

# SUTTON & ASSOCIATES INC.

2250 McKinley Avenue • Columbus, Ohio 43204 • (614) 487-9096 • Fax. (614) 487-9099  
 INDUSTRIAL REFRIGERATION • FOOD PROCESSING • DESIGN • SALES • SERVICE

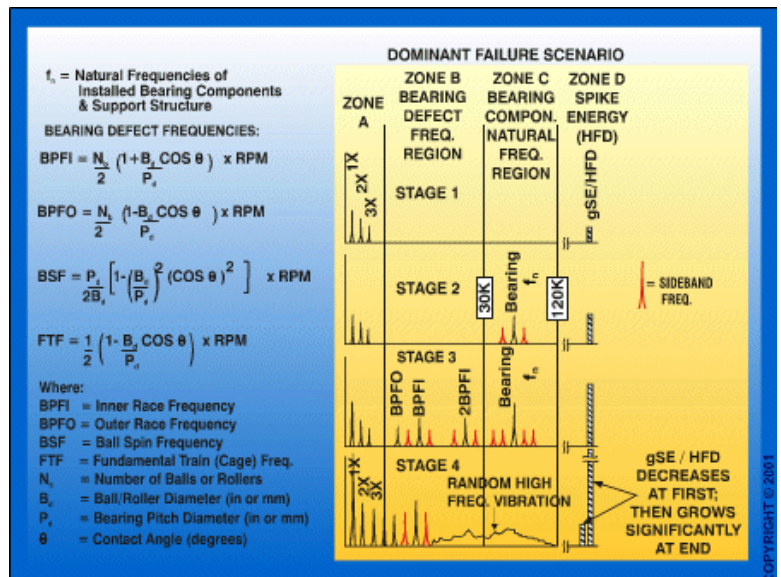
## PREVENTIVE MAINTENANCE SERVICES FOR INDUSTRIAL REFRIGERATION

- ❑ Vibration Analysis
- ❑ Ammonia Detection Calibration
- ❑ Oil Analysis
- ❑ Ammonia Contamination
- ❑ Thermal Imaging
- ❑ Evaporator Cleaning

### Compressor Vibration Analysis CSI 2130 Machinery Health Analyzer The Foundation for Effective Machinery Health Management

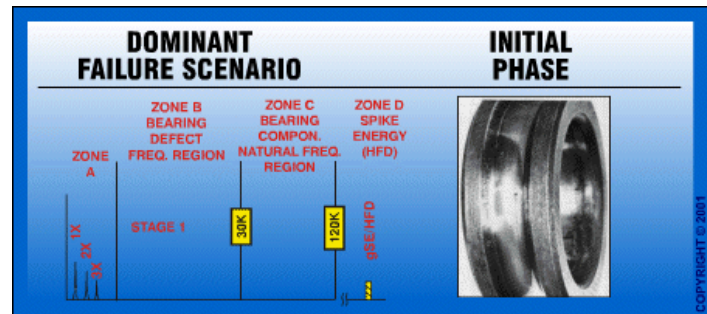


Regular reporting will indicate if a machine is experiencing excessive wear during normal operation. The vibration data will be graphed as a spectral analysis. This graph will be compared to known problems for the particular compressor bearings and electric motor inspected. A report will include the spectral analysis and electric motor diagnostics, detailing specific problems, the severity, and the recommended action to correct the problem. Motor bearing problems normally take more than 6 months to develop to a point of failure. Tracking machine vibration frequencies on a regular basis, costs of compressor rebuilds and motor refurbishing can be reduced.



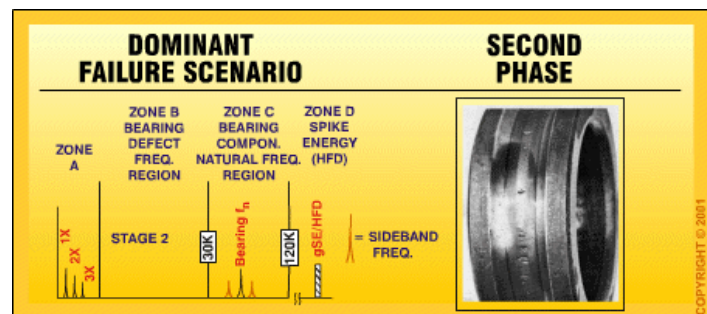
### STAGE 1:

Earliest indications of bearing problems appear in ultrasonic frequencies ranging from about 250,000 - 350,000 Hz; later, as wear increases, usually drops to approximately 20,000 - 60,000 Hz (1,200,000 - 3,600,000 CPM). These are frequencies evaluated by Spike Energy (gSE), HFD(g) and Shock Pulse dB). For example, spike energy may first appear at about .25 gSE in Stage 1 (actual value depending on measurement location and machine speed). Acquiring high frequency enveloped spectra confirms whether or not wearing is in Failure Stage 1.



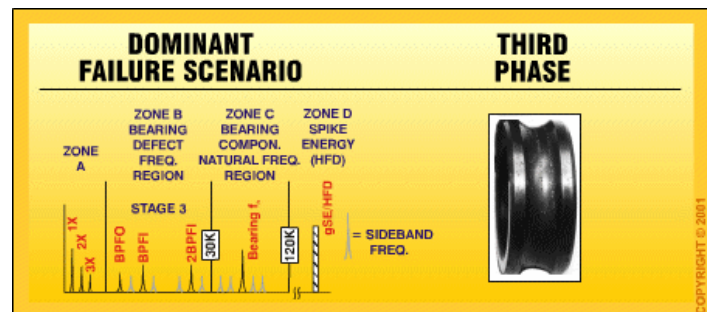
### STAGE 2:

Slight bearing defects begin to "ring" bearing component natural frequencies ( $f_n$ ) which predominantly occur in 30K - 120K CPM range. Such natural frequencies may also be resonances of bearing support structures. Sideband frequencies appear above and below natural frequency peak at end of Stage 2.



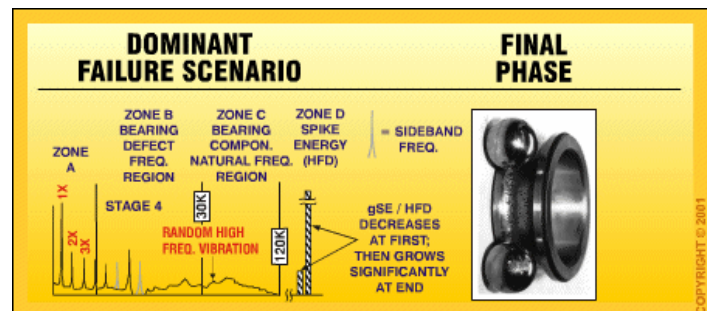
### STAGE 3:

Bearing defect frequencies and harmonics appear. When wear progresses, more defect frequency harmonics appear and number of sidebands grows, both around these and bearing component natural frequencies. Overall spike energy continues to increase (for example, from .5 to over 1 gSE). Wear is now usually visible and may extend throughout periphery of bearing, particularly when many well-formed sidebands accompany bearing defect frequency harmonics. High frequency demodulated and enveloped spectra help confirm Stage III. Schedule the bearings for replacement, (independent of bearing defect frequency amplitudes in vibration spectra).



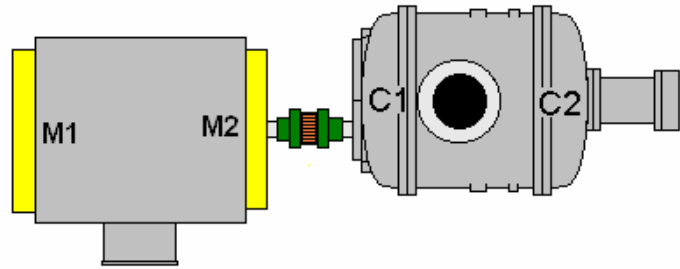
### STAGE 4:

Towards the end, amplitude of 1X RPM is even affected. It grows, and normally causes growth of many running speed harmonics. Discrete bearing defect and component natural frequencies actually begin to "disappear" and are replaced by random, broadband high frequency "noise floor". In addition, amplitudes of both high frequency noise floor and spike energy may in fact decrease; but just prior to failure, spike energy and HFD will usually grow to excessive amplitudes.

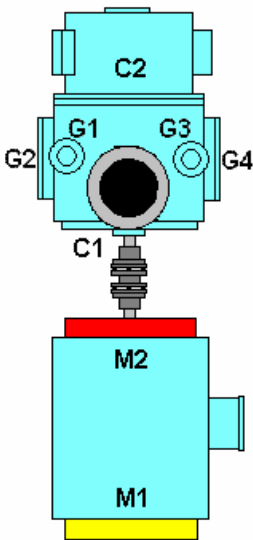
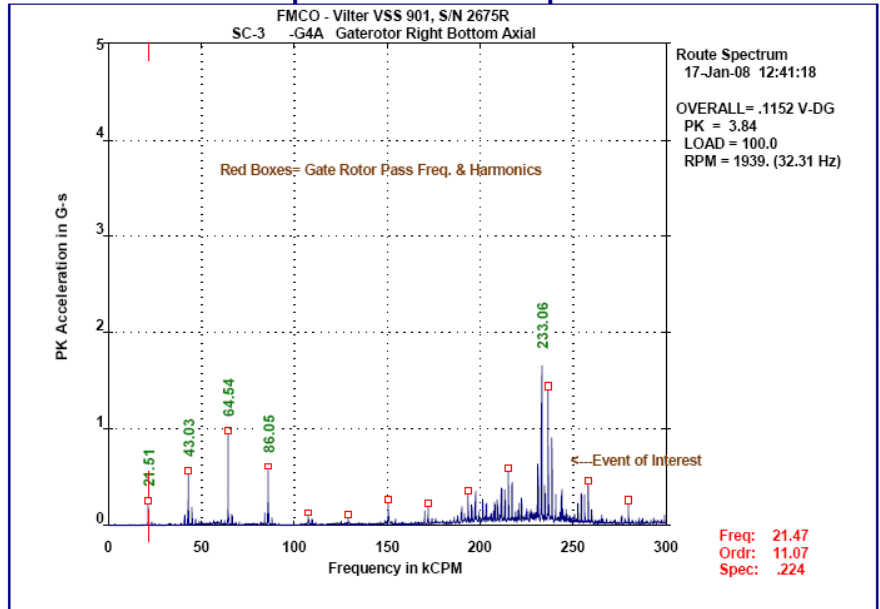
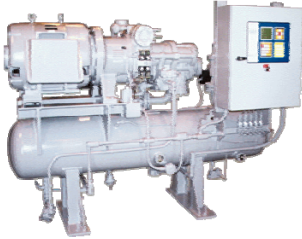


# Where is Vibration Analysis Useful?

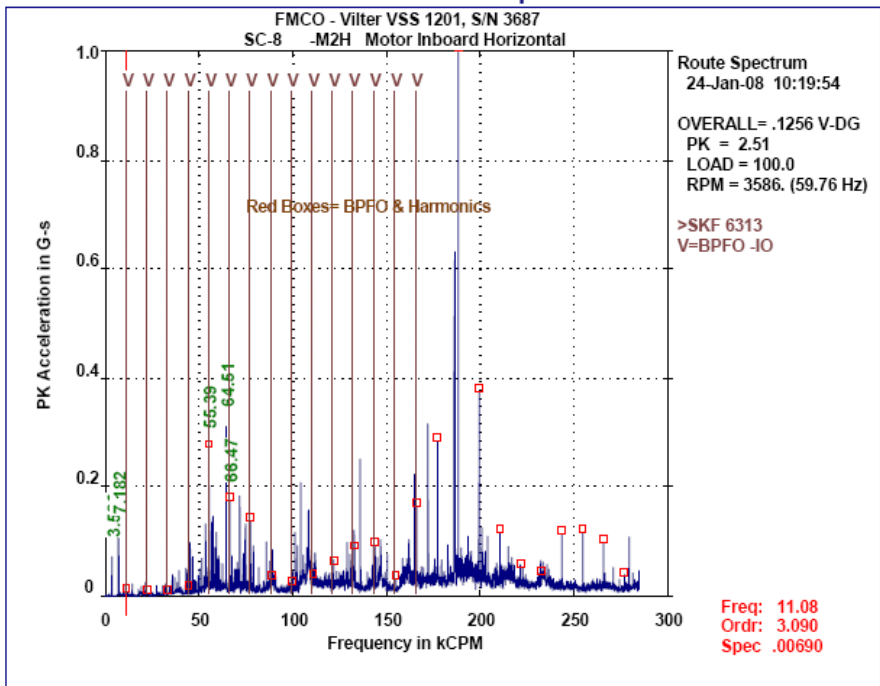
- ❑ Vilter Single Screw
- ❑ Vilter Twin Screw
- ❑ FES Twin Screw
- ❑ Frick Twin Screw
- ❑ York Reciprocating
- ❑ Vilter Reciprocating
- ❑ All Motors



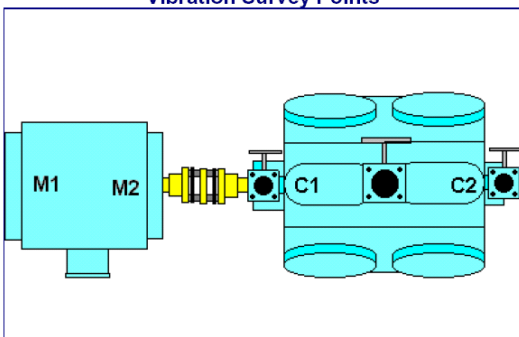
## Compressor Problem Spectrum



## Motor Problem Spectrum



## Vibration Survey Points





## Ammonia Detection Calibration

- ❑ Periodic Sensor Calibration (6 Months)
- ❑ Maintain Regulatory Compliance
- ❑ Insurance Carrier Discounts
- ❑ Annual Safety Interlock Testing



Calibrate ammonia detectors per manufacturer recommendations. Sutton to use manufacturer certified calibration gas and equipment on all sensors.



## Ammonia Contamination

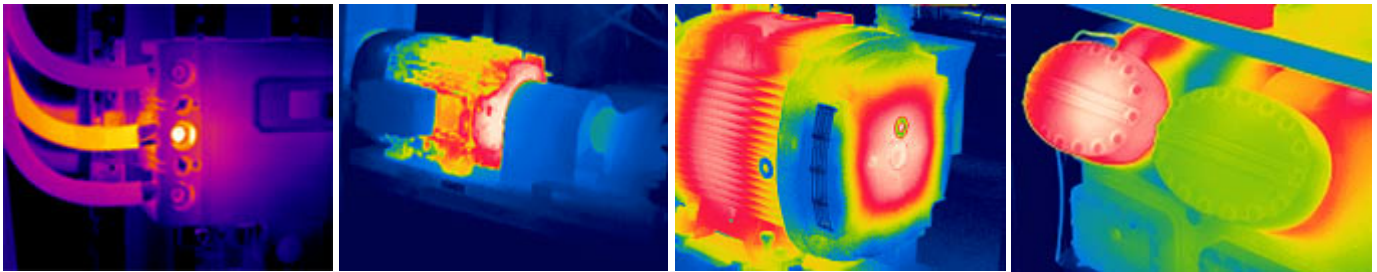
IIAR bulletin 108, "Water Contamination in Ammonia Refrigeration Systems" outlines the usefulness of an ammonia flow sampler. Report the amount of contamination in 500ppm increments, accurate to the 100ppm. Recommended inspection interval every 1-2 years.

## Oil Analysis

Oil tests can be an early warning sign for compressor breakdown and lubrication quality. Monitoring alignment and endplay on a regular basis will help track the condition of a compressor. Recommended analysis interval every 6 months.

## Thermal Imaging

Thermal imaging is useful for fast comparative snapshots of electrical and mechanical equipment. Other uses include locating breakdowns in insulation, identifying condensed liquid in hot gas defrost lines. Recommended inspection interval every 6 months.



## Evaporator Cleaning

Oil tests can be an early warning sign for compressor breakdown and lubrication quality. Monitoring alignment and endplay on a regular basis will help track the condition of a compressor. Recommended cleaning interval every 6 months.

Before

After



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