# How to use the Morton Effect Addin for *XL**ROTOR***

## Opening the Morton Effect Addin

To use the Morton Effect (ME) program, the program file named Morton VBA code.xla must be opened manually. This file is located in the XLRotor program folder. The file can be opened by double clicking on it. To make the file easier to open, put a shortcut to it in a convenient place like on the Desktop. When this file is open, a custom toolbar appears in Excel 2003, or a menu appears on the Add-Ins ribbon tab in Excel 2007/2010.

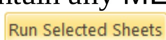
Excel 2003


Excel 2007 and later

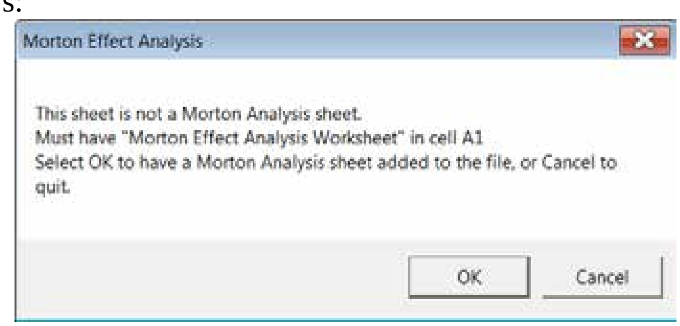

If the XLHydrodyn program is not already loaded when the ME addin is opened, the ME addin will open it, in which case the XLHydrodyn splash box will appear. The ME addin does not have its own splash box.

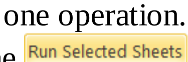
When you close Excel, the ME toolbar menu is deleted. This means you need to open the addin file each time you want to use it.

## Running a ME Analysis

An ME analysis is launched from a ME worksheet that looks like the sample given below. In an XLRotor file that doesn't contain any ME Sheets, or if an ME Sheet is not the currently displayed sheet, clicking the 

button will offer to add a ME Sheet to the file as follows:




The inputs and outputs appearing on this sheet are explained in later sections. Keep in mind that you can select more than one ME Sheet tab before clicking the button, and the program will run all sheets in succession, one ME Sheet at a time, in one operation. The following is a list of the actions performed by the program when you click the 

button.

1) Save a copy of whatever is currently on the Brg's sheet.
2) Check the specifications on the Imb's sheet to make sure only a single imbalance has been specified, and that its phase angle is zero. This imbalance should be at an axial location either at or close to the center of gravity of the overhung weight, but this is not checked by the program.

3) Start a loop to run each of the selected ME Sheets.
   a) Go to the XLHydrodyn sheet associated with the first ME Sheet, and Run that sheet to make sure it is up to date.
   b) Copy from the ME Sheet to the Brg's sheet the table of bearing station numbers and Links.
   c) Run a Response analysis so the Resp sheet will contain responses for the current case. Note that this analysis is done using whatever imbalance is on the Imb's sheet, and responses will scaled up or down as needed to correspond to the input value of Umech.
   d) Start a loop for each speed in the speed range specified on the ME Sheet.
      i) On the XLHydrodyn sheet, set it to run the current speed (i.e. a one speed case)
      ii) Run the XLHydrodyn sheet and save the static eccentricity and load components.
      iii) Start a loop for the number of specified orbit points.
         (1) On the XLHydrodyn sheet set either the eccentricity (or load) for this orbit point. Whether it is eccentricity or load that is set is explained later.
         (2) Run the XLHydrodyn sheet to get the load (or eccentricity), and put copies of the resulting eccentricity and load components on the Morton Orbit sheet.
         (3) Copy the entire circumferential temperature profile from the P+T Circ. Prof. sheet to the Morton T sheet.
         *(4) Loop back to do all orbit points.*
      iv) Process the temperature data saved on the Morton T sheet during the orbit point loop to determine the 360 degree circumferential temperature profile for the shaft surface for this speed, and write the resulting peak overall shaft delta T to the output table on the ME Sheet.
      v) Write all other output values for this speed on the ME Sheet.
      *vi) Loop back to do all speeds.*

*4) Loop back to do all* ME Sheets.

# Morton Effect Worksheet

**Morton Effect Analysis Worksheet**

| | | | |
|---|---|---|---|
| 2 Pad | | | |
| Bearing D | 3 | inches | Bearing D=3"Bearing L=1"Umech=0.1 oz-inCTE=0.000007Weight=1792 ozLweight=6"Hot Spot Lag=30 |
| Bearing L | 1 | inches | |
| Umech | 0.1 | oz-in | |
| CTE | 7.00E-06 | -/F | |
| Weight | 1792 | oz | |
| Lweight | 6 | in | |
| MinRpm | 5000 | rpm | |
| MaxRpm | 10000 | rpm | |
| Which Brg | 2 | | |
| Which Resp | 2 | | |
| # Orb Pts | 20 | | |
| Hot Spot Lag | 30 | | |
| Morton Analysis Type | Imb Disp Orbit | | |
| Specified Orbit Size | 0.1 | | |

| STN 1 # | STN 2 # | Link (Paste Special in here) |
|---|---|---|
| 3 | | User defined bearing coefficients |
| 15 | | 2 pad bearing |
| | | |

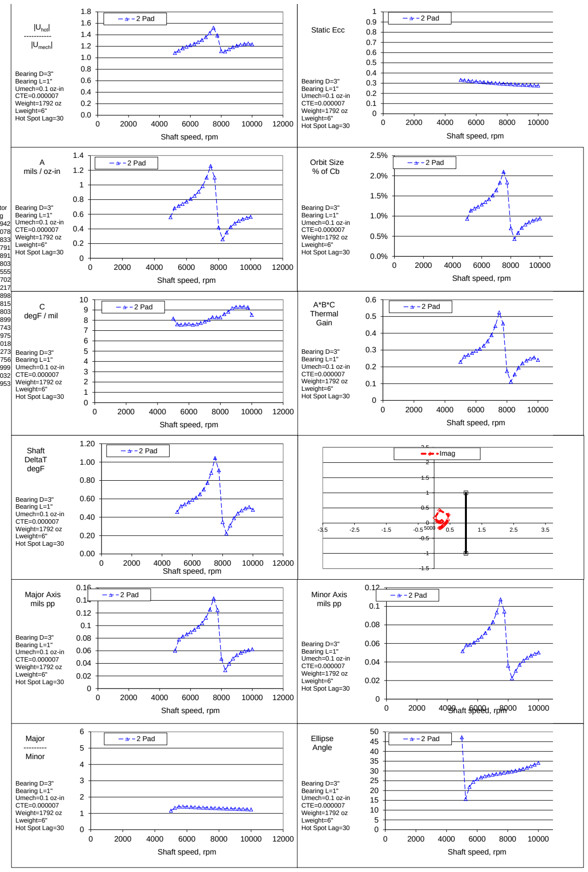
**All Output Below This Row**

This calculation was done 5/17/2013 9:28:18 AM, Morton code version = 5/10/2013 11:42:59 PM, in 99.46 sec

Sample rotor with 2 disks, one midspan, one overhungWith both bearings embedded in the rotor model file

| # | Speed | Umech | Utherm | Uhot | DeltaT | Lag | Uhot/Umech | phi | Orbit Size | Static Ecc |
|---|---|---|---|---|---|---|---|---|---|---|
| -- | rpm | oz-in | oz-in | oz-in | F | degrees | -- | deg | -- | -- |
| 40 | 5000 | 0.1 | 0.0 | 0.1 | 0.46 | 106 | 1.1 | -11.7 | 0.9% | 0.333034 |
| 41 | 5250 | 0.1 | 0.0 | 0.1 | 0.5 | 112 | 1.1 | -12.4 | 1.1% | 0.328531 |
| 42 | 5500 | 0.1 | 0.0 | 0.1 | 0.5 | 122 | 1.2 | -11.4 | 1.2% | 0.324339 |
| 43 | 5750 | 0.1 | 0.0 | 0.1 | 0.6 | 128 | 1.2 | -10.8 | 1.2% | 0.320367 |
| 44 | 6000 | 0.1 | 0.0 | 0.1 | 0.6 | 133 | 1.2 | -10.3 | 1.3% | 0.316517 |
| 45 | 6250 | 0.1 | 0.0 | 0.1 | 0.6 | 137 | 1.2 | -9.7 | 1.3% | 0.313024 |
| 46 | 6500 | 0.1 | 0.0 | 0.1 | 0.6 | 142 | 1.3 | -9.1 | 1.4% | 0.309643 |
| 47 | 6750 | 0.1 | 0.0 | 0.1 | 0.7 | 147 | 1.3 | -8.4 | 1.5% | 0.306456 |
| 48 | 7000 | 0.1 | 0.0 | 0.1 | 0.8 | 154 | 1.4 | -7.3 | 1.6% | 0.303437 |
| 49 | 7250 | 0.1 | 0.0 | 0.1 | 0.9 | 163 | 1.4 | -5.2 | 1.8% | 0.300443 |
| 50 | 7500 | 0.1 | 0.1 | 0.2 | 1.0 | 181 | 1.5 | 0.4 | 2.1% | 0.29773 |
| 51 | 7750 | 0.1 | 0.0 | 0.1 | 0.9 | 218 | 1.4 | 11.7 | 1.8% | 0.295148 |
| 52 | 8000 | 0.1 | 0.0 | 0.1 | 0.3 | 232 | 1.1 | 7.1 | 0.7% | 0.292558 |
| 53 | 8250 | 0.1 | 0.0 | 0.1 | 0.2 | 183 | 1.1 | 0.3 | 0.4% | 0.29022 |
| 54 | 8500 | 0.1 | 0.0 | 0.1 | 0.3 | 163 | 1.1 | -2.3 | 0.6% | 0.287989 |
| 55 | 8750 | 0.1 | 0.0 | 0.1 | 0.4 | 159 | 1.2 | -3.3 | 0.7% | 0.285731 |
| 56 | 9000 | 0.1 | 0.0 | 0.1 | 0.4 | 160 | 1.2 | -3.6 | 0.8% | 0.283741 |
| 57 | 9250 | 0.1 | 0.0 | 0.1 | 0.5 | 161 | 1.2 | -3.6 | 0.8% | 0.281756 |
| 58 | 9500 | 0.1 | 0.0 | 0.1 | 0.5 | 162 | 1.2 | -3.5 | 0.9% | 0.279848 |
| 59 | 9750 | 0.1 | 0.0 | 0.1 | 0.5 | 164 | 1.2 | -3.3 | 0.9% | 0.277876 |
| 60 | 10000 | 0.1 | 0.0 | 0.1 | 0.5 | 165 | 1.2 | -2.9 | 0.9% | 0.276123 |

| # | A | B | C | ABC | MajorAxis | MinorAxis | Maj/Min | Ell Angle | ABC Stability Vector Real | Imag |
|---|---|---|---|---|---|---|---|---|---|---|
| -- | mils p-p/oz-in | oz-in/F | F/mils p-p | -- | mils p-p | mils p-p | -- | deg | Real | Imag |
| 40 | 0.560049 | 0.050176 | 8.17178 | 0.229636 | 0.06021 | 0.051635 | 1.166078 | 47.2129 | 0.16528 | -0.15942 |
| 41 | 0.683687 | 0.050176 | 7.612156 | 0.261132 | 0.077921 | 0.058093 | 1.341326 | 15.71184 | 0.205769 | -0.16078 |
| 42 | 0.713788 | 0.050176 | 7.571798 | 0.271184 | 0.082978 | 0.058741 | 1.412599 | 21.90692 | 0.238895 | -0.12833 |
| 43 | 0.74117 | 0.050176 | 7.606387 | 0.282873 | 0.08619 | 0.060961 | 1.413866 | 24.48685 | 0.261482 | -0.10791 |
| 44 | 0.772824 | 0.050176 | 7.634761 | 0.296055 | 0.089612 | 0.063872 | 1.402993 | 25.85506 | 0.282389 | -0.08891 |
| 45 | 0.809194 | 0.050176 | 7.575793 | 0.307593 | 0.09349 | 0.067278 | 1.389606 | 26.71295 | 0.299977 | -0.06803 |
| 46 | 0.852453 | 0.050176 | 7.623074 | 0.32606 | 0.098124 | 0.071304 | 1.376132 | 27.31312 | 0.322862 | -0.04555 |
| 47 | 0.907428 | 0.050176 | 7.73659 | 0.352255 | 0.104077 | 0.076341 | 1.363331 | 27.76893 | 0.351844 | -0.01702 |
| 48 | 0.98373 | 0.050176 | 7.877731 | 0.388842 | 0.112447 | 0.083205 | 1.35144 | 28.14074 | 0.388087 | 0.024217 |
| 49 | 1.09936 | 0.050176 | 8.034267 | 0.443182 | 0.125266 | 0.093447 | 1.340498 | 28.46568 | 0.431776 | 0.099898 |
| 50 | 1.258967 | 0.050176 | 8.298301 | 0.524203 | 0.143029 | 0.107504 | 1.330453 | 28.76972 | 0.448224 | 0.271815 |
| 51 | 1.100978 | 0.050176 | 8.283798 | 0.457619 | 0.124735 | 0.09441 | 1.321204 | 29.07312 | 0.170171 | 0.424803 |
| 52 | 0.419439 | 0.050176 | 8.288314 | 0.174434 | 0.047397 | 0.036109 | 1.312614 | 29.393 | 0.023092 | 0.172899 |
| 53 | 0.258864 | 0.050176 | 8.600223 | 0.111706 | 0.02918 | 0.022368 | 1.304517 | 29.74476 | 0.093748 | 0.060743 |
| 54 | 0.351231 | 0.050176 | 8.832116 | 0.155652 | 0.039496 | 0.030458 | 1.296721 | 30.14262 | 0.151898 | 0.033975 |
| 55 | 0.425459 | 0.050176 | 9.162536 | 0.1956 | 0.047727 | 0.037027 | 1.288998 | 30.6 | 0.192962 | 0.032018 |
| 56 | 0.474862 | 0.050176 | 9.293465 | 0.221432 | 0.053136 | 0.041477 | 1.281088 | 31.12951 | 0.218273 | 0.037273 |
| 57 | 0.508791 | 0.050176 | 9.314647 | 0.237795 | 0.056779 | 0.044614 | 1.27269 | 31.74283 | 0.233545 | 0.044756 |
| 58 | 0.533077 | 0.050176 | 9.313692 | 0.249119 | 0.059311 | 0.046944 | 1.263457 | 32.45037 | 0.243417 | 0.052999 |
| 59 | 0.551088 | 0.050176 | 9.254817 | 0.255909 | 0.061104 | 0.048767 | 1.252991 | 33.26056 | 0.248524 | 0.061032 |
| 60 | 0.564857 | 0.050176 | 8.517547 | 0.241406 | 0.062376 | 0.050269 | 1.240842 | 34.17846 | 0.233054 | 0.062953 |




Every ME Sheet contains the following:

- An input table in the upper left corner
- An output table below the input table
- A set of 12 charts that display values from the output table.

At the conclusion of a run, for the last speed point of the last ME Sheet analyzed:

- The sheet named [Morton T] will contain the XLHydrodyn temperature data for each orbit point
- The sheet named [Morton Orbit] will contain the shaft surface temperature profile and orbits for displacement and force

# ME Input Table

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | Morton Effect Analysis Worksheet | | | | | |
| 2 | 2 Pad | | | | | |
| 3 | Bearing D | 3 | inches | Bearing D=3"Bearing L=1"Umech= | | |
| 4 | Bearing L | 1 | inches | | | |
| 5 | Umech | 0.1 | oz-in | | | |
| 6 | CTE | 7.00E-06 | -/F | | | |
| 7 | Weight | 1792 | oz | | | |
| 8 | Lweight | 6 | in | | | |
| 9 | MinRpm | 5000 | rpm | | | |
| 10 | MaxRpm | 10000 | rpm | | | |
| 11 | Which Brg | 2 | | | | |
| 12 | Which Resp | 1 | | | | |
| 13 | # Orb Pts | 20 | | | | |
| 14 | Hot Spot Lag | 30 | | | | |
| 15 | Morton Analysis Type | | Imb Disp Orbit | | | |
| 16 | Specified Orbit Size | | 0.1 | | | |
| 17 | STN 1 | STN 2 | Link (Paste Special in here) | | | |
| 18 | # | # | | | | |
| 19 | 3 | | User defined bearing coefficients | | | |
| 20 | 15 | | 5 pad bearing | | | |
| 21 | | | | | | |
| 22 | | | | | | |
| 23 | All Output Below This Row | | | | | |

### Sheet Name

Cell A2 contains the name on the worksheet tab. The following cell formula is used which returns the name from the sheet tab.

=MID(CELL("filename",$A$1),SEARCH("]",CELL("filename",$A$1))+1,255)

The following are the ME inputs which appear in column B. The inputs specify the parameters of the bearing at which ME is occurring, the amount and location of the overhung weight, and options which govern certain aspects of the ME analysis. The bearing at which ME is occurring must be modeled separately on an XLHydrodyn worksheet.

### Bearing D

This is the diameter of the shaft in the bearing, and would generally be the same as the diameter on the corresponding XLHydrodyn sheet. The units for this value must be the same as the units on the Shaft Input sheet.

### Bearing L

This is the axial length of the shaft in the bearing, and would generally be the same as the length on the corresponding XLHydrodyn sheet. The units for this value must be the same as the units for Bearing D.

### Umech

The nominal imbalance of the overhung weight (could be before or after balancing at the balance shop). This is not a critical input, but it should not be too small or too large. A good value would be an amount that produces a synchronous response at the bearing in the range of 2% to 10% of the bearing clearance. The units for this value must be the same as the units on the Imb's sheet. The program always uses zero degrees for the phase angle of Umech.

### CTE

Coefficient of Thermal Expansion of the shaft material. This is a very important input. Typical value for steel is around 7E-6 1/°F. The temperature units for this value must be the same as the temperature units on the XLHydrodyn sheet.

### Weight

The amount of the overhung weight. When ME causes thermal bow, the overhung weight will be thrown out of balance. The units for this value must be the same as the weight part of the units for Umech. This is very important. In most cases, this will be ounces or grams, and not pounds or kilograms.

### LWeight

This is the axial length from the midline of the ME bearing, to the center of gravity of the overhung weight. The units for this value must be the same as the units for Bearing D.

### MinRpm & MaxRpm

These two inputs specify the speed range over which to run the ME analysis. Response Speeds values on the Imb's sheet that fall between MinRpm & MaxRpm will be the actual speed values at which the ME analysis is performed.

### Which Brg

This is a number to identify which bearing on the Brg's worksheet is the ME bearing. For instance, an input of 1 would designate the first bearing listed on the Brg's sheet.

### Which Resp

This number identifies which response output on the Imb's worksheet should be used for the ME analysis. This should be the relative response at the bearing film, but the program does not check this.

### # Orbit Points

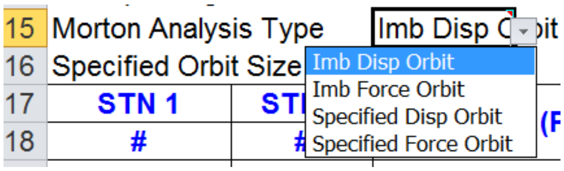
At each speed, the ME analysis covers one orbit of the shaft. This is the number of equally spaced points to use in traversing the orbit. We recommend 24 points. The execution time of the ME analysis is proportional to this input.

### Hot Spot Lag

This is an angle in degrees from the "high spot" to the "hot spot". The "high spot" is the spot on the shaft that experiences the minimum film thickness during each orbit. When there is no "hot spot lag", the "high spot" and "hot spot" are the same spot. This input value would normally be between 0 and +60 degrees according to the small amount of temperature measurements published in the open literature. After running an ME analysis, this input can be changed and the ME analysis does not need to be re-run. The result of the change can be seen immediately in the plots and in the summary table. If you don't see a change, auto-recalculation may be turned off, so press F9 to recalculate the sheet.

Test data has shown that the highest temperature is not exactly at the shaft spot that experiences the minimum film thickness. It is slightly downstream from there, possibly in the neighborhood of 30 degrees or so. Any ME analysis done with a steady state bearing code like XLHydrodyn cannot predict this additional lag of the hot spot.

### Morton Analysis Type




There are 4 options for how to construct the orbit for the ME analysis, which is picked from an in-cell dropdown list. Use the first option unless you want to experiment with the others.

At each rpm of every ME analysis, one synchronous orbit of the shaft is traced. This option governs on what basis that orbit is derived. Note that at the ME bearing there is both a displacement orbit and a corresponding force orbit. At each point around the orbit, either a position vector is input to XLHydrodyn to compute a force vector, or a force vector is input to compute a position vector. In both cases the entire collection of oil film temperature profiles for all orbit points is used to eventually determine how much temperature difference is generated across the shaft.

Imb Disp Orbit – The displacement orbit is calculated by XLRotor and listed on the Resp sheet corresponding to imbalance Umech. This orbit is centered at the static eccentricity point and passed one orbit point at a time to XLHydrodyn to compute fluid film force components and oil film temperature profile. The points of the force orbit are the journal forces calculated by XLHydrodyn.
Imb Force Orbit – A force orbit is computed by taking the Resp sheet displacement orbit multiplied by the linearized bearing stiffness matrix. These force components are input to XLHydrodyn to compute static eccentricity and oil film temperature profiles. The static positions resulting from this form the displacement orbit.
Specified Disp Orbit – The displacement orbit is a circle, centered at the static eccentricity point, with a size specified on the ME Sheet as a percentage of the pad clearance. The points for the force orbit are the static journal forces computed by XLHydrodyn for the points on the displacement orbit. Since the input value for Umech is not used with this option, the values in the output table for Umech are the average force/$W^2$. When using this option, take care to ensure the orbit is not so large as to have the shaft contact the bearing pads.
Specified Force Orbit – The force orbit is circular and specified on the Morton sheet as a percentage of the static journal force, and this rotating force vector is added to the static journal force vector. The points for the displacement orbit are the static positions computed by XLHydrodyn for the points on the force orbit. The output value of Umech = specified_force/$W^2$.

### Specified Orbit Size

This input is only used for the Specified Disp Orbit and Specified Force Orbit options. Refer to the descriptions of those options.

### Stn 1, Stn 2 & Link

These inputs will be copied to the Brg's worksheet when the ME analysis is run for this sheet. This allows you to run more than one ME Sheet in one operation, each with different bearing specifications.

## ME Output Table

**All Output Below This Row**

This calculation was done 5/2/2011 11:32:23 AM, Morton code version = 4/9/2011 6:13:08 PM, in 150 sec

Sample rotor with 2 disks, one midspan, one overhungWith both bearings embedded in the rotor model file

| # | Speed | Umech | Utherm | Uhot | DeltaT | Lag | Uhot/Umech | phi | Orbit Size | Static Ecc | A |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -- | rpm | oz-in | oz-in | oz-in | F | degrees | -- | deg | -- | -- | nils p-p/c |
| 40 | 5000 | 0.1 | 0.0 | 0.1 | 0.26 | 104 | 1.0 | -6.9 | 1.0% | 0.333024 | 0.5969 |
| 41 | 5250 | 0.1 | 0.0 | 0.1 | 0.2 | 161 | 1.1 | -1.5 | 1.0% | 0.328648 | 0.5770 |
| 42 | 5500 | 0.1 | 0.0 | 0.1 | 0.3 | 183 | 1.2 | 0.5 | 1.0% | 0.324324 | 0.5739 |
| 43 | 5750 | 0.1 | 0.0 | 0.1 | 0.4 | 192 | 1.2 | 2.2 | 1.1% | 0.320353 | 0.6585 |
| 44 | 6000 | 0.1 | 0.0 | 0.1 | 0.6 | 198 | 1.3 | 3.9 | 1.3% | 0.316501 | 0.7855 |
| 45 | 6250 | 0.1 | 0.0 | 0.1 | 0.7 | 203 | 1.3 | 5.8 | 1.6% | 0.313008 | 0.9596 |
| 46 | 6500 | 0.1 | 0.0 | 0.1 | 0.9 | 207 | 1.4 | 8.4 | 2.0% | 0.309624 | 1.2025 |
| 47 | 6750 | 0.1 | 0.1 | 0.2 | 1.2 | 213 | 1.6 | 12.3 | 2.6% | 0.306436 | 1.5596 |
| 48 | 7000 | 0.1 | 0.1 | 0.2 | 1.8 | 220 | 1.8 | 18.7 | 3.5% | 0.303418 | 2.1272 |
| 49 | 7250 | 0.1 | 0.1 | 0.2 | 2.7 | 232 | 2.1 | 30.4 | 5.2% | 0.30042 | 3.1330 |
| 50 | 7500 | 0.1 | 0.2 | 0.3 | 4.7 | 257 | 2.7 | 56.1 | 8.5% | 0.29771 | 5.0869 |
| 51 | 7750 | 0.1 | 0.3 | 0.3 | 6.7 | 306 | 2.9 | 109.6 | 11.9% | 0.29513 | 7.1601 |

| A | B | C | ABC | MajorAxis | MinorAxis | Maj/Min | Ell Angle | ABC Stability Vector Real | Imag |
|---|---|---|---|---|---|---|---|---|---|
| nils p-p/oz-i | oz-in/F | F/mils p-p | -- | mils p-p | mils p-p | -- | deg | Real | Imag |
| 0.596901 | 0.050176 | 4.276886 | 0.128093 | 0.090998 | -0.013344 | -6.819141 | 111.0239 | 0.088721 | -0.09239 |
| 0.577057 | 0.050176 | 2.995452 | 0.086732 | 0.090626 | 0.000754 | 120.1448 | 145.0732 | 0.084994 | 0.017273 |
| 0.573963 | 0.050176 | 5.771092 | 0.166203 | 0.081662 | 0.025707 | 3.176589 | 157.7757 | 0.138863 | 0.091326 |
| 0.658557 | 0.050176 | 6.619421 | 0.21873 | 0.085238 | 0.042964 | 1.983962 | 163.2759 | 0.161901 | 0.147075 |
| 0.785558 | 0.050176 | 7.065435 | 0.278492 | 0.095417 | 0.059622 | 1.600375 | 166.655 | 0.186762 | 0.206586 |
| 0.959619 | 0.050176 | 7.263933 | 0.349757 | 0.111506 | 0.079032 | 1.410892 | 169.1103 | 0.212679 | 0.277665 |
| 1.202594 | 0.050176 | 7.537884 | 0.454846 | 0.135225 | 0.104294 | 1.296582 | 171.0234 | 0.246896 | 0.382004 |
| 1.559658 | 0.050176 | 7.860542 | 0.615145 | 0.170934 | 0.140241 | 1.21886 | 172.5203 | 0.28312 | 0.54612 |
| 2.127205 | 0.050176 | 8.262116 | 0.881854 | 0.228296 | 0.196551 | 1.16151 | 173.5964 | 0.300906 | 0.828928 |
| 3.133012 | 0.050176 | 8.653832 | 1.3604 | 0.330304 | 0.295824 | 1.116555 | 174.1069 | 0.182741 | 1.34807 |
| 5.086923 | 0.050176 | 9.157302 | 2.337323 | 0.527991 | 0.48902 | 1.079693 | 173.6009 | -0.67718 | 2.237074 |
| 7.160183 | 0.050176 | 9.396868 | 3.376007 | 0.732959 | 0.698875 | 1.048769 | 170.5651 | -3.07876 | 1.385151 |

### # and Speed

This is the point number and rpm from the Resp worksheet.

### Umech

This will either be an echo of the Umech input value, or else a calculated value as explained earlier in the Morton Analysis Type option.

### Utherm

The amount of thermally induced imbalance resulting from the shaft temperature difference created by the imposed synchronous response orbit. The phase angle of Utherm is the Lag output explained below.

### Uhot

This is the magnitude of the vector sum of Umech and Utherm.

### DeltaT

This is the shaft temperature difference arising from the imposed synchronous response orbit.

### Lag

Phase lag at the hottest spot on the shaft surface. At the exact instant when the journal is at the orbit point of minimum film thickness, this is the angle between the Umech vector and the point of minimum film thickness.

### Uhot/Umech

The ratio of Uhot to Umech.

### phi

This is the phase angle of the Uhot imbalance vector (Uhot=Umech+Utherm). The phase angle of Umech is always zero. The phase angle of Utherm is the "Lag" output described above, plus 180. The "plus 180" is because shaft bow shifts the overhung weight away from the hot spot.

### Orbit Size

This is the arithmetic average of the orbit radius, expressed as a fraction of the pad bore clearance (i.e. orbit size=1 means the orbit is as big as the clearance).

### Static Ecc

This is the static eccentricity as determined by XLHydrodyn in a run done specifically for the given rpm value. Output values are actual radial displacement divided by pad bore radial clearance.

### A

Sensitivity of vibration at the bearing to imbalance at the overhung weight. This would have units like mils/oz-in. It is the same thing as an influence coefficient for balancing. This output is only the magnitude of what is actually a vector quantity.

### B

Sensitivity of thermally induced imbalance per degree of shaft temperature difference. It has units like oz-in/degF. This output is only the magnitude of what is actually a vector quantity.

### C

Sensitivity of shaft temperature difference per unit of synchronous response (i.e. orbit size). It has units like degF/mil. This output is only the magnitude of what is actually a vector quantity.

### ABC

The magnitude of the vector product of these three vectors.

### Major & Minor Axis

These are the magnitudes of the major and minor axes taken directly from the Resp sheet, but scaled up or down to correspond to the input value of Umech.

### Major/Minor

This is simply the ratio of the major to minor axis lengths, and indicates how elliptic the orbit is.

### Ellipse Angle

This is the orientation of the major axis, taken directly from the Resp sheet.

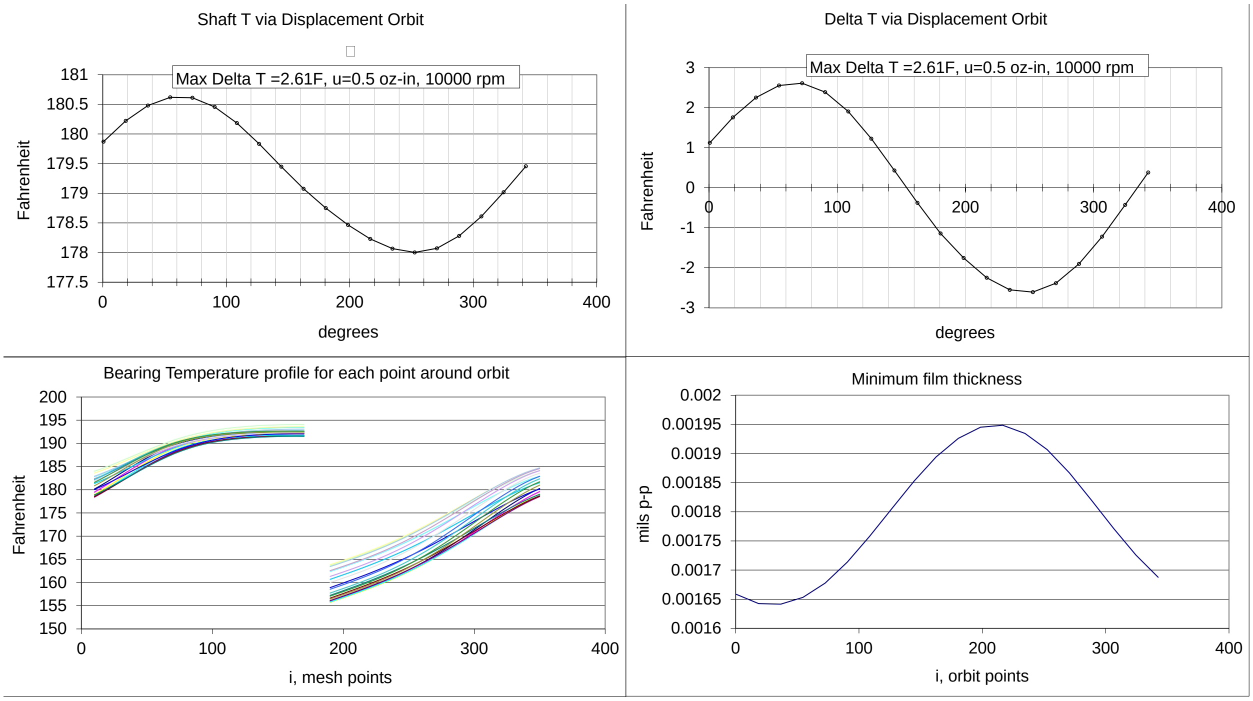
### ABC Stability Vector

These are Cartesian coordinates of the stability vector product. These values are plotted in the ABC Stability chart. The plot of these two columns of data is used to assess stability. Points to the left of +1 are stable, and points to the right of +1 are unstable.

## Morton T Worksheet

When every ME analysis is done, this worksheet is created if one does not already exist in the current XLRotor file. Otherwise the existing sheet is overwritten. This sheet contains the temperature results for one complete orbit at one value of speed. The speed value is documented in cell A1.

| Max Delta | 0.001768 | 0.001765 | 0.001764 | 0.001767 | 0.001772 | 0.001779 | 0.001788 | 0.001798 | 0.001807 | 0.001815 | 0.001822 | 0.001825 | 0.001826 | 0.001823 | 0.001818 | 0.00181 | 0.001801 | 0.001791 | 0.001782 | 0.001774 | Shaft Angl | Shaft T | Delta T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 180.62 | 180.4813 | 180.3693 | 180.2949 | 180.2658 | 180.286 | 180.3996 | 180.6307 | 180.9602 | 181.2118 | 181.4337 | 181.6033 | 181.7039 | 181.726 | 181.6685 | 181.538 | 181.3483 | 181.0606 | 180.9225 | 180.7718 | 7.483943 | 179.0528 | 0.22223 |
| 14.94788 | 181.2929 | 181.1589 | 181.0482 | 180.9719 | 180.9377 | 180.9503 | 181.0535 | 181.2716 | 181.5867 | 181.8273 | 182.0409 | 182.2056 | 182.305 | 182.3299 | 182.2788 | 182.158 | 181.9801 | 181.7068 | 181.5789 | 181.4375 | 25.48394 | 179.1151 | 0.344405 |
| 19.93282 | 182.0127 | 181.8829 | 181.7734 | 181.695 | 181.6558 | 181.6608 | 181.7538 | 181.9595 | 182.2613 | 182.4915 | 182.6973 | 182.8574 | 182.9559 | 182.9836 | 182.9389 | 182.8272 | 182.6607 | 182.4008 | 182.2829 | 182.1503 | 43.48394 | 179.1579 | 0.432993 |
| 24.95391 | 182.7613 | 182.6359 | 182.5276 | 182.4473 | 182.4031 | 182.4007 | 182.4838 | 182.6774 | 182.9663 | 183.1864 | 183.3845 | 183.5401 | 183.6376 | 183.6679 | 183.6292 | 183.5264 | 183.3708 | 183.1238 | 183.0158 | 182.892 | 61.48394 | 179.177 | 0.481119 |
| 30.01017 | 183.5266 | 183.4057 | 183.2989 | 183.2169 | 183.1681 | 183.1586 | 183.232 | 183.4139 | 183.6902 | 183.9003 | 184.0906 | 184.2415 | 184.3378 | 184.3704 | 184.3373 | 184.243 | 184.0979 | 183.8634 | 183.7651 | 183.6502 | 79.48394 | 179.1719 | 0.480795 |
| 35.10061 | 184.298 | 184.1819 | 184.0771 | 183.9939 | 183.9409 | 183.9246 | 183.9888 | 184.1592 | 184.4233 | 184.6233 | 184.8058 | 184.9518 | 185.0465 | 185.0809 | 185.0529 | 184.9666 | 184.8316 | 184.6091 | 184.5204 | 184.4143 | 97.48394 | 179.1448 | 0.432328 |
| 40.22422 | 185.0658 | 184.9549 | 184.8525 | 184.7686 | 184.7119 | 184.6895 | 184.7448 | 184.9043 | 185.1564 | 185.3465 | 185.5212 | 185.6619 | 185.7546 | 185.7904 | 185.7669 | 185.6879 | 185.5624 | 185.3514 | 185.2721 | 185.1749 | 115.4839 | 179.0995 | 0.341812 |
| 45.37993 | 185.8212 | 185.7156 | 185.6159 | 185.5319 | 185.4722 | 185.4442 | 185.4914 | 185.6405 | 185.8811 | 186.0615 | 186.2282 | 186.3636 | 186.4539 | 186.4905 | 186.4709 | 186.3986 | 186.282 | 186.0818 | 186.0115 | 185.9228 | 133.4839 | 179.04 | 0.218172 |
| 50.56665 | 186.5558 | 186.4557 | 186.3591 | 186.2755 | 186.2135 | 186.1807 | 186.2205 | 186.3598 | 186.5895 | 186.7606 | 186.9195 | 187.0494 | 187.137 | 187.1738 | 187.1575 | 187.0911 | 186.9825 | 186.7924 | 186.7306 | 186.6502 | 151.4839 | 178.9714 | 0.073433 |
| 55.78329 | 187.2629 | 187.1683 | 187.0751 | 186.9924 | 186.9288 | 186.8919 | 186.9251 | 187.0555 | 187.275 | 187.4372 | 187.5886 | 187.713 | 187.7975 | 187.8342 | 187.8205 | 187.7592 | 187.6578 | 187.4769 | 187.4229 | 187.3504 | 169.4839 | 178.8995 | -0.07829 |
| 61.02869 | 187.9379 | 187.8486 | 187.7589 | 187.6775 | 187.6127 | 187.5725 | 187.5999 | 187.7223 | 187.9324 | 188.0863 | 188.2305 | 188.3495 | 188.4309 | 188.467 | 188.4553 | 188.3985 | 188.3034 | 188.1309 | 188.0841 | 188.0187 | 187.4839 | 178.8306 | -0.22223 |
| 66.30166 | 188.5565 | 188.473 | 188.3877 | 188.3089 | 188.2448 | 188.2029 | 188.2261 | 188.3419 | 188.5437 | 188.6898 | 188.8269 | 188.94 | 189.0175 | 189.0518 | 189.0405 | 188.9864 | 188.8961 | 188.7303 | 188.6896 | 188.6309 | 205.4839 | 178.7707 | -0.3444 |
| 71.60101 | 189.1136 | 189.0355 | 188.9548 | 188.8791 | 188.8163 | 188.7738 | 188.7942 | 188.9048 | 189.0996 | 189.239 | 189.3696 | 189.4773 | 189.5506 | 189.5825 | 189.5709 | 189.5184 | 189.4315 | 189.2711 | 189.2353 | 189.1821 | 223.4839 | 178.7249 | -0.43299 |
| 76.92554 | 189.608 | 189.5349 | 189.4585 | 189.3863 | 189.3254 | 189.2834 | 189.3021 | 189.4087 | 189.5979 | 189.7316 | 189.8566 | 189.9591 | 190.0284 | 190.0576 | 190.0449 | 189.993 | 189.9084 | 189.7521 | 189.7201 | 189.6715 | 241.4839 | 178.6958 | -0.48112 |
| 82.27397 | 190.0412 | 189.9725 | 189.9003 | 189.8315 | 189.7731 | 189.7322 | 189.7501 | 189.854 | 190.0387 | 190.1678 | 190.2879 | 190.3858 | 190.4511 | 190.4775 | 190.4633 | 190.4113 | 190.3279 | 190.1745 | 190.1453 | 190.1005 | 259.4839 | 178.6911 | -0.48079 |
| 87.64502 | 190.4164 | 190.3515 | 190.2831 | 190.2178 | 190.162 | 190.1227 | 190.1408 | 190.2429 | 190.4242 | 190.5496 | 190.6655 | 190.7594 | 190.8211 | 190.8446 | 190.8286 | 190.7759 | 190.693 | 190.5416 | 190.5143 | 190.4722 | 277.4839 | 178.7125 | -0.43233 |
| 93.03741 | 190.7382 | 190.6765 | 190.6116 | 190.5495 | 190.4966 | 190.4592 | 190.4779 | 190.579 | 190.7579 | 190.8804 | 190.993 | 191.0833 | 191.1417 | 191.1625 | 191.1444 | 191.0906 | 191.0076 | 190.8574 | 190.8313 | 190.7912 | 295.4839 | 178.7577 | -0.34181 |
| 98.44981 | 191.0118 | 190.9529 | 190.8909 | 190.8319 | 190.7817 | 190.7465 | 190.7662 | 190.8669 | 191.0441 | 191.1645 | 191.2744 | 191.3617 | 191.4172 | 191.4353 | 191.4152 | 191.36 | 191.2765 | 191.1269 | 191.1013 | 191.0627 | 313.4839 | 178.8219 | -0.21817 |
| 103.8809 | 191.2427 | 191.186 | 191.1267 | 191.0704 | 191.0228 | 190.9898 | 191.0108 | 191.1117 | 191.2878 | 191.4065 | 191.5143 | 191.5992 | 191.6521 | 191.6678 | 191.6456 | 191.5889 | 191.5046 | 191.3551 | 191.3297 | 191.292 | 331.4839 | 178.898 | -0.07343 |
| 109.3293 | 191.4363 | 191.3814 | 191.3243 | 191.2705 | 191.2253 | 191.1945 | 191.217 | 191.3182 | 191.4937 | 191.6114 | 191.7175 | 191.8003 | 191.851 | 191.8645 | 191.8404 | 191.7822 | 191.6968 | 191.5472 | 191.5215 | 191.4843 | 349.4839 | 178.9778 | 0.078291 |
| 114.7936 | 191.5975 | 191.544 | 191.4888 | 191.4371 | 191.3942 | 191.3655 | 191.3895 | 191.4914 | 191.6665 | 191.7836 | 191.8884 | 191.9696 | 192.0184 | 192.0299 | 192.004 | 191.9442 | 191.8578 | 191.7078 | 191.6817 | 191.6447 | | | |
| 120.2725 | 191.7308 | 191.6784 | 191.6248 | 191.575 | 191.5342 | 191.5074 | 191.5329 | 191.6356 | 191.8107 | 191.9273 | 192.0313 | 192.1111 | 192.1582 | 192.1681 | 192.1405 | 192.0793 | 191.9917 | 191.8411 | 191.8145 | 191.7774 | | | |
| 125.7645 | 191.8401 | 191.7886 | 191.7363 | 191.6882 | 191.6491 | 191.6241 | 191.6511 | 191.7547 | 191.9299 | 192.0464 | 192.1497 | 192.2284 | 192.2742 | 192.2826 | 192.2535 | 192.1909 | 192.1022 | 191.951 | 191.9237 | 191.8864 | | | |
| 131.2681 | 191.9288 | 191.8779 | 191.8267 | 191.78 | 191.7426 | 191.7192 | 191.7476 | 191.852 | 192.0274 | 192.1439 | 192.2468 | 192.3247 | 192.3694 | 192.3765 | 192.346 | 192.2822 | 192.1924 | 192.0406 | 192.0124 | 191.9749 | | | |
| 136.7821 | 191.9994 | 191.9491 | 191.8987 | 191.8532 | 191.8172 | 191.7954 | 191.8251 | 191.9303 | 192.106 | 192.2226 | 192.3252 | 192.4025 | 192.4463 | 192.4522 | 192.4206 | 192.3556 | 192.2648 | 192.1124 | 192.0835 | 192.0455 | | | |
| 142.3049 | 192.0543 | 192.0042 | 191.9546 | 191.9101 | 191.8754 | 191.8549 | 191.8857 | 191.9918 | 192.1678 | 192.2846 | 192.387 | 192.4638 | 192.5068 | 192.5119 | 192.4792 | 192.4132 | 192.3215 | 192.1685 | 192.1388 | 192.1004 | | | |
| 147.8351 | 192.0947 | 192.045 | 191.9959 | 191.9523 | 191.9187 | 191.8993 | 191.9312 | 192.038 | 192.2144 | 192.3313 | 192.4337 | 192.5101 | 192.5525 | 192.5568 | 192.5232 | 192.4564 | 192.3638 | 192.2103 | 192.1798 | 192.141 | | | |
| 153.3711 | 192.1218 | 192.0722 | 192.0236 | 191.9808 | 191.948 | 191.9297 | 191.9625 | 192.0699 | 192.2466 | 192.3638 | 192.4661 | 192.5422 | 192.5841 | 192.5878 | 192.5535 | 192.4859 | 192.3926 | 192.2386 | 192.2075 | 192.1682 | | | |
| 158.9116 | 192.1359 | 192.0863 | 192.0381 | 191.9958 | 191.9639 | 191.9465 | 191.9801 | 192.088 | 192.2648 | 192.3822 | 192.4845 | 192.5604 | 192.602 | 192.6051 | 192.5703 | 192.502 | 192.4082 | 192.2539 | 192.2221 | 192.1824 | | | |
| 164.4551 | 192.1365 | 192.087 | 192.0391 | 191.9973 | 191.9659 | 191.9492 | 191.9835 | 192.0918 | 192.2687 | 192.3862 | 192.4885 | 192.5643 | 192.6055 | 192.6083 | 192.573 | 192.5043 | 192.4101 | 192.2555 | 192.2233 | 192.1832 | | | |
| 170 | 192.1225 | 192.0731 | 192.0253 | 191.9839 | 191.953 | 191.9368 | 191.9715 | 192.08 | 192.2569 | 192.3745 | 192.4767 | 192.5523 | 192.5934 | 192.5959 | 192.5603 | 192.4914 | 192.3969 | 192.2423 | 192.2097 | 192.1693 | | | |
| 190 | 157.5367 | 157.4681 | 157.4433 | 157.4647 | 157.5306 | 157.6359 | 157.8394 | 158.1919 | 158.5891 | 158.8875 | 159.1098 | 159.2323 | 159.2423 | 159.1386 | 158.9326 | 158.6461 | 158.3089 | 157.9322 | 157.7786 | 157.6434 | | | |
| 194.9479 | 158.0253 | 157.957 | 157.9329 | 157.9552 | 158.022 | 158.1282 | 158.3317 | 158.6823 | 159.077 | 159.3736 | 159.5943 | 159.7158 | 159.7253 | 159.6218 | 159.4166 | 159.1314 | 158.7958 | 158.4212 | 158.2672 | 158.1318 | | | |
| 199.9328 | 158.5186 | 158.4506 | 158.427 | 158.45 | 158.5178 | 158.625 | 158.8287 | 159.1778 | 159.5704 | 159.8654 | 160.0848 | 160.2055 | 160.2145 | 160.1112 | 159.9067 | 159.6226 | 159.2884 | 158.9154 | 158.7609 | 158.6251 | | | |
| 204.9539 | 159.0222 | 158.9543 | 158.9312 | 158.9549 | 159.0236 | 159.1319 | 159.3358 | 159.6837 | 160.0745 | 160.3682 | 160.5866 | 160.7066 | 160.7154 | 160.6123 | 160.4084 | 160.1252 | 159.7922 | 159.4206 | 159.2653 | 159.1291 | | | |
| 210.0102 | 159.5408 | 159.4727 | 159.4499 | 159.4742 | 159.5438 | 159.6531 | 159.8575 | 160.2042 | 160.5934 | 160.8862 | 161.1037 | 161.2232 | 161.232 | 161.1291 | 160.9259 | 160.6436 | 160.3116 | 159.9412 | 159.785 | 159.648 | | | |
| 215.1006 | 160.0778 | 160.0095 | 159.9866 | 160.0115 | 160.0818 | 160.1922 | 160.397 | 160.7428 | 161.1307 | 161.4226 | 161.6397 | 161.7589 | 161.7677 | 161.6653 | 161.4628 | 161.1814 | 160.8504 | 160.4811 | 160.3237 | 160.1858 | | | |
| 220.2242 | 160.6367 | 160.5678 | 160.5448 | 160.5699 | 160.6409 | 160.7523 | 160.9577 | 161.3026 | 161.6893 | 161.9807 | 162.1974 | 162.3166 | 162.3258 | 162.224 | 162.0223 | 161.7419 | 161.4118 | 161.0434 | 160.8847 | 160.7456 | | | |
| 225.3799 | 161.2204 | 161.1506 | 161.1272 | 161.1524 | 161.224 | 161.3363 | 161.5422 | 161.8863 | 162.2719 | 162.5629 | 162.7796 | 162.8991 | 162.9089 | 162.8079 | 162.6072 | 162.3279 | 161.9989 | 161.6313 | 161.4711 | 161.3305 | | | |
| 230.5667 | 161.8317 | 161.7608 | 161.7367 | 161.7616 | 161.8336 | 161.9468 | 162.1531 | 162.4964 | 162.8812 | 163.172 | 163.3888 | 163.5089 | 163.5196 | 163.4198 | 163.2204 | 162.9423 | 162.6143 | 162.2475 | 162.0856 | 161.9433 | | | |
| 235.7833 | 162.4732 | 162.4007 | 162.3756 | 162.4001 | 162.4721 | 162.586 | 162.7927 | 163.1353 | 163.5192 | 163.81 | 164.0273 | 164.1483 | 164.1602 | 164.0619 | 163.864 | 163.5874 | 163.2605 | 162.8946 | 162.7309 | 162.5866 | | | |
| 241.0287 | 163.1472 | 163.0728 | 163.0462 | 163.0699 | 163.1417 | 163.2561 | 163.4631 | 163.8048 | 164.1879 | 164.479 | 164.697 | 164.8193 | 164.8328 | 164.7364 | 164.5404 | 164.2654 | 163.94 | 163.5749 | 163.4092 | 163.2627 | | | |
| 246.3016 | 163.8556 | 163.779 | 163.7505 | 163.7729 | 163.8442 | 163.9588 | 164.1659 | 164.5066 | 164.889 | 165.1804 | 165.3995 | 165.5233 | 165.5389 | 165.4448 | 165.2511 | 164.9783 | 164.6544 | 164.2903 | 164.1225 | 163.9736 | | | |
| 251.601 | 164.6 | 164.5207 | 164.49 | 164.5106 | 164.581 | 164.6954 | 164.9024 | 165.242 | 165.6235 | 165.9154 | 166.1358 | 166.2616 | 166.2798 | 166.1885 | 165.9976 | 165.7272 | 165.4053 | 165.0423 | 164.8723 | 164.7208 | | | |
| 256.9255 | 165.3814 | 165.299 | 165.2655 | 165.284 | 165.3529 | 165.4667 | 165.6732 | 166.0115 | 166.3922 | 166.6846 | 166.9065 | 167.0348 | 167.056 | 166.968 | 166.7805 | 166.5131 | 166.1934 | 165.8318 | 165.6596 | 165.5054 | | | |
| 262.274 | 166.2002 | 166.1143 | 166.0775 | 166.0931 | 166.1601 | 166.2729 | 166.4785 | 166.8151 | 167.1948 | 167.4878 | 167.7115 | 167.8425 | 167.8673 | 167.7833 | 167.5997 | 167.3359 | 167.019 | 166.659 | 166.4847 | 166.3276 | | | |
| 267.645 | 167.0559 | 166.966 | 166.9253 | 166.9377 | 167.002 | 167.1133 | 167.3176 | 167.6521 | 168.0306 | 168.3242 | 168.5498 | 168.684 | 168.7128 | 168.6334 | 168.4545 | 168.1948 | 167.8812 | 167.5233 | 167.347 | 167.1869 | | | |
| 273.0374 | 167.9469 | 167.8528 | 167.8077 | 167.8161 | 167.8772 | 167.9864 | 168.1887 | 168.5207 | 168.8976 | 169.1918 | 169.4195 | 169.5571 | 169.5905 | 169.5163 | 169.3427 | 169.088 | 168.7782 | 168.4229 | 168.2449 | 168.0818 | | | |
| 278.4498 | 168.8708 | 168.772 | 168.7222 | 168.726 | 168.7832 | 168.8895 | 169.0893 | 169.4183 | 169.7933 | 170.0877 | 170.3176 | 170.459 | 170.4974 | 170.4291 | 170.2615 | 170.0124 | 169.7073 | 169.355 | 169.1756 | 169.0096 | | | |
| 283.8809 | 169.8239 | 169.7202 | 169.665 | 169.6636 | 169.7163 | 169.819 | 170.0156 | 170.3409 | 170.7136 | 171.0081 | 171.2401 | 171.3855 | 171.4294 | 171.3675 | 171.2067 | 170.964 | 170.6643 | 170.3157 | 170.1353 | 169.9666 | | | |
| 289.3293 | 170.801 | 170.6923 | 170.6315 | 170.6243 | 170.6717 | 170.7701 | 170.9628 | 171.2837 | 171.6536 | 171.9479 | 172.1818 | 172.3313 | 172.381 | 172.3261 | 172.1728 | 171.9373 | 171.6437 | 171.2995 | 171.1186 | 170.9477 | | | |
| 294.7936 | 171.7961 | 171.6823 | 171.6155 | 171.6021 | 171.6436 | 171.737 | 171.9249 | 172.2408 | 172.6072 | 172.9009 | 173.1366 | 173.2902 | 173.3459 | 173.2985 | 173.1533 | 172.9257 | 172.6391 | 172.3001 | 172.1193 | 171.9465 | | | |
| 300.2725 | 172.8018 | 172.6829 | 172.61 | 172.59 | 172.625 | 172.7126 | 172.8951 | 173.2052 | 173.5676 | 173.86 | 174.0972 | 174.2548 | 174.3167 | 174.2771 | 174.1406 | 173.9216 | 173.6427 | 173.3096 | 173.1297 | 172.9555 | | | |




Cell A1 contains a cell formula that forms a title displayed in a TextBox on the charts.

Values in Column A are angles of the circumferential mesh points in the XLHydrodyn analysis.

Values in Row 1 are of minimum film thickness from the XLHydrodyn analysis. These values are plotted in one the plots on this sheet.

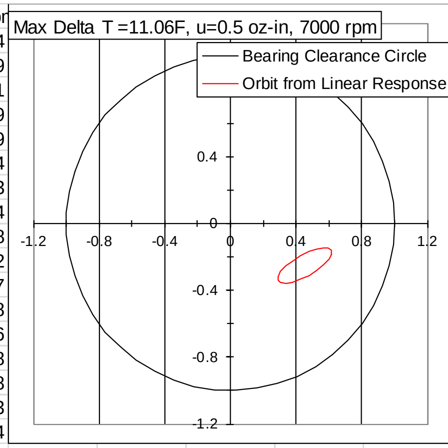
Values in each of Columns 2 through 2+#OrbitPoints are the circumferential temperature profile copied from the P+T Circ. Prof. worksheet. Temperature data for all pads in the bearing are in each of these columns. All of these columns are plotted in one of the plots on this sheet.

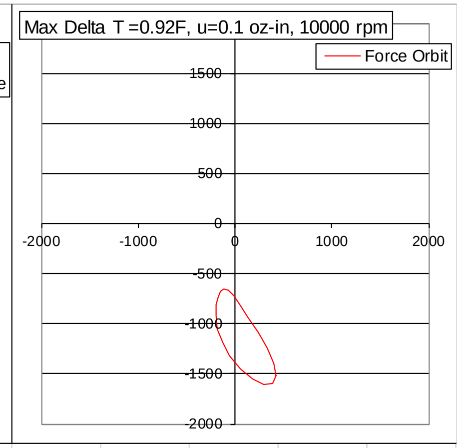
The last three columns contain 1) angles locating equally spaced points on the surface of the shaft where 0 degrees is at the heavy spot (i.e. location of Umech), 2) shaft surface temperature at that angle, and 3) the delta T between this point and a point 180 degrees around the shaft. The number of points in these columns is taken to be the same as #OrbitPoints. These values are plotted in two of the plots on this sheet.

# Morton Orbit Worksheet

When every ME analysis is done, this worksheet is created if one does not already exist in the file. Otherwise the existing sheet is overwritten. This sheet contains data for the displacement and force orbits at one value of speed. The speed value is documented in cell A1.

| Max Delta T =11.06F, u=0.5 oz-in, 7000 rpm | | | |
|---|---|---|---|
| 426.3478 | -1518.8 | 0.614577 | -0.184 |
| 403.1561 | -1393.43 | 0.614345 | -0.16159 |
| 331.5717 | -1239.85 | 0.598266 | -0.14791 |
| 236.4832 | -1083.19 | 0.567912 | -0.14429 |
| 136.8602 | -942.067 | 0.526255 | -0.15109 |
| 51.40583 | -818.129 | 0.477373 | -0.16764 |
| -18.3277 | -725.141 | 0.42605 | -0.19233 |
| -72.2876 | -669.024 | 0.377311 | -0.22274 |
| -114.997 | -651.857 | 0.335926 | -0.25588 |
| -150.58 | -670.449 | 0.305947 | -0.28852 |
| -178.175 | -727.805 | 0.290307 | -0.31747 |
| -196.91 | -812.629 | 0.290539 | -0.33988 |
| -200.169 | -924.724 | 0.306618 | -0.35356 |
| -180.95 | -1050.65 | 0.336972 | -0.35718 |
| -132.849 | -1184.94 | 0.378629 | -0.35038 |
| -57.1054 | -1315.64 | 0.427511 | -0.33383 |
| 51.38069 | -1448.92 | 0.478834 | -0.30914 |
| 176.8899 | -1553.89 | 0.527573 | -0.27873 |
| 297.9686 | -1610.24 | 0.568958 | -0.24559 |
| 386.975 | -1591.82 | 0.598937 | -0.21295 |
| 426.3478 | -1518.8 | 0.614577 | -0.184 |




Cell A1 contains a cell formula that forms a title displayed in a TextBox on the charts.

Values in the first two columns are for the force orbit. The units of these values are the same as the units for load on the XLHydrodyn sheet.

Values in the next two columns are for the displacement orbit expressed as dimensionless eccentricity (i.e. radial position divided by pad bore radius). The unit circle in this chart represents the pad bore clearance circle. If the bearing preload is zero, the shaft is close to contacting the pads when the displacement orbit is close to touching the unit circle. If the bearing has a preload of, for instance 0.3, contact is then closer to an eccentricity of 0.7. Note that pads can tilt in some bearings, and the preload and clearance profiles can be different for different pads. The pad bore, however, is constrained to be the same for all pads on an XLHydrodyn worksheet.