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Goals

Our goal is for you to...	So that you...
Provide “best in industry” proactive and mechanical services	Increase our customers’ profits by reducing maintenance and downtime costs.
Complete the Vibration, Alignment, and Balancing Training Course	Have the skills and knowledge to collect data, analyze data to identify the root of a problem, and fix an existing problem.
	Are knowledgeable when you need to contact the Predictive Diagnostics Team so that they can efficiently assist you.
Continue to develop your skills in analysis	Can translate your skills and knowledge to new, unique situations and continue to successfully collect and analyze data.

Our goal is for you to...	**So that you...**
Deliver service right the first time, which includes: • Obtaining all equipment component information • Collecting all the necessary data • Performing an accurate analysis	Provide customers with the quality service they were sold.
	Ensure that your analysis (and any resulting repairs) are accurate.
	Do not pass on additional costs to the customer because you had to recollect or re-analyze data.
Use the *Fan and Pump Vibration, Alignment, and Balancing Technical Reference Guide* as your primary source of on-the-job information	Are self-sufficient and efficient at the customer site. Rely on the Predictive Diagnostics Team only for verification of your own analyses.
Know where to get information and assistance	Are able to quickly answer questions and solve problems as they arise.

Safety guidelines

Employees are responsible for following the safety guidelines established by the Systems & Services Safety Program (SSSP).

Please refer to the *Employee Safety Handbook* (FAN 833.3) for these guidelines.

Safety while collecting vibration data

- Loose or hanging clothing, jewelry, and long hair are not permitted around moving machine parts.
- Wear safety glasses to prevent debris from being blown into your eyes.
- Use caution when collecting data near sheaves and belts so that your fingers or equipment do not become entangled.
- Secure the accelerometer cable so it does not get caught in moving components.
- Use caution with tools and papers so that they are not sucked into the fan.

- Use caution when taking vibration readings on the sheave end of a motor or fan. If you do not have enough room to safely take these readings, skip them.
- Remember when using a strobe light that even though a shaft or sheave appears to be stationary, it is still rotating and will cause personal injury if you grab or touch it.
- Strobe lights can induce epileptic seizures; therefore, take all necessary precautions.

Safety while locking out an energy source

You are required to lock out the energy source for the part of the equipment you are working on before you service it.

Refer to the *Employee Safety Handbook* (FAN 833.3) for information about the Lockout/Tagout Program.

Safety while servicing walk-in airhandlers

When working in a walk-in airhandler, please follow these precautions.

1. Identify all actual and potential air contaminants that exist in the airhandler.

- Contact the customer for this information.

2. Identify the air monitoring equipment required to analyze the air quality.

    - Contact the area office to obtain the MSA Passport Monitor.

3. Identify the means to eliminate the actual and potential air contaminants (valves, etc.).

4. Identify and obtain the personal protective equipment that is required when working in the airhandler.

Additionally, please keep these precautions in mind:

- Use extra caution when working in a walk-in air handler due to the absence of belt guards.

- Do not stand on the base pan in roof top and suspended air handler units. The base pan is not a weight-bearing part, and corrosion could cause it to give way.

- Check for fan corrosion. If a fan is corroded, excessive balance weights on a blade could cause it to come apart.

If you have any questions, consult the *Johnson Controls Confined Space Handbook for Employees*.

Phone numbers

For data collection help and information

When you have a question or encounter a problem on the job, you can call the Engineering Services Help Line. Engineering Services directs your question to the Predictive Diagnostics Team, who answers your question in the shortest time possible.

The phone number for the Engineering Services Help Line is **(800) 333-2222**, **ext. 4357**.

For more information about getting help, see *Understanding the Technical Support Process* in Section 3.

If you need to fax a form or question, the fax number for the Predictive Diagnostics Team is **(414) 274-4120**.

For data collection equipment

If you need...	Call...	Ext. or phone #
Microlog equipment	James L. Griffin Co., Inc.	(414) 241-4451
Accelerometer cables		
Batteries		
Mounting tabs		
Glue		
Rental equipment, including: • Vibration analysis kits • Reverse dial indicator kit • Strobe light • Motor current kits	Engineering Services Help Line	(800) 333-2222, ext. 4357

For other information

The extensions in this table are for (800) 333-2222.

If you need...	Call...	Ext. or phone #
Mechanical service support or information about OEM relations	John Bauernfeind Ken Oakleaf	4005 4265
Information on environmental and regulatory issues and refrigeration management strategies	John Bauernfeind Jeff Werwie	4005 4757
Infrared analysis, eddy current analysis, and multiamp testing	JCI Diversified Services	(708) 916-6616
Help with Microlog problems	SKF Condition Monitoring	(800) 523-7514

Process overview

It is very important that you complete Vibration, Alignment, and Balancing Training before you attempt to collect fan and pump vibration data.

Once you have been trained, you can use the *Fan and Pump Vibration, Alignment, and Balancing Technical Reference Guide* on the job. It guides you through every task you need to complete. The table below outlines these tasks.

	It is essential that you...
Before you go to the customer site...	Complete the Nameplate Information form.
	Perform a Microlog, accelerometer, and cable operational check.
	Prepare the Microlog for data collection.
	Set up the modem.
	Download the route.
When you are at the customer site...	Collect the data to screen for high overalls and defective bearings.
	Review the data you collect.
	Analyze the problem.
	Diagnose the problem.
	Fix the problem (if a problem exists) and recollect data to verify repairs.

Finally, once you finish the above tasks, you should complete a Vibration Report for the customer.

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SECTION 1: PREPARING TO GO TO THE CUSTOMER SITE

Before you go to a customer site, you must:

- Make sure you have all of the equipment you need
- Complete and fax the Nameplate Information form
- Perform a Microlog, accelerometer, and cable operational check
- Prepare the Microlog for data collection
- Set up the modem

To collect data at a customer site, you primarily use the Microlog, a data collector that detects and records machine vibrations. The main components of the Microlog include the display screen, keys, and connector port.

Equipment list

Fan and pump equipment

- ☐ Microlog
- ☐ Accelerometer
- ☐ 2 accelerometer cables
- ☐ Spare Microlog battery
- ☐ Support module (battery charger)
- ☐ Small magnets
- ☐ Strobe light
- ☐ Reverse dial indicator kit
- ☐ Assortment of weights
- ☐ 4” Stinger
- ☐ Reflective marking medium (tape, marker, paint pen)
- ☐ Sheave and belt gauge
- ☐ Belt tension gauge
- ☐ Shims
- ☐ Diagnostic calculator OR laptop computer with JCI Alignment Program loaded
- ☐ Printer adaptor and printer

Communications equipment

- ☐ Hayes Optima Modem (9600 or higher)
- ☐ Cable (Use model CMSS 50077A for assisted communications **only**. Use model CMSS 50238 for either assisted communications or remote communications.)

Other equipment

- ☐ *Fan and Pump Vibration, Alignment, and Balancing Technical Reference Guide*
- ☐ Note paper and pen
- ☐ Nameplate Information Forms
- ☐ Amplitude and Phase Data Forms
- ☐ Vibration Report Forms
- ☐ Soft Foot Recording Forms

Completing the Nameplate Information form

You must complete a Nameplate Information before you collect data for:

- A fan or pump for a new customer
- A fan or pump which has never had a vibration analysis

When the Predictive Diagnostics Team receives the completed form, they save the customer information in their database.

Therefore, you only have to fill out a form once for each fan and pump.

To complete the Nameplate Information form, follow these steps:

1. Complete all appropriate sections of the form.

   NOTE: Write as much information as you have: if you are not sure that you should include certain information, write it on the form anyway.

   Incomplete forms will not be processed. Be sure to fill out the form completely and accurately.

2. Fax the completed form to the Predictive Diagnostics Team.

   The fax number is **(414) 274-4120**.

The Predictive Diagnostics Team enters the customer information into their database. Typically, it takes less than an hour for them to enter the information, during which time you can perform a Microlog, accelerometer, and cable operational check.

Performing a Microlog, accelerometer, and cable operational check

You should check that you have all of your equipment and that it is in working order before you go to collect data at a customer site. It is especially important that you check the Microlog, accelerometer, and accelerometer cables **before** you collect data.

To perform a Microlog, accelerometer, and cable operational check, follow these steps:

1. Connect the accelerometer and cable to the Microlog.
   - Use one of the accelerometer cables.

   CAUTION: Do not twist the cable because over-twisting may cause the cable to short.
2. Turn on the Microlog.
3. Select the Route option from the Main menu.

The Route mode displays.

4. Open any vibration route.
5. Highlight the “MOIL” (Motor Off End In Line) point.
6. Set the accelerometer in a location that does not allow it to move, and isolate it from any vibrations.
7. Press <ENTER>.

   The Dynamic Data Point screen displays.

8. Press <ENTER> again.

   The Microlog collects data and displays a spectrum.

9. Determine if the levels in the spectrum are below 0.010 IPS.

   NOTE: All levels must be below 0.010 IPS, as Figure 1 shows.

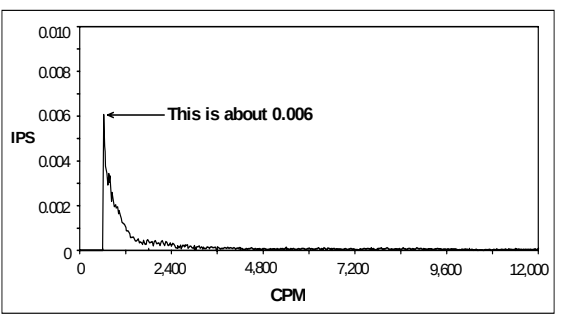

Figure 1: Sample spectrum with all levels below 0.010 IPS

If the levels are...	Then you should...
Below 0.010 IPS	Continue with Step 10.
Above 0.010 IPS	Press <RESET MEASMT> to recollect the data. If you get the same results, complete these Section 9 procedures: • *Checking the Microlog voltage* • *Checking the accelerometer* • *Checking the accelerometer cable* If you still encounter the same problems, contact the Engineering Services Help Line.

10. Hold the accelerometer in one hand.
11. Press <RESET MEASMT>.

12. Shake the accelerometer or **lightly** tap it on a table as the Microlog collects data.

    The Microlog collects data and displays a spectrum.

13. Determine if the levels from 600 to 900 CPM are above 0.030 IPS.

    Figure 2 shows a spectrum in which the levels from 600 to 900 CPM are above 0.030 IPS.

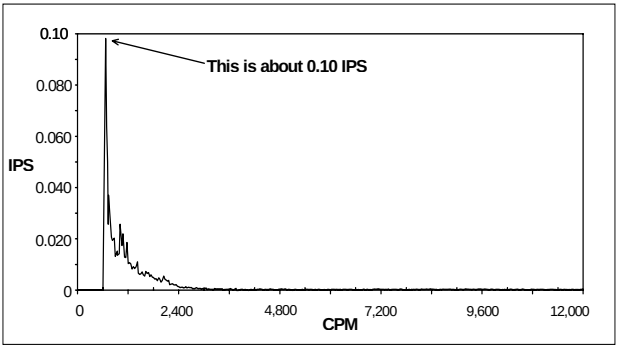

Figure 2: Sample spectrum with the level between 600 to 900 CPM above 0.030 IPS

If the levels are...	Then you should...
Above 0.030 IPS	Continue with Step 14.
Below 0.030 IPS	Press <RESET MEASMT> to recollect the data. If you get the same results, complete these Section 9 procedures: • *Checking the Microlog voltage* • *Checking the accelerometer* • *Checking the accelerometer cable* If you still encounter the same problems, contact the Engineering Services Help Line.

14. Repeat Steps 1-13 for the other accelerometer cable in your kit.

NOTE: If your cables and accelerometer pass the operational check, this does not guarantee that you will not encounter bad data at the customer site. Since an accelerometer cable can break at any time, it is essential that you always check the data you collect at the site for accuracy and quality.

Preparing the Microlog for data collection

To prepare the Microlog for data collection, you must enter certain settings (parameters). Once you enter the parameters, the Microlog saves them until you change them.

Therefore, if you prepare the Microlog once, you only have to check the parameters the next time you use the Microlog (and every time after).

To prepare the Microlog for data collection, you must:

- Enter system setup parameters
- Enter route setup parameters

Entering system setup parameters

To enter the system setup parameters, follow these steps:

1. Access the System Setup screen.

   From the Main menu:

   - Select the Utilities option. The Utilities menu displays.

- Select the System Setup option. The System Setup screen displays.

2. Enter the appropriate system setup parameters.

	Enter these parameters
FFT Hz/CPM	CPM
FFT Lin/Log	Linear
System	English
Auto Range	On
Sensor Mode	Always On
User Mode	Analysis
Data Storage	Normal

3. Press <ESCAPE> once you have entered all of the system setup parameters.

Entering route setup parameters

To enter the route setup parameters, follow these steps:

1. Access the Route Setup screen.

   From the Main menu:

   - Select the Utilities option. The Utilities menu displays.
   - Select the Route Setup option. The Route Setup screen displays.

2. Enter the appropriate route setup parameters.

	Enter these parameters
Route Mode	Normal
Route Spectrum	Show
Route Trigger Slope	+
Route Collection	Fast

3. Press <ESCAPE> once you have entered all of the route setup parameters.

Setting up the modem

The Predictive Diagnostics Team makes the recommendations below for a successful data transfer.

We require that you...	Because...
Use a Hayes Optima modem that is 9600 or higher	The Hayes Optima is recommended by SKF Condition Monitoring.
Use the modem only for vibration data collection	Once you set up the modem for vibration data collection, you do not have to do it again. Keep the modem with your kit, and do not use it for anything other than vibration data collection.

How you set up your modem depends on how your Microlog and modem can communicate with the Predictive Diagnostics Team.

Here are the two methods for communication:

- If you have the *Remote Communications* feature, your Microlog has a memory chip that allows you to upload data and download routes without assistance from the Predictive Diagnostics Team.
- If you don't have the Remote Communications feature, your communication is *assisted*. This means that the Predictive Diagnostics Team directly assists you with uploads and downloads.

  NOTE: The Remote Communications feature is the preferred method. You should use the assisted communications method only when Remote Communications is not available.

You can tell if you have the Remote Communications feature by accessing the Communications screen in the Microlog. If you see the Remote and Modem Setup fields on this screen, you have the Remote Communications feature: these fields display only when the feature is loaded in your Microlog.

For more information and instructions for accessing the Communications screen, see *Setting communication parameters for dialing*.

If you...	Then go to...
Have the Remote Communications feature	*Using the Remote Communications feature*
Do NOT have the Remote Communications feature	*Using assisted communications*

Using the Remote Communications feature

The following *Technical Reference Guide* procedures are related to using the Remote Communications feature:

- *Equipment needed: Remote Communications*
- *Programming the modem: Remote Communications*
- *Resetting the modem to factory defaults*
- *Setting the communication parameters for dialing*
- *Microlog remote capabilities*, including *Send Data, Load Route, Change Dbase, Clear Memory, Reset Dbase,* and *Disconnect*

Complete these procedures if your Microlog has the Remote Communications feature.

Equipment needed: Remote Communications

You need the following equipment to program the modem when you have the Remote Communications feature:

- ☐ Microlog CMVA10
- ☐ Modem
- ☐ Straight-through 25-pin cable

  NOTE: You may also need a 9-pin adaptor to connect to the computer.
- ☐ Modem power adaptor
- ☐ Dedicated phone line

Programming the modem: Remote Communications

To prepare the Microlog and modem for remote communication, you must:

- ♦ Reset the modem to the factory defaults
- ♦ Set the communication parameters for dialing

Resetting the modem to factory defaults

To use the Remote Communications feature, you should use the Microlog to reset your modem back to the factory defaults. However, you only have to reset the modem **once**.

To reset the communication parameters to the factory defaults, follow these steps:

1. Access the Communications screen in the Microlog.

   From the Main menu:

   - Select the Utilities option. The Utilities menu displays.
   - Select the Communications option. The Communications screen displays.

2. Enter the appropriate baud and modem mode settings. Press <ENTER> after each entry.

	Enter these settings
Baud	9600
Modem Mode	Originate
Remote	Yes
Phone #	leave blank (see NOTE after table)

Modem Setup (Optional)	AT&F&W0&Y0

Remember to press <SHIFT> to type letters, and press <SHIFT> again to type numbers. Press the <MENU> key to type special characters like commas and ampersands (&).

NOTE: If you leave a phone number in the Microlog, you should turn off the modem when you hear it start dialing.

3. Press <ESCAPE> twice to return to the Main menu.
4. Select the Transfer option.

   The Remote Login screen displays.

5. Press <F1>.

   Several messages display at the bottom of the screen. The final message will be “Host did not answer”. When this message disappears, the Remote Login screen will still be displayed.

6. Press <ESCAPE> to return to the Main menu.

You are now ready to set up the communication parameters for dialing.

Setting communication parameters for dialing

You only have to set up the communication parameters **once**; however, setting up the communication parameters requires some preparation. Review the preparations in the table below before you enter the communication parameters in the Microlog.

You should know...	Because you must...
The baud rate of the modem you are using	Enter the baud rate in the Microlog.
If you need to dial a “9” or some other character to get an outside line	Enter dialing instructions in the Microlog.
If the phone line has call waiting	Disable call waiting so the call is not interrupted.

Once you have prepared the above information, you can set up the communication parameters.

To set up the communication parameters, follow these steps:

1. Access the Communications screen.

   From the Main menu:

   - Select the Utilities option. The Utilities menu displays.
   - Select the Communications option. The Communications screen displays.

2. Enter the appropriate baud and modem mode settings.

   - Move the cursor to the field you want to change.
   - Press the <MENU> key.
   - Highlight the option you want to select.
   - Press <ENTER>.

	Enter these settings
Baud	9600
Modem Mode	Originate
Remote	If you have the Remote Communications feature, you can see and use this field. Set the field to Yes if you want to use Remote, OR set the field to No if you don't. If you do NOT have the Remote Communications feature, this field does not display.
Phone #	*See Step 3 below.*
Modem Setup	If you have the Remote Communications feature, this field displays. *Make sure this field is blank: delete any characters displaying here.* If you do NOT have the Remote Communications feature, this field does not display.

3. Enter the phone number in the Phone # field.

   - Press <SHIFT> to type the letters and asterisks. Notice how the up arrow displays in the status line.
   - Press <SHIFT> again to type numbers. Notice how the up arrow no longer displays in the status line.
   - When <SHIFT> is NOT pressed, you can also:
     - Press <F1> to type an equal sign
     - Press <DISPLY EXPAND> to type commas
     - Press <ZOOM IN> to type pound signs

If you have to...	Then you should...
Dial “9” to get an outside line	Type **ATS8=8DT9W18003332222,,,5266**
Dial some other character(s) to get an outside line	Enter the appropriate phone string. In most cases, you should be able to delete, substitute for, or add characters to the “9” above.
Dial nothing to get an outside line	Type **ATS8=8DTW18003332222,,,5266**
Disable call waiting	Type **ATS8=8DTW*7018003332222,,,5266** In most areas, *70 disables call waiting. Contact your local phone company if you are not sure that *70 works in your area.

NOTE:

- “ATS8=8DT” are modem codes.
- “W” waits for the dial tone.
- “18003332222” is the toll free modem number.

4. Press <ENTER> once you enter the phone string in Step 3.
5. Press <ESCAPE> to exit the screen.

Microlog remote capabilities

To access the Microlog's remote capabilities, you must access the Remote Active menu, which displays several options from which you can choose.

To access the Remote Active menu, follow these steps:

1. Select the Transfer option from the Main menu.

   The Microlog prompts you for a user name and a password.

2. Enter your user name.

   Use your first name and as much of your last name that you can fit in the field: you can enter up to 8 characters. Remember to press <SHIFT> to type letters.

3. Enter your password.

   Each person is assigned a password. This password allows you to access the database that only contains the routes you need.

4. Press <F1> to start the transmission.

   The following messages display at the bottom of the Microlog screen if there are no problems with the communication:

   Starting modem....
   Dialing host....
   Connect at 9600 BPS....
   Host answered....
   Host available....
   Host program available....
   Connection complete....
   Comparing databases....

Following this final message, the Remote Active menu displays in the upper left hand corner of the screen. The message at the bottom of the screen varies depending on where the cursor is in the menu.

Once you are connected, you have several options available to you in the Microlog. Each of these options is described in detail in the following sections.

Send Data

Once you have collected data at a site, you need to upload or “send data” to Milwaukee.

To send data, follow these steps:

1. Select the Send Data option from the Remote Active menu.

   The Upload Routes screen displays. (This screen looks similar to the Route Mode screen.)

2. Select the name of the site with the data you wish to upload.

   Upon completion of the upload, the message “DATA TRANSMITTED OK” displays at the bottom of the screen.

3. Press <ESCAPE> to return to the Remote Active menu.

4. To upload additional data, repeat Steps 1-3.

Load Route

Before you can collect data at a site, you must download the proper routes to the Micrologic.

To load a route, follow these steps:

1. Select the Load Route option from the Remote Active menu.

   The Download Route(s) screen displays.

2. Select the name of the site you wish to download.

   NOTE: If you don't see the site that you want, highlight the MORE option at the bottom of the list and press <ENTER> to view additional sites.

   Once you select a site, the Transfer screen displays. Upon completion of the download, the message "DATA TRANSMITTED OK" displays at the bottom of the screen.

3. Press <ESCAPE> to return to the Remote Active menu.

4. To download additional routes, repeat Steps 1-3.

Change DBase

If your password allows you to access more than one database, you can use the Change DBase option to control which database you download your routes from or upload data to. Remember that the Microlog does not allow you to store routes from two different databases at the same time.

Clear Memory

You can use this feature if you want to delete all routes and all associated data in the Microlog. To clear the memory, follow these steps:

1. Select the Clear Memory option from the Remote Active menu.

   This message displays:

   Warning
   This will remove all
   collected data and all
   route information.
   Do you wish to proceed?

2. Select either YES or NO at the right of the warning.

If you...	Then...
Do not want to clear the memory after all	Select NO. The Remote Active menu displays again.
Want to clear the memory	Select YES. Read on below this table.

What happens next depends on whether you have collected data on all points and uploaded the data:

If you...	Then...
Did NOT collect data on all points and did NOT upload it	This message displays: *Warning:* *Data not taken on all points or not all points uploaded!* In other words, you should collect and upload data for all points before removing it from memory. If you still want to delete the data, go to Step 3.
Collected and uploaded data for all points	No message displays. Go to Step 3.

3. Press <F1>.

   When the data has been deleted, the message "Database is cleared" displays.

4. Press <ESCAPE> to return to the Remote Active menu.

Reset DBase

After each upload, you should reset the database to free up as much memory as possible. This process removes all data from the Microlog while retaining the route information. Therefore, you should reset the database only after you have reviewed all of the data you collected.

To reset the database, follow these steps:

1. Make sure that you have actually uploaded all data in the Microlog.

   For help with uploading data, see "Send Data."

2. Select the Reset DBase option from the Remote Active menu.

This message displays:

Warning
This will remove all
spectrum and time data,
but will retain the route
setup information with
the updated overall value.
Do you wish to proceed?

3. Select either YES or NO at the right of the warning.

If you...	**Then...**
Do not want to reset the database after all	Select NO. The Remote Active menu displays again.
Want to reset the database	Select YES. Continue reading after this table.

What happens next depends on whether you have collected data on all points and uploaded the collected data:

If you...	Then...
Did NOT collect data on all points and did NOT upload it	This message displays: *Warning:* *Data not taken on all points or not all points uploaded!* In other words, you should collect and upload data for all points before resetting the database. If you still want to reset the database, go to Step 4.
Collected and uploaded data for all points	No message displays. Go to Step 4.

4. Press <F1>.

   When the database has been reset, the message "Database is reset" displays.

5. Press <ESCAPE> to return to the Remote Active menu.

Disconnect

Select the Disconnect option from the Remote Active menu when you are ready to disconnect from the computer in Milwaukee.

Please do not simply turn all the power off to disconnect.

Disconnecting properly ensures that the host modem resets properly and is ready to answer the next call.

Using assisted communications

The following *Technical Reference Guide* procedures are related to using assisted communications:

- Equipment needed: Assisted communications
- Setting communication parameters
- Programming the modem: Assisted communications
- Programming the modem with Windows 3.0 or 3.1
- Programming the modem with Windows 95
- Transferring data

Complete these procedures if you do **NOT** have the Remote Communications feature on your Microlog.

Equipment needed: Assisted communications

You need the following equipment to program the modem:

- ☐ IBM-compatible computer with Microsoft Windows 3.0 or 3.1 OR Microsoft Windows 95 loaded
- ☐ Modem
- ☐ Straight-through 25-pin cable

  NOTE: You may also need a 9-pin adaptor to connect to the computer.
- ☐ Modem power adaptor
- ☐ Dedicated phone line

Setting communication parameters

The procedure for setting communication parameters for assisted communication is the same as the procedure for the Remote Communications feature.

See *Setting communication parameters for dialing* for instructions on setting communication parameters for assisted communications.

Programming the modem: Assisted communications

You must use an IBM-compatible computer with Microsoft Windows 3.0 or 3.1 or Microsoft Windows 95 loaded to program the modem for assisted communications.

NOTE: If you are not familiar with how to use Windows, please ask someone at your office for help with programming the modem.

How you program the modem depends on the version of Windows you have loaded on your computer.

If you have...	Then you should complete...
Windows 3.0 or 3.1	*Programming the modem with Windows 3.0 or 3.1*
Windows 95	*Programming the modem with Windows 95*

Programming the modem with Windows 3.0 or 3.1

To program the modem using Windows 3.0 or 3.1, follow these steps:

1. Connect the modem to the computer's COM port.
   - Use a straight-through 25-pin cable.
2. Connect the power adaptor to the modem.
   - Plug the modem power adaptor into the back of the modem.
   - Plug the power adaptor in an electric socket.

   CAUTION: Make sure you use the power adaptor that came with your modem. Do NOT use the adaptor that comes with the Support Module (battery charger): it will damage the modem.
3. Turn on the computer and the modem.
4. Start Windows.
5. Open the Accessories group.
   - Double-click on the Accessories icon.

6. Load the terminal.

   - Double-click on the Terminal icon.

   The Terminal window displays.

7. From the Settings menu, select Communications.

   The Communications box displays.

8. Verify the settings.

   - Click the button next to the setting you want to select.

	Enter these settings
Baud Rate	9600
Data Bits	8
Stop Bits	1
Parity	None
Flow Control	Xon/Xoff
Connector	Select the COM port to which the modem is connected.
Parity Check	Make sure it is not selected (there is no “x” in the box).
Carrier Detect	Make sure it is not selected (there is no “x” in the box).

9. Select OK.

   The cursor returns to the upper left corner of the Terminal window.

10. Type **ate1** and press <Enter>.

    NOTE: You cannot see what you are typing as you type ate1.

    - If there were no processing errors, an “OK” or “0” displays.
    - If there were processing errors, something other than “OK” or “0” displays.

If there were...	Then you should...
No processing errors	Go to Step 11.
Processing errors	1. Press <Enter>. 2. Retype **ate1**. Check to see that the modem lights flicker as you type. 3. Press <Enter>. If the modem lights did not flicker as you typed, and an “OK” or “0” still does not display, check that: • The cable is connected properly.

If there were...	Then you should...
	• You selected the correct COM port in the Communications menu. If the modem is still not working after you have retyped the string, checked the cable, and checked the COM port, call the Predictive Diagnostics Team.

11. Type **at&f v0 e0 t w0 &q0 s0=1 s10=50 &w0 &y0** and press <Enter>.

    NOTE: Make sure you type zeros (0), not the capital letter "O."

    An "OK" or "0" displays and replaces the "a" or the "at" at the beginning of the string you just typed. Notice that the "AA" light on the modem is now lit as well.

12. From the File menu, select Exit.

    The terminal asks you if you would like to save the changes to the terminal settings.

13. Select No.

14. From the File menu, select Exit Windows.

    The Exit Windows box displays to warn you that this action will end your Windows session.

15. Select OK.

16. Turn off the computer and modem.

Programming the modem with Windows 95

To program the modem using Windows 95, follow these steps:

1. Connect the modem to the computer's COM port.

   - Use a straight-through 25-pin cable.

2. Connect the power adaptor to the modem.

   - Plug the modem power adaptor into the back of the modem.

   - Plug the power adaptor in an electric socket.

   CAUTION: Make sure you use the power adaptor that came with your modem. Do NOT use the

adaptor that comes with the Support Module (battery charger): it will damage the modem.

3. Start Windows.
4. Select Programs.
   - Double-click on the Programs icon.
5. Open the Accessories group.
   - Double-click on the Accessories icon.
6. Select HyperTerminal Connections.
   - Double-click on the HyperTerminal Connections icon.

   A window displays with the Hypertrm icon.
7. Select the Hypertrm icon.
   - Double-click on the Hypertrm icon.

   The HyperTerminal opens and displays the Connection Description window.
8. Click in the Name text box.
9. Type **vibrations** and select OK.

   The Phone Number window displays.
10. Click the box to the right of the “Connect using” option.
11. Select the COM port to which you connected the modem, and select OK.

A window displaying the properties of the COM port displays.

12. Verify the settings.

	Enter these settings
Baud Rate	9600
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	Xon/Xoff

13. Select OK.

    The HyperTerminal window displays.

14. Type **ate1** and press <Enter>.

    NOTE: You cannot see what you are typing as you type ate1.

    - If there were no processing errors, an “OK” or “0” displays.
    - If there were processing errors, something other than “OK” or “0” displays.

If there were...	Then you should...
No processing errors	Go to Step 15.
Processing errors	1. Press <Enter>. 2. Retype **ate1**. Check to see that the modem lights flicker as you type. 3. Press <Enter>. If the modem lights did not flicker as you typed, and an "OK" or "0" still does not display, check that: • The cable is connected properly. • You selected the correct COM port in the Communications menu. If the modem is still not working after you have retyped the string, checked the cable, and checked the COM port, call the Predictive Diagnostics Team.

15. Type **at&f v0 e0 t w0 &q0 s0=1 s10=50 &w0 &y0** and press <Enter>.

    NOTE: Make sure you type zeros (0), not the capital letter "O."

    An "OK" or "0" displays and replaces the "a" or the "at" at the beginning of the string you just typed. Notice that the "AA" light on the modem is now lit as well.

16. From the File menu, select Exit.

    The terminal asks you if you are sure you want to disconnect.

17. Select Yes.

    The terminal asks you if you would like to save the settings.

18. Select No.

19. Exit Windows.

    - Click the Start button.
    - Select the Shut Down option.

    The Shut Down window displays.

20. Select Yes.

21. Turn off the computer and modem.

Transferring data

You transfer data for two different reasons: downloads and uploads.

- Downloads

  Once you have set up the modem, you are ready to download.

  The Predictive Diagnostics Team downloads routes directly to your Microlog. Downloading provides you with the routes you need to collect data for specific sites.

  Once a route is downloaded to the Microlog, it remains in the Microlog. Thus, once a route is in the Microlog, you are ready to go to the site.

- Uploads

  Once you have collected good data, you upload the data to the Predictive Diagnostics Team.

You follow the same procedure to transfer uploaded data and downloaded routes. The only difference is that most often you will download from your office and upload from the site.

When you transfer data, the phone line must be:

- **Analog**: digital phone lines will not work with the modem
- **Dedicated**: you may use a fax line if a dedicated line is not available

To transfer data, follow these steps:

1. Connect the Microlog to the modem.
    - Use the model CMSS 50238 cable for either remote communications or assisted communications.
    - Use the model CMSS 50077A cable for assisted communications **only**.
2. Plug one end of the phone cord into the “line jack” on the back of the modem.
3. Plug the other end of the phone cord into the analog jack in the wall.
4. Connect the power adaptor.
    - Plug the modem power adaptor into the back of the modem.
    - Plug the power adaptor in an electric socket.

CAUTION: Make sure you use the power adaptor that came with your modem. Do NOT use the adaptor that comes with the Support Module (battery charger): it will damage the modem.

5. Turn on the modem.
6. Turn on the Microlog.
7. Call the Predictive Diagnostics Team.

   Tell them:

   - You are getting ready to upload or download.

     The call handler immediately transfers you to the Predictive Diagnostics Team.

   - Tell the Predictive Diagnostics Team the name of the site(s) you want downloaded OR the name of the site(s) you are uploading.

8. Select the Transfer option from the Main menu.

   Once you press <ENTER>, the data transfer begins. Look at the MODEM STATUS line at the bottom of the Microlog screen.

What the MODEM STATUS line says	What is happening
OK STATUS	You hear a dial tone.
DIALING	The modem dials.
WAITING	You hear the phone ring. The automated operator picks up and speaks. After a short period of time, the modem dials the four-digit extension and rings once. The modem makes several different noises.
CONNECT	The modem connects. Six lights remain lit. The RD (receive data) and SD (send data) lights flash to indicate that data is being transferred.

9. Continue to watch the modem lights.

If the CD and OH lights...	Then...
Go out less than one minute after connecting with the Predictive Diagnostics Team's modem	The modem connection was probably interrupted. You should: • Turn both the Microlog and modem off and on. • Repeat Steps 8-9 until the lights remain lit longer. • Go to Step 10.
Remain lit for longer than a minute, and then go out	Communication should be successful. • Go to Step 10.

10. Press <ESCAPE> to return to the Main menu.

    NOTE: It may take several seconds for the Microlog to return to the Main menu.

11. Verify the route.

    If you downloaded, you are now ready to collect data. If you uploaded, call the Predictive Diagnostics Team to verify that they received the upload.

NOTES

Section 2
Screening for high overalls and bearing defects

Collecting data to screen for high overalls and bearing defects 2-2

Ensuring collected data has been stored (Reviewing collected data) 2-4

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Trane AVPA fans 2-12

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SECTION 2: SCREENING FOR HIGH OVERALLS & BEARING DEFECTS

You collect data on a fan or pump to determine if excessive vibrations and/or bearing defect frequencies exist. If these conditions exist, you can perform an analysis to accurately diagnose the problem.

To screen for high overall amplitudes and potential bearing defects, you must:

- Collect data
- Review the data you collect

Collecting data to screen for high overalls and bearing defects

To collect data on a fan or pump, follow these steps:

1. Access the Route mode.

   From the Main menu:

   - Select the Route option.

   The Route mode displays the routes that have been downloaded to your Microlog.

2. Select the appropriate branch name.

3. Select the Fan and Pump Analysis option.

   A list of customers displays.

4. Select the appropriate customer.

   A list of machines at that customer site displays.

5. Select the machine for which you are collecting data.

6. Press <ENTER> twice to move the cursor to the first data point.

7. Attach the accelerometer at the position specified by the Microlog.

   NOTE: See the *Attaching the accelerometer* procedure in this section for diagrams of where to attach the accelerometer.

8. Press <ENTER> to begin data collection.

9. Press <ENTER> to save the data when averaging is complete.

10. Press <ENTER> to proceed to the next data point.

11. Repeat Steps 7-10 until the route is complete.

12. Press <ESCAPE> once you are finished.

Ensuring collected data has been stored (Reviewing collected data)

To review the data you collected, follow these steps:

1. Access the Review mode.

   From the Main menu:

   - Select the Review option.

   The Review mode displays the routes for which you have collected data.

2. Select the appropriate branch name.
3. Select the Fan and Pump Analysis option.

   A list of customers displays.

4. Select the appropriate customer.

   A list of machines at that customer site displays.

5. Select the machine for which you are reviewing data.

   A list of the data points display.

6. Move the cursor to the first data point and press <ENTER> to select it.

   The overall amplitude for the point displays in the "This" box.

7. Record the overall amplitude on the Vibration Report sheet.

8. Press <ENTER> again.

   The spectrum for that point displays.

9. Look for possible bearing defect frequencies.

   - See the *Analyzing bearing data* procedure in this section for more information.

10. Press <ENTER>.

    The overall amplitude for the next data point displays in the "This" box.

11. Repeat Steps 7-10 for every data point.

If...	**Then...**
Any spectrum in the screening process has an overall above 0.2 IPS or a 1xRPM amplitude of 0.15 IPS	You should further analyze and then diagnose the fan. Go to Section 3.
You suspect bearing defects	You should verify that the bearing defect exists. See *Analyzing bearing data* in this section for more information.
None of the overall vibration amplitudes are greater than 0.2 IPS and you do not suspect bearing defects	The fan does not need to be analyzed further at this time.

Attaching the accelerometer

You should use the small magnet to mount the accelerometer on fans. However, if you have limited access to a measurement point, use the Stinger instead.

To use a magnet to mount the accelerometer, follow these steps:

1. Prepare the machine for mounting.
    - Make sure that the machine surface is clean and dry.
2. Mark the mounting positions on the machine with the paint pen.

    NOTE: You should always collect data at the same mounting positions. Marking positions allows you to mount the magnet at the same points when you collect data the next time.
3. Screw the accelerometer into the magnet base.

    CAUTION: Do not overtighten and strip out the threads in the magnet base.

4. Mount the magnet on the machine surface.

   NOTE: Do not snap the magnet to the machine surface since the accelerometer could be permanently damaged.

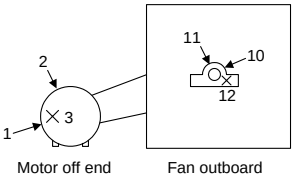
   - Mount the magnet as flat as possible so no rocking or sliding occurs.

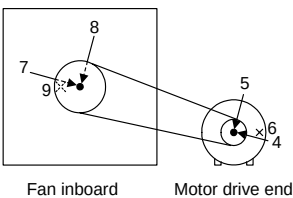
Measurement points

Use the following diagrams and measurement points when mounting the accelerometer. Measurement points are given for:

- Belt driven fans
- Belt driven overhung fans
- Direct drive fans
- Multiple bearing fans
- Trane AVPA fans
- Pumps
- Single stage vertical pumps

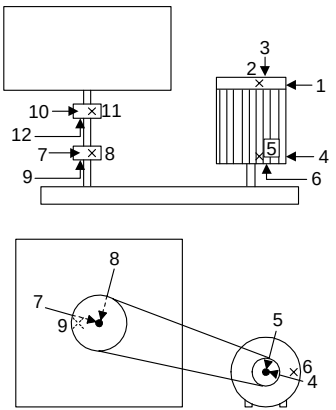
Belt driven fans





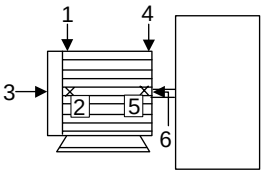
1. MOIL Motor off end in line
2. MOP Motor off end perpendicular
3. MOA Motor off end axial
4. MDIL Motor drive end in line
5. MDP Motor drive end perpendicular
6. MDA Motor drive end axial
7. FIIL Fan inboard in line
8. FIP Fan inboard perpendicular
9. FIA Fan inboard axial
10. FOIL Fan outboard in line
11. FOP Fan outboard perpendicular
12. FOA Fan outboard axial

Belt driven overhung fans

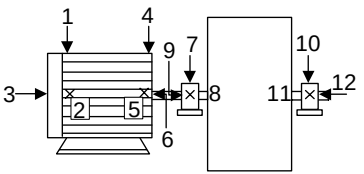


1. MOIL Motor off end in line
2. MOP Motor off end perpendicular
3. MOA Motor off end axial
4. MDIL Motor drive end in line
5. MDP Motor drive end perpendicular
6. MDA Motor drive end axial
7. FIIL Fan inboard in line
8. FIP Fan inboard perpendicular
9. FIA Fan inboard axial
10. FOIL Fan outboard in line
11. FOP Fan outboard perpendicular
12. FOA Fan outboard axial

Direct drive fans



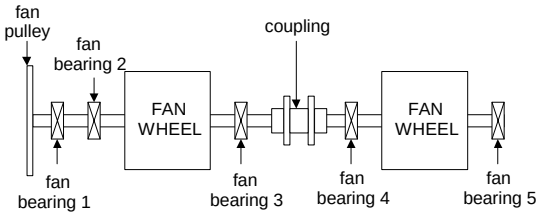
NOTE: Positions 7-12 do not apply to overhung conditions



1. MOV Motor off end vertical
2. MOH Motor off end horizontal
3. MOA Motor off end axial
4. MDV Motor drive end vertical
5. MDH Motor drive end horizontal
6. MDA Motor drive end axial
7. FIV Fan inboard vertical
8. FIH Fan inboard horizontal
9. FIA Fan inboard axial
10. FOV Fan outboard vertical
11. FOH Fan outboard horizontal

12. FOA Fan outboard axial

Multiple bearing fans

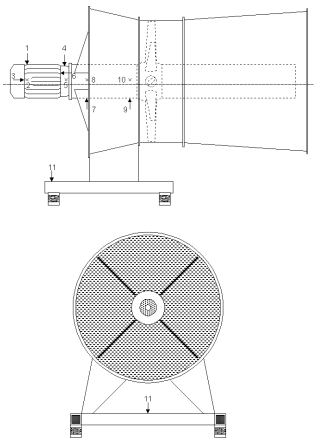


*NOTE: Use this configuration as an example. The bearing closest to the pulley will always be referred to as **fan bearing 1**. The next closest bearing along the fan shaft will always be referred to as **fan bearing 2**.*

1. FB1IL Fan bearing one inline
2. FB1P Fan bearing one perpendicular
3. FB1A Fan bearing two inline
4. FB2P Fan bearing two perpendicular
5. FB3IL Fan bearing three inline
6. FB3P Fan bearing three perpendicular
7. FB3A Fan bearing three axial
8. FB4IL Fan bearing four inline
9. FB4P Fan bearing four perpendicular
10. FB4A Fan bearing four axial
11. FB5IL Fan bearing five inline
12. FB5P Fan bearing five perpendicular

13. FB5A Fan bearing five axial

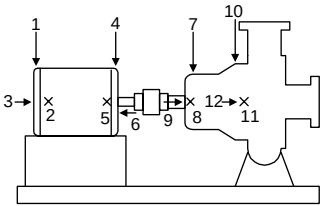
Trane AVPA fans

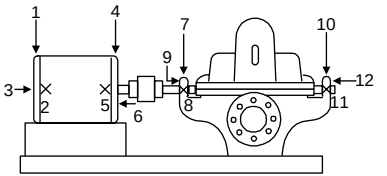


1. MIV Motor inboard vertical
2. MIH Motor inboard horizontal
3. MIA Motor inboard axial
4. MOV Motor outboard vertical
5. MOH Motor outboard horizontal
6. MOA Motor outboard axial
7. FIV Fan inboard vertical
8. FIH Fan inboard horizontal
9. FOV Fan inboard axial

10. FOH Fan outboard vertical
11. Frame

Pumps

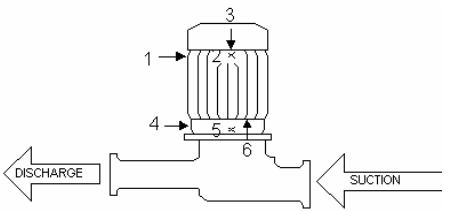


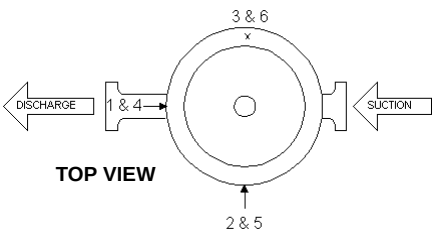


1. MOV Motor off end vertical
2. MOH Motor off end horizontal
3. MOA Motor off end axial
4. MDV Motor drive end vertical
5. MDH Motor drive end horizontal
6. MDA Motor drive end axial
7. PIV Pump inboard vertical
8. PIH Pump inboard horizontal
9. PIA Pump inboard axial

10. POV Pump outboard vertical
11. POH Pump outboard horizontal
12. POA Pump outboard axial

Single stage vertical pumps





NOTE: "Inline" and "perpendicular" are oriented with respect to the pump's discharge.

1. MII Motor inboard inline
2. MIP Motor inboard perpendicular
3. MIA Motor inboard axial
4. MOI Motor outboard inline
5. MOP Motor outboard perpendicular

6. MOA Motor outboard axial

Analyzing bearing data

You use the data you collected in the screening route to perform a bearing analysis.

To analyze bearing data, follow these steps:

1. Access the Review mode.

   From the Main menu:

   - Select the Review option.

   The Review mode displays the routes for which you have collected data.

2. Select the appropriate branch name.
3. Select the Fan and Pump Analysis option.

   A list of customers displays.

4. Select the appropriate customer.

   A list of machines at that customer site displays.

5. Select the machine for which you are reviewing data.

   A list of the data points display.

6. Move the cursor to the first data point and press <ENTER> to select it.

The overall amplitude for the point displays.

7. Press <ENTER> again.

   The spectrum for that point displays.

8. Press the Right Arrow key to move the cursor across the spectrum.

If you...	Then...
Know the bearing defect frequencies	1. Move the cursor to the known frequencies. 2. Press <MKRS ON/OFF> to display the harmonic markers. If the fundamental frequency and/or harmonics are present, then a defect exists. See *Worn rolling element bearings* in Section 4 for more information.
Do NOT know the bearing defect frequencies	Look for nonsynchronous frequencies as potential bearing frequencies. Call the Engineering Services Help Line if you need help.

9. Determine the severity of the defect.

   The severity of the defect is determined by the amplitude, sidebands, and number of harmonics. Time and experience will aid in the assigning of the severity. Call the Engineering Services Help Line if

you are having trouble determining the severity of a defect.

Section 3
Analyzing problems

Amplitude and phase data 3-2

Configuring the Microlog to collect amplitude and phase data 3-2

Collecting amplitude and phase data.....3-6

If amplitude and phase fluctuate 3-8

Using the strobe light as a trigger.....3-9

Using the Technical Assistant Program 3-14

Performing a bump test.....3-17

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Preparing to call 3-22

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Amplitude and phase data

Before you collect amplitude and phase data, you must configure the Microlog.

Configuring the Microlog to collect amplitude and phase data

To configure the Microlog, follow these steps:

1. Access the Input Setup screen.

   From the Main menu:

   - Select the Analyzer option. The Analyzer menu displays.
   - Select the Input Setup option. The Input Setup screen displays.

2. Enter the appropriate input setup parameters.

   NOTE: You do not have to change or enter anything for those parameters with blank spaces in the following table.

	Enter these parameters
ID	
Desc	
Type	Acc to Vel
Full scale	
Detection	Peak
Input	100.0 mv/EU
Low Freq Cutoff	300 CPM
RPM	

3. Press <ESCAPE> once you have entered all of the input setup parameters.

   The Analyzer menu displays.

4. Select the Spectrum Setup option.

   The Spectrum Setup screen displays.

5. Enter the appropriate spectrum setup parameters.

   NOTE: You do not have to change or enter anything for those parameters with blank spaces in the following table.

	Enter these parameters
Lines	400
Freq Type	Track
Start Freq	0
Maximum Freq	
Number of Averages	
Average Type	Off
Average Mode	Cont.
Average Overlap	Max
Window	Hanning

6. Press <ESCAPE> once you have entered all of the spectrum setup parameters.

   The Analyzer menu displays.

7. Select the Display Setup option.

   The Display Setup screen displays.

8. Enter the appropriate display setup parameters.

   NOTE: You do not have to change or enter anything for those parameters with blank spaces in the following table.

	Enter these parameters
Trace	
Screen 1	
Phase Type	0-360
Cursor Type	
X-Axis Label	

9. Press <ESCAPE> once you have entered all of the display setup parameters.

   The Analyzer menu displays.

10. Select the Trigger Setup option.

    The Trigger Setup screen displays.

11. Enter the appropriate trigger setup parameters.

    NOTE: You do not have to change or enter anything for those parameters with blank spaces in the following table.

	Enter these parameters
Trigger Mode	Trigger
Trigger Source	External
Input Trigger Slope	+
Input Trigger Level	
Trigger Delay	0 ms
Pulses/Rev	1.0
Length/Rev	1.0

12. Press <ESCAPE> until the Main menu displays.

Collecting amplitude and phase data

You should collect amplitude and phase data if any spectrum in the screening process has an overall above 0.2 IPS or a 1xRPM amplitude of 0.15 IPS. These conditions indicate potential problems that will require repairs.

To collect amplitude and phase data, follow these steps:

1. Attach the accelerometer and strobe light to the Microlog.
2. Adjust the strobe light to trigger off the motor shaft.
    - See the *Using the strobe light as a trigger* procedure in this section for help.

3. Access the Analyzer menu.

   From the Main menu:

   - Select the Analyzer option. The Analyzer menu displays.

4. Attach the accelerometer at the position specified on the Amplitude and Phase Data Form.

5. Select the Take Data option from the Analyzer menu.

   The Tracking Filter screen displays the amplitude and phase values for that position. As the values display, they will vary: you should record an average of these values.

   If the amplitude and/or phase fluctuate widely during data collection, see *If amplitude and phase fluctuate* following this procedure.

6. Record the average amplitude and phase on the Amplitude and Phase Data Form.

7. Repeat Steps 4-6 for each measurement position.

   NOTE: If you are collecting data for belt drive equipment, such as a fan, you should move the strobe to trigger from the fan shaft. Then, you should collect amplitude and phase data again for each position.

8. Diagnose the problem.

   - Enter the data from the Amplitude and Phase Data Form into the Technical Assistant Program.

     The Technical Assistant Program uses the data you enter and gives you results to help you determine the problem. If you need help using the program, see *Using the Technical Assistant Program* in this section.

   - Use the information in Section 4 to help diagnose the problem.

If amplitude and phase fluctuate

If the **phase** is fluctuating during phase and amplitude data collection, check the screening 1xRPM amplitude:

- If it is less than 0.02 IPS, the data is good. The amplitude is so low that the Microlog cannot accurately get a trigger from the 1xRPM spike.
- If the 1xRPM is greater than 0.02 IPS, you should reset the strobe to Internal and steady the shaft. Then, switch to Tracking and steady the shaft at the same reference point you've been using. Finally, recollect the phase and amplitude data for that point.

If the **amplitude** is fluctuating, listen for audible beats or varying sounds. If you hear such sounds, the amplitudes

may vary. When this happens, record the average amplitude for the amplitude and phase data.

Using the strobe light as a trigger

To use the strobe light as a trigger for phase readings, follow these steps:

1. Find access to the rotating shaft.
2. Identify a reference mark on the shaft.
    - You can use a keyway, an obvious scratch, or a paint mark for reference.
3. Place a reference mark on the bearing housing using a paint pen, reflective marker, or tape.
    - A mental clock position will also work but may result in slight errors.

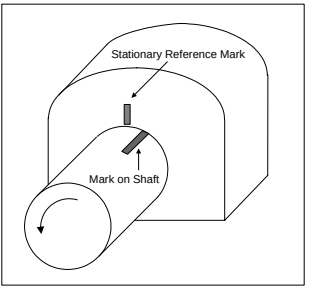

Figure 1: Identifying reference marks on the shaft and bearing housing

4. Turn on the strobe and set its EXT/INT/TRACK toggle switch to INT.

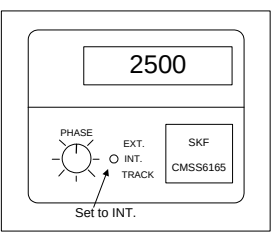

Figure 2: Setting the toggle switch to INT

5. With the Flashes Per Minute indicator higher than the shaft rotating speed, slowly lower the rate setting until the shaft freezes.

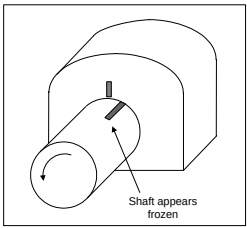

Figure 3: Freezing the shaft

CAUTION: The shaft freezes at twice and half the RPM. If the shaft appears frozen and you see two keyways on opposite sides, you have stopped at two times shaft speed. You should continue reducing the strobe flash rate until you freeze the shaft again.

6. Switch the toggle switch to TRACK when the shaft is frozen.

   Switching to TRACK may cause the mark on the shaft to shift to a new position.

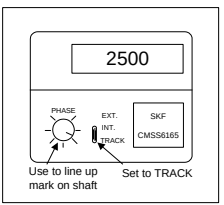

Figure 4: Setting the toggle switch to TRACK

7. Use the Phase dial to shift the position of the shaft to align the reference mark on the stationary bearing housing with the mark on the shaft.

   NOTE: The reference mark on the bearing housing must be kept in line with the reference mark on the shaft for all readings.

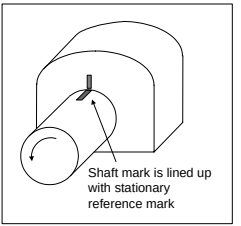

Figure 5: Lining up shaft mark with stationary reference mark

8. Take data following the *Collecting amplitude and phase data* procedure in this section.

NOTE: If the strobe fires inconsistently during this process, see *Solving strobe problems* in Section 9 for help.

Using the Technical Assistant Program

You use the Technical Assistant Program to help analyze machinery problems. It analyzes data you collect and enter in the program to give you a list of probable causes of a problem.

However, the Technical Assistant Program does not replace your own analysis, and you should always manually verify its results.

You should copy the Technical Assistant Program onto the hard drive of a laptop computer or diagnostic calculator and take the laptop or calculator with you to the customer site when performing an alignment.

To use the Technical Assistant Program for new data, follow these steps:

1. Make sure you are in the directory that contains the program.
2. Type **TAP**.

   The Main menu displays.
3. Press “3” to open a new data sheet.

   This message displays: “Enter a brief description (up to 60 characters).”
4. Type a description of the file you are creating.

5. Press <Enter> when you are finished.

   This message displays: “What type of equipment will this analysis be for?”

6. Select the type of equipment you are analyzing.
   - Press “1” if you are analyzing a fan.
   - Press “2” if you are analyzing a pump.

If you pressed...	Then...
1, for fans	This message displays: “What type of drive system will this analysis be for?” • Select the appropriate drive system. A screen that looks like the Amplitude and Phase Data Form displays. • Type the data from the Amplitude and Phase Data Form into the Technical Assistant Program.
2, for pumps	A screen that looks like the Amplitude and Phase Data Form displays. Type the data from the Amplitude and Phase Data Form into the Technical Assistant Program.

7. Press <ESCAPE> once you have entered all of the information from the form.

   A list of probable problems displays. Those problems at the top of the list are the most probable causes.

8. If you want a printout of the results, press <Print Screen>.

   The results print.

9. Press any key to continue.

   The Main menu displays again. You can either:

   - Press “1” to read a stored file.
   - Press “2” to edit the file you are working on.

10. Press “4” to exit the program when you are finished.

    The program asks you if you want to save the current file. Press “1” for yes and enter the filename.

Performing a bump test

You should perform a bump test anytime you suspect resonance. The bump test:

- Helps you to identify the natural frequency of the machine.
- Determines if the natural frequency is equal to a generated frequency of the machine, such as the running speed of the motor.

To perform a bump test, follow these steps:

1. Access the Input Setup screen.

   From the Main Menu:

   - Select the Analyzer option. The Analyzer menu displays.
   - Select the Input Setup option. The Input Setup screen displays.

2. Enter the appropriate settings.

	Enter these settings
ID	Bump test (set as desired—if you save the data, the Microlog saves it under this ID)
Desc	
Type	Acceleration
Full scale	10 Gs
Detection	Peak
Input	100.0 mv/EU
Low Freq Cutoff	600 CPM (set lower than the suspected resonance frequency)
RPM	1800.0

3. Access the Spectrum Setup screen.
   - Press <ESCAPE> to return to the Analyzer menu.
   - Select the Spectrum Setup option. The Spectrum Setup screen displays.

4. Enter the appropriate settings.

	Enter these settings
Lines	400
Freq Type	Freq.
Start Freq	0
Maximum Freq	12,000 CPM (set higher than the suspected resonance frequency)
Number of Averages	0
Average Type	Pk Hold
Average Mode	Cont.
Average Overlap	None
Window	Uniform

5. Access the Display Setup screen.
   - Press <ESCAPE> to return to the Analyzer menu.
   - Select the Display Setup option. The Display Setup screen displays.

6. Enter the appropriate settings.

	Enter these settings
Trace	Single
Screen 1	Magnitude
Phase Type	0-360
Cursor type	Cross

7. Access the Trigger Setup screen.
    - Press <ESCAPE> to return to the Analyzer menu.
    - Select the Trigger Setup option. The Trigger Setup screen displays.
8. Enter the “Free Run” setting for Trigger Mode.
    - With Trigger Mode set to “Free Run,” you do not have to enter any other Trigger Setup settings.
9. Turn off the machine.
    - Follow the Lockout/Tagout procedure given in the *Employee Safety Handbook (FAN 833.3)*.
10. Mount the accelerometer on the machine.
11. Begin tapping the machine with a rubber or plastic-tipped hammer.
12. Access the Take Data screen.

- Press <ESCAPE> to return to the Analyzer menu.
- Select the Take Data option. The Take Data screen displays.
- Continue tapping the machine until data displays.

As the data displays, it changes, but the highest amplitude at each frequency is recorded. When you see little change in the spectrum:

- Press <FREEZE> on the Microlog.
- Use the cursor to identify the frequency of the individual peaks.

If there is a high amplitude at the running speed of the machine or at some other machine-generated frequency, then a resonance condition exists.

Understanding the Technical Support Process

When you have a question or encounter a problem on the job, you can call the Engineering Services Help Line. Engineering Services will then direct your question or problem to the Predictive Diagnostics Team, who will get you the answer you need in the shortest time possible.

Preparing to call

You should complete certain preparations before you call Engineering Services. These preparations are outlined in the following table.

In the next section, *Calling Engineering Services*, there is a Features List that you may find helpful when preparing to call. This list helps you describe the problem or question you have.

	If you...	Then you should...
1	Are performing route setup or requesting a download	Complete the Nameplate Information Form.
		Fax the Nameplate Information Form to the Predictive Diagnostics Team.
		Remember to immediately tell Engineering Services that you need a download when you call.
2	Are having a problem with equipment or data collection	Be ready to fully describe the problem to the call handler. Use the Features List to help describe the problem.

	If you...	Then you should...
3	Need help with screening data	Make sure you have collected amplitude and phase data and recorded it on the Amplitude and Phase Data Form.
		Complete the Screening Results section of the Vibration Report.
		Upload the screening data to the Predictive Diagnostics Team.

	If you...	Then you should...
4	Need help with diagnosing amplitude and phase data	Make sure you have collected amplitude and phase data and recorded it on the Amplitude and Phase Data Form.
		Enter the information from the Amplitude and Phase Data Form into the Technical Assistant Program.
		Print the results generated by the Technical Assistant Program OR write them on the back of the Amplitude and Phase Data Form.
		Fax the Technical Assistant Program results and the Amplitude

If you...	Then you should...
	and Phase Data Form to the Predictive Diagnostics Team.

If you...	Then you should...
5 Need help with writing a report	Make sure you have collected all data.
	Complete the items given for 3 and 4.
	Fill out the Vibration Report as completely as you can and fax it to the Predictive Diagnostics Team.

The fax number for the Predictive Diagnostics Team is **(414) 274-4120**.

If you have to fax a document mentioned in the table, include a cover sheet with the following information:

- Your name, branch, and pager number (or a number where you can be reached)
- The problem or question you have
- When you need an answer (especially if you are at a customer site and need an immediate answer)

Additionally, if you ever have a question or problem that does not need an immediate answer, you can fax it to the Predictive Diagnostics Team at the number given.

Once you are fully prepared, you can go to the next section, *Calling Engineering Services*.

Calling Engineering Services

The phone number for the Engineering Services Help Line is **(800) 333-2222**, **ext. 4357**. An Engineering Services call handler answers when you call this number.

If you need to upload data or download a route, immediately tell the call handler that you need an upload or download. He or she will transfer you right away to a member of the Predictive Diagnostics Team.

Otherwise, if you have a question or an equipment problem, you should be prepared to give the call handler the following information:

- General information
  - Your name and branch
  - Job site or project name
- System type, which includes:
  - "Fans" for questions or problems related to fans
  - "Pumps" for questions or problems related to pumps
  - "Equipment problems" for questions or problems related to the Microlog or measurement equipment
- The appropriate feature(s) related to the system type

  To further describe the nature of your problem or question, you must also identify the feature(s) for the system type you're calling about.

Use the Features List below to describe the problem or question:

Fan features	Pump features
Route setup	Route setup
Data transfer	Data transfer
Data collection	Data collection
Data analysis	Data analysis
Balancing	Alignment
Maintenance	Maintenance
Reporting	Reporting

Equipment problem features	
Microlog	Current clamps
Accelerometer	Magnets and Stinger
Accelerometer cable	Microlog batteries
Accessory cables	Computer programs:
Strobe	Alignment program
Reverse dial indicator	Balance program
Shims	Technical Assistant Program
Balance weights	

- The specific problem you are having or the question you have
- The type of fan or pump (for example, “squirrel cage fan”)
- When you need a response (this is especially important if you are at a customer site and you need an immediate response)

So that the Predictive Diagnostics Team can handle all calls appropriately, please be honest and conscientious about the seriousness of your question and the time in which you need a response.

After the call handler has gathered your information, he or she will give you a call number. The call number serves as a permanent reference for any future callbacks for your problem or question. **Record the call number.**

As the call handler assigns a call number to your call, he or she assigns a priority to it as well. Basically, the calls with the highest priority are those from mechanics at a customer site needing help with an issue that affects the immediate delivery of the service.

When your call is high priority and requires an immediate response, the call handler transfers you directly to a member of the Predictive Diagnostics Team. If your call does NOT require an immediate response, the call handler places the call number in a queue and assigns it a lower priority.

The following table details the priority levels and when you can expect a callback.

Priority	Definition	Callback?
1	Mechanic at customer site with an analysis question or equipment problem; needs immediate assistance.	Your call will be transferred to the Predictive Diagnostics Team, who will accept the call only if you have completed the preparations outlined in *Preparing to call*.
2	Mechanic at customer site; needs an answer within the day.	Within one day
3	Mechanic not at the customer site but has a technical question or equipment problem. Does not need the answer within the day.	Within two days
4	The caller does not have a problem but has an application	Within five days

	question.	

Section 4
Diagnosing problems

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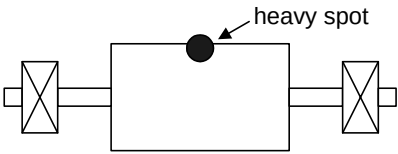
Imbalance



Physical check

Not possible.

Maintenance

Balance the shaft.

Vibration check

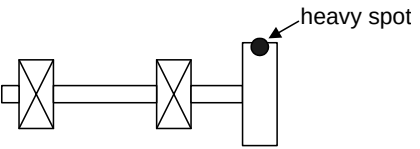
Frequency components: 1x shaft RPM.

Vibration characteristics:

- A radial 1x shaft RPM amplitude is in alarm. If not true, imbalance does not exist.
- The larger radial 1x shaft RPM amplitude is less than twice the smaller radial 1x shaft RPM amplitude at the same end of the machine. This must be true at both ends of the machine.
- Harmonics of 1x shaft RPM amplitude are less than half the 1x shaft RPM amplitude in the same orientation and end of the machine. This must be true for all orientations at both ends of the machine.
- The axial 1x shaft RPM amplitude is less than half the smallest radial 1x shaft RPM amplitude at the same end of the machine. This must be true at both ends of the machine.
- The PAD between the two radial 1x shaft RPM phase angles at one end of the machine is 90° (±30°). This must be true at both ends of the machine.

Alarm limits: Radial 1x shaft RPM amplitude greater than 0.15 IPS.

Over hung fan or sheave imbalance



Physical check

Not possible.

Maintenance

Balance the fan. Overhung squirrel cage fans require a special balancing procedure if the length to diameter ratio is less than 0.5. (See *Balancing fans of different configurations* in Section 6.)

Improper key length can cause imbalance on a sheave and should be corrected.

Vibration check

Frequency components: 1x shaft RPM.

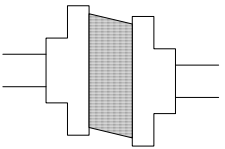
Vibration characteristics:

- A radial 1x shaft RPM amplitude is in alarm. An axial 1x shaft RPM amplitude is in alarm and is greater than half the smaller of the two radial 1x shaft RPM amplitudes at the same end of the machine. If not true, overhung imbalance does not exist.
- The larger radial 1x shaft RPM amplitude is less than twice the smaller radial 1x shaft RPM amplitude at the same end of the machine. This must be true at both ends of the machine.
- Harmonics of 1x shaft RPM amplitude are less than half the 1x shaft RPM amplitude in the same orientation and end of the machine. This must be true for all orientations at both ends of the machine.
- The PAD between the two axial 1x shaft RPM phase angles at each end of the machine is

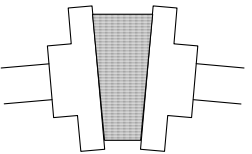
  0° (±30°).
- Radial 1x shaft RPM phase angles may be unsteady.

Alarm limits: Radial 1x shaft RPM amplitude greater than 0.15 IPS. Axial 1x shaft RPM amplitude greater than 0.075 IPS.

Coupling misalignment



Parallel misalignment



Angular misalignment

Physical check

Shut down the pump. Check for gross misalignment across the coupling with a straight edge.

A reverse dial indicator configuration is required to check and correct anything less than gross misalignment.

An acceptable amount of misalignment is 2 mils or less.

Other indicators of parallel coupling misalignment include:

- A very warm coupling temperature (possibly warmer than the motor)
- The presence of coupling material under the coupling
- A squeaking noise during operation

Maintenance

Align the motor and pump shafts.

Vibration check

Frequency components: 1x shaft RPM, 2x shaft RPM, and 3x shaft RPM.

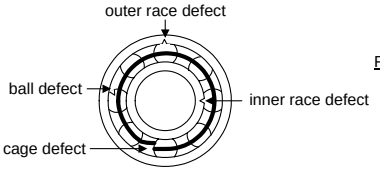
Vibration characteristics:

- A radial or axial 1x shaft RPM amplitude is in alarm. If not true, coupling misalignment does not exist.
- The larger radial 1x shaft RPM amplitude is greater than twice the smaller radial 1x shaft RPM amplitude at the same end of the machine. This must be true on at least one end of either the drive or driven machine.
- A harmonic of 1x shaft RPM amplitude is greater than half the 1x shaft RPM amplitude in the same orientation and end of the machine. This must be true on at least one end of either the drive or driven machine.

- The axial 1x shaft RPM amplitude is greater than half the smallest radial 1x shaft RPM amplitude at the same end of the machine. This must be true on at least one end of either the drive or driven machine.
- The PAD between the two vertical 1x shaft RPM phase angles at each end of the drive or driven machine is 0° or 180° (±30°), **or** the PAD between the two horizontal 1x shaft RPM phase angles at each end of the drive or driven machine is 0° or 180° (±30°). This must be true for three of the four PAD's.
- The PAD between the two axial 1x shaft RPM phase angles at each side of the coupling is 180° (±30°).
- The PAD between the two radial 1x shaft RPM phase angles at one end of the drive or driven machine is 0° or 180° (±30°). This must be true on at least one end of either the drive or driven machine.

Alarm limits: Radial 1x shaft RPM amplitude greater than 0.15 IPS. Axial 1x shaft RPM amplitude and radial 2x shaft RPM amplitude greater than 0.075 IPS. Axial 2x shaft RPM amplitude greater than 0.0375 IPS.

Worn rolling element bearings



SKF 6313
Fundamental Defect Frequencies

BPFO: 3.089	(outer race)
BPFI: 4.911	(inner race)
BSF: 2.082	(ball spin)
FTF: 0.386	(cage)

Physical check

Listen for a squealing or grinding noise. Feel the bearing temperature for excess heat.

Maintenance

Replace the bearing.

If you are unsure about a bearing defect, call the Engineering Services Help Line.

Vibration check

Frequency components: Bearing defect frequencies and/or harmonics.

Vibration characteristics: The presence of bearing defect frequencies and harmonics indicate a bearing defect. The more harmonics and the greater the amplitude, the worse the problem is.

As the defect worsens, the harmonics and frequency increase, as will the sidebanding around the individual frequencies.

To calculate the bearing defect frequencies, multiply the fundamental defect frequency by the running speed. The result is the actual defect frequency of that bearing running at that speed.

Example: For the SKF 6313 bearing above, knowing the fundamental BPFO and the running speed of 1180 CPM, the outer race defect frequency would be:

1180 x 3.089 or **3645 CPM**

You can make an estimate if you know the number of rolling elements. These equations are:

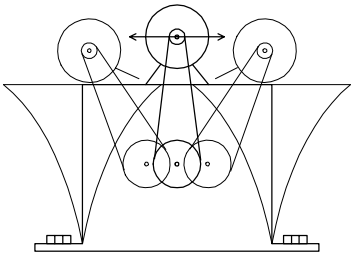
BPFO = RS x N x 0.4 and **BPFI = RS x N x 0.6**

(RS = running speed and N = number of rolling elements)

The fundamental bearing defect frequencies are available from the bearing manufacturer or the Predictive Diagnostics Team.

Alarm limits: Alarm greater than 0.04 IPS.

Resonance—Fans



Physical check

Fan unit shaking violently in one direction.

Maintenance

Secure the fan or motor. Additional bracing may be necessary: loose hold down bolts can allow the unit to resonate.

If fan imbalance is causing the motor to resonate at the fan shaft turning frequency, balancing the fan could decrease the resonant vibration.

Vibration check

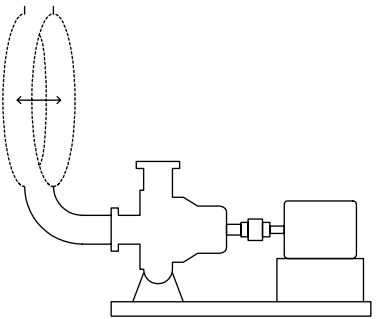
Frequency components: 1x shaft RPM. See *Performing a bump test* in Section 3.

Vibration characteristics:

- A radial or axial 1x shaft RPM amplitude is in alarm. If not true, resonance does not exist.
- The larger radial 1x shaft RPM amplitude is greater than five times the smaller radial 1x shaft RPM amplitude at the same end of the machine, **or** the axial 1x shaft RPM amplitude is greater than two and one half times the larger radial 1x shaft RPM amplitude at the same end of the machine. This must be true on at least one end of the machine.
- If resonance is in a radial direction, the PAD between the two radial 1x shaft RPM phase angles at the resonant end of the machine is 0° or 180° (±30°).
- Slight variations in speed can cause the phase angle measurements to be unstable and vary by 50° or more in the resonant position.

Alarm limits: Radial 1x shaft RPM amplitude greater than 0.15 IPS. Axial 1x shaft RPM amplitude greater than 0.075 IPS.

Resonance—Pumps



Physical check

Pump shaking violently in one direction.

Maintenance

Secure the motor or pump. Additional bracing on the piping may be necessary: loose hold down bolts can allow the unit to resonate.

Vibration check

Frequency components: 1x shaft RPM. You can perform a bump test to determine resonance. Resonant

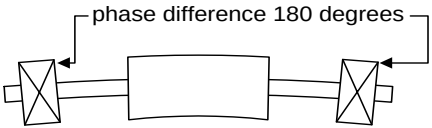
frequencies appear as wide spikes in the spectrum. If they occur at 1x shaft RPM, the resonance problem is confirmed. See *Performing a bump test* in Section 3.

Vibration characteristics:

- A radial or axial 1x shaft RPM amplitude is in alarm. If not true, resonance does not exist.
- The larger radial 1x shaft RPM amplitude is greater than five times the smaller radial 1x shaft RPM amplitude at the same end of the machine, **or** the axial 1x shaft RPM amplitude is greater than two and one half times the larger radial 1x shaft RPM amplitude at the same end of the machine. This must be true on at least one end of the machine.
- If resonance is in a radial direction, the PAD between the two radial 1x shaft RPM phase angles at the resonant end of the machine is 0° or 180° (±30°).
- Slight variations in speed can cause the phase angle measurements to be unstable and vary by 50° or more in the resonant position.

Alarm limits: Radial 1x shaft RPM amplitude greater than 0.15 IPS. Axial 1x shaft RPM amplitude greater than 0.075 IPS.

Bent shaft



Physical check

Shut down the fan. Check the runout on the shaft near the sheave with a dial indicator. An acceptable shaft runout is 2 mils or less.

Maintenance

Straighten or replace the shaft.

Vibration check

Frequency components: 1x shaft RPM and 2x shaft RPM.

Vibration characteristics:

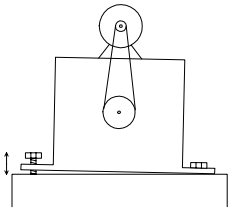
- A radial 1x shaft RPM amplitude is in alarm. If not true, bent shaft does not exist.
- An axial 1x shaft RPM amplitude is in alarm and is greater than half the smaller of the two radial 1x

shaft RPM amplitudes at the same end of the machine.

- The larger radial 1x shaft RPM amplitude is less than twice the smaller radial 1x shaft RPM amplitude at the same end of the machine. This must be true at both ends of the machine.
- The 2x shaft RPM amplitude is greater than half the 1x shaft RPM amplitude in the same orientation and end of the machine. This must be true on at least one orientation at either end of the machine.
- The PAD between the two radial 1x shaft RPM phase angles at one end of the machine is 90° (±30°). This must be true at both ends of the machine.
- The PAD between the two axial 1x shaft RPM phase angles at each end of the machine is 180° (±30°).
- The PAD between the two vertical 1x shaft RPM phase angles at each end of the machine is 0° (±30°) and the PAD between the two horizontal 1x shaft RPM phase angles at each end of the machine is 0° (±30°).

Alarm limits: Radial 1x shaft RPM amplitude greater than 0.15 IPS. Axial 1x shaft RPM amplitude and radial 2x shaft RPM amplitude greater than 0.075 IPS.

Loose mounting bolts



Physical check

Feel for relative motion of the fan housing to the floor or the motor to its mounting.

Maintenance

Secure the fan or motor. Additional bracing may be necessary. Shimming may be necessary so the frame is not distorted when you secure it.

Vibration check

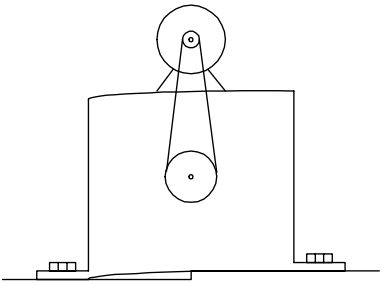
Frequency components: 1x shaft RPM and harmonics. ½x shaft RPM and harmonics.

Vibration characteristics:

- A radial or axial 1x shaft RPM amplitude is in alarm. If not true, looseness does not exist.
- The larger radial 1x shaft RPM amplitude is greater than three times the smaller radial 1x shaft RPM amplitude at the same end of the machine, **or** the axial 1x shaft RPM amplitude is greater than one and one half times the larger radial 1x shaft RPM amplitude. This must be true on at least one end of the machine.
- Harmonics of 1x shaft RPM amplitude are greater than half the 1x shaft RPM amplitude in the same orientation and end of the machine. This must be true on at least one orientation at one end of the machine.
- ½x shaft RPM harmonics are present. This must be true on at least one orientation at one end of the machine.
- The PAD between the two radial 1x shaft RPM phase angles at the end of the machine that is loose is 0° or 180° (±30°) if looseness is in the radial direction.

Alarm limits: Radial 1x shaft RPM amplitude greater than 0.15 IPS. Axial 1x shaft RPM amplitude and radial 2x shaft RPM amplitude greater than 0.075 IPS. Axial 2x shaft RPM amplitude greater than 0.0375 IPS.

Frame distortion



Physical check

Loosen the hold down bolts mounting the fan unit to the floor or the motor to the frame. If a foot raises, soft foot is present, and the frame is being distorted when tightened back down.

Maintenance

Shim the fan or motor so it sits flat and stress-free on its base.

Vibration check

Frequency components: 1x shaft RPM.

Vibration characteristics:

- A radial or axial 1x shaft RPM amplitude is in alarm. If not true, distortion does not exist.
- The larger radial 1x shaft RPM amplitude is greater than three times the smaller radial 1x shaft RPM amplitude at the same end of the machine, **or** the axial 1x shaft RPM amplitude is greater than one and one half times the larger radial 1x shaft RPM amplitude. This must be true on at least one end of the machine.
- The PAD between the two radial 1x shaft RPM phase angles at the end of the machine that is distorted is 0° or 180° (±30°) if distortion is in the radial direction.

Alarm limits: Radial 1x shaft RPM amplitude greater than 0.15 IPS. Axial 1x shaft RPM amplitude greater than 0.075 IPS.

Worn, loose, or mismatched belts

Physical check

The belt makes a periodic thumping, chirping, squealing, or grinding noise while in operation.

Shut down the fan unit and check for cracks, glazing, and wear spots.

Check for proper belt tension. The belts should be as loose as possible without slipping or squealing on startup or under maximum load.

On multi-belt sheaves, measured tension should be the same on all belts when tested with a belt tension gauge.

Maintenance

If belts are worn, replace them. If one belt is bad, you must replace all the belts; if you do not, there will be unequal tension (mismatch). You can also replace individual belts with one multi-belt.

When replacing the belts, remember that proper belt tension is important. The belts should be as loose as

possible without slipping or squealing on startup. You should check the belt tension after 10 to 12 hours of operation.

Vibration check

Frequency components: The belt frequency is always lower than 1x motor or fan. 1x belt frequency is usually not present; the harmonics usually dominate and are the key indicators of a problem.

$$\text{Belt frequency (RPM)} = \frac{3.142 \times \text{speed (RPM)} \times \text{pulley pitch diam (in)}}{\text{Belt length (in)}}$$

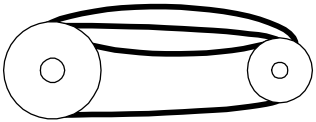
Vibration characteristics:

- The more belt frequency harmonics and the greater the amplitude, the worse the problem is.
- Vibration should be greater in line with the belts than perpendicular to the belts.

If any of these frequency components are higher than the 1x motor RPM or 1x fan RPM vibration amplitudes, belt problems are the major cause of vibration.

Alarm limits: Any belt frequency harmonic greater than 0.15 IPS. If the belt frequency harmonics are in alarm and the axial belt frequency harmonics are greater than 50% of the highest radial, this indicates the belts may be mismatched.

Belt resonance



Physical check

The belt whips violently back and forth even though the tension and condition of the belt is good.

Maintenance

Alter the tension or belt length to correct for resonance.

Vibration check

Frequency components: Normally 1x motor or 1x fan RPM, but can be any frequency.

Vibration characteristics: A belt resonance shows up at the natural frequency of the belt only if excited by another source such as 1x motor or 1x fan.

Alarm limits: Belt resonant frequency greater than 0.15 IPS.

Sheave misalignment

Physical check

Turn off the fan and use a straight edge across the face of the sheaves to check the alignment. The straight edge should touch at two points on each sheave.

Maintenance

Move a sheave in or out to correct for parallel misalignment. You should shim the motor to correct for angular misalignment.

When aligned, the string or straight edge should touch at two points on each sheave. Rotate a sheave one-half turn and recheck alignment. If the edge on one sheave is wider than the other sheave, it must be compensated for.

Vibration check

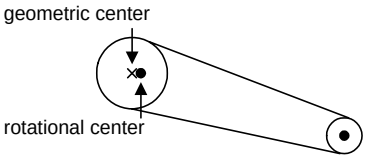
Frequency components: 1x shaft RPM, 2x shaft RPM.

Vibration characteristics:

- A radial or axial 1x shaft RPM amplitude is in alarm. If not true, sheave misalignment does not exist.
- The axial 1x shaft RPM amplitude is greater than half the smallest radial 1x shaft RPM amplitude at the same end of the machine. This must be true on at least one end of either the drive or driven machine.
- The driver (1x motor shaft RPM amplitude) vibration is usually the dominant vibration.
- Often the highest amplitude on the motor is at 1x fan shaft RPM and the highest amplitude on the fan is at 1x motor shaft RPM.
- The 2x shaft RPM amplitude is greater than half the 1x shaft RPM amplitude in the same orientation and end of the machine. This must be true in at least one orientation at one end of either the drive or driven machine.

Alarm limits: Radial 1x shaft RPM amplitude greater than 0.15 IPS. Axial 1x shaft RPM amplitude greater than 0.075 IPS.

Eccentric sheave



Physical check

Turn off the fan and use a dial indicator to measure the runout of the sheave along a surface on which the belt rides.

Runout should be less than 5 mils.

If you loosen the belt tension and the fan unit runs more smoothly, this indicates eccentricity of one sheave.

Maintenance

Replace or remachine the eccentric sheave. If not tightened uniformly, taper lock sheaves can cause the belt tension to vary, resulting in the same effect as eccentric sheaves.

Vibration check

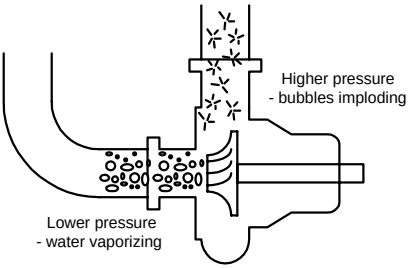
Frequency components: 1x fan RPM or 1x motor RPM.

Vibration characteristics:

- An in line 1x shaft RPM amplitude is in alarm at the sheave end of either the drive or driven machine. The 1x shaft RPM amplitude that is in alarm indicates which sheave is eccentric. If not true, an eccentric sheave does not exist.
- The in line 1x shaft RPM amplitude must be greater than twice the perpendicular 1x shaft RPM amplitude at the RPM of the machine with the eccentric sheave. This must be true on both the drive and driven machine.
- The PAD between the two radial 1x eccentric sheave shaft RPM phase angles at the sheave end of the machine is 0° or 180° (±30°). This must be true on both the drive and driven machine.

Alarm limits: Radial 1x shaft RPM amplitude greater than 0.15 IPS.

Cavitation



Physical check

Listen with the ear on the impeller housing, piping, and valves on both the suction and discharge sides of the pump. Cavitation sounds like a cappuccino maker steaming milk, or as if gravel is traveling through the pump.

Compare the sound you heard on the questionable pump to the sound of other pumps not suspected of cavitating.

Maintenance

- Increase the suction flow and/or reduce discharge flow.
- Check for restrictions in the return from the cooling tower and partially closed valves.
- Reduce the pump capacity by reducing the impeller diameter.
- Check for sharp elbows in the piping near the pump. Install straightening vanes in the piping to reduce vortex action.

Vibration check

Frequency components: Raised noise floor in the 7200 CPM to 120K CPM range.

Vibration characteristics: Resonances appear as peaks in the raised noise floor of the vibration spectrum. Do NOT confuse cavitation with bearing defects.

Cavitation occurs when the pump, valves, or sections of pipe are being starved of flow, causing such low pressure that the liquid is vaporized. When formed on internal surfaces, these vapor bubbles are destructive, causing pitting. When the vapor bubbles reach an area of higher pressure, they implode, causing the characteristic cavitation sound.

The implosions occur randomly, causing random noise throughout a broad band of frequencies in the vibration spectrum. This random noise may excite resonances which can crack pipes, damage impellers and casings, and cause frequent bearing failures.

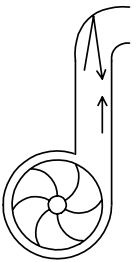
Make certain the noise is greater as you move away from the bearing locations and towards the impeller housing and piping.

Some of the causes of cavitation include:

- Low suction flow or low back pressure caused by control valves or over-design of pumping capacity
- Pumping hot liquids: hot liquids flash more readily than cooler liquids
- Piping elbows and pump inlets causing low pressure regions
- Liquids with high concentrations of air

Alarm limits: The noise floor with an average height above 0.01 IPS.

Fluid column resonance (organ piping)



Physical check

None.

Maintenance

- Change the piping length or diameter.
- Install a pulsation damper.
- Change the number of vanes on the pump.

Vibration check

Frequency components: 1x vane pass frequency - shaft turning speed times the number of impeller vanes, usually 4x to 8x shaft speed.

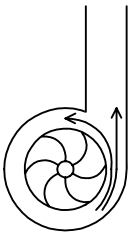
Vibration characteristics: Fluid column resonance is caused by pressure pulsations coming from the pump, hitting an elbow or valve, and reflecting back. If the pipe length, diameter, or frequency of pulsations are such that the forward and reflected pressure waves add in phase, the magnitude can be as high as twice that of the original pressure wave.

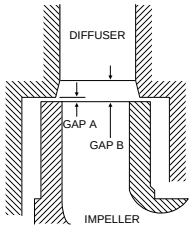
If the mechanical resonance of the piping corresponds to the fluid resonance, the piping, bracing, and pump internals can be damaged.

Mechanical bracing of the piping does not solve a fluid resonance problem.

Alarm limits: 1x vane pass greater than 0.15 IPS.

Recirculation





Physical check

Very high levels of pump noise are present. Open the pump and check for proper impeller axial and radial positioning.

Maintenance

Correct clearances gap A, gap B, and axial position.

Vibration check

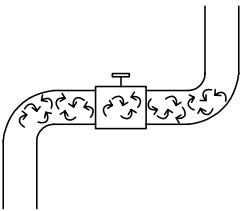
Frequency components: 1x vane pass frequency - shaft turning speed times the number of impeller vanes, usually 4x to 8x shaft speed. Low frequency vibration 300 to 700 CPM. High axial vibrations.

Vibration characteristics:

- Improper gap B causes high vane pass.
- Improper gap A causes low frequency noise.
- Improper axial positioning causes high axial vibrations.

Alarm limits: Vane pass above 0.15 IPS and low frequency noise with an average height greater than 0.5 IPS.

Turbulence



Physical check

Listen at elbows and valves.

Maintenance

Ten pipe diameters of pipe length should be present between pumps, valves, and elbows.

Vibration check

Frequency components: Low frequency noise.

Vibration characteristics: Random low frequency vibration in the 50 to 2000 CPM range.

Alarm limits: Low frequency noise with an average height greater than 0.5 IPS.

Section 5
Alignment

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SECTION 5: ALIGNMENT

Prealignment procedures

Minimum tool requirements

- ❒ Reverse dial indicator kit with shaft mounting hardware
- ❒ Dial indicator with magnetic base
- ❒ Standard tool complement (torque wrenches and crows feet are recommended)
- ❒ Lifting tools (pry bars, hydraulic lifting devices)
- ❒ Horizontal movement aids (carpenter's bar clamps, jacking bolts, commercial adjustment product)
- ❒ Pre-cut shims
- ❒ 0-1 outside micrometer (to check shim thickness)
- ❒ Thickness gauges

What you should know

As you prepare to align a machine, you should know:

- Alignment tolerances for the machine
- Cold misalignment offsets
- Shaft axial float (endplay)
- Coupling gap (nominal space between coupling hubs)
- Dial indicator bar sag

In addition, you should check:

- Coupling and shaft runout
- Axial position
- Pipe strain
- Soft foot
- Coupling condition and lubrication
- Coupling and hold-down bolts and washers

Finally, always follow the Lockout/Tagout program in the *Employee Safety Handbook FAN 833.3*.

Checking runout

You should check for runout in both the driven side and the driver side of the coupling. To check runout, begin with the driven side and follow these steps:

1. With the coupling broken, mount the magnetic base to the coupling that is adjacent to the shaft you're checking.
2. Span to the coupling that you want to check and center the dial indicator plunger.
3. Rotate the shaft you're checking until the dial indicator reaches a maximum travel (positive or negative).
4. Zero the dial indicator.

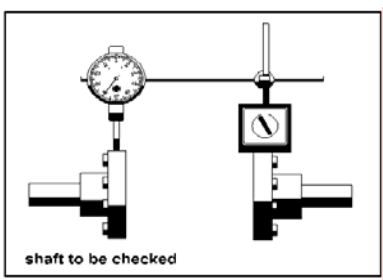


Figure 1: Mounting the dial indicators for checking runout

5. Rotate the shaft you're checking until the dial indicator reaches a maximum value. This value is the runout amount.

6. Using the value you determined in Step 5, look at the following tables to determine what to do next.

Checking driven side runout

If the coupling runout is...	Then...
.002" or less	The driven side is acceptable. Complete the previous procedure for the driven side and use the tables in *Checking driver side runout* to verify your results.
Greater than .002"	Check the shaft runout and use the next table to determine the results.

If the shaft runout is...	Then...
.001" or less	The shaft is good, but the coupling is eccentric.
Greater than .001"	The shaft is bent.

Checking driver side runout

If the coupling runout is...	Then...
.002” or less	You have completed the runout checks.
Greater than .002”	Check the shaft runout and use the next table to determine the results.

If the shaft runout is...	Then...
.001” or less	The shaft is good, but the coupling is eccentric.
Greater than .001”	The shaft is bent.

Checking for pipe strain

The effect that pipe strain has on the driven shaft is reflected in changes to the dial indicator values when you loosen the flanges.

To check for pipe strain, follow these steps:

1. With the coupling broken, mount the magnetic base to the driver coupling.
2. Span to the driven coupling and center the dial indicator plunger.
3. With the dial at 12:00, zero the dial indicator.
4. Rotate the driver shaft to 3:00 and record the value.
5. Loosen the suction flange bolts and record the dial indicator values at 12:00 and 3:00.
6. Retighten the suction flange bolts.
7. Rotate the driver shaft to 3:00 and record the value.
8. Loosen the discharge flange bolts and record the dial indicator values at 12:00 and 3:00.
9. Retighten the discharge flange bolts.

Correcting gross soft foot

You correct gross soft foot to accelerate the rough alignment process.

To correct gross soft foot, follow these steps:

1. Loosen all mounting bolts.
2. Determine if there are any shims under the feet.

If there are...	Then you should...
NO shims under the feet	Try to slip a .005” shim under each foot. If the shim will fit under a foot, make up the gap by gradually increasing the shim thickness until you achieve a tight fit.
Shims under the feet	Check if existing shim piles have more than four shims. If so, consolidate the shims by using thicker shims.

NOTE: Always begin adding shims at the foot with the largest gap.

3. Check each foot for loose shims. Make up any gaps by gradually increasing the shim thickness until you achieve a tight fit.

   NOTE: Do not add too thick of a shim pack under any foot; this will increase soft foot at adjacent feet.

4. To document and retain historical data on each machine, record what you did on a Soft Foot Recording Form.

Setting the coupling gap

To set the coupling gap, follow these steps:

1. Use a scale to quickly correct rough horizontal position. This gives you a reference position to set the proper coupling gap.

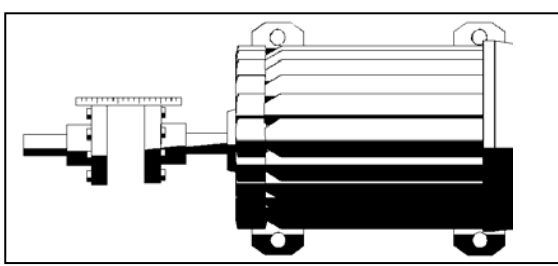


Figure 2: Finding the rough horizontal position

2. Use a taper of feeler gauge to find the coupling gap.

3. Set to the coupling manufacturer's recommendation.

   If the motor has plain bearings with endplay, be sure to position the motor shaft axially at magnetic center before setting the coupling gap.

Performing rough alignment

Before you check for soft foot or perform the actual precision alignment, you must align the machine "in the ball park." You can accomplish this by using a straight edge.

Always perform a rough alignment by correcting these planes in this order:

- Vertical angular, vertical offset
- Horizontal angular, horizontal offset

To perform a rough alignment, follow these steps:

1. Place a straight edge on the fixed machine coupling half at the 12:00 position.

   See Figure 3 for an example.

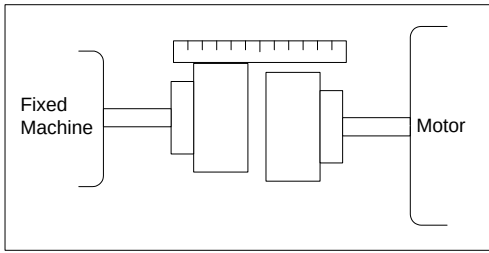


Figure 3: Placing the straight edge on the fixed machine coupling

2. Determine if the motor needs to be raised or lowered. (Find the top and bottom gap difference.)

Gap difference = widest gap - narrowest gap

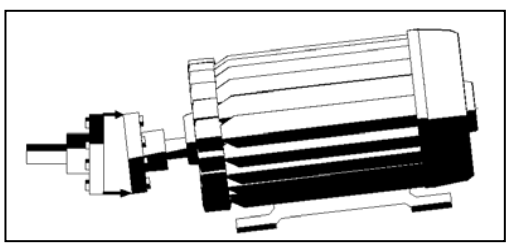


Figure 4: Coupling with wide and narrow gaps

3. Add or remove the appropriate shims to align the motor coupling half to the straight edge.

If the gap is wider...	Then...
At the top	Remove shims from the front feet *or* add shims to the rear feet.
At the bottom	Remove shims from the rear feet *or* add shims to the front feet.

You can calculate the angular correction by using this equation:

$$\frac{\text{gap difference}}{\text{coupling diameter}} \times \text{distance between bolt centers}$$

Figure 5 shows the coupling half aligned to the straight edge.

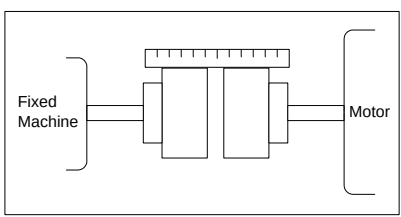


Figure 5: Aligning the coupling half to the straight edge

If the motor coupling half is not parallel with the straight edge, you should place additional shims at one end of the motor.

If the coupling is angled, as shown in Figure 6, additional shimming is required under the back feet of the motor to bring it parallel to the fixed machine.

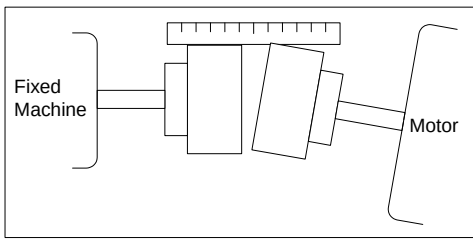


Figure 6: Angled coupling

4. Use a scale to correct vertical offset position.
5. Repeat Steps 1-4 for the horizontal plane.

Tightening hold-down bolts

To tighten hold-down bolts, follow these steps:

1. Number the bolts in a diagonal pattern.
2. Tighten the bolts in this sequence.

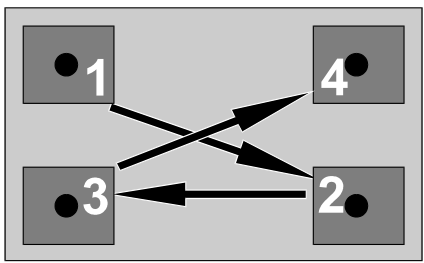


Figure 7: Sequence for tightening hold-down bolts

NOTE: If you loosen more than one bolt at a time when you are performing a precision alignment, be sure to loosen all of the hold-down bolts and retighten in this sequence.

Precision soft foot procedure

Soft foot measurements in excess of 0.003” are outside recommended tolerances and should be corrected.

To perform the precision soft foot procedure, follow these steps:

1. Loosen and re-torque all machine hold-down bolts to their proper torque value.
2. Loosen one hold-down bolt.
3. Using thickness gauges or shims, check for a gap between the foot and the base plate.
    - Check at a minimum of three points along the foot surface.
4. Record the results on a Soft Foot Recording Form.

    NOTE: Do NOT make corrections at this time.
5. Re-torque the hold-down bolt.
6. Repeat Steps 2-5 for all of the feet on the machine.
7. Determine the size of shim you need to use for each foot.

8. Beginning with the foot with the largest gap, add the largest shim that will completely fit under the foot.

   NOTE: Do not add too thick of a shim pack under any foot; this will increase soft foot at adjacent feet.

   To correct severe angular soft foot conditions, either step shimming or machining is required.

9. Continue adding shims, one foot at a time.

   - After you correct each foot, re-check adjacent feet to ensure their soft foot values did not increase. If the value increased, you added too much shim to the last corrected foot.

10. Record the final shim sizes on the Soft Foot Recording Form.

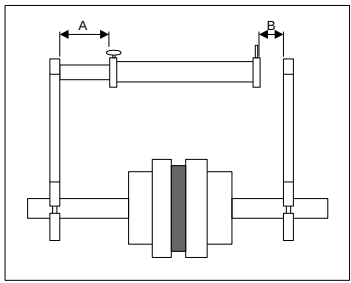
Reverse dial indicator method of alignment

To perform an alignment using the reverse dial indicator method, follow these steps:

1. Check for bar sag.

   Indicator bar sag affects all vertical offset readings. How you check for bar sag depends on whether or not you're using the A-1000-½" Alignment Kit.

   If you are using the A-1000-½" Alignment Kit, use the following bar sag value charts for the short and long bars. Distance A in the chart is shown in the following figure. The sag values were taken with the end of the bar placed one inch from the opposite bracket (Distance B).



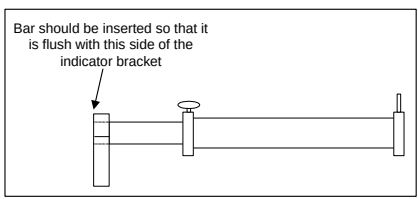


Figure 8: Dial indicator bracket setup for using the bar sag tables

Short Bar

Distance A (inches)	Bar sag (mils)
0	1
1	1.5
2	2

3	3

Long Bar

Distance A (inches)	Bar sag (mils)
0	5
1	6
2	8
3	9
4	10
5	11.5
6	13
7	15

If you are NOT using the A-1000-½" Alignment Kit, determine and document the indicator bar sag of each indicator bracket:

- Remove the alignment fixtures from the machine and mount them on a rigid pipe at the distance they will be mounted on the machine.
- Zero the dial indicators at the 12:00 position.

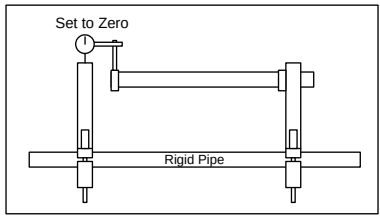


Figure 9: Bar sag setup

- Rotate the pipe to the 6:00 position.
- Read and record the sag amount for each indicator.

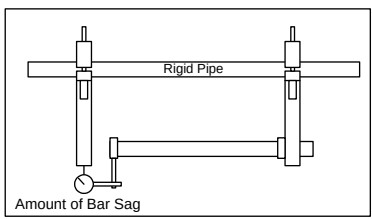


Figure 10: Measuring bar sag

2. Mount two dial indicators with brackets in a configuration to obtain offset readings.

   The dial indicators should be perpendicular to the shaft axes. If you do not set up the plungers at 90º to each shaft axis, your readings will be off.

- Mount one dial indicator (Pump Side Indicator, or PSI) to read the pump shaft.
- Mount the other dial indicator (Motor Side Indicator, or MSI) to read the motor shaft.

The indicators may contact the shafts or brackets, but they should be at the same clock position, such as 12:00. See Figure 10 for an example.

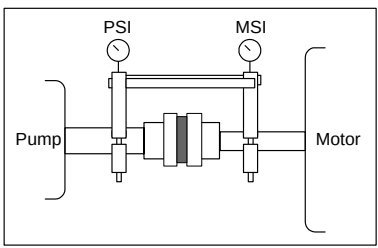


Figure 11: Dial indicator setup

3. Set both dial indicators to read 0.000" at the 12:00 position.
4. Obtain and record two full sets (12:00, 3:00, 6:00, and 9:00) of dial indicator readings for both dial indicators.

To establish the true clock positions, you can use an accurate level after you attach the fixtures. Once you establish the positions, you can use marks on the bearing housing and shaft to make sure that

you take all readings at the proper positions. Additionally:

- Watch the indicators throughout the shaft rotation to make sure that you record the proper amount and sign (positive or negative) of the reading.
- Hold opposing pressures on the shafts while they rotate. This helps to eliminate errors caused by coupling backlash.

NOTE: If you can't physically obtain the 12:00 reading, see *Using JCAlign when you can't obtain a 12:00 reading*. If you can't obtain the 3:00 or 9:00 reading, see *Using JCAlign when you can't obtain a 3:00 or 9:00 reading*.

5. Check readings for repeatability and mathematical validity.
   - Indicators should return to 0.000" at the 12:00 position.
   - Indicator values at each clock position should repeat. You should make sure that the dial comes back to the initial reading at the first position. You should also double-check all readings for consistency.
   - The sum of the 12:00 and 6:00 values should equal the sum of the 3:00 and 9:00 values.

If the readings are...	Then you should...
Repeatable and mathematically valid	Go to Step 6.
NOT repeatable nor mathematically valid	Repeat Steps 4 and 5 while making sure that: • The indicator hardware is tight. • The indicator plungers are mounted perpendicular to the shaft axes. • You are taking readings at the true 12:00, 3:00, 6:00, and 9:00 positions. • Both shafts are being rotated together as you take readings. • The adverse effects of coupling backlash are being eliminated. Once you get repeatable, valid results, go to Step 6.

6. Obtain and record the following measurements:

- **A** Distance between the motor feet
- **B** Distance from the MSI (Motor Side Indicator) to the front feet of the motor
- **C** Distance from the MSI to the PSI (Pump Side Indicator)
- **D** Distance from the PSI to the front feet of the pump
- **E** Distance between the pump feet
- **F** Distance from the MSI to the power plane of the pump

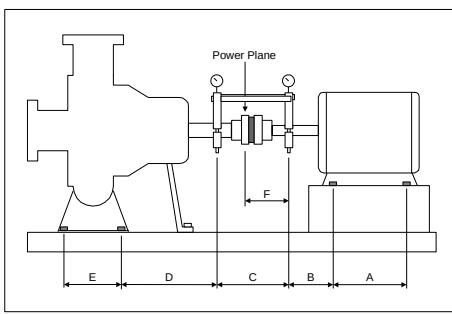


Figure 12: Machine measurements

7. Access the Distances and Thermal Growth screen in the JCI Reverse Dial Indicator Alignment Program.

   From the Main menu:

   - Select option 2. The Distances and Thermal Growth screen displays.

   If you are not sure how to access or use the JCI Alignment Program, refer to *Using the JCI Reverse Dial Indicator Alignment Program* in this section.

8. Enter the values from Step 6 in the Distances and Thermal Growth screen.

   - If thermal growth is present, enter these values in this screen as well.

   NOTE: Before you can move to any other screen, you must enter positive values for each of the dimensions. Once you enter positive values, you will be able to return to the Main menu.

9. Obtain and document dial indicator readings.

   - Ensure both indicators are at the 12:00 position.
   - Set both dial indicators to a positive value equal to the amount of sag determined in Step 5.
   - Press <ESCAPE> to return to the Main menu.
   - Select option 3. The Dial Indicator Readings screen displays.

- Enter the positive bar sag in the Dial Indicator Readings screen.
- While watching the direction of the indicator needle movement, rotate indicators to the 3:00, 6:00, and 9:00 positions.
- Record the Total Indicator Readings (TIRs) for the MSI and PSI in JCAlign.
- Check your tolerances by accessing options 4 and 5 in JCAlign.

10. Repeat Step 9 to ensure that the readings are repeatable.

If the readings are...	**Then you should...**
Repeatable and mathematically valid	Go to Step 11.
NOT repeatable and mathematically valid	Repeat the checks given in Step 5. Once you get repeatable, valid results, enter them in the program. Then, go to Step 11.

11. Make rough horizontal moves.
    - Zero the dial indicators at the 3:00 position.
    - Rotate the indicators to the 9:00 position.
    - Halve the values indicated on the dial indicators.
    - Move the front feet of the motor until the motor side indicator reads close to zero (within 1-2 mils).
    - Move the back feet of the motor until the pump side indicator reads close to zero (within 1-2 mils).

    When both indicators read zero, the shafts are aligned in the horizontal plane.
12. Repeat Step 9 and record the values.
13. Repeat Step 10 and record the values.
14. Determine the vertical position of the motor shaft by accessing the Vertical Foot Movement screen.
    - Press <ESCAPE> to return to the Main menu.
    - Select option 4. The Vertical Foot Movement screen displays.
15. Make shim changes based on the results in Step 14.
16. Repeat Steps 12-15 until you achieve specified tolerances in the vertical plane.

17. Determine the horizontal position of the motor shaft by accessing the Horizontal Foot Movement screen.

    - If you are not within tolerance, go directly to Step 18.
    - Press <ESCAPE> to return to the Main menu.
    - Select option 5. The Horizontal Foot Movement screen displays.

18. Make precision horizontal moves.

    - Zero the dial indicators at the 3:00 position.
    - Rotate the indicators to the 9:00 position.
    - Halve the values indicated on the dial indicators.
    - Move the front feet of the motor until the motor side indicator reads zero.
    - Move the back feet of the motor until the pump side indicator reads zero.

    When both indicators read zero, the shafts are aligned in the horizontal plane.

19. Repeat Steps 15-18 until you achieve specified tolerances in the horizontal plane.

20. Peform a final check: use Step 9 as a guide.

21. Record the final tolerances on the appropriate report.

Using the JCI Reverse Dial Indicator Alignment Program

You use the JCI Reverse Dial Indicator Alignment Program (JCAlign) when you are aligning a machine with a reverse dial indicator.

You should copy JCAlign onto the hard drive of a laptop computer or diagnostic calculator and take the laptop or calculator with you to the customer site when performing an alignment.

To use JCAlign, follow these steps:

1. Make sure you are in the directory that contains the program.
2. Type **jcalign**.

   The Main menu displays.
3. Press “2” to enter distances and thermal growth.

   The Distances and Thermal Growth screen displays. The cursor is on the RPM field in the upper right corner.
4. Enter the machine’s RPM.

   NOTE: Notice how the cursor moves to the next field near the middle of the screen. Whenever you type

enough characters to fill a field, the cursor moves to the next one.

5. Enter any thermal growth amounts that exist.

   NOTE: Be careful as you type: wherever the cursor is flashing is where the characters appear. Use the arrow keys to move the cursor within a field.

   - Use the Right Arrow, <Enter>, or <Tab> keys to move the cursor to the next field.

6. Enter the appropriate distances.
7. Press <Esc> when you are finished.

   The Main menu displays.

8. Press “3” to enter the dial indicator readings.

   The Dial Indicator Readings screen displays.

9. Enter the dial indicator readings as you viewed them from the motor side.

   - Follow the same suggestions given in the Notes for Steps 4 and 5.

10. Press <Esc> when you are finished.

    The Main menu displays.

11. Press “4” to view the vertical foot movements.

    The Vertical Foot Movement screen displays the vertical movement, which is based on the figures you entered.

12. Correct the machine’s vertical foot movement based on the figures given on the Vertical Foot Movement screen.

13. Press <Esc> when you are finished.

    The Main menu displays.

14. Press “5” to view the horizontal foot movements.

    The Horizontal Foot Movement screen displays the horizontal movement, which is based on the figures you entered.

15. Correct the machine’s horizontal foot movement based on the figures given on the Horizontal Foot Movement screen.

16. Press <Esc> when you are finished.

    The Main menu displays.

If you want to...	Then you should...
Use the distance and thermal growth values you've entered for later analyses	Press "7" to save the file. Later, when you want to reaccess the data, press "6" to read in the values. The program enters the values in the Distances and Thermal Growth screen for you.
Print the analysis	Press "8" to print. The printer is set to LPT1 for dot matrix. If you have trouble printing, contact Engineering Services.

17. Press "9" to exit the program.

Using JCAlign when you can't obtain a 12:00 reading

The precision of the alignment process depends upon the accuracy of the dial indicator readings that you obtain. If you cannot physically obtain a 12:00 reading while taking dial indicator readings, you can use the JCI Reverse Dial Indicator Alignment Program (JCAlign) to help ensure the accuracy of your measurements.

To use JCAlign when you can't obtain a 12:00 reading, follow these steps:

1. Rotate to the 9:00 position and adjust the dial indicators to 0.
2. Rotate to the 6:00 position and record the values on paper.
3. Rotate to the 3:00 position and record the values on paper.
4. Using the validity rule, calculate and record the 12:00 position.

   The validity rule states that the sum of the 3:00 and 9:00 readings is equal to the sum of the 6:00 and 9:00 readings, so:

   3:00 + 9:00 = 6:00 + 12:00

   OR

   12:00 = 3:00 + 9:00 – 6:00
5. Calculate the adjustment value.

   Bar Sag – 12:00 reading = adjustment value
6. Add the adjustment value to each initial reading.
7. Enter the adjusted values into JCAlign and proceed as normal.

Using JCAlign when you can't obtain a 3:00 or 9:00 reading

You always need to obtain at least three readings to perform an alignment. As long as you obtain three readings, you can use the validity rule to calculate the fourth and complete the alignment process.

Therefore, if you cannot get a reading at one of the horizontal readings (3:00 or 9:00), the procedure you should follow is the same as if you can't get the 6:00 reading. The only difference is that you must manually calculate the unknown reading when you use JCAlign because the program does not calculate it for you.

To use JCAlign when you can't obtain a 3:00 or 9:00 reading, follow these steps:

1. Position the brackets so that they are measuring the 12:00 position.
2. Adjust the dial indicator reading so that it reads the amount of positive bar sag.
3. Collect and record the other two obtainable readings.
4. Using the validity rule, calculate and record the unknown position.

   3:00 = 12:00 + 6:00 - 9:00

   OR

   9:00 = 12:00 + 6:00 - 3:00

5. Enter the three measured values and the one calculated value into JCAlign.
6. Proceed as normal.

Special alignment configurations

Aligning cooling tower line shafts

You can use the reverse dial indicator and JCAlign to align the line shaft between the motor and gear box of cooling tower fans. Here is a sample configuration:

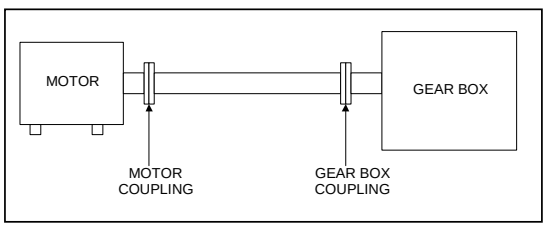


Figure 13: Sample cooling tower line shaft configuration

To align cooling tower line shafts, follow these steps:

1. Attach the reverse dial indicator tool to the gear box coupling side.
2. Input your measurements into JCAlign (ignoring the motor coupling).

   NOTE: For the distance between the motor feet, input 0.1".

3. Zero the dial indicators and proceed to take your dial indicator measurements. Input them into JCAlign.

   NOTE: Don't forget to adjust for bar sag.

4. Using the values calculated in JCAlign for the front feet of the motor, move the front and the back feet by that amount. This means you move the front and back feet by the same amount, side to side and up and down.
5. Remove the dial indicators from the gear box coupling and move them to the motor coupling.
6. Enter the correct dimension into JCAlign for all dimensions (ignoring the gear box coupling).
7. Take the dial indicator readings and input them into JCAlign.

8. Move the feet of the motor as calculated in the program.

Because of the long line shaft and the two-step process that has to be used, the final acceptable offset should be within 15 mils. Do not try to achieve the offset values given in the program.

Section 6
Balancing

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SECTION 6: BALANCING

You must prepare each machine before you balance it. Additionally, before you begin balancing a machine, you should:

- Know how to attach weights to it
- Understand angle positions

Then, depending on the type of machine, you can:

- Perform a single plane balance
- Perform a dual plane balance

Preparing to balance machinery

To prepare to balance a machine, you must:

- Configure the Microlog for balancing
- Clean and inspect the machine
- Know how to attach weights to the machine

Configuring the Microlog for balancing

You enter settings, or parameters, to help determine how the Microlog collects data. To configure the Microlog for balancing, you enter:

- Input setup parameters
- Trigger setup parameters
- Balance setup parameters

Once you enter these parameters, the Microlog saves the parameters until you change them. Therefore, if you have already configured the Microlog, you only have to check the parameters each time you use it.

To configure the Microlog for balancing, follow these steps:

1. Access the Input Setup screen.

   From the Main menu:

   - Select the Analyzer option. The Analyzer menu displays.
   - Select the Input Setup option. The Input Setup screen displays.

2. Enter the appropriate input setup parameters.

   NOTE: You do not have to change or enter anything for those parameters with blank spaces in the following table.

	Enter these parameters
ID	
Desc	
Type	Acc to Vel
Full scale	
Detection	Peak
Input	100.0 mv/EU
Low Freq Cutoff	300.0 CPM
RPM	

3. Press <ESCAPE> once you have entered all of the input setup parameters.

   The Analyzer menu displays.

4. Select the Trigger Setup option.

   The Trigger Setup screen displays.

5. Enter the appropriate trigger setup parameters.

   NOTE: You do not have to change or enter anything for those parameters with blank spaces in the following table.

	Enter these parameters
Trigger Mode	Trigger
Trigger Source	External
Input Trigger Slope	+
Input Trigger Level	
Trigger Delay	0 ms
Pulses/Rev	1.0
Length/Rev	1.0

6. Press <ESCAPE> once you have entered the trigger setup parameters.

   The Analyzer menu displays.

7. Access the Balance Setup screen.

   - Select the Balance option. The Balance menu displays.
   - Select the Balance Setup option. The Balance Setup screen displays.

8. Enter the appropriate balance setup parameters.

   - Press <SHIFT> to type the letters. Notice how the up arrow displays in the status line.
   - Press <SHIFT> again when you want to type numbers. Notice how the up arrow no longer displays in the status line.

	For single plane balancing	**For dual plane balancing**
ID	Type the name you want to display in the balance report.	Type the name you want to display in the balance report.
Planes	1	2, separately
Units for Weights	OZ	OZ
Weights Left In Forever	No	No
Average	Off	Off

9. Press <ESCAPE> three times to return to the Main menu.

Cleaning and inspecting machinery

You should clean all machinery and inspect it for mechanical integrity before you begin balancing it.

You must inspect the machine for:

- Dirt
- Corrosion
- Missing blades

If the machine is...	Then...
Clean, uncorroded, and in good condition	You can continue to balance the machine. Complete the appropriate balancing procedure.
Dirty, corroded, or missing parts, such as fan blades	You should clean the machine and correct any problems. Make sure to repair the machine before you continue to balance it.

Attaching weights

When attaching weights to a fan, you should:

- Use pre-weighed balancing clips or c-clamp weights.
- Combine final weights into as few weights as possible.
- Place weights on the fan's inside circumference whenever possible.

  Weights on the inside circumference are less likely to come loose.
- Weld on any weights you place on the fan's outer circumference.

  Weights on the outside circumference are most likely to come loose.

When attaching weights to a fan, you should NOT

- Leave old or new weights distributed about the fan.

Balancing with a strobe light

How you balance a machine depends on the model it is. You can either:

- Perform a single plane balance
- Perform a dual plane balance

NOTE: If you are not sure which procedure to use to balance a particular fan, refer to *Balancing fans of different configurations* for help.

Performing a single plane balance

You perform a single plane balance for fans with a length-to-diameter ratio less than 0.5. To use a strobe light to perform a single plane balance, you must:

- Perform a reference run
- Perform a trial run
- Perform a trim run

To perform a single plane balance, follow these steps:

1. Set up the balancing equipment. (See Figure 1.)

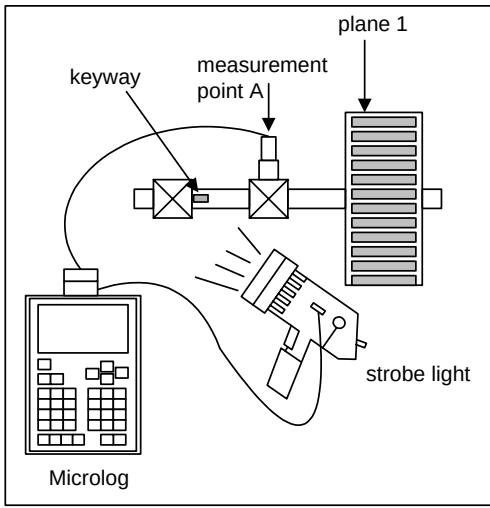

Figure 1: Setting up equipment for single plane balancing

2. Place a reference mark on the bearing housing using a paint pen, marker, or reflective tape.

3. Access the Balance menu.

   From the Main menu in the Microlog:

   - Select the Analyzer option. The Analyzer menu displays.
   - Select the Balance option. The Balance menu displays.

4. Place the accelerometer on Measurement point A.

5. Turn on the strobe and set its EXT/INT/TRACK toggle switch to INT.

6. With the Flashes Per Minute indicator higher than the shaft rotating speed, slowly lower the rate setting until the shaft freezes.

   CAUTION: The shaft freezes at twice and half the RPM.

7. Switch the toggle switch to TRACK when the shaft is frozen.

   The shaft locks in place.

8. Use the Phase dial to shift the position of the shaft.

   - Align the reference mark on the stationary bearing housing with the reference mark on the shaft.

   NOTE: The reference mark on the bearing housing must be kept in line with the reference mark on the shaft for all readings.

9. Select the Take Data option from the Balance menu.

   The Take Data menu displays.

10. Select the Reference Run option.

    The Tracking Filter screen displays.

11. Write down the displayed phase angle after the values stabilize.

12. Press <ENTER> to save the run.

13. Press <ESCAPE> to return to the Balance menu.

14. Select the Trial Weight Setup option.

    The Trial Weight Setup screen displays.

15. Enter the trial weight in the Weight field.

    - Press <ENTER> after you type the number.

If...	**Then...**
The fan is less than 2 feet in diameter	Use a 1 oz. weight.
The fan is more than 2 feet in diameter	Use a ½ oz. weight.

If...	Then...
You know the weight of the rotor	1. Press <ESCAPE> to return to the Balance menu. 2. Select the Estimate Trial Weight option. 3. Select the Setup option. 4. Enter the rotor weight, speed, and radius. • Press <ENTER> when you are done. 5. Press <ESCAPE>. 6. Select the Calculation option. The Microlog recommends a trial weight for you to use. 7. Press <ESCAPE> twice. 8. Select the Trial Weight Setup option. 9. Enter the trial weight.

16. Enter the angle at which you placed the weight.

    - See *Determining angle positions* in this section if you need help determining the angle.
    - Press <ENTER> after you type the angle.

17. Press <ESCAPE> to return to the Balance menu.
18. Turn off the fan.
    - Follow the Lockout/Tagout procedure given in the *Employee Safety Handbook (FAN 833.3)*.
19. Attach the trial weight in Plane 1 at the chosen angle.
20. Turn on the fan.
21. Adjust the reference mark as described in Step 8.
22. Select the Take Data option from the Balance menu.

    The Take Data menu displays.
23. Select the Trial Run #1 option.

    The Tracking Filter screen displays.

    After the values are stable, compare the current phase angle and 1x amplitude with the phase angle and 1x amplitude before the trial weight was added.

If...	Then...
The phase angle difference is greater than 60° OR 1x amplitude shows greater than 30% change	Press <ENTER> to save the run. Go to Step 24.
The phase is less than 60° AND 1x amplitude shows less than 30% change	1. Shift the trial weight position by 180°. OR Use a trial weight that is 50 percent heavier than the one you first used. 2. Repeat Steps 1-23 to re-enter the values for the trial weight setup and to repeat Trial Run #1. 3. Press <ENTER> to save the run. 4. Go to Step 24.

24. Press <ESCAPE> to return to the Balance menu.

25. Access the Initial Weight screen.
    - Select the Correction Weight option. The Correction Weight menu displays.
    - Select the Initial Weight option. The Initial Weight screen displays.
26. Turn off the fan.
    - Follow the Lockout/Tagout procedure given in the *Employee Safety Handbook (FAN 833.3)*.
27. Remove the trial weight and add the displayed amount of initial weight at the requested angle in Plane 1.
28. Turn on the fan.
29. Adjust the reference mark as described in Step 8.
30. Press <ESCAPE> twice to return to the Balance menu.
31. Select the Take Data option.

    The Take Data menu displays.
32. Select the Trim Run option.

    The Tracking Filter screen displays.
33. Press <ENTER> to save the values once they stabilize.
34. Press <ESCAPE> to return to the Balance menu.

35. Access the Trim Weight screen.
    - Select the Correction Weight option. The Correction Weight menu displays.
    - Select the Trim Weight option. The Trim Weight screen displays.
36. Turn off the fan.
    - Follow the Lockout/Tagout procedure given in the *Employee Safety Handbook (FAN 833.3)*.
37. Add the displayed amount of trim weight at the requested angle on the fan.
38. Turn on the fan.
39. Adjust the reference mark as described in Step 8.
40. Repeat Steps 30-39 as necessary until the desired degree of balance is achieved or until no further improvement in balance occurs.
41. Perform a final trim run reading at Measurement point A so that the final degree of balance can be displayed in the balance report.
42. Print the report.
    - See the *Printing balance reports* procedure for help.

Performing a dual plane balance

You perform a dual plane balance for fans with a length-to-diameter ratio greater than 0.5. To use the strobe light to perform a dual plane balance, you must:

- Perform a reference run
- Perform a trial run
- Perform a trim run

To perform a dual plane balance, follow these steps:

1. Set up the balancing equipment. (See Figure 2.)

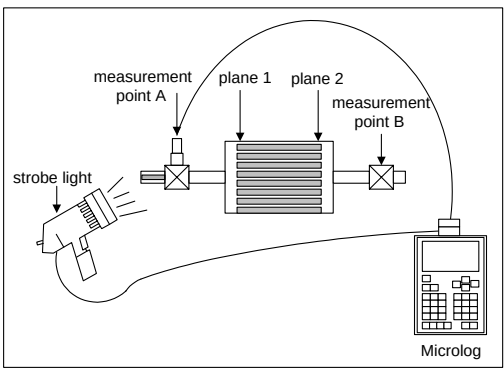

Figure 2: Setting up equipment for dual plane balancing

2. Place a reference mark on the bearing housing using a paint pen, marker, or reflective tape.
3. Access the Balance menu.

   From the Main menu in the Microlog:

   - Select the Analyzer option. The Analyzer menu displays.
   - Select the Balance option. The Balance menu displays.

4. Place the accelerometer on Measurement point A.
5. Turn on the strobe and set its EXT/INT/TRACK toggle switch to INT.
6. With the Flashes Per Minute indicator higher than the shaft rotating speed, slowly lower the rate setting until the shaft freezes.

   CAUTION: The shaft freezes at twice and half the RPM.

7. Switch the toggle switch to TRACK when the shaft is frozen.

   The shaft locks in place.

8. Use the Phase dial to shift the position of the shaft.

   - Align the reference mark on the stationary bearing housing with the reference mark on the shaft.

NOTE: The reference mark on the bearing housing must be kept in line with the reference mark on the shaft for all readings.

9. Select the Take Data option from the Balance menu.

   The Take Data menu displays.

10. Select the Reference Run-Point A option.

    The Tracking Filter screen displays.

11. Write down the displayed phase angle after the values stabilize.

12. Press <ENTER> to save the run.

13. Place the accelerometer on Measurement point B.

14. Select the Reference Run-Point B option.

    The Tracking Filter screen displays.

15. Write down the displayed phase angle after the values stabilize.

16. Press <ENTER> to save the run.

17. Press <ESCAPE> to return to the Balance menu.

18. Select the Trial Weight Setup option.

    The Trial Weight Setup screen displays.

19. Enter the trial weight in the Plane 1 Weight field.

- Press <ENTER> after you type the number.

If...	Then...
The fan is less than 2 feet in diameter	Use a 1 oz. weight.
The fan is more than 2 feet in diameter	Use a ½ oz. weight.
You know the weight of the rotor	1. Press <ESCAPE> to return to the Balance menu. 2. Select the Estimate Trial Weight option. 3. Select the Setup option. 4. Enter the rotor weight, speed, and radius. Press <ENTER> when you finish. 5. Press <ESCAPE>. 6. Select the Calculation option. The Microlog gives a trial weight for you to use. 7. Press <ESCAPE> twice. 8. Select the Trial Weight Setup option. 9. Enter the trial weight.

20. Enter the angle in the Plane 1 Angle field.
    - See *Determining angle positions* in this section if you need help determining the angle.
    - Press <ENTER> after you type the angle.
21. Repeat Steps 19-20 for Plane 2.

    NOTE: Remember that the trial weight is in Plane 2 for Trial Run 2.
22. Press <ESCAPE> to return to the Balance menu.
23. Turn off the fan.
    - Follow the Lockout/Tagout procedure given in the *Employee Safety Handbook (FAN 833.3)*.
24. Attach the trial weight in Plane 1 at the chosen angle.
25. Turn on the fan.
26. Place the accelerometer on Measurement point A.
27. Adjust the reference mark as described in Step 8.
28. Select the Take Data option from the Balance menu.

    The Take Data menu displays.

29. Select the Trial Run 1-Point A option.

    The Tracking Filter screen displays.

    After the values are stable, compare the current phase angle and 1x amplitude with the phase angle and 1x amplitude before the trial weight was added.

If...	Then...
The phase angle difference is greater than 60° OR 1x amplitude shows greater than 30% change	Press <ENTER> to save the run. Go to Step 30.
The phase is less than 60° AND 1x amplitude shows less than 30% change	1. Shift the trial weight position by 180°. OR Use a trial weight that is 50 percent heavier than the one you first used. 2. Repeat Steps 1-28 to re-enter the values for the trial weight setup and to repeat Trial Run 1. 3. Press <ENTER> to save the run. 4. Go to Step 30.

30. Place the accelerometer on Measurement point B.
31. Select the Trial Run 1-Point B option.

    The Tracking Filter screen displays.

    After the values are stable, compare the current phase angle and 1x amplitude with the phase angle and 1x amplitude before the trial weight was added.

If...	**Then...**
The phase angle difference is greater than 60° OR 1x amplitude shows greater than 30% change	Press <ENTER> to save the run. Go to Step 32.
The phase is less than 60° AND 1x amplitude shows less than 30% change	1. Shift the trial weight position by 180°. OR Use a trial weight that is 50 percent heavier than the one you first used. 2. Repeat Steps 29-31 to re-enter the values for the trial weight setup and to repeat Trial Run 1.

If...	Then...
	3. Press <ENTER> to save the run. 4. Go to Step 32.

32. Turn off the fan.

    - Follow the Lockout/Tagout procedure given in the *Employee Safety Handbook (FAN 833.3)*.

33. Remove the trial weight from Plane 1 and place it in Plane 2 at the chosen angle.

34. Turn on the fan.

35. Repeat Steps 22-34 for Trial Run 2.

    NOTE: Remember that the trial weight is in Plane 2 for Trial Run 2.

36. Press <ESCAPE> to return to the Balance menu.

37. Access the Initial Weight screen.

    - Select the Correction Weight option. The Correction Weight menu displays.

    - Select the Initial Weight option. The Initial Weight screen displays.

38. Turn off the fan.

- Follow the Lockout/Tagout procedure given in the *Employee Safety Handbook (FAN 833.3)*.

39. Remove the trial weight and add the displayed amount of initial weight at the requested angle in Plane 1 and Plane 2.
40. Turn on the fan.
41. Adjust the reference mark as described in Step 8.
42. Place the accelerometer on Measurement point A.
43. Press <ESCAPE> twice to return to the Balance menu.
44. Select the Take Data option.

    The Take Data menu displays.
45. Select the Trim Run-Point A option.

    The Tracking Filter screen displays.
46. Press <ENTER> to save the values once they stabilize.
47. Press <ESCAPE> to return to the Balance menu.
48. Select the Take Data option.

    The Take Data menu displays.
49. Select the Trim Run-Point B option.

    The Tracking Filter screen displays.

50. Press <ENTER> to save the values once they stabilize.
51. Press <ESCAPE> to return to the Balance menu.
52. Access the Trim Weight screen.
    - Select the Correction Weight option. The Correction Weight menu displays.
    - Select the Trim Weight option. The Trim Weight screen displays.
53. Turn off the fan.
    - Follow the Lockout/Tagout procedure given in the *Employee Safety Handbook (FAN 833.3)*.
54. Add the displayed amount of trim weight at the requested angle.
55. Turn on the fan.
56. Repeat Steps 47-55 as necessary until the desired degree of balance is achieved or until no further improvement in balance occurs.
57. Perform a final trim run reading at Measurement point A and Measurement Point B so that the final degree of balance can be displayed in the balance report.
58. Print the report.
    - See the *Printing balance reports* procedure for help.

Determining angle positions

For balancing to be accurate, you must be able to determine degree angles for the fan you are balancing.

To determine angle positions, follow these steps:

1. Determine the 0° position.

   The 0° position corresponds to the location of the accelerometer.

2. Adjust the strobe so that the shaft reference mark lines up with a fixed reference point on the bearing housing when the shaft is frozen.

3. Determine the degrees per blade.

   - Count the number of blades.
   - Divide 360 by the number of blades to get the degrees per blade.

   Degrees per blade = 360 / Number of blades

   As you can see in Figure 3, the angles increase opposite to the direction of shaft rotation.

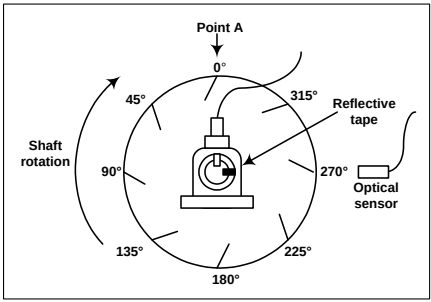

Figure 3: Identifying degrees of angle when balancing a fan

4. Determine the blade number.

   - When the Microlog displays the angle on which to place the correction weight, divide that angle by the degrees per blade.

If the blade number is a...	**Then...**
Whole number	Go to Step 5.
Fraction	1. Access the Balance menu. 2. Select the Other Functions option. 3. Select the Split Weight option.

If the blade number is a...	Then...
	4. Select the Setup option. 5. Enter the weight to split, weight angle, and the split weight 1 and 2 angles. 6. Press <ENTER> when you are done. 7. Press <ESCAPE>. 8. Select the Calculation option. The Microlog displays the weight(s) and the angle(s) where you should place the weight(s). Use the two nearest blade angles available.

5. With the blade number, count that many blades from the blade which corresponds to the accelerometer 0° position.
   - Since the blade at the 0° position is blade 0, start counting at the next blade.
6. Place the weight(s) on the appropriate blade(s).

Balancing fans of different configurations

This section details several different configurations of fans and guides you to the procedure you should use to balance each kind of fan.

Balancing a single squirrel cage between two bearings

To balance this fan configuration, follow the *Performing a dual plane balance* procedure.

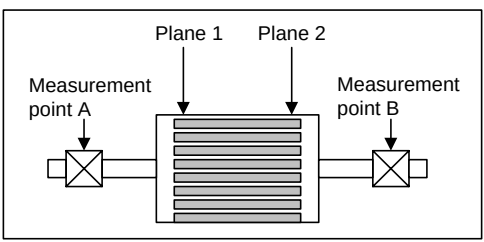

Figure 4: Plane and measurement points for a single squirrel cage between two bearings

Balancing multiple squirrel cages with multiple bearings

To balance multiple squirrel cages with multiple bearings, follow the *Performing a dual plane balance* procedure.

Be aware that balancing problems can occur for long, thin shafts carrying heavy weights and rotating at higher speeds. Such shafts are considered flexible, not rigid.

If you have trouble balancing these shafts, call the Engineering Services Help Line for assistance.

Balancing two squirrel cages between two bearings

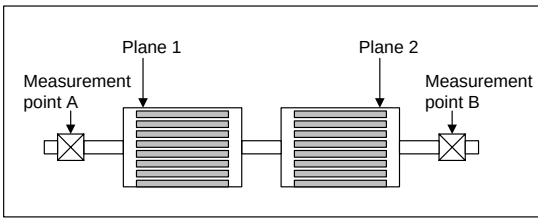

Figure 5: Plane and measurement points for two squirrel cages between two bearings

Balancing two squirrel cages between three bearings

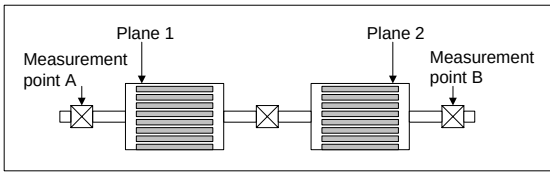

Figure 6: Plane and measurement points for two squirrel cages between three bearings

Balancing three squirrel cages with three bearings

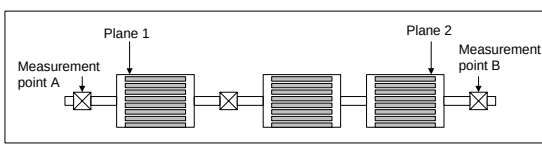

Figure 7: Plane and measurement points for three squirrel cages with three bearings

Balancing two squirrel cages, one overhung, with two bearings

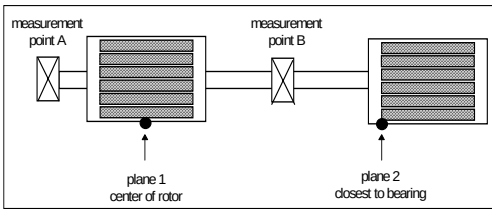

Figure 8: Plane and measurement points for two squirrel cages, one overhung, with two bearings

If performing a dual plane balance on this fan configuration does not repair the equipment, you can also try the static-couple approach presented here.

Static-couple approach

To balance a fan using the static-couple approach, follow these steps:

1. Using the *Performing a dual plane balance* procedure, complete these tasks:
    - Perform a reference run, steps 1-16.
    - For trial weight 1 in Plane 1, follow steps 18-33.

- For trial weight 2 in Plane 2, follow step 35.
- Run the standard program: follow steps 36-58.

2. Write down the correction weights you calculated.
3. Using the combined weight function in the Microlog, enter the results of the correction weights from Plane 1 and Plane 2.
   - From the Balance menu, select Other Function. The Other Function menu displays.
   - Select Combine Weights. The Combine Weight menu displays.
   - Select Setup.
   - Enter the weight and angle for Plane 1 into Weight 1, and enter the weight and angle for Plane 2 into Weight 2.
   - Press <ESCAPE> after you enter the values.
   - Select Calculation. One weight and angle displays.
   - Write down the weight and angle.
4. Divide the combined weight from step 3 into an equal amount. (Divide by 2.)
5. Using the weight calculated from step 4 and the angle from step 3, place the weight at the calculated angle.

6. Perform a trim run to remove couple imbalance. Follow steps 40-58 in *Performing a dual plane balance*.

   If the static imbalance was removed in steps 1-5 above, then the results of the trim run at Plane 1 and 2 should have approximately the same weight but at opposite angles (couple imbalance).

If Plane 1 and Plane 2 are not within 15% of each other for the weight and angle, restart from the trial weights procedures.

Balancing an overhung, narrow squirrel cage with two bearings

NOTE: A narrow fan is one with a length-to-diameter ratio less than 0.5.

To balance this fan configuration, the *Performing a single plane balance* procedure should be sufficient.

You should place the weights in Plane 1 and take the vibration readings on the bearing nearest the fan (Measurement point A).

After balancing is complete, check Measurement point B for excessive vibrations. If you find high vibrations, complete the *Correcting couple imbalance* procedure.

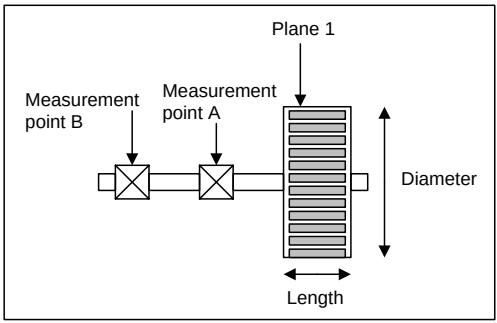

Figure 9: Plane and measurement points for an overhung, narrow squirrel cage with two bearings

Balancing an overhung, wide squirrel cage with two bearings

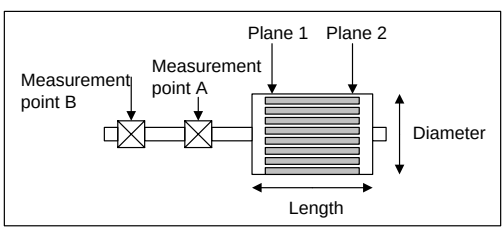

Figure 10: Plane and measurement points for an overhung, narrow squirrel cage with two bearings

For this configuration, two single plane balancing procedures are usually required:

- Correcting static imbalance
- Correcting couple imbalance

Correcting static imbalance

To correct static imbalance, you should:

- Place the trial and balance weights in Plane 1.
- Take the vibration readings on the bearing nearest the fan (Measurement point A).

See the *Performing a single plane balance* procedure for more information.

Correcting couple imbalance

After you complete static balancing, check Measurement point B for excessive vibrations.

If Measurement point B is high and Measurement point A is low, static imbalance has been removed. However, the couple imbalance must still be removed.

To correct couple imbalance, you should perform single plane balancing in plane 2 and take vibration readings at Measurement point B.

Please make these modifications to the procedure:

- When you perform the trial run with the trial weight in plane 2, attach an additional weight to plane 1.

  The additional weight should be equal in weight, but 180° opposite in phase position. However, do not include the additional weight or the angle when you enter the trial weight amount and angle in the Microlog.

- After you have removed both trial weights and calculated the correction weight, add that amount to plane 2 at the specified angle.

- Add a weight equal in weight, but 180° opposite in phase angle, to plane 1.

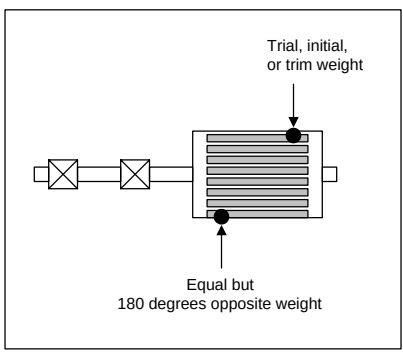

Figure 11: Weight placement on an overhung, wide squirrel cage with two bearings

♦ Recheck Measurement point A when vibrations at Measurement point B have reached acceptable levels.

If vibrations at Measurement point A have increased to an unacceptable level, repeat single plane balancing for plane 1. Then, recheck Measurement point B and balance in plane 2 if necessary.

Printing balance reports

Once you complete a balancing procedure, you can print a report of the results for the customer.

To print a balance report, follow these steps:

1. Connect the printer to the Microlog.
   - Use the printer adapter.
2. Access the Balance menu.

   From the Main menu:
   - Select the Analyzer option. The Analyzer menu displays.
   - Select the Balance option. The Balance menu displays.
3. Select the Report option.

   The report prints.

NOTES

Section 7
Vibration Reports

Completing Vibration Reports 7-3

Reporting customer and equipment identification 7-4

Reporting analysis results 7-4

Reporting screening and corrective results 7-10

Printing spectrum plots.....7-11

Printing an Exception Report 7-12

SECTION 7: VIBRATION REPORTS

When you collect vibration data for a fan or pump, you should provide the customer with a Vibration Report. The Vibration Report details the condition of the machine, offers a recommendation and diagnosis of any existing problems, and gives the screening levels before and after repairs.

Before you read about how to complete a report, please review and remember these two important issues:

- All reports should be filed electronically and stored at the branch.

  You have been provided with electronic copies of these reports: Fan Vibration Report (fanrpt.doc) and Pump Vibration Report (pumprpt.doc). For details on filing these reports electronically, see the *Report Package*.

  If you like, you may also file hardcopies for future reference. In addition, the analysis data should be maintained with the customer file.

- Follow your branch's report tracking process at all times. See the *Report Package* for more information.

Completing Vibration Reports

You should complete a Vibration Report each time you collect vibration data for a fan or pump. You should complete the report as you are in the process of collecting data for the machine.

This section offers you *guidelines* (*not* strict instructions) to help you complete reports. These guidelines include many standard statements that you can use in reports and the situations in which you may use the statements.

However, it is impossible to cover all situations here. Most importantly, you should provide customers with customized reports that accurately reflect the condition of their machines. With experience, you will learn to adapt the guidelines to any report so the customer always receives an accurate written assessment of the machine's condition and the work you completed.

Every fan or pump Vibration Report should include customer and equipment identification, analysis results, and screening and corrective results.

Reporting customer and equipment identification

So that the report is properly identified, make sure to include the following information:

- Customer's name
- Equipment make, model, and serial number
- Customer identification number (optional)

Reporting analysis results

When completing the Analysis Results section, you should:

- Circle the correct priority.

Priority	Definition	Solution
1	Definite problems exist.	Correct problems immediately or at the nearest opportunity. If left uncorrected, problems may cause machine failure and unscheduled downtime.
2	Possible problems exist.	Monitor the vibration levels more frequently to establish a trend and determine if repairs should be made during next shutdown. Check inventory for repair parts.

Priority	Definition	Solution
3	Vibration levels are within acceptable limits.	Monitor vibration levels on a regularly scheduled basis to establish a trend.

- Write a complete recommendation.

  Your recommendation may be for repairing or monitoring the fan or pump.

  Recommending repairs. When you recommend a repair, begin the recommendation with "The following repairs are recommended:". Then, use the appropriate Maintenance statement for the problem from Section 4 of the *Fan and Pump Technical Reference Guide*.

  For example, suppose you find that a fan is imbalanced. The Maintenance statement for imbalance says "Balance the shaft." You can use this statement as part of your recommendation.

Example

The following repairs are recommended:
1. Replace motor bearings
2. Balance the shaft

If a machine component such as the cage or fan blade needs to be cleaned before you attempt repairs, use this recommendation statement: “The cage (or fan blade) should be cleaned before attempting to balance the equipment.”

Recommending monitoring. Rather than recommending repairs, you may recommend monitoring the machine instead. You should recommend monitoring when you obtain at or near Priority 2 readings the first time you collect data for a machine.

If the machine is...	This means that...	Use this statement
Non-critical	There is no downtime impact. Secondary damage and costs are minimal. Backup/redundant system available.	Monitor twice per year.

If the machine is...	This means that...	Use this statement
Critical	Downtime may cause reduced levels of production. The system will still run, but not at full capacity. Backup/redundant system may or may not be available.	Monitor six times for the first year to establish a trend.
Highly critical	Downtime will cause complete loss of production. Secondary damage and costs could be severe. No backup/ redundant system available.	Monitor monthly for six months to establish a trend.

For example, suppose you obtain at or near Priority 2 readings the first time you collect data for a machine. You determine that the machine is critical, so you can use the recommendation statement for critical machines.

Example

The following monitoring is recommended:

Monitor six times for the first year to establish a trend.

- Write a complete diagnosis.

  Begin the diagnosis with “Vibration analysis and visual inspections indicate the following:” Then, list the problems you identified. (Also list their causes, if appropriate, as in number 1 in the example.)

Example

Vibration analysis and visual inspections indicated the following:

1. *Belt wear caused by misaligned sheaves*
2. *Inboard bearing damage on the motor*
3. *Imbalance*

When you perform another analysis on the machine, the diagnosis statement you use depends on the change in the highest overall vibration level:

If there is...	And the machine is at...	Use this statement
No increase in the highest overall vibration level	Priority 2 or 3	The highest overall vibration level has not changed. Monitor in XX months to continue building a trend.
A 50% or more increase in the highest overall vibration level	Priority 1 or 2	The highest overall vibration level has increased by XX%. Monitor the vibration level monthly until the next scheduled repair shutdown

To calculate the percentage increase, use this equation:

$$\frac{\text{current vibration level - previous vibration level}}{\text{previous vibration level}} \times 100$$

Lastly, once you repair the machine, you should include this statement with the diagnosis: “The vibration levels have decreased from X.XXX IPS to X.XXX IPS. The following repairs were made:”. Then, after you list the repairs, write “These repairs account for the decreased vibration levels.”

Example

The vibration levels have decreased from 0.30 IPS to 0.08 IPS. The following repairs were made:

1. *Fan was balanced*
2. *Motor bearings were replaced*

These repairs account for the decreased vibration levels.

Reporting screening and corrective results

You should record the overall amplitudes as you collect the screening data. Then, you should also record the overall amplitudes once you have repaired the machine.

Printing spectrum plots

You can attach individual spectrum plots to customer reports to help communicate the criteria used to make a recommendation about the customer's equipment. To print individual spectrum plots, follow these steps:

NOTE: You may damage the Microlog if you attempt to print without the SKF Microlog printer adapter.

To print spectrum plots, follow these steps:

1. Connect the printer adapter to the Microlog.
2. Connect the printer to the printer adapter using a standard printer cable.

   Do not use any SKF cables to make this connection.
3. Turn on both the Microlog and the printer.
4. Make sure the printer is on line.
   - If you're using the Cannon J30, press the On Line button, and make sure the light is lit.
   - Follow the manufacturer's instructions for other printers.
5. From the Main menu of the Microlog, access the Report menu.
6. Press <F1> to open the Route list.

7. Move the cursor to the data point you wish to print and press <F2> to print the spectrum.

Printing an Exception Report

Printing an exception report allows you to list those points that exceed 0.2 IPS overall. This information helps you to determine when to collect amplitude and phase data. You can also include the list with the customer report.

NOTE: You may damage the Microlog if you attempt to print without the SKF Microlog printer adapter.

To print an exception report, follow these steps:

1. Connect the printer adapter to the Microlog.
2. Connect the printer to the printer adapter using a standard printer cable.

   Do not use any SKF cables to make this connection.
3. Turn on both the Microlog and the printer.
4. Make sure the printer is on line.

   - If you're using the Cannon J30, press the On Line button, and make sure the light is lit.
   - Follow the manufacturer's instructions for other printers.

5. From the Main menu of the Microlog, access the Report menu.
6. Press <F1> to open the Route list.
7. Open the routes for which you want a report.
8. Press <ESCAPE>.
9. Move the cursor to the Exception option and press <ENTER> to print the report.

NOTES

Section 8
Maintenance tips

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Maintaining V-belts.....8-5

Maintaining shafts 8-7

Checking sheave alignment

Sheave misalignment results in accelerated belt and sheave wear. Uneven loading between belts on multiple belt drives results in one belt wearing more than others.

To check sheave alignment, place a string or straight edge across the face of the sheaves. Rotate the motor sheave 180° and repeat the check. When placing the string, remember these requirements:

- The string or straight edge should make contact at four points: two points on the driver and two points on the driven sheave.
- The edges of both sheaves must be the same thickness so that the grooves in which the belts ride are in alignment. If the edges are not the same thickness, you must compensate for the difference.

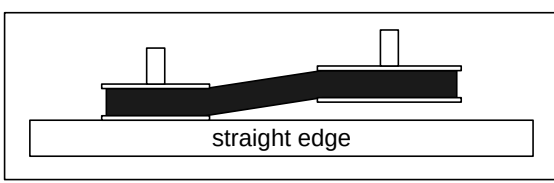

Figure 1: Checking sheave alignment

Maintaining sheaves

As you are checking sheaves, please keep in mind the following:

- Sheave runout causes excessive vibration in line with the sheaves. Place a dial indicator on a belt riding surface of the sheave, perpendicular to the surface. A TIR of 5 mils or less is good.

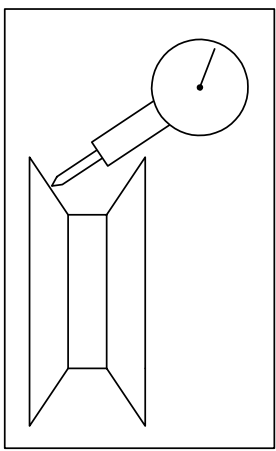

Figure 2: Checking sheave runout

- Check sheave grooves for burrs and debris.
- Sheaves held on with taper lock bushings can become cocked if not carefully installed. To avoid sheave wobble, use a dial indicator to check runout.
- To check for sheave wear and belt wear, use belt and sheave groove gauges.
- You should use adjustable pitch sheaves only to adjust for proper air flow. Then, you should replace the adjustable sheaves with pitch sheaves of the proper pitch diameter.

  Belts can never be in proper alignment when an adjustable pitch sheave is used.
- Mount sheaves as close to the bearings as possible; this increases bearing life.

Maintaining fans

Before balancing a fan:

- Make sure all fan blades are clean.
- Make sure that no fan blades are corroded or missing.
- Remove any balance weights, but mark their positions on the fan so that the original balance could be restored if problems occur.

Recognizing structural problems

Frame distortion can cause increased vibration. Loosen the hold down bolts: if a foot raises (soft foot), add proper shimming.

Maintaining V-belts

- For maximum V-belt life, sheave diameters must adhere to the minimum recommended diameters established by the Rubber Manufacturers Association.

  Sub minimum sheave diameters result in shortened belt life. When sheave diameters are reduced by 10%, belt life is reduced by 50%.

- Never roll or pry belts into sheave grooves because the load carrying tensile members can be broken. Always loosen motor hold down bolts and move the sheaves closer together.

- Check belt tension with a belt tension gauge. The proper tension is to make the belt as loose as possible without slipping or squealing on startup or under maximum load.

- After you achieve proper tension on a belt and secure the motor, you should loosen the jacking bolts so they do not cause frame distortion.
- If one belt needs to be changed on a sheave which contains multiple belts, you must change all of the belts. Changing only one belt causes unequal tension between belts and higher belt and axial vibrations.
- A properly maintained V-belt should not exceed an operating temperature of 140° F. This is the maximum temperature your hand can tolerate for extended periods. Excess heating may indicate tension, alignment, or loading problems.
- Never use belt dressing: a dressing is just a temporary fix for squealing belts and may damage them in the long run.
- Store spare belts in their original cartons in a cool dry place out of direct sunlight.

Maintaining shafts

- Improper key length can contribute to imbalance. Proper key length is determined as follows:

  Proper key length = (A+B)÷2

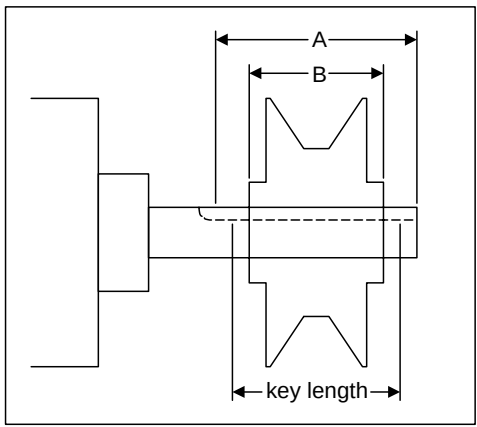

Figure 3: Determining proper key length

- Shaft runout measured near the sheave should be 2 mils or less.

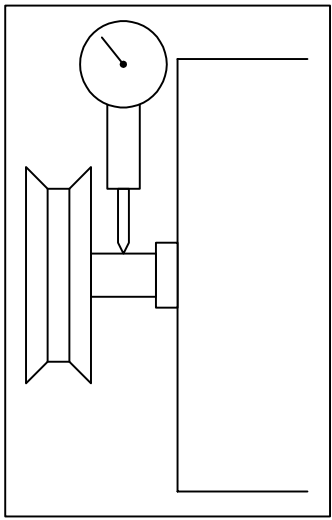

Figure 4: Checking shaft runout

- Use a pry bar to check for excessive axial play in a fan shaft due to loose locking collars on the bearing.

Section 9
Troubleshooting Microlog and equipment problems

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SECTION 9: TROUBLESHOOTING MICROLOG AND EQUIPMENT PROBLEMS

Performing standard Microlog and accelerometer checks

Standard Microlog and accelerometer checks include:

- Checking the Microlog voltage
- Checking the accelerometer
- Checking the accelerometer cable

Checking the Microlog voltage

If you have been getting frequent bad data readings, you may need to check the Microlog voltage.

To check the Microlog voltage, follow these steps:

1. Set the Digital Multi-Meter (DMM) to measure up to 200 volts DC.

2. Connect the red lead.
    - Connect one end to each location:
        - "Voltage" terminal on the DMM
        - Pinhole #23 on the Microlog

    NOTE: See Figure 1 for pinhole number locations.

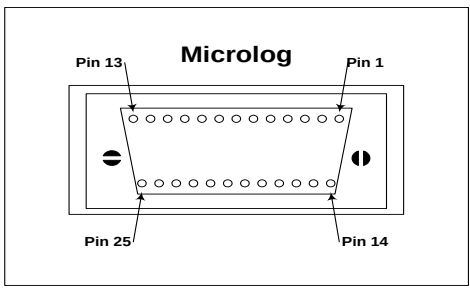

Figure 1: Locating pinhole number locations on the Microlog

3. Connect the black lead.
    - Connect one end to each location:
        - "Common" terminal on the DMM
        - Pinhole #20 on the Microlog

    When you finish making the connections, the equipment should look like Figure 2.

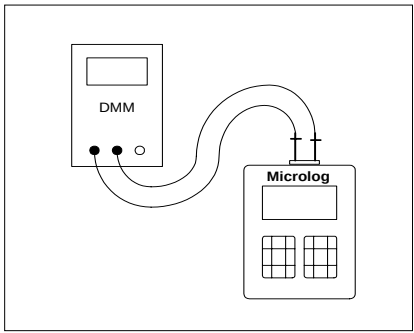

Figure 2: Connecting the DMM to the Microlog to check voltage

4. Access the Analyzer menu on the Microlog.

   From the Main menu:

   - Select the Analyzer option. The Analyzer menu displays.

5. Select the Take Data option.

6. Look at the DMM reading.

   The DMM should read between 19 to 24 volts DC.

   NOTE: If the DMM does not read between 19 to 24 volts, call the Engineering Services Help Line for assistance.

Checking the accelerometer

To check the accelerometer, you must:

- Perform a bias voltage check
- Perform a current check

Performing a bias voltage check

To perform a bias voltage check, follow these steps:

1. Connect the accelerometer cable to the Microlog.

   NOTE: Do NOT connect the accelerometer to the cable.

2. Connect a wire from the accelerometer to the accelerometer cable.
   - Connect one end to each location:
     - Pin A on the accelerometer
     - Pinhole A on the accelerometer cable
3. Connect another wire from the accelerometer to the accelerometer cable.
   - Connect one end to each location:
     - Pin B on the accelerometer
     - Pinhole B on the accelerometer cable

4. Set the Digital Multi-Meter (DMM) to read voltage.
5. Connect the black lead.
    - Connect one end to each location:
        - "Common" terminal on the DMM
        - Pin A on the accelerometer
6. Connect the red lead.
    - Connect one end to each location:
        - Current terminal to read milliamps
        - Pin B on the accelerometer

When you finish making connections, the equipment should look like Figure 3.

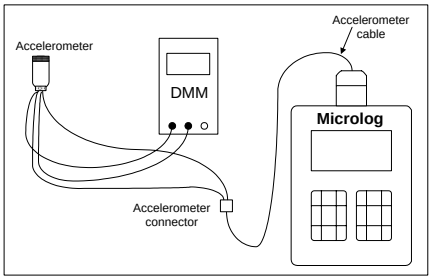

Figure 3: Connecting equipment for a bias voltage test

7. Access the Analyzer menu on the Microlog.

   From the Main menu:

   - Select the Analyzer option. The Analyzer menu displays.

8. Select the Take Data option.

9. Look at the DMM reading.

   The DMM should read between 9 to 12 volts.

   NOTE: If the DMM does not read between 9 to 12 volts, call the Engineering Services Help Line for assistance.

Performing a current check

To perform a current check, follow these steps:

1. Connect the accelerometer cable to the Microlog.

   NOTE: Do NOT connect the accelerometer to the cable.

2. Connect a wire from the accelerometer to the accelerometer cable.

   - Connect one end to each location:
     - Pin A on the accelerometer
     - Pinhole A on the accelerometer cable

3. Connect the black lead.
    - Connect one end to each location:
        - "Common" terminal on the Digital Multi-Meter (DMM)
        - Pin B on the accelerometer
4. Connect the red lead.
    - Connect one end to each location:
        - "Amp" terminal on the DMM
        - Pinhole B on the accelerometer cable

When you finish making connections, the equipment should look like Figure 4.

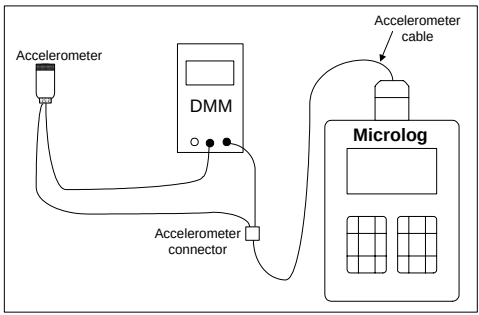

Figure 4: Connecting equipment for a current test

5. Access the Analyzer menu.

   From the Main menu:

   - Select the Analyzer option. The Analyzer menu displays.

6. Select the Take Data option.
7. Set the DMM to measure up to at least 10 milliamps.
8. Look at the DMM reading.

   The DMM should read approximately 2.2 milliamps.

Checking the accelerometer cable

To check the accelerometer cable, follow these steps:

1. Set the Digital Multi-Meter (DMM) to the lowest resistance setting.
2. Connect the black lead.

   - Connect one end to each location:
     - "Common" terminal on the DMM
     - Pinhole A on the accelerometer cable

   See Figure 5 for pin and pinhole locations.

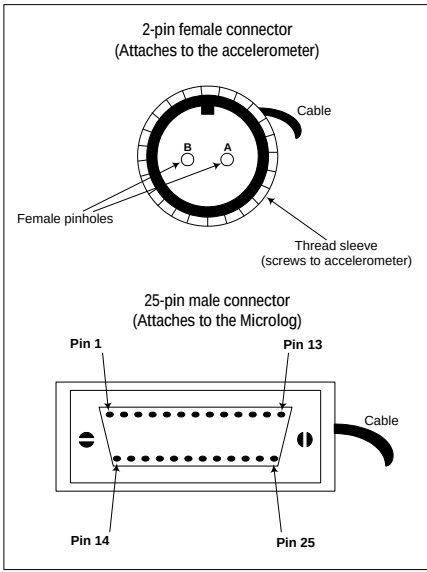

Figure 5: 2-pin female and 25-pin male connectors

3. Connect the red lead.
    - Connect one end to each location:
        - "Resistance" terminal on the DMM
        - Pin #22 on the accelerometer cable

4. Look at the DMM reading.

If the cable is...	Then the DMM...	So you should...
Good	Reads “0” or close to “0”	Use the cable.
Bad	Remains at an open circuit state	Repair the cable or purchase a new one.

5. Move the red lead to Pin #23.
6. Look at the DMM reading.

If the cable is...	Then the DMM...	So you should...
Good	Reads “0” or close to “0”	Use the cable.
Bad	Remains at an open circuit state	Repair the cable or purchase a new one.

7. Move the black lead to Pinhole B on the accelerometer cable.
8. Move the red lead to Pin #20 on the accelerometer cable.

9. Look at the DMM reading.

If the cable is...	Then the DMM...	So you should...
Good	Reads “0” or close to “0”	Use the cable.
Bad	Remains at an open circuit state	Repair the cable or purchase a new one.

Rebooting the Microlog

If the Microlog is having memory problems, you may have to perform a reboot to clear the memory. The Microlog is having memory problems if:

- “Invalid List Element” displays in the routes
- Unusual or incorrect characters display on the screen
- The percent memory at the top of the screen is greater than 100%

Rebooting the Microlog completely removes ALL data from the Microlog. You should always upload all data to the Predictive Diagnostics Team before you reboot the Microlog.

To reboot the Microlog, follow these steps:

1. Upload all data to the Predictive Diagnostics Team.
    - If you are not sure how to upload the data, refer to the *Transferring data* procedure in Section 1.
2. Turn off the Microlog.
3. Press and hold the 6 and 9 keys at the same time.
4. Turn on the Microlog.

The percent memory at the top of the screen should be 100%. If another number displays, repeat the Microlog reboot.

Troubleshooting common problems

This section presents solutions for the most common problems you may encounter while using the Microlog.

The procedures in the *Fan and Pump Vibration, Alignment, and Balancing Technical Reference Guide* provide you with most of the information you need to solve these problems.

Solving Microlog problems

Problem	***Cause* and solution**
The Microlog will not power up.	*The battery may be dead.* Replace the battery with a fully charged spare battery.
The Microlog powers down on its own.	*The Microlog automatically powers down when not used for about two minutes.* Turn on the Microlog when you're ready to use it again. OR Check the battery condition and replace the battery with a spare if recharge condition is indicated.

Problem	***Cause* and solution**
"Invalid List Element" displays somewhere in the routes. Unusual or incorrect characters display on the Microlog screen. The percent of memory at the top of the Microlog screen is greater than 100%.	*The Microlog is having memory problems.* 1. Call the Engineering Services Help Line. 2. Upload all data. 3. Perform a Microlog reboot.
"TP" displays at the top of the Microlog screen.	*The internal temperature of the Microlog is too high.* Let the Microlog cool down. If the problem persists, contact SKF Condition Monitoring (1-800-523-7514) for help.
You think you are getting frequent bad data readings.	Use a different accelerometer cable. If the problem continues, perform a Microlog, accelerometer, and cable operational check. Call the Engineering Services Help Line if the problem persists.

Solving modem and communications problems

Problem	*Cause* and solution
When you select the Transfer option to transfer data, the Microlog skips to "WAITING" and does not display "OK STATUS" or "DIALING."	1. Check that all cable connections are correct. 2. Cycle power on the Microlog and modem. 3. Try the transfer again. If the problem still exists after you attempt the transfer three times, refer to *Transferring data* in Section 1 to check that everything is set up properly. If you still cannot transfer data, call the Engineering Services Help Line for assistance.
You hear a fast busy signal (phone error message) just as the modem dials.	Find out if the phone line you are using needs a "9" to dial an outside line. • If you are not using a 9 in the phone string, you

Problem	*Cause* and solution
	may need to add it. • If you are using a 9 in the phone string, you may need to remove it. Check the phone string in the Microlog and change the communication parameters, if necessary.
When in the Transfer mode, the Microlog displays "NO DIAL TONE" in the MODEM STATUS line.	Check to make sure the phone line is plugged into the modem line jack. If the modem is set up properly, then the phone line may not be functional. Check the phone line.
When you are in the Transfer mode, the MODEM STATUS displays "KEY ABORT."	*You pressed <ENTER> twice when you entered the Transfer mode.* 1. Cycle power on the Microlog and modem. 2. Select the Transfer option from the Main menu.

Problem	*Cause* and solution
	3. Press <ENTER> **once**.
The CD and OH lights on the modem go out less than one minute after connecting with the Predictive Diagnostics Team's computer.	*Communication was lost.* 4. Cycle power on the Microlog and modem. 5. Select the Transfer option from the Main menu. 3. Press <ENTER> **once**.
The modem will not dial.	1. Check that the phone line is in the modem **line** jack, not the phone jack. 2. Check the phone line. • Connect a phone to the line and try to dial the same number in the Microlog. 3. Make sure the phone line is **analog**, not digital.
When trying to transfer data, MODEM STATUS displays an error 80, error 123, or some	If the modem continues to dial into Milwaukee and eventually makes the connection, ignore the error message.

Problem	*Cause* and solution
other error.	If the modem does not connect with Milwaukee: 4. Cycle power on the Microlog and modem. 5. Try the transfer again. Call the Engineering Services Help Line if the modem still does not connect.
The dial tone on the modem goes out before the modem dials the toll-free number.	Change the length of the pause in the phone string. For example, change S8=8 to S8=5.
When performing the data transfer, the modem reaches the toll-free line. But after the automated operator, a person answers instead of the modem.	Change the length of the pause in the phone string. For example, change S8=8 to S8=5. OR Remove one comma between the toll-free number and “5266”.

Solving route and data collection problems

Problem	***Cause* and solution**
The route you want is not present in the Microlog, or no routes are present at all.	Access the Route mode. If the branch name displays, highlight the branch name and press the Right Arrow key. If you do not see the route you want, call the Predictive Diagnostics Team for a download.
The Microlog does not display a spectrum while you are collecting data.	1. Press <ESCAPE> until the Main menu displays. 2. Check that the system setup parameter Auto Range is set to On. 3. Return to the Route mode and continue collecting data.

Problem	*Cause* and solution
"OV" displays at the top of the Microlog screen while you are collecting data, and a spectrum does not display.	1. Press <ESCAPE> until the Main menu displays. 2. Check that the system setup parameter Auto Range is set to On. 3. Return to the Route mode and continue collecting data.

Solving battery problems

Problem	*Cause* and solution
"BT" displays at the top of the Microlog screen.	*The battery is nearly discharged.* Have the spare battery charged and available to install in the Microlog when it powers itself down on a low battery charge.
The Microlog does not power up even after the battery is recharged.	*The battery has developed a memory set.* Deep discharge the battery several times following the *Restoring battery capacity* procedure in Section 10.

Problem	*Cause* and solution
	If the battery still will not hold a charge, replace it.
A brand new battery does not hold a full charge.	Deep discharge the battery at least three times following the *Restoring battery capacity* procedure in Section 10. If the battery does not hold a charge after the deep discharges, contact the James L. Griffin Co., Inc. for a replacement.

Solving strobe problems

When taking phase and amplitude data, you must make sure that the strobe is firing correctly. Inconsistent firing of the strobe is a result of one of the following issues:

- Low machine vibrations at the location of the transducer
- Improper strobe/Microlog setup
- Equipment problems

Handling low machine vibrations

Low machine vibration at the location of the transducer at 1x RPM makes the phase inconsistent and causes the strobe to fire erratically.

If this occurs, check the 1x amplitude. If the amplitude at 1x RPM is less than 0.020 IPS, the data is good despite the inconsistent phase and erratic strobe. You can then go on to the next point.

Checking for improper strobe/Microlog setup

Another cause of an inconsistently firing strobe is an incorrect Microlog setup. The strobe will fire erratically if it is not receiving a signal at 1x RPM from the Microlog.

If you think this is the case, refer *to Preparing the Microlog for data collection* in Section 1. If all of the Microlog parameters are correct and you still experience the problem, check the shaft for two or more keyways. Check that the strobe is not triggering at a speed that would show the reference mark twice (180º apart). This indicates that you are triggering at either ½x or 2x shaft speed.

If the strobe is triggering off of two keyways while in Internal (INT) mode, the Microlog will look for a vibration at ½x RPM to trigger off of when you switch the strobe to tracking (TRACK).

To ensure that the you are triggering off of 1x RPM rather than ½x RPM, follow these guidelines:

1. Start the strobe at the shaft's nominal running speed.
2. Slowly decrease the speed of the strobe until the shaft is steadied.
3. Switch the strobe to TRACK and try taking phase and amplitude readings again.

If you continue to have problems getting a trigger, you can use the strobe in Internal (INT) mode to collect phase and amplitude data. **NOTE:** Only use the INT setting for locations that you can not get the strobe to trigger in Tracking (TRACK) mode.

With this method, you control the position of the mark at all times. You must keep your mark at the reference point by using the phase control knobs on the strobe.

To use the strobe in Internal (INT) mode, follow these guidelines:

1. Set the strobe so the trigger is held in and the mode is set to INT.
2. Center the trigger mark at the same reference point you were using while in tracking mode.
3. Select "Take Data" on the Microlog.

4. Steady the reference mark and manually record the 1x amplitude and phase. You have to control and adjust the mark continuously.
5. Check the reference mark again, re-steady if it moves, and record the 2x amplitude and phase.

Handling equipment problems

In addition to low machine vibrations and an improper strobe/Microlog setup, equipment problems can also cause the strobe to fire inconsistently.

To approach this problem, you should check all cable connections. Most importantly, observe these guidelines:

- Make sure the strobe-to-phase reference adapter cable is connected properly.

  The cord should hang down the side of the strobe from the two-prong connector.

- Check the accelerometer cable.

  Make sure you are getting good data when collecting screening data. If the accelerometer cable is broken, you will not be able to collect any valid data.

Solving palmtop memory problems

Some FLSPs use an HP200LX palmtop computer to run the JCI Alignment Program (JCALIGN) and the Technical Assistant Program (TAP). This computer uses three batteries:

- Two AA batteries supply the main power.
- One watch battery supplies backup power when the AA batteries are going dead.

You can remove the two AA batteries for replacement when needed. However, you should:

- *Never* remove all three batteries at the same time.
- Always keep fresh batteries in the palmtop.

If you remove all of the batteries at once or allow all three batteries to "die," the palmtop's memory resets and JCALIGN and TAP are removed.

If this happens, you must download the programs again into the palmtop's memory. For the download, you need a connectivity pack that most locations don't have.

Call the Engineering Services Help Line if you lose the programs and need to re-download them into the palmtop's memory.

NOTES

Section 10
Maintaining Microlog batteries

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SECTION 10: MAINTAINING MICROLOG BATTERIES

Maintaining NiCad batteries

To maintain a NiCad Microlog battery, you must periodically:

- Check the battery
- Recharge the battery
- Perform a capacity test
- Restore the battery's capacity

Checking the battery

You should check the battery and the spare every time before you go to the customer site.

NOTE: You should also check the battery when "BT" displays in the status line at the top of the Microlog screen. This means that the battery capacity is low. After checking the battery, you should then recharge it or replace it with a charged battery.

Before you check the battery, keep in mind the requirements in the following table:

You should...	Because...
Wait at least two minutes after turning on the Microlog before you check the battery	This draws the battery down to its actual charged level.
NOT remove the battery from the Microlog for any longer than it takes to install the spare	Removing the battery for an extended period: • Will discharge the backup source. • May cause Microlog memory loss.

To check the battery, follow these steps:

1. Access the Temp/Battery screen.

   From the Main menu:

   - Select the Utilities option. The Utilities menu displays.
   - Select the Temp/Battery option. The Temp/Battery screen displays.

2. Look at the meter: it shows the condition of the battery.

If the indicator points to the...	Then the battery...
Charged, or "+" side of the meter	Does not need to be charged right away.
Recharge, or "-" side of the meter	Should be charged immediately. Go to the *Recharging the battery* procedure in this section.

Recharging the battery

Your Microlog includes two batteries so you have a spare on hand at all times.

You should always make sure that the spare is fully charged so that it is ready for you to use if the battery in the Microlog dies while you are at a customer site.

To recharge these batteries, you can either charge the spare battery alone or charge both batteries at once.

To charge the battery, follow these steps:

1. Connect the power source to the Support Module.
   - Plug the power source into the Power Supply port in the back of the Support Module.
   - Place the plug in a wall outlet.
2. Determine if you want to charge the spare battery alone or charge both batteries at once.

If you are...	Then you should...
Charging just the spare battery	Insert the spare battery in the Support Module. As the battery is being charged, Battery 1's LED is lit on the face of the Support Module.
Charging both batteries at once	1. Leave the battery in the Microlog. 2. Connect the Support Module to the Microlog. 3. Insert the spare battery in the Support Module. Battery 1's LED is lit as the battery in the Support Module is charging. Battery 2's LED is lit as the battery

If you are...	Then you should...
	in the Microlog is charging.

Charging both batteries takes about eight hours from full discharge to full charge. Charging begins at a fast rate that slows to a trickle as the batteries reach full capacity.

Performing a capacity test

To determine if you need to restore battery capacity, you perform a capacity test.

NOTE: You only need to perform capacity tests on NiCad batteries.

To perform a capacity test, follow these steps:

1. Charge the battery you want to test.

   NOTE: Make sure you charge the battery for at least 16 hours.

2. Install the battery in the Microlog.
3. Turn on the Microlog.
4. Access the Temp/Battery screen.

   From the Main menu:

   - Select the Utilities option. The Utilities menu displays.

- Select the Temp/Battery option. The Temp/Battery screen displays.

5. Reset the elapsed timer.
   - Press the <F1> key to reset the timer.
6. Leave the Microlog on until it shuts itself down on low charge.

   A message displays to warn you that the Microlog will shut itself off. The screen then goes blank.
7. Turn on the Microlog again.

   NOTE: If the Microlog will not turn on at this point, you may need to install a charged battery in the Microlog.
8. Return to the Temp/Battery screen.
   - Select the Utilities option from the Main menu.
   - Select the Temp/Battery option. The Temp/Battery screen displays.
9. Look at the elapsed time indicator.

If the elapsed time is...	**Then...**
Less than seven hours	You should restore the battery's capacity before you recharge it. Complete the *Restoring battery capacity*

If the elapsed time is...	Then...
	procedure in this section.
More than seven hours	You do not have to restore battery capacity at this time.

NOTE: As NiCad batteries get old, they will eventually hold less than seven hours of charge. If you deep discharge a battery twice and it holds less than two hours of charge, replace it.

Restoring battery capacity

Like all NiCad batteries, a Microlog battery develops a capacity set or memory that diminishes its lifetime between charges. This memory occurs when Microlog batteries are held at near or peak charge for extended periods.

To restore the battery capacity, you perform a deep discharge.

To restore battery capacity, follow these steps:

1. Make sure you have performed a capacity test on the battery.

- See *Performing a capacity test* in this section if you are not sure that you have tested the battery's capacity.

2. Access the Analyzer menu.

   From the Main menu:

   - Select the Analyzer option. The Analyzer menu displays.

3. Select the Take Data option.

4. Leave the Microlog on until it shuts itself down.

   A message displays to warn you that the Microlog will shut itself off. The screen then goes blank.

5. Recharge the battery for at least 16 hours.

   - Follow the *Recharging the battery* procedure in this section.

6. Repeat the capacity test.

   - Follow the *Performing a capacity test* procedure in this section.

   - Repeat the capacity test until the elapsed time indicator displays more than seven hours.

     NOTE: As NiCad batteries get old, they will eventually hold less than seven hours of charge.

If you deep discharge a battery twice and it holds less than two hours of charge, replace it.

Maintaining nickel metal hydride batteries

All Micrologs purchased in 1995 and after will be equipped with nickel metal hydride batteries. How you care for these batteries differs from how you care for NiCad batteries.

In order for a new nickel metal hydride battery to hold a charge, you should deep discharge it several times before you use it.

To maintain nickel metal hydride batteries, follow these steps:

1. Deep discharge the battery.
    - If you are not sure how to deep discharge the battery, refer to *Restoring the battery's capacity* in this section.
2. Check the battery's charge.
    - If you are not sure how to check the battery's charge, refer to *Checking the battery* in this section.
    - Make sure you access the Temp/Battery screen.

If the indicator points...	Then the battery is...	So you should...
All the way to the right, or the "+" side of the meter	Fully charged	Use the battery.
Anywhere other than all the way to the right side of the meter	NOT fully charged	Repeat Steps 1-2 until the indicator points all the way to the right.

After you perform the necessary initial deep discharge(s) for nickel metal hydride batteries, you do not have to perform any additional deep discharges for the life of the batteries.

NOTES