Ensuring VCM Succeeds

Vibration Condition Monitoring Practical Considerations that Make or Break Your Program

A Global Leader

Shipboard Condition Monitoring,

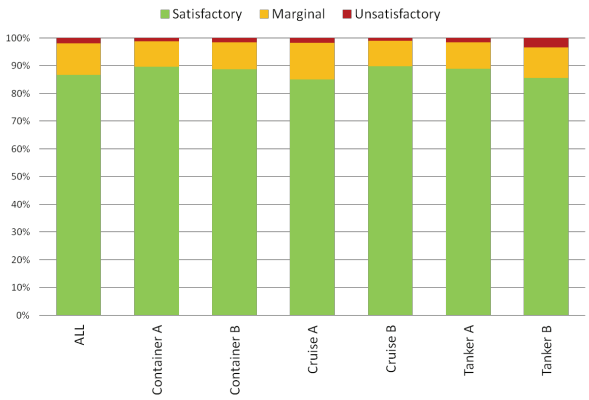
Vibration Analysis &

Thermographic Imaging

5 Areas of Practical Consideration

How you go about VCM determines the benefits you realize.

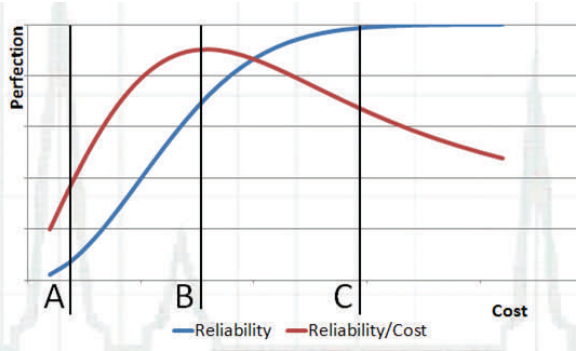
- Managerial Decisions
- Personnel
- Technical Support
- Integration with Work Order Systems
- Class Society Involvement



Results of over 330,000 readings taken over 30 years, rated by CAC's 3-scale measure of machine health and reliability.
2% unsatisfactory; 11% marginal; 87% satisfactory

Is it always necessary to carry out planned maintenance?

← Planned maintenance can be safely deferred when recommended by analysts.



There is an optimum data collection frequency. Below that threshold, reliability suffer. Beyond the threshold quality does not significantly increase, however costs continue to rise.

Is there an optimum data collection frequency or interval?

←For most equipment, two times per year is the optimum collection frequency.

Managerial Decisions

Vibration Reports are addressed to the Chief Engineer and copied to senior management of the vessel operator.

Chief Engineers receive recommendations:

- to postpone maintenance because the monitoring indicators are acceptable; or
- to increase maintenance because the machine is unhealthy.

VCM results are best used to fine-tune a fixed maintenance schedule.

Chief Engineers need the authority to deviate from a scheduled maintenance plan, when data supports the decision

Scheduled maintenance is expensive. Using VCM as a complement to, not a replacement for, fixed maintenance allows you to defer planned maintenance with confidence, when data shows the machine is healthy. When results indicate a problem, you can take action before failure. Either way, you save money.

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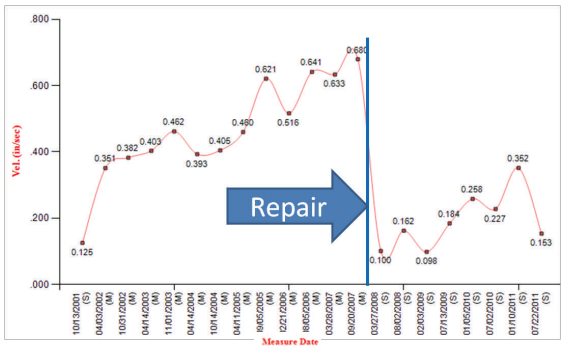
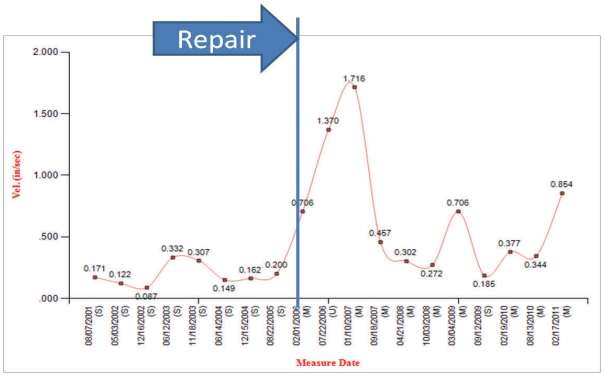
Semi-annual Readings are Sufficient to Show Trends



In this case, machine vibration increased gradually. Two tests per year were sufficient to detect the problem before failure occurred.

←Semi-annual Inspection allows repair before failure occurs.

Unnecessary opening → can compromise machine reliability.



Here is a case where the repair increased the vibration. Why was the repair done? Was it to satisfy the 5-year class opening rule? Was it to satisfy a fixed pm schedule from the home office? Unnecessary opening can compromise machine reliability.

Management needs a system that can show trends and summarize the data.

Too frequent reporting and/or too much detail is overwhelming to the person who has to read, understand, and respond to the report.

Too many recipients of copies, especially of non-essential information, clogs email systems.

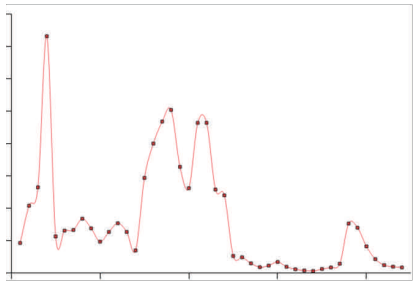
Over-reporting clouds the really important information in a haze of information that is not as critical. We call this Data Smog

Rather than enhancing the information a decision-maker can consider, a certain volume of information has the opposite effect – it distracts from it.

An effective and streamlined reporting protocol can avoid this common problem.

↓ Data Smog/Report Spam

Pt	Set_dt	O 1	Vertical	F 1,765	Horiz	Vel_bb	Axial
A	2011/05/25	0.2054		0.0889		0.0899	
A	2010/11/01	0.1065		0.0863		0.1190	
A	2010/03/22	0.1279		0.1046		0.1057	
A	2009/06/29	0.1626		0.1417		0.1567	
A	2008/12/31	0.2110		0.1182		0.2561	
A	2008/05/06	0.2870		0.2392		0.2024	
A	2007/10/28	0.3455		0.0874		0.1917	
A	2007/03/09	0.1721		0.1664		0.1735	
A	2006/09/14	0.1352		0.1148		0.1049	
A	2006/02/12	0.1048		0.1862		0.1525	
A	2005/08/12	0.1124		0.0875		0.2884	
A	2005/02/26	0.1378		0.1846		0.1370	
A	2004/10/28	0.1274		0.1650		0.1160	
A	2004/05/13	0.1580		0.1550		0.1308	
A	2004/03/23	0.1497		0.2084		0.1291	
A	2004/02/24	0.2040		0.1462		0.1749	
A	2004/01/23	0.1567		0.1056		0.1566	
A	2003/11/04	0.1612		0.1205		0.1844	
A	2003/04/16	0.2185		0.1948		0.1729	
A	2002/09/07	0.2567		0.1784		0.2985	
A	2002/04/10	0.5375		0.2032		0.2716	
A	2002/03/06	0.6179		0.2074		0.2908	
A	2001/08/07	1.0384		0.2475		0.1478	
A	2001/02/07	0.8853		0.2319		0.1429	
A	2000/05/28	0.6783		0.2154		0.1678	
A	2000/03/02	0.9819		0.2142		0.2391	
A	1999/12/28	0.9811		0.2826		0.2129	
A	1999/07/30	0.7837		0.1687		0.2189	
A	1999/04/18	0.5905		0.1852		0.1339	
A	1998/07/23	0.3127		0.1465		0.2244	



Rather than enhancing the information a decision-maker can consider, a certain volume at a certain point has the opposite effect – it distracts them. Too much data means too many reports.

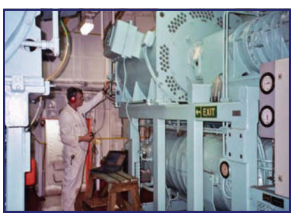
Personnel

Data must be collected by experienced and qualified personnel.

VCM depends on accurate data consistently collected thoroughly and accurately Proficiency requires extensive (and expensive) training.

Only those crewmembers who have received thorough training in vibration and data collection techniques should obtain vibration readings.

ISO qualification does not necessarily prepare a crew member to collect data effectively.

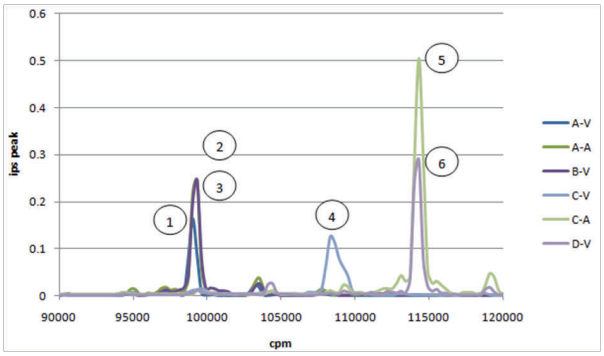


Certification courses provide theoretical instruction; they are not designed for the marine environment and provide little in the way of practical application.

An effective alternative is to develop, within your fleet, a team of data specialists who movie from ship to ship, collecting data.

This approach models the way in which outside specialists, like CAC, operate.

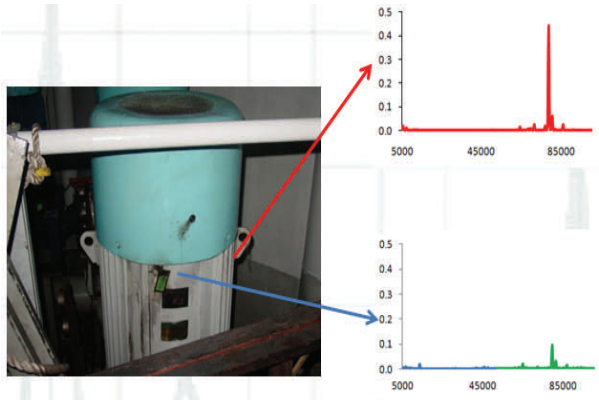
Technical Support



Crew did not notice the pump speed increasing...

← Direct contact between the person collecting the data and the analyst is essential.

The speed of a Turbine-driven cargo ballast pump was increasing during the test. The data collector did not notice this fact while taking data. The Vibration Analyst recognized that vibration at the gear mesh frequency indicated a possible gear problem. However, the increasing speed meant that the load on the machine was abnormal. When the machine was retested at full speed, the vibration went away and was normal. This example illustrates the importance of recording conditions as well as readings, and underscores the need for direct contact between the person collecting the data and the analyst.



Readings taken in one direction only missed a critical vibration...

← Effective crew training and commitment to continued learning are essential.

During an audit of a ship, it was found that the crew had been taking one reading at the top of this motor in the STBD direction. The Fmax was 45,000cpm and showed no problem. If a higher Fmax had been chosen, a new vibration frequency would have been found. In fact, if a reading had been taken in the RWF direction, a bigger problem would have been found – motor bar vibration at 44X-rotation rate. This shows how the way data is collected can affect results, and underscores the need for effective crew training.

The technical support function consists of setting up the measurement points, choosing baseline parameters, reviewing data collection procedures, and providing feedback as to the results. The taking of data and evaluation of results cannot be trivialized.

Marine VCM has unique factors, such as hull vibration, ship operation restrictions, and class society review that can best be handled by specialists with experience in the marine environment.

The data collection specialist needs a support person or Senior Analyst.

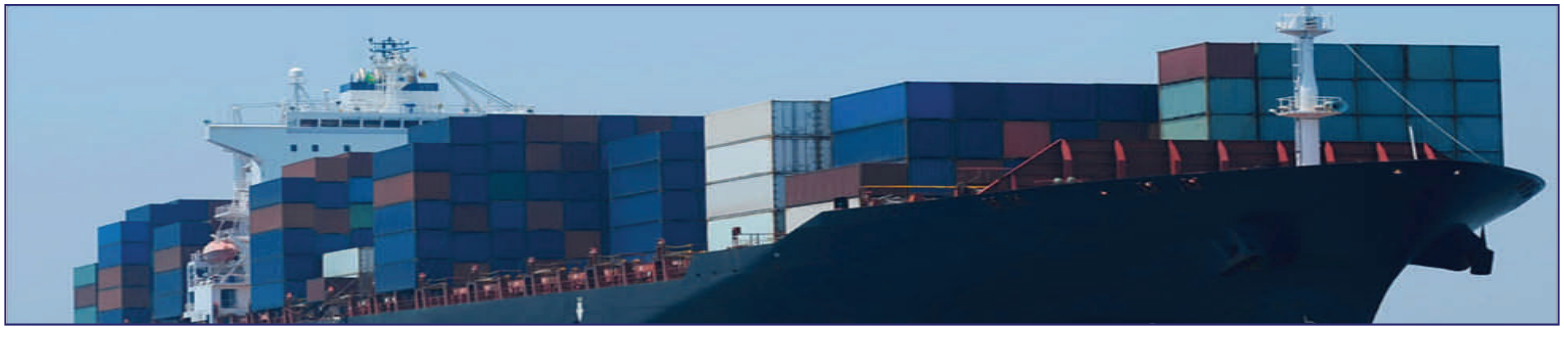
A crewman or even a full-time data collection specialist cannot be expected to completely manage a VCM program. While computer assisted analysis is helpful, human analysis can more effectively detect trends and relate them to repair histories. The Senior Analyst can study fleet-wide trends, modify test parameters, and conduct testing with advanced methods such as modal testing.

Communication and collaboration between the Senior Analyst and the Data Collection Specialist are essential.

Data Specialist can describe the test conditions—for example, heavy seas, load conditions and other relevant observations.

The Analyst can call for more testing to be done to rule out hull vibration, faulty data, wrong machine, etc.

This collaboration qualifies and clarifies the readings, resulting in a more thorough analysis.



Integration with Work Order Systems

Technological innovations have recently made VCM more user-friendly.

Integrating data with existing work order systems and fleet management software – capacities we have at CAC – has complementary effects: it gives the analyst ready access to repair history, and it gives crew access to vibration data.

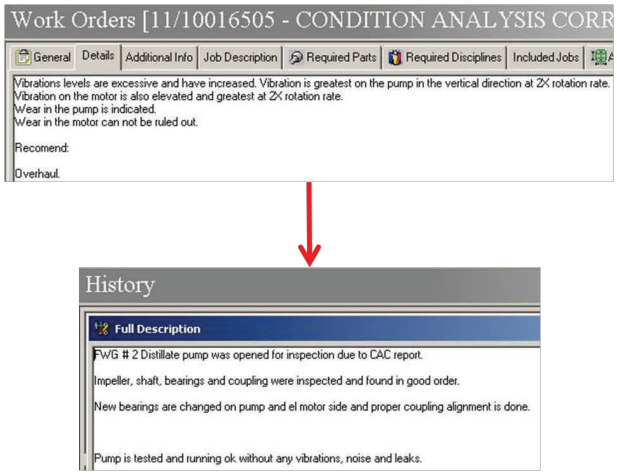
The vibration analyst needs to know the repair history.

The crew needs to have the vibration data integrated into the machinery history, and to know when to schedule data collection.

Chief Engineers, Marine Superintendents, Class Surveyors, and other decision-makers need a Summary Report that clearly shows what action needs to be taken, and the condition of machines from worst to best. Too often, the machine test results are not easily available to all the parties involved, or easily interpreted quickly.

Posting to a website is an excellent way to distribute the data. It is available to anyone with Internet access and a password. A full survey report can be distributed promptly. Items of greatest concern can be distributed immediately.

The best way to → distribute reports is directly to fleet management software.



At top is a screen shot from a ship's own management software, showing the results of a vibration survey requiring action. CAC can export vibration survey reports into several fleet management software programs. The end user does not have to flip screens or learn new programs to access the data or receive alerts.

Below is the resulting work order ,again, in the ship's own software, showing corrective action.

CAC Decision Point ® is a secure website containing an interactive database of over 330,000 readings which can be accessed for analytical and comparative purposes.↓

CAC Decision Point ®

CAC ID	Class	Client ID	Machine Description	Summary	Rating	Occurs	Report Date	Recommendation	Status
212	DNV		#2 EVAPORATOR DISTILLATE PUMP Repair History | Add Action | Print Vibration Report | Rating Trend	Wear, greater in pump.	Unsatisfactory	1	2011-07-31	Overhaul.	CLOSED
057	DNV		#2 HFO SEPARATOR Repair History | Add Action | Print Vibration Report | Rating Trend	Mild wear vertical and horizontal shafts.	Marginal	4	2011-07-31	Verify foundation security. Clean the centrifuge of deposits. Service the motor.	OPEN
085	DNV	721001011	#1 CWS PUMP FOR D/GEN #3 & #4 Repair History | Add Action | Print Vibration Report | Rating Trend	Imbalance/flexibility/wear.	Marginal	1	2011-07-31	Verify foundation security. Renew the motor bearings. Recheck the pump.	OPEN
087	DNV	722001021	#1 LT CFW PUMP FOR D/GEN #1 & #2 Repair History | Add Action | Print Vibration Report | Rating Trend	Imbalance/flexibility/wear.	Marginal	4	2011-07-31	Verify foundation security. Renew the motor and pump.	OPEN

Classification Society Involvement

Classification Societies are increasingly recognizing VCM. The growth potential of the approach is great.

CAC advocates that Classification Societies, through their membership in IACS, take four steps to support VCM.

Four things Class can do to help the industry reach the full potential of VCM:

- **Establish clear rules;**
- **Train ship inspectors to read and understand monitoring reports, providing an important independent perspective;**
- **Develop a reward or incentive for ships to participate in condition monitoring programs; and**
- **Consider an approved review of a VCM program equivalent to a mandatory five-year opening.**

A pair of Boiler Feed Water Pumps were opened in accordance with a Classification Society requirement. Both were rated as satisfactory in their performance at the time of the opening. One remained so afterwards, but the other actually became worse, indicating that the opening, itself, had an adverse effect on the machine. As both machines were satisfactory, they perhaps should not have been opened for inspection. →

Another machine was satisfactory but had a leaking mechanical seal. Instead of just replacing the seal, they performed an overhaul. The unit remained in satisfactory condition. This is an example of where a focused maintenance procedure could have been performed at less cost than a complete overhaul.

The fourth machine was found to be marginal. It was overhauled but the machine did not improve.

#1 BOILER FEED WATER PUMP	S	2006-07-19	2006-12-04	Due to Lloyd's requirement (survey code 03797 01-2002) stdb boiler feedwater inner pump has been dismantled for overhaul. Reassembled and tested. Left in good condition.	M
#2 BOILER FEED WATER PUMP	S	2006-07-19	2006-12-04	Due to Lloyd's requirement (survey code 03780 01-2002) stbd boiler feedwater inner pump has been dismantled for overhaul. Reassembled and tested. Left in good condition.	S
#1 F.O. BOOSTER PUMP FOR ME 5&6	S	2006-07-19	2006-11-06	Due to leakage on mechanical seal, complete pump has been overhauled. Replaced mechanical seal, bearing and gasket. Checked and tested, OK.	S
#2 EVAPORATOR EJECTOR PUMP	M	2006-07-19	2006-11-05	Dismantled the pum for complete overhaul. Reassembled and tested. Left in good running condition.	M

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How you go about VCM determines the benefits you realize.

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