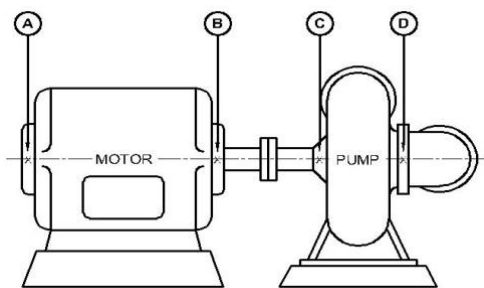




INTRODUCTION: Centrifugal Pumps are used in process plants for transporting liquid product. They come in many sizes and duties but Cooling Water is the most common and strategic. Over time erosion and corrosion of the impellor occurs. This results in a progressive increase in vibrations due to unbalance of the rotor. If ignored consequential damage to the drive motor’s bearings and coupling will result but often are predictable. Unscheduled failure can threaten personnel and plant safety. The loss of a single line pump can shut down the process causing significant financial losses. A continuous vibration monitoring system will give timely warning to prevent premature plant failure.



A pumps power consumption often accounts for over 12% of the total electricity used and it is a well recorded fact that an out of balance rotor will consume or waste up to 15% more energy.



CHALLENGES: Problems with centrifugal pumps are most likely to occur at the time of initial installation and run-in or after overall. Analysing and designing a Vibration Monitoring System must take into account the following:

- Unbalance
- Misalignment
- Bad bearings
- Mechanical looseness
- Hydraulic forces (Cavitation, resonance)
- Rubbing

TYPICAL VIBRATION SENSOR MEASUREMENT POSITIONS: Locating the vibration sensors as indicated in the schematic will be most sensitive and effective in detecting the above faults listed. The sensor orientations are summarised as follows:

1. HORIZONTAL on two motor bearings (A & B) and two pump bearings (C&D). Measures velocity mm/sec (Peak or RMS) to detect unbalance and structural rigidity & foundation problems.
2. VERTICAL on motor & pump drive end bearings (B&C). Measures velocity mm/sec (Peak or RMS) to detect looseness and structural rigidity & foundation problems..
3. AXIAL on motor & pump drive end bearings (B&C). Measures velocity mm/sec (Peak or RMS) to detect misalignment between motor & fan.

VIBRATION DIAGNOSTIC CHART - FAULTS COMMON TO CENTRIFUGAL PUMPS

SN	FAULT	AMPLITUDE	FREQUENCY	PHASE	REMARKS
1	Unbalance	Proportional to unbalance in radial direction	1 x RPM	Single steady reference mark	Most common cause of vibration. Correct by balancing each rotating parts before assembly then after assembly.
2	Misalignment of couplings, bearings or bent shaft	Axial vibration 50% of more of the radial level	1 x RPM common but often x 2 or 3 CPM	Single double or triple reference mark	Best identified by dominant axial vibration. Confirm with phase measurement or dial gauges. If sleeve bearing with no coupling misalignment balance the rotor
3	Antifriction Bearings	Use Spike Energy (gSE), Demodulation, enveloping or g	High frequency 35K to 55K CPM not related to RPM.	Erratic	Sensor proximity to a defective bearing is a clear indicator. External signals like steam leaks and cavitation can give false readings
4	Mechanical Looseness	Often highest in vertical direction	2 x CPM	1 or 2 reference marks depending on frequency. Usually unsteady	Usually accompanied by unbalance and/or misalignment
5	Hydraulic Forces	Erratic or pulsating, use velocity measurement	1 x RPM or number of blades on fan or impellor x RPM	Multiple marks , sometimes erratic or fanning	If vibration increases with capacity then cavitation could be the cause. If noise or vibration decreases then problem is probably recirculation. Resonance is most common problem if distinct frequencies are not equal to those described.
6	Rubbing	Unsteady large erratic increases	1 x RPM or higher frequencies	Multiple marks erratic, watch for abrupt changes	Likely to occur if shaft is bent or bearings are worn, use noise analysis for high frequencies.

IRD Mechanalysis Engineered Solution for on-line vibration protection is shown overleaf:

**Centrifugal Pumps Heavy Duty
Machinery Protection Monitor API670**

**IRD Mechanalysis Ltd
IRDES211**

MONITOR ON-LINE: This IRD Engineered Solution is applied where an API670 Vibration Protection Monitoring System is specified. The IRD8800 monitor is unique in that it can be supplied in smaller racks. This is possible since each module has an individual power supply unit where failure will only lose two channels, not the whole rack. Redundant PSUs are also available. The traditional 19" rack is supplied where multiple machines are to be monitored. The vibration modules are programmable for Velocity Peak or RMS and Displacement Pk-Pk measurements as required. Outputs will be 4-20mA and RS485/MODBUS as well as buffered raw signal for spectrum analysis or Diagnostics On-Line (contact IRD for IRD9900 DOLS). Dual vibration and temperature sensors are available reducing costs and improving bearing detection.



IRD ENGINEERED SOLUTION - BILL OF MATERIALS - (Optional systems see IRDES212 or 213)

The vibration protection system for installations with antifriction bearings on the motor & pump covers 4 sensors at horizontal (unbalance, misalignment, bearings, mechanical looseness & aerodynamic forces) and 1 axial (alignment) directions. The BOM below provides for 5 channels and 1 spare.

SN	DESCRIPTION	QTY	PART NUMBER
1	Sensor Mounting Pad Mild Steel Blackodized for IRD544M(60x60x16mm) with M6 thread d	5	M60015
2	Sensor Inductive Velocity, model IRD544M Classic, On-line measurements, 14-1 KHz, <8% Accuracy, 42.52 mV/mm/s, 260DegC, Class1 Div2 Hazardous Area, AI Enclosure, Note the signal is isolated from the body. Top Exit, Mil 2 Pin Connector. Square base mounting on 4 holes 7.15mm Dia. on 2 x 2 centres, with National Traceable Cal. Cert.	5	M97120
3	Cable Assembly General Purpose, Stainless Steel Conduit flexible 5 mm Dia. ID, for IRD sensors to JB or Transmitter. FRLS Shielded 4mm Dia. 5m length, integral to Mil 2 Pin connector and spade lugs at free end. (For Sensor model IRD533)	5	M62107
4	Junction Box - AI Di-cast, powder coated, IP65 rated for terminating up to 8x Sensors, supplied with glands and fittings (230x200x110mm)	1	M60047
5	Cable Bulk, 6 twisted pair, 0.5 Sq. mm., tinned copper, individual pair shielded and overall shielded, PVC, FRLS, Armoured - Price per metre	TBA	M60096
6	MONITOR MINI RACK, 3 POS, 5U, PCW 198mm. IRD8800 SERIES - API670 Compliant: caters up to 3 Dual Channel modules. Complete with backplane, terminal strips, RS485 'D' connector and panel bezel. Individual rear mounted dual BNC sockets for TWF buffered output per module to optional Diagnostic On-Line System (Refer to IRD9900 DOLS).	1	M88003
7	MONITOR M88200 ABSOLUTE CASE VIBRATION MODULE, IRD8800 SERIES - 2 CHL, VEL INPUT - Dual Channel Bar-Graph with bright LCD and Digital display and Warning, Alarm & Startup LEDs. Complete with individual SMPS 90-270V AC, 50/60Hz, 1Ø.	3	M88200
8	Cabinet / Panel, for VMS, wall mounted, IP55, (H)600mm x (W)800mm x (D)600mm, fully wired for supplied modules.	1	M68701

Taking you Further:

Most online vibration protection systems are limited to measuring only overall vibration levels and hence alarming. It is always beneficial to undertake a FFT frequency analysis from the raw signal at the BNC sockets on the monitor system. IRD Mechanalysis provides consultancy services as well as a range of state of the art diagnostic analysers and meters.

The Vibration People of IRD Mechanalysis can be contacted at the following branches or your local distributor:

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