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# *Vibration Sensors for Cooling Towers*

## Challenges

Cooling towers offer the vibration analyst many challenges in sensor selection, mounting and environmental conditions. The motor is typically out in the open and very easy to access, but almost always the gear box is the failure point. Unfortunately for the analyst, the gear box is normally located above an environmentally hazardous soup bowl and just slightly below a rotational guillotine. Is it any wonder that the motors rarely fail? Technology and safety can prevail with the installation of permanent vibration sensors. This improves the life and reliability of the cooling tower and the vibration analyst!

*Cooling Tower Shaft Driven Gear Box*

## Parts & Pieces

Primarily the cooling tower is designed to provide cooled water through heat transfer using evaporation. They come in many shapes, sizes, and configurations ranging from small single cell units to large multi-cell units. Those towers that employ rotational equipment like motors, belts, gear boxes, and fans all need measurement and analysis of vibrations to improve reliability and extend equipment life. Many cooling towers utilize long drive shafts between the motor and gearbox as pictured, but other configurations could include belt drives or direct drives. The gearbox is used to transfer energy from the motor to the fan at a reduced speed.

## Sensors

Accelerometers are typically placed at key locations on the motor and gear box. Since the gearbox is the load bearing part of the mechanical drive train, accelerometers should be placed on the input and output bearing housings to measure the vibration levels.

*Radial & Axial Sensors on Gear Box Input Bearing Housing*

It doesn't mean that the motor can be neglected, it just means that the gearbox has to be included in the monitoring process. Vibration sensors

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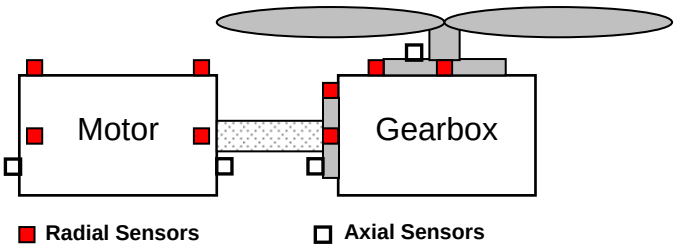
should be placed in the radial and axial locations on the motor and gearbox.



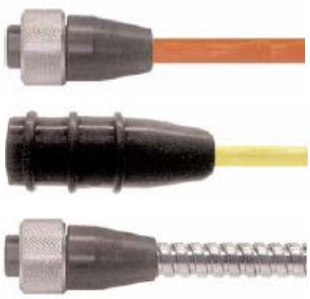

Installing 6 sensors on the motor (4 radial & 2 axial) and 6 sensors on the gearbox (4 radial & 2 axial) would provide maximum coverage. Radial sensors will measure vibration related to imbalance and misalignment, and axial sensors will measure vibration related to misalignment, bearing faults, and gear mesh. Sensors would be placed in similar locations on the motor and gear box for belt drives or the motor for direct drives.

General purpose sensor types AC102 (top exit) or AC104 (side exit) could be used for measuring vibration frequencies greater than 30 CPM (0.5 Hz). Special purpose low frequency sensor types AC135 (top exit) and AC136 (side exit) could be used to measure vibration frequencies greater than 12 CPM (0.2 Hz).


*AC102-1A & AC104-1A Sensors*

**Cables & Connectors**

The environmental surroundings of cooling towers will require connectors rated to IP66. This level of ingress protection against dirt and water is ideal. Using the A2A Mil Style connector, or the B2A seal tight boot will provide a rugged connection to the sensor that is protected from the cooling tower environment. Teflon jacketed cables or armored cable should be used in conjunction with the connectors to form a complete cable connection package.



*A2A Connector with CB102 Cable*

*B2A Connector with CB111 Cable*

*A2A Connector with CB206 Armor Cable*

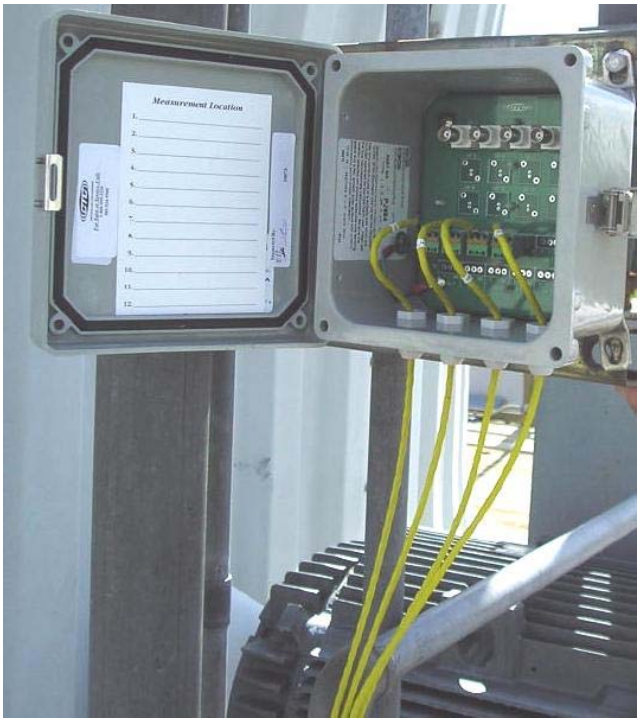
**Mounting Hardware**

The cooling tower environment almost demands stud mounted sensors. Other attachment methods are just not appropriate for this application. Be sure to use a spot facing tool like the MH117-1B to simultaneously drill a hole and machine a flat mounting surface.

*Spot Face, Drill & then Tap for Stud Mounting*

**Junction Boxes**

Having rugged secure connections to the sensor is a necessity. These same thoughts should also be applied to the data collection end of the cables. There are several options available to keep the interface between the sensor cables and data collection dry, clean, and organized. Portable data collection can be easily completed by interfacing with a MAXX Box or with a Switch Box. Both of these options provide convenient connections for the data collector cable. In permanent monitoring, a Switch Box or a Signal management Box can be used. No matter which method is chosen, it will prevent wiring spaghetti and organize your data collection points.




*MX102-4C MAXX Box with 4 Channels Mounted Outside Cooling Tower*

**Frequencies of Interest**

High speed and low speed components in the cooling towers provide a wide range of frequencies that the analyst must measure and analyze. Multiple frequency windows will be needed.

- **Motor** – Running speed and bearing fault frequencies will be of primary interest, but don't forget electrical faults related to the rotor and stator.
- **Drive Shaft & Drive Belts** – Alignment will be the primary concern. Watch for running speed faults with 2x and 3x multiples.
- **Gearbox** – High speed input and low speed output running speeds will need to be measured. High speed and low speed gear mesh will also be present along with bearing fault frequencies.
- **Fan** – Imbalance and blade passing frequencies will be the primary concern. Both can be measured at the output of the gear box with the radial sensors.

**Alarms**

The alarm levels will depend on the fault frequency being measured, and the configuration of the cooling tower. Historical data collection will provide an important baseline for performance comparison. Trending of routine data will indicate shifts in performance and possible faults developing that require detailed analysis.

Typical application guidelines and operating limits for vibration are available from Chapter 10 *"Mechanical Components for Cooling Towers"* of the *"Cooling Tower Manual"*. These limits are based on the structural design and components of the cooling tower.

**Bibliography**

1. *"Cooling Tower Fundamentals"* published by SPX Cooling Technologies edited by John C. Hensley. (http://www.marleyct.com/publications.asp)
2. *Mechanical Components for Cooling Towers"* chapter 10 of the *"Cooling Tower Manual"* published by the Cooling Tower Institute. (www.cti.org)

# *12 Channel Cooling Tower Kit*

| | |
|---|---|
|  | **Multi-Purpose Accelerometer, Top Connector**<br>***AC102-1A*** **Includes ¼-28 stud**<br>*M/AC102-1A* Includes M6x1 adaptor stud<br>Sensitivity +/-10% 100 mV/g<br>Frequency<br>Response +/- 3 dB 30-900,000 CPM (0.5 – 15,000 Hz)<br>Dynamic Range +/- 50 g, peak<br>Temperature Range -50 to 121$^0$C<br>**Quantity in Kit 8** |
|  | **Multi-Purpose Accelerometer, Side Connector**<br>***AC104-1A*** **Includes ¼-28 bolt**<br>*M/AC104-1A* Includes M6x1 adaptor bolt<br>Sensitivity +/-10% 100 mV/g<br>Frequency<br>Response +/- 3 dB 30-600,000 CPM (0.5 – 10,000 Hz)<br>Dynamic Range +/- 50 g, peak<br>Temperature Range -50 to 121$^0$C<br>**Quantity in Kit 4** |
|  | **Twelve Channel Stainless Steel Switch Box**<br>***SB202-12A***<br>Inputs Terminal Block, 3 inputs per channel<br>Output BNC Jack and 2 Pin Mil<br>Enclosure NEMA 4X (IP66)<br>Temperature Range -58 to 82$^0$C<br>**Quantity in Kit 1** |
|  | **Yellow Teflon ® jacketed cable with 2 socket MIL Style connector, 30 ft.**<br>***CB111-A2A-030-Z***<br>**Quantity in Kit 12** |

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