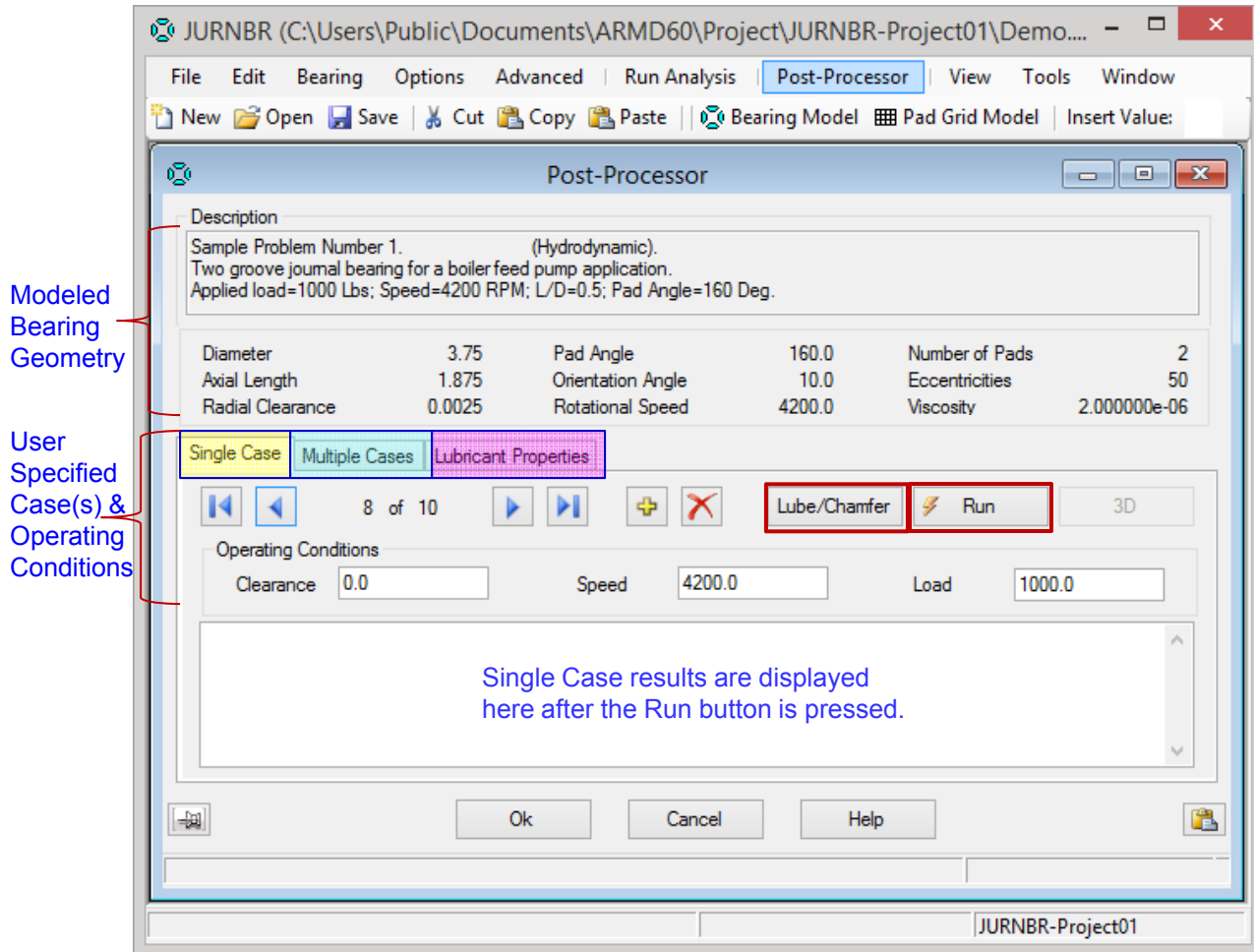
Modifying pad grid network size from 26 X 41 to 13 X 21 (shown below for axially symmetric grid) displays new grid model, including its feature of shrouded tapered land configuration added to the specified grid size.



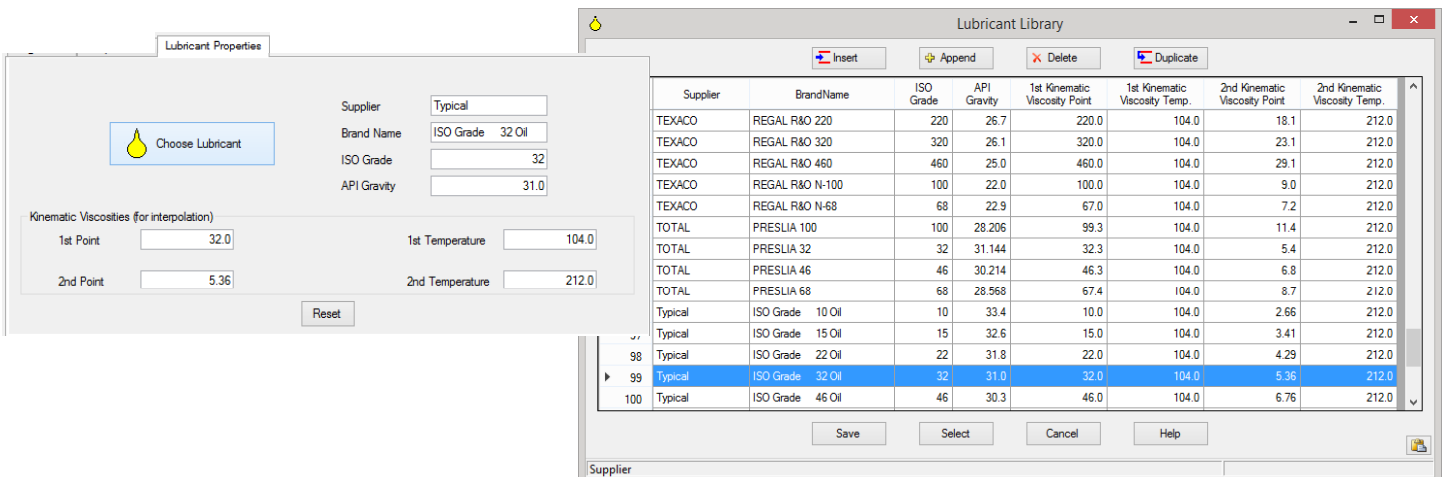
Metafile enabled copy and paste of bearing and pad grid graphics models for better reporting.

ARMD™ V6.0 – JURNBR Module

- **Post-Processor.** Following a complete bearing modeling and performance map solution as a function of eccentricity ratio, 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, Speed, Load, Viscosity, Flow Rate, Temperatures, Pressure, Chamfers geometry, etc.



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



ARMD™ V6.0 – JURNBR Module

Lube / Chamfers: Oil grooves feeding system in bearings and their geometrical chamfers may influence the bearing performance significantly in that the flow rate through the bearing is controlled by both the bearing internal clearances and grooves resistance to flow. This flow rate impacts the heat balance and temperature rise through the bearing which in turn influences the oil film viscosity thus affecting bearing performance. Three geometrical chamfers (triangular, rectangular and circular) shown below and commonly incorporated in bearings may be considered in the bearing heat balance model and analysis.

- Grooved
- Classical
- Grooved

Simulation can include the influence of either a pressurized feed system or a 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 conditions). When the flow type is set to "Grooved", the supply pressure and groove details (including chamfer type and dimensions) are to be specified by the user. Depending on the chamfer type selected, the required data will be displayed as illustrated below.

ARMD™ V6.0 – JURNBR Module

Single Case: Illustrated below, complete bearing performance results are generated when the *Run* button is pressed. The solution is performed for the user specified operating conditions taking into consideration the pressurized feeding system. Heat balance is performed for the overall bearing system, and for each individual pad in the bearing. **With the newly implemented algorithms, heat balance on pad-per-pad basis is performed for flooded and non-flooded environments.**

Modeled Bearing Details

| | | | | | |
|------------------|--------|-------------------|--------|----------------|--------------|
| Diameter | 3.75 | Pad Angle | 160.0 | Number of Pads | 2 |
| Axial Length | 1.875 | Orientation Angle | 10.0 | Eccentricities | 50 |
| Radial Clearance | 0.0025 | Rotational Speed | 4200.0 | Viscosity | 2.000000e-06 |

Complete Bearing Performance Results including bearing system heat balance and supply pressure considerations.

Operating Conditions: Clearance 0.0, Speed 4200.0, Load 3000.0

Heat balance calculation & temperature rise on a pad per pad basis for Flooded Environment.

| Individual Pad Heat Balance Results Estimate For FLOODED Environment | | | | | | |
|--|-------------------------|----------------------------------|----------------------------------|-----------------|------------------|--------------------|
| Pad Temperature No. | Sump/Groove (degree F.) | Avg-Film Temperature (degree F.) | Max-Film Temperature (degree F.) | Power Loss (hp) | Inlet Flow (gpm) | Side Leakage (gpm) |
| 1 | 1.3000E+02 | 1.3625E+02 | 1.4251E+02 | 3.4069E-01 | -3.4514E-01 | 3.9333E-02 |
| 2 | 1.3000E+02 | 1.5664E+02 | 1.8328E+02 | 1.5101E+00 | -5.3251E-01 | 3.8769E-01 |

Heat balance calculation & temperature rise on a pad per pad basis for Non-Flooded Environment / direct lubricant feed system.

| Individual Pad Heat Balance Results Estimate For NON-Flooded Environment | | | | | | |
|--|-------------------------|----------------------------------|----------------------------------|-----------------|------------------|--------------------|
| Pad Temperature No. | Sump/Groove (degree F.) | Avg-Film Temperature (degree F.) | Max-Film Temperature (degree F.) | Power Loss (hp) | Inlet Flow (gpm) | Side Leakage (gpm) |
| 1 | 1.2763E+02 | 1.3389E+02 | 1.4014E+02 | 3.4069E-01 | -3.4514E-01 | 3.9333E-02 |
| 2 | 1.2208E+02 | 1.4872E+02 | 1.7536E+02 | 1.5101E+00 | -5.3251E-01 | 3.8769E-01 |

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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. Parametric evaluation of bearing performance is accomplished efficiently.

Expand button if pressed will expand the window to the full width of the parent window which provides a quick view of all the columns for efficient data entry and modifications.

Post-Processor

Description
Sample Problem Number 1. (Hydrodynamic).
Two groove journal bearing for a boiler feed pump application.
Applied load=1000 Lbs; Speed=4200 RPM; L/D=0.5; Pad Angle=160 Deg.

Diameter 3.75 Pad Angle 160.0 Number of Pads 2
Axial Length 1.875 Orientation Angle 10.0 Eccentricities 50
Radial Clearance 0.0025 Rotational Speed 4200.0 Viscosity 2.000000e-06

Single Case **Multiple Cases** Lubricant Properties

Expand Run

| | Radial Clearance | Speed | Load | Use Lube Viscosity / Heat Content | Specified Viscosity | Specified Heat Content | Film Temperat |
|---|------------------|--------|--------|-----------------------------------|---------------------|------------------------|---------------|
| 1 | 0.0 | 500.0 | 1000.0 | <input type="checkbox"/> | 0.0 | 0.0 | |
| 2 | 0.0 | 1000.0 | 1000.0 | <input type="checkbox"/> | 0.0 | 0.0 | |
| 3 | 0.0 | 1500.0 | 1000.0 | <input type="checkbox"/> | 0.0 | 0.0 | |

Multiple Cases

Restore Run

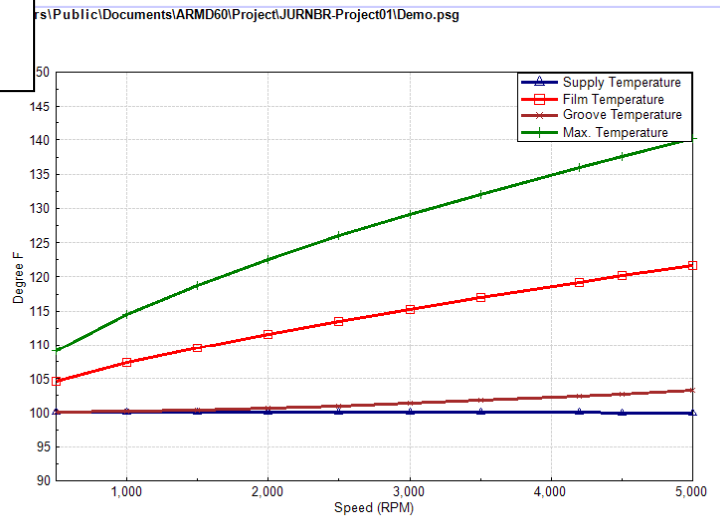
| | Radial Clearance | Speed | Load | Use Lube Viscosity / Heat Content | Specified Viscosity | Specified Heat Content | Film Temperature | Supply Temperature | Flow Rate | Flow Type | Chamfer Type | Supply Pressure | Orifice Diameter | Groove Length | Chamfer Depth | Chamfer Size |
|----|------------------|--------|--------|-----------------------------------|---------------------|------------------------|------------------|--------------------|-----------|-----------|--------------|-----------------|------------------|---------------|---------------|--------------|
| 1 | 0.0 | 500.0 | 1000.0 | <input type="checkbox"/> | 0.0 | 0.0 | 0.0 | 100.0 | 1.0 | Grooved | Triangular | 20.0 | 0.5 | 1.5 | 0.125 | 90.0 |
| 2 | 0.0 | 1000.0 | 1000.0 | <input type="checkbox"/> | 0.0 | 0.0 | 0.0 | 100.0 | 1.0 | Grooved | Triangular | 20.0 | 0.5 | 1.5 | 0.125 | 90.0 |
| 3 | 0.0 | 1500.0 | 1000.0 | <input type="checkbox"/> | 0.0 | 0.0 | 0.0 | 100.0 | 1.0 | Grooved | Triangular | 20.0 | 0.5 | 1.5 | 0.125 | 90.0 |
| 4 | 0.0 | 2000.0 | 1000.0 | <input type="checkbox"/> | 0.0 | 0.0 | 0.0 | 100.0 | 1.0 | Grooved | Triangular | 20.0 | 0.5 | 1.5 | 0.125 | 90.0 |
| 5 | 0.0 | 2500.0 | 1000.0 | <input type="checkbox"/> | 0.0 | 0.0 | 0.0 | 100.0 | 1.0 | Grooved | Triangular | 20.0 | 0.5 | 1.5 | 0.125 | 90.0 |
| 6 | 0.0 | 3000.0 | 1000.0 | <input type="checkbox"/> | 0.0 | 0.0 | 0.0 | 100.0 | 1.0 | Grooved | Triangular | 20.0 | 0.5 | 1.5 | 0.125 | 90.0 |
| 7 | 0.0 | 3500.0 | 1000.0 | <input type="checkbox"/> | 0.0 | 0.0 | 0.0 | 100.0 | 1.0 | Grooved | Triangular | 20.0 | 0.5 | 1.5 | 0.125 | 90.0 |
| 8 | 0.0 | 4200.0 | 1000.0 | <input type="checkbox"/> | 0.0 | 0.0 | 0.0 | 100.0 | 1.0 | Grooved | Triangular | 20.0 | 0.5 | 1.5 | 0.125 | 90.0 |
| 9 | 0.0 | 4500.0 | 1000.0 | <input type="checkbox"/> | 0.0 | 0.0 | 0.0 | 100.0 | 1.0 | Grooved | Triangular | 20.0 | 0.5 | 1.5 | 0.125 | 90.0 |
| 10 | 0.0 | 5000.0 | 1000.0 | <input type="checkbox"/> | 0.0 | 0.0 | 0.0 | 100.0 | 1.0 | Grooved | Triangular | 20.0 | 0.5 | 1.5 | 0.125 | 90.0 |

Ok Cancel Help

Multiple case bearing performance results are automatically displayed in text format as illustrated below. The ARMD graphics utility can be used to display X-Y plots of any of the generated results.

| Case No. | ECC Ratio | Load-Angle (Degree) Input | ECC-Angle (Degree) | Clearance (inch) Input | Minimum-C (inch) | ECC (inch) |
|----------|-----------|---------------------------|--------------------|------------------------|------------------|------------|
| 1 | 0.757 | 2.700E+02 | 3.036E+02 | 2.500E-03 | 6.075E-04 | 1.893E-03 |
| 2 | 0.657 | 2.700E+02 | 3.101E+02 | 2.500E-03 | 8.568E-04 | 1.643E-03 |
| 3 | 0.590 | 2.700E+02 | 3.142E+02 | 2.500E-03 | 1.025E-03 | 1.475E-03 |
| 4 | 0.540 | 2.700E+02 | 3.172E+02 | 2.500E-03 | 1.152E-03 | 1.349E-03 |
| 5 | 0.500 | 2.700E+02 | 3.195E+02 | 2.500E-03 | 1.251E-03 | 1.250E-03 |
| 6 | 0.468 | 2.700E+02 | 3.215E+02 | 2.500E-03 | 1.331E-03 | 1.169E-03 |
| 7 | 0.441 | 2.700E+02 | 3.231E+02 | 2.500E-03 | 1.398E-03 | 1.102E-03 |
| 8 | 0.410 | 2.700E+02 | 3.249E+02 | 2.500E-03 | 1.474E-03 | 1.026E-03 |
| 9 | 0.399 | 2.700E+02 | 3.256E+02 | 2.500E-03 | 1.502E-03 | 9.980E-04 |
| 10 | 0.383 | 2.700E+02 | 3.267E+02 | 2.500E-03 | 1.544E-03 | 9.563E-04 |

| Case No. | Supply Flow-Rate (gpm) | Side Leakage (gpm) | Total Inlet-Flow (gpm) | Power Lose (hp) | Critical Mass (lbt) | Maximum Pressure (psi) |
|----------|------------------------|--------------------|------------------------|-----------------|---------------------|------------------------|
| 1 | 8.879E+00 | 5.167E-02 | -1.038E-01 | 6.568E-02 | 9.651E+05 | 4.868E+02 |
| 2 | 8.914E+00 | 9.536E-02 | -2.135E-01 | 2.070E-01 | 9.602E+04 | 4.223E+02 |
| 3 | 8.944E+00 | 1.337E-01 | -3.259E-01 | 4.049E-01 | 3.514E+04 | 3.911E+02 |
| 4 | 8.980E+00 | 1.682E-01 | -4.398E-01 | 6.534E-01 | 1.927E+04 | 3.719E+02 |
| 5 | 9.003E+00 | 1.996E-01 | -5.547E-01 | 9.477E-01 | 1.230E+04 | 3.597E+02 |
| 6 | 9.035E+00 | 2.285E-01 | -6.703E-01 | 1.280E+00 | 8.333E+03 | 3.489E+02 |
| 7 | 9.055E+00 | 2.556E-01 | -7.864E-01 | 1.648E+00 | 6.060E+03 | 3.412E+02 |
| 8 | 9.090E+00 | 2.909E-01 | -9.494E-01 | 2.221E+00 | 4.189E+03 | 3.332E+02 |
| 9 | 9.102E+00 | 3.053E-01 | -1.019E+00 | 2.485E+00 | 3.649E+03 | 3.304E+02 |
| 10 | 9.129E+00 | 3.284E-01 | -1.136E+00 | 2.945E+00 | 2.971E+03 | 3.262E+02 |

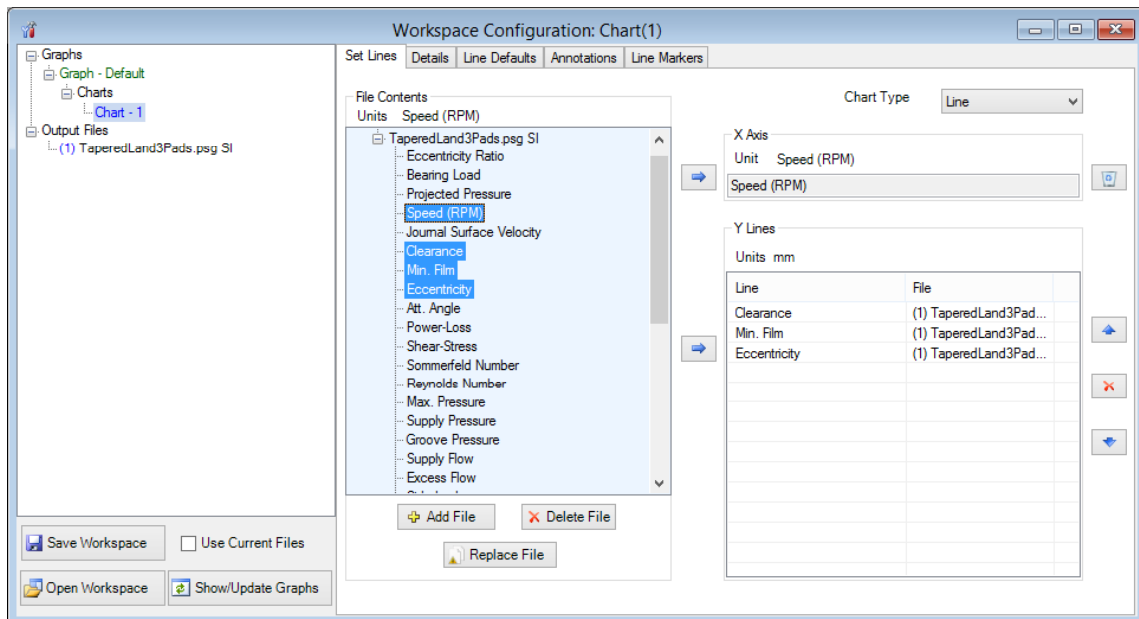


2-D Graphics Utility (ARMDGraph)

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.

The workspace configuration form consists of two panels. The left panel contains a tree view of the graphs, charts, and graphic output files. The right panel contains all chart and graph settings.



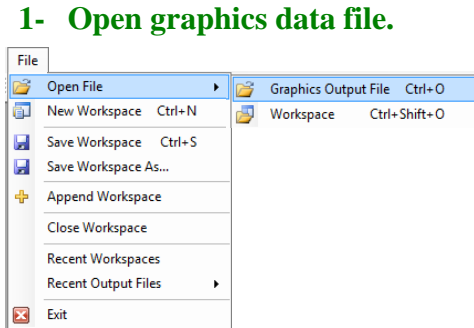
ARMDGraph features include:

- 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.
 - Grid lines (ON or OFF).
 - Draw curves with lines, symbols or both.
 - Automatic or manual axis scaling.
 - Legend position (hidden, inside or outside right).
 - Macro strings for flexible title assignment.

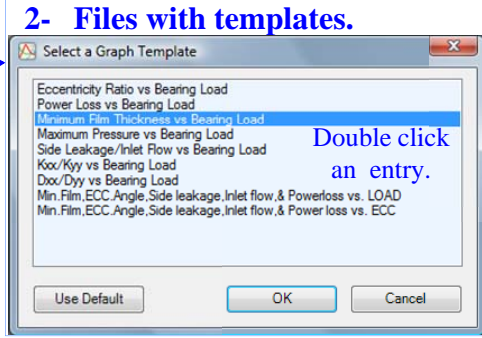
Graphics Utility (ARMDGraph)

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.

1- Open graphics data file.



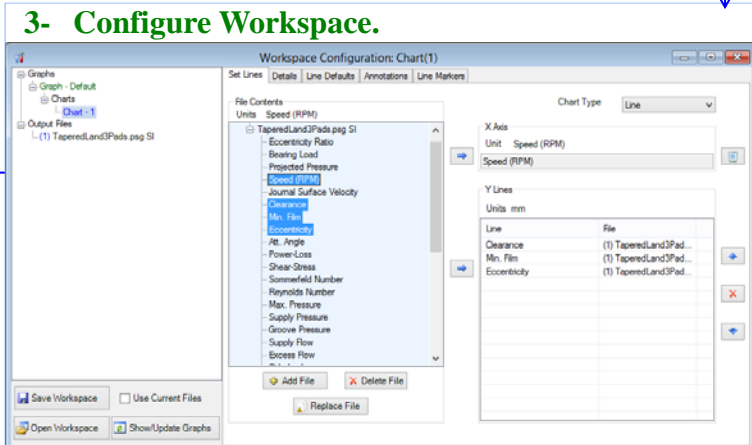
2- Files with templates.



Double click an entry.

2- Files with no templates.

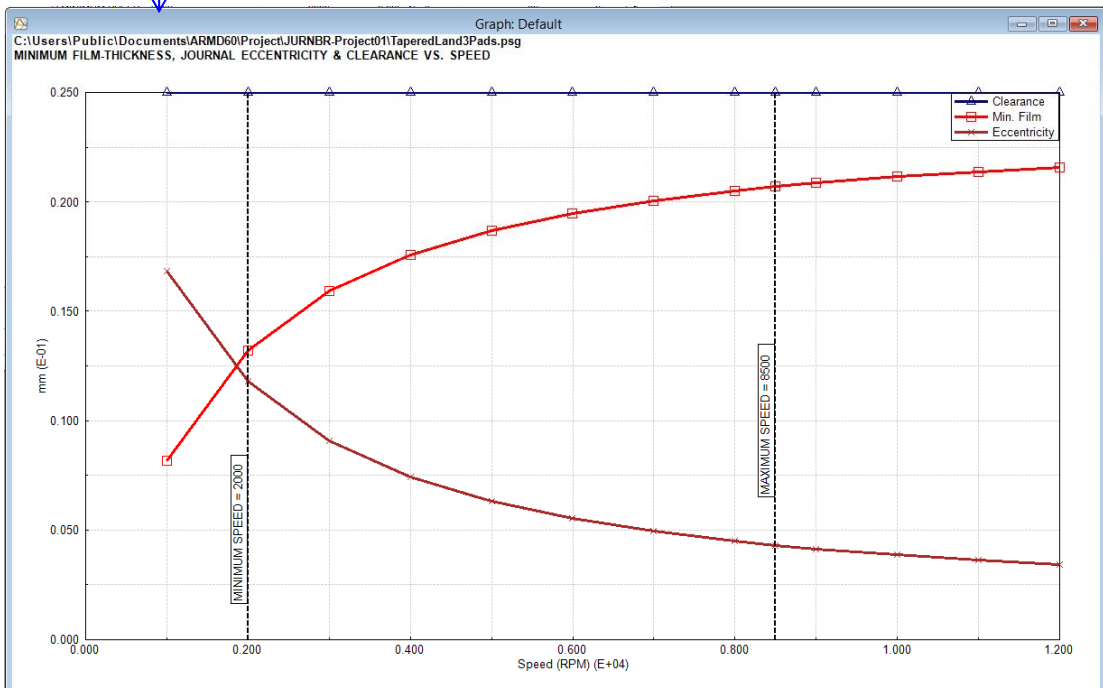
3- Configure Workspace.



4- Press "Show/Update Graphs" button to display the chart/graph window.

Graph: Default

C:\Users\Public\Documents\ARMD60\Project\JURNBR-Project01\TaperedLand3Pads.psg
MINIMUM FILM-THICKNESS, JOURNAL ECCENTRICITY & CLEARANCE VS. SPEED



| Speed (RPM) (E+04) | Clearance (mm) (E-01) | Min. Film (mm) (E-01) | Eccentricity (mm) (E-01) |
|--------------------|-----------------------|-----------------------|--------------------------|
| 0.000 | 0.250 | 0.080 | 0.170 |
| 0.200 | 0.250 | 0.130 | 0.130 |
| 0.400 | 0.250 | 0.170 | 0.090 |
| 0.600 | 0.250 | 0.190 | 0.060 |
| 0.800 | 0.250 | 0.200 | 0.050 |
| 1.000 | 0.250 | 0.210 | 0.045 |
| 1.200 | 0.250 | 0.220 | 0.040 |

Purchasing Options

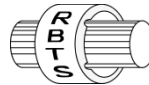
ARMD is constructed from various solution modules. It can be tailored to suit your needs and budget. You may purchase any combination of programs/modules or all if you wish. Licensing is available as a single seat or multi-seat network configuration. With your purchase, the package includes the software (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 7, 8, 10 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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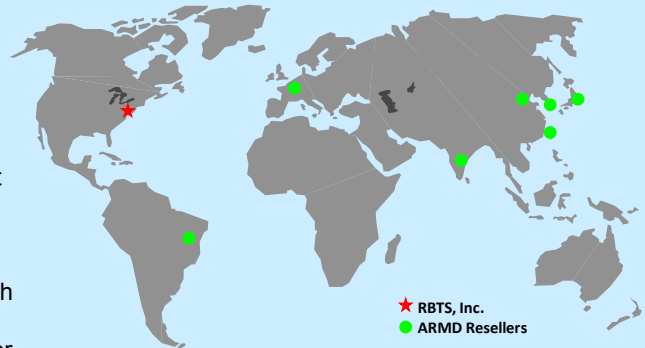
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