YORK®	CHILLER VIBRATION ANALYSIS	
CUSTOMER REPORT	Supersedes: Nothing	Form 50.40-CR32.0 (1098)

Machinery Vibration Analysis Report

on

Water Chillers

September 1, 1996

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INTRODUCTION

SUMMARY OF RECOMMENDATIONS

The data submitted for analysis included one machine with a mechanical problem of a serious severity and four machines which have mechanical problems of a moderate severity. Repair recommendations have been made and are listed below. The spectra for these machines have been included in the last section of this report.

REPAIR RECOMMENDATION PRIORITY DEFINITIONS

HIGH
Failure may occur within Days
(issued whenever an Extreme Fault is Detected)

MED (MEDIUM)
Failure may occur within Weeks
(issued whenever a Serious Fault is Detected)

LOW
Failure may occur within Months
(issued whenever a Moderate Fault is Detected)

Williams Module Two/1250 Ton YORK Chiller #2

Priority Low: Replace motor bearings, check alignment and inspect coupling for wear.

Chemistry Module 1/1200 Ton YORK Chiller #1

Priority Low: Balance compressor and inspect bearings for looseness

Stemmler Module 3/1181 Ton YORK Chiller #3

Priority Low: Monitor for increased gear wear indications

Module Five/1250 Ton YORK Chiller #2

Priority Low: Check alignment. If satisfactory, balance motor.

Stouflers/201 Ton YORK Chiller #1

Priority Med: Inspect compressor bearings for proper clearances.

MACHINERY COVERED BY THIS REPORT

Chemistry Module 1/600 Ton Carrier Chiller #2 (85-18-36773)

Chemistry Module 1/1200 Ton YORK Chiller #1 (JM-077-556)

Module Five/1250 Ton YORK Chiller #1 (YFVM168729)

Module Five/1250 Ton YORK Chiller #2 (YFVM168773)

Module Five/1250 Ton YORK Chiller #3 (YFUM178170)

Stemmler Module 3/1181 Ton YORK Chiller #3 (GM-002387)

Stoulfers/201 Ton YORK Chiller #1 (WO 174905)

Williams Module Two/1250 Ton YORK Chiller #2 (JM-085554)

Williams Module Two/1250 Ton YORK Chiller #3 (JM-085555)

Williams Module Two/1250 Ton YORK Chiller #4 (YBTMO19596)

MACHINES FOR WHICH DATA WAS NOT SUBMITTED

None

VIBRATION TEST AND ANALYSIS PROCEDURE

The standard instrumentation package used for *PdM Express* consists of a DLI WATCHMAN® Model 8603 portable vibration data collector fitted with a triaxial vibration sensor. Vibration measurements are made by temporarily attaching the triaxial sensor to small attachment pads that have previously been attached to the machinery at selected locations, usually at or near bearing caps. Vibration measurements are made automatically over two frequency ranges, usually at about 10 times and 100 times the rotational rate of the machine being tested. As the data is collected, it is stored in the memory of the portable data collector.

When the data collector is returned to DLI Engineering, the stored data is off loaded to a computer for program assisted analysis. The computer contains specific information about the mechanical configuration of the machinery in your plant. It also contains an expert system that has been set up to identify which of your machines are off-normal, and to diagnose the nature and severity of the faults.

DEFINITIONS AND TERMS FOR REPORT INTERPRETATION

Vibration amplitudes in this report are expressed in terms of velocity decibels, abbreviated as VdB. The zero reference for VdB is $1x10^{-8}$ (0.000,000,01) meters per second rms. For comparison, a vibration velocity amplitude of 120 VdB is equivalent to 10 millimeter per second rms, and 125 VdB is equivalent to 1 inch per second peak.

When using decibel amplitude scales, a difference of 6 dB between any two readings means that there is a 2:1 ratio between the two vibration levels; a difference of 20 dB between any two readings means that there is a 10:1 ratio between the two vibration levels. If you prefer to use units of inches per second, a conversion table from VdB to inches per second peak is included below for your convenience.

VDB	INCHES/SECOND (PK)	VDB	INCHES/SECOND (PK)
60	0.0006	105	0.099
70	0.0018	110	0.18
75	0.0031	115	0.31
80	0.0056	120	0.56
85	0.0099	125	0.99
90	0.018	130	1.8
95	0.031	135	3.1
100	0.056	140	5.6

HOW TO READ VIBRATION ANALYSIS RESULTS

Where faults are indicated in the Vibration Analysis Results section, the numbers in parenthesis ( ) indicate the amount that the current vibration level exceeded a statistically derived vibration amplitude that is equal to the average plus one standard deviation. Statistically, that means that 20 out of 24 identical machines will not exceed the level, or roughly 16 percent will exceed the "alarm" level and will be subject to more detailed expert system and engineering analysis.

Machinery vibration is measured in three directions at each of the pre-established measurement locations. The directions of **A**xial, **R**adial and **T**ransverse are oriented relative to the machinery shafting. The measurement locations are on, or close to, the bearing housings and are numbered beginning from the free end of the driving component (such as a motor) through the free end of the driven component (such as a pump). The combination of the measurement location and the direction at the location make up the pickup designator used in the reports. For example, an **A**xial measurement at bearing number 3 (such as the coupled end of a pump) would be denoted in the Vibration Analysis Results by the symbol [**3A**].

In most cases, vibration frequencies are referred to as a multiple of the significant machine rotating element. This is done as a multiple or order number together with a suffix that denotes the significant rotating element. The following table lists most of the suffixes used in the report.

SUFFIX	REFERS TO	SUFFIX	REFERS TO
M	Motor	F	Fan
C	Compressor	B	Purifier Bowl
D	Diesel	T	Turbine
G	Generator or Governor	P	Pump
I	Intermediate Shaft	S	Shaft

For example, if a **P**ump has 6 vanes in the impeller and we wanted to refer to the vibration signal caused by the vane passing rate, we would refer to it as "6xP," which means, "the vibration that is occurring at six times the pump rotational rate." Similarly, a vibration signal at 10,740 CPM (cycles per minute) on a **M**otor shaft that is turning at 3580 RPM would be referred to as a vibration signal at a frequency equal to "3xM."

VIBRATION ANALYSIS RESULTS

WILLIAMS MODULE TWO/1250 TON YORK CHILLER #2

Acquired: 08-23-1994 10:18:29 Speed: 1XM = 3589. (1XC = 10227.)RPM

PRIORITY LOW: REPLACE MOTOR BEARINGS, CHECK ALIGNMENT AND INSPECT COUPLING FOR WEAR.

Maximum Level is: 113 (+ 9) VdB [1T] at 1.00xM

MODERATE MOTOR BEARING LOOSENESS is indicated by
97 (+39) VdB [2A] at 4.00xM
100 (+36) VdB [2R] at 4.00xM
97 (+27) VdB [2T] at 4.00xM
105 (+11) VdB [2A] at 1.00xM
110 (+13) VdB [2R] at 1.00xM
108 (+15) VdB [2T] at 1.00xM
104 (+23) VdB [1R] at 2.00xM
108 (+20) VdB [1T] at 2.00xM
108 (+24) VdB [2R] at 2.00xM
110 (+19) VdB [2T] at 2.00xM
MODERATE MOTOR TO GEARBOX PARALLEL MISALIGNMENT is indicated by
108 (+24) VdB [2R] at 2.00xM
110 (+19) VdB [2T] at 2.00xM
107 (+21) VdB [3T] at 2.00xM
MODERATE INDICATION OF MOTOR TO GEARBOX COUPLING WEAR is indicated by
105 (+30) VdB [2A] at 3.00xM
100 (+29) VdB [2R] at 3.00xM

WILLIAMS MODULE TWO/ 1250 TON YORK CHILLER #3

Acquired: 08-23-1994 10:35:28 Speed: 1XM = 3588. (1XC = 10224.)RPM

NO RECOMMENDATION
Maximum Level is: 105 (+ 1) VdB [1T] at 1.00xM

NO MECHANICAL FAULTS DETECTED.

WILLIAMS MODULE TWO/ 1250 TON YORK CHILLER #4

Acquired: 08-23-1994 10:46:25 Speed: 1XM = 3541. (1XC = 9702.)RPM

NO RECOMMENDATION
Maximum Level is: 112 VdB [3R] at 1.00xM

Strong 0.45XM (1622 CPM) harmonics are present throughout the spectra for this machine. The pattern is consistent with externally excited vibration, however we are unaware of any possible sources.

CHEMISTRY MODULE 1/ 1200 TON YORK CHILLER #1

Acquired: 08-23-1994 07:58:00 Speed: 1XM = 3571. (1XC = 10177.)RPM

PRIORITY LOW: BALANCE COMPRESSOR AND INSPECT BEARINGS FOR LOOSENESS
Maximum Level is: 117 VdB [1A] at 1.00xC

MODERATE COMPRESSOR ROTOR IMBALANCE is indicated by
117 VdB [1A] at 1.00xC
111 VdB [6R] at 1.00xC
110 VdB [6T] at 1.00xC
MODERATE COMPRESSOR BEARING WEAR AND/OR LOOSENES is indicated by
94 VdB [6A] at 4.00xC
95 VdB [6R] at 4.00xC

STEMMLER MODULE 3/ 1181 TON YORK CHILLER #3

Acquired: 08-24-1994 06:36:42 Speed: 1XM = 3576. (1XC = 10730.)RPM

PRIORITY LOW: MONITOR FOR INCREASED GEAR WEAR INDICATIONS
Maximum Level is: 102 VdB [3R] at 22.00xC

MODERATE GEAR MESH PROBLEM is indicated by
102 VdB [3R] at 22.00xC
98 VdB [3R] at 18.00xC
97 VdB [3R] at 24.00xC

MODULE FIVE/ 1250 TON YORK CHILLER #1

Acquired: 08-23-1994 13:06:10 Speed: 1XM = 3561. (1XC = 10398.)RPM

NO RECOMMENDATION
Maximum Level is: 109 (+13) VdB [1R] at 1.00xM

NO MECHANICAL FAULTS DETECTED.

MODULE FIVE/ 1250 TON YORK CHILLER #2

Acquired: 08-25-1994 06:43:12 Speed: 1XM = 3563. (1XC = 10402.)RPM

PRIORITY LOW: CHECK ALIGNMENT. IF SATISFACTORY, BALANCE MOTOR.
Maximum Level is: 120 (+17) VdB [3R] at 1.00xM

MODERATE MISALIGNMENT AND/OR MOTOR IMBALANCE is indicated by
120 VdB [3R] at 1.00xM
119 VdB [2R] at 1.00xM
109 VdB [2A] at 1.00xM
118 VdB [1R] at 1.00xM

MODULE FIVE/ 1250 TON YORK CHILLER #3

Acquired: 08-23-1994 12:45:16 Speed: 1XM = 3562. (1XC = 10401.)RPM

NO RECOMMENDATION
Maximum Level is: 116 (+13) VdB [3R] at 1.00xM

NO MECHANICAL FAULTS DETECTED.

CHEMISTRY MODULE 1/ 600 TON CARRIER CHILLER #2

Acquired: 08-23-1994 08:48:33 Speed: 1XM = 3581. (1XC = 10888.)RPM

NO RECOMMENDATION
Maximum Level is: 111 (+ 4) VdB [1R] at 1.56xM

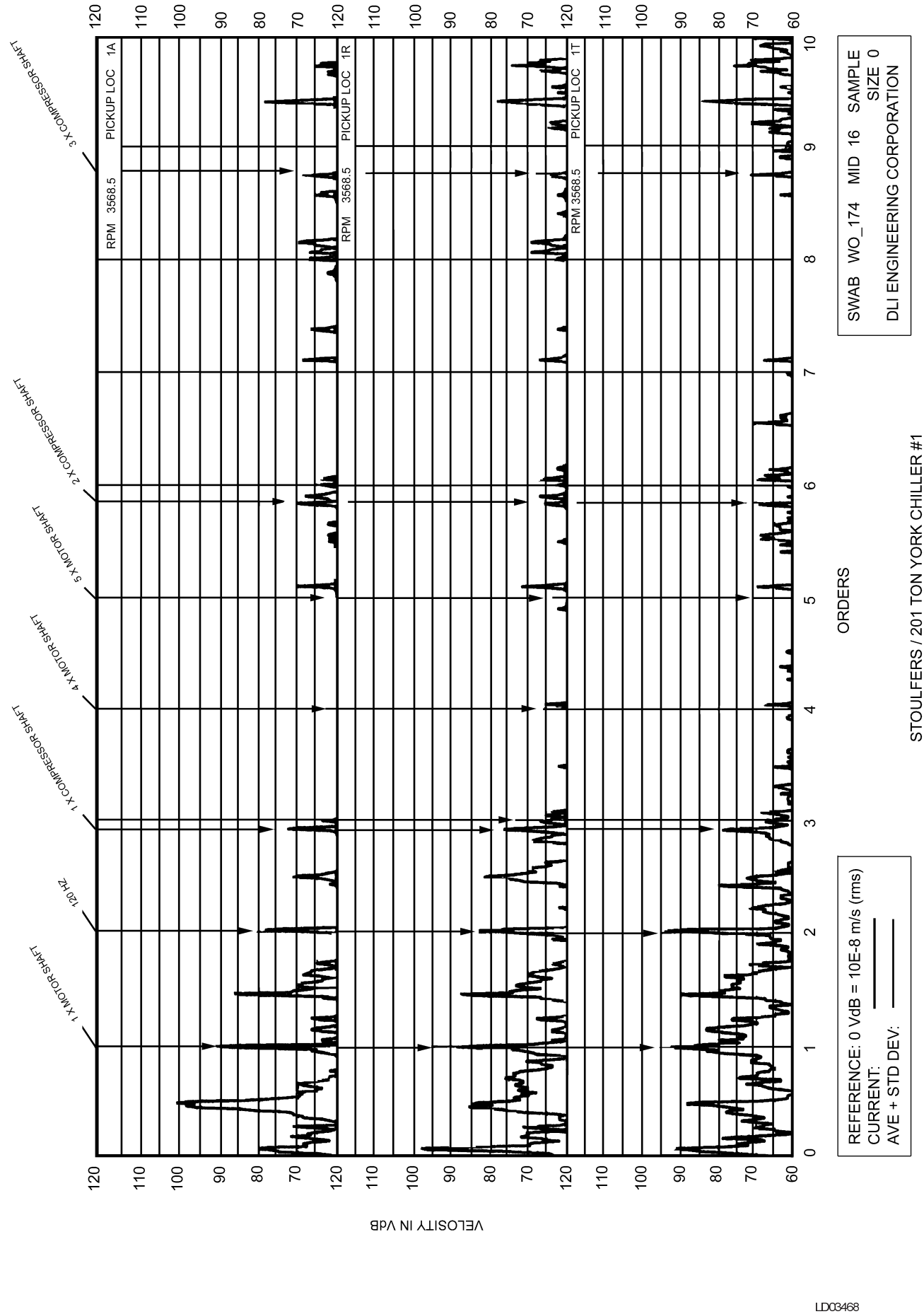
No mechanical faults were detected, however a strong resonance or flow related peak exists at 5660 CPM in all measured spectra.

STOULFERS/ 201 TON YORK CHILLER #1

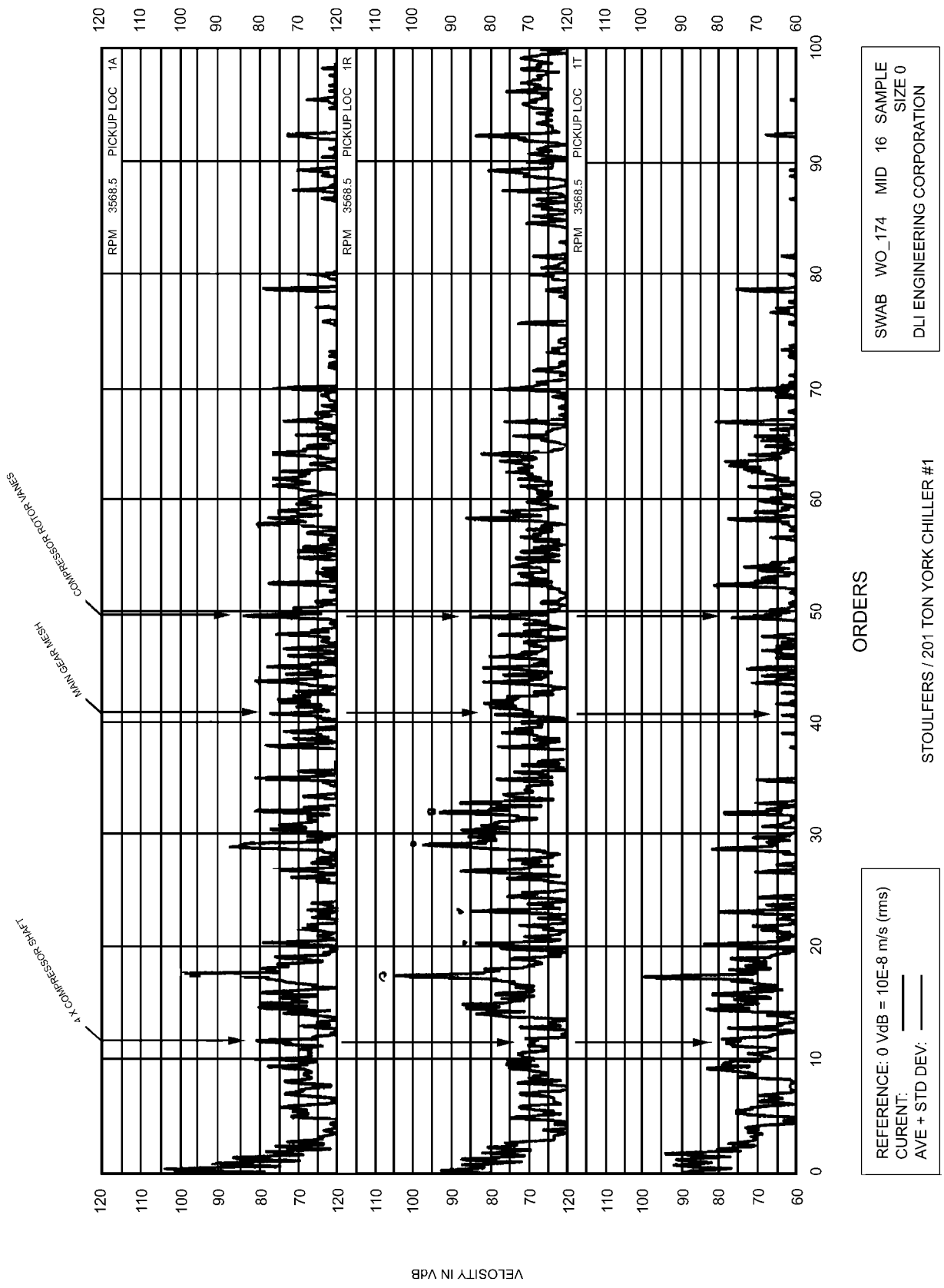
Acquired: 08-29-1994 05:55:01 Speed: 1XM = 3569. (1XC = 10419.)RPM

PRIORITY MED: INSPECT COMPRESSOR BEARINGS FOR PROPER CLEARANCES.
Maximum Level is: 114 (+ 7) VdB [3A] at 6.00xC

SERIOUS COMPRESSOR JOURNAL BEARING WEAR is indicated by
114 VdB [3A] at 6.00xC
112 VdB [3R] at 6.00xC
105 VdB [3R] at 8.00xC
107 VdB [3R] at 18.00xC
108 VdB [3R] at 20.00xC


1 X MOTOR SHAFT
120 HZ
1 X COMPRESSOR SHAFT
4 X MOTOR SHAFT
5 X MOTOR SHAFT
2 X COMPRESSOR SHAFT
3 X COMPRESSOR SHAFT
RPM 3568.5
PICKUP LOC 1A
RPM 3568.5
PICKUP LOC 1R
RPM 3568.5
PICKUP LOC 1T
VELOSITY IN VdB
ORDERS
REFERENCE: 0 VdB = 10E-8 m/s (rms)
CURRENT:
AVE + STD DEV:
SWAB WO_174 MID 16 SAMPLE SIZE 0
DLI ENGINEERING CORPORATION
STOULFERS / 201 TON YORK CHILLER #1

LD03468


RPM 3568.5 PICKUP LOC 1A
RPM 3568.5 PICKUP LOC 1R
RPM 3568.5 PICKUP LOC 1T
4 X COMPRESSOR SHAFT
MAIN GEAR MESH
COMPRESSOR ROTOR VANES
VELOSITY IN VdB
ORDERS
STOULFERS / 201 TON YORK CHILLER #1
REFERENCE: 0 VdB = 10E-8 m/s (rms)
CURENT:
AVE + STD DEV:
SWAB WO_174 MID 16 SAMPLE SIZE 0
DLI ENGINEERING CORPORATION

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