INTRODUCTION

The OIL-SENSE-2 oil quality alert is a sensing device that continuously monitors the condition of the lubricating oil in any centrifugal chiller and provides an alert signal when the overall oil quality deteriorates below an acceptable level. See Fig. 1. The OIL-SENSE-2 device is available exclusively from Carrier Corporation.

The alert condition is annunciated by an amber indicator light and by DIALOG or CCN remote monitoring when those systems are connected to the appropriate OIL-SENSE-2 output terminals. When an alert is signaled, an oil sample should be taken for a quantitative laboratory analysis.

The complete OIL-SENSE-2 device includes, within a single unit, the sensor assembly, power conversion components, signal conditioning circuit board, oil line and electrical connections, status lights, and test and reset switches. The unit is mounted on the chiller near the oil system and is connected to the compressor oil supply tubing. A small amount of bypass oil continuously flows from the chiller oil pump, through the unit's oil quality sensor assembly, and back to the chiller oil reservoir. Electrical wiring is connected to the chiller control circuit for the power supply, and also to remote monitoring terminals when optional DIALOG, CCN, or remote annunciation is used.

The unique sensing method measures the transmittance of regulated light through the oil. As the oil flows through a sight glass assembly and past the light source, the light is passed through the oil. A special detector located opposite the light source creates an output voltage in proportion to the amount of light reaching the surface of the detector.

The amount of regulated light absorbed by the oil is governed by its quality, and is directly related to inhibitor depletion, thermal breakdown, corrosion, wear, hydrolysis, water content, etc.

INSTALLATION

The OIL-SENSE-2 device may be used to monitor the quality of the lubricating oil in any model of centrifugal chiller, from any manufacturer. Therefore, the mounting location and method, the oil line connection fittings, and the wiring source connections must be specifically selected for the particular chiller and monitoring method being used. Following are guidelines for field requirements and installation. Refer to Fig. 2.

Field-Supplied Material Requirements

- Mounting plate, bracket, or channels, as required, for mounting the sensor unit near the oil system, with a bolt hole pattern of 61/2-in. vertical center line separation and 101/4-in. horizontal center line separation.
- Four 1/4-in. bolts, lockwashers, and nuts for mounting the unit.
- 1/4-in. OD copper tubing to connect between the chiller oil supply line and the sensor unit, and back to the chiller oil return line.
- Solder tee fitting to connect into oil supply line (typically 3/8 in.).
- Solder tee fitting to connect into oil return line (typically 1/2 in.).
- Two shut-off valves (may be either straight or angle as appropriate), 1/2-in. male NPT x 1/2-in. male flare. Shut-off valves must have removable handles that will be removed after valves have been opened and set to adjust flow at start-up.
Miscellaneous bushings to connect the valves to the solder tee fittings and 2 flare nuts to connect the tubing to the valves. The oil sensor unit is supplied with its own 1/4-in. flare tubing connections.

- 18-gage wire with 115-v insulation.
- Wire connectors for screw terminals.
- 1/2-in. conduit with end connectors.

**Sensor Unit Mounting** — Select a location to mount the box securely on the chiller (preferably close to the lubricating system to minimize the length of the connecting sensor bypass oil lines). Make sure space is provided on the sides of the box for the sensor bypass oil lines and wiring conduit connections. See Fig. 2. Mount the box low enough to ensure that status lights on the front of the unit are easily visible and to provide access to the TEST and RESET switches. See Fig. 1. Provide clearance in front of the box so that the cover can be opened and the internal components easily accessed. Be sure that sensor unit does not block or interfere with the adjustment, clearance or visibility of any other chiller controls or serviceable components. Mount the box with the side flanges running vertically (cover facing forward).

Overall box size, including side mounting flanges is 12 in. x 8 3/4 in. x 3 inches. The mounting plate or brackets may be either welded or bolted to the chiller, but the box itself should be bolted to its mounting to allow subsequent removal, if necessary.

**Oil Line Connections** — See Fig. 1 and 2. Remove the refrigerant and lube oil before installing the sensor bypass oil lines. Cut both the oil supply line (above the oil pump discharge) and the oil return line, and solder in the tee fittings. Connect the shut-off valves to the tee fittings with appropriate bushings. Run and secure 1/4-in. OD copper tubing from the oil supply line valve (high-pressure side) to the inlet oil supply line connector on the sensor unit, and from the outlet oil return line connector on the sensor unit back to the oil return line valve (low-pressure side). To ensure upward oil flow through the sensor unit, the inlet oil supply line must go to the bottom connection and the outlet oil return line from the top connection. Leak test the new oil lines and fittings when the installation has been completed. The shut-off valves should remain closed until the OIL-SENSE®-2 unit is started.

![OIL-SENSE-2 Wiring Connections](image-url)
Electrical Wiring Connections — The basic wiring consists of two sets of 115-v power supply connections to be run in a single conduit between the oil sensor box and the chiller control cabinet. See Fig. 2 and 3. One set is for the oil quality sensor circuitry and the alert relay and light. It allows an alert signal to remain latched when the chiller is shut down, as long as the chiller control circuit remains powered. The other set of power supply connections ensures that an alert signal can be generated only when the oil pump is operating. With shared neutral and ground connections, this normally will require 4 wires.

When DIALOG® monitoring or annunciation away from the chiller is used, two additional 115-v wires are run in the same conduit to the control panel and then to the remote location. When remote monitoring with an analog source signal is used, the low-voltage wiring should be run in a separate conduit to keep the low-voltage and line-voltage wiring separate.

⚠️ DANGER

The NEC (National Electrical Code) requires that the 115-v line voltage wiring should be separated from the low-voltage wiring or circuit boards at all times. To avoid the chance of a shock hazard from 115-v line voltage leakage to low-voltage wiring with less protective insulation, no contact should occur. Therefore, the 115-v line voltage power wiring and DIALOG wiring, if used, must be connected through the conduit hole on the right side of the box, and the wires connected directly from there to the adjacent line voltage terminals. Low-voltage wiring, if used, must be connected only through the wiring hole on the left side of the box.

⚠️ CAUTION

Before beginning any installation work, ensure that all electrical power is disconnected from the chiller control circuit and any other electrical connections. Tag all open disconnect switches. All work should be done by qualified personnel in conformance to applicable local and national codes.

Use 18-gage wire in thinline or flex conduit, in accordance with NEC and local codes. When finished, visually check and verify the wiring to be sure all wires are firmly secured and connected to the correct terminals, with the correct voltage, before power is applied to the oil sensor unit.

NOTE: The following wiring connections are correct only for the OIL-SENSE®-2 units. They are the reverse of the connections required for the original OIL-SENSE units.

POWER SUPPLY WIRING CONNECTIONS

Continuous power to the sensor circuits, latching alert switch, and light:

- From “RUN PWR L1” to chiller control circuit power (L1) terminal.
- From “RUN PWR L2” to chiller control circuit neutral (L2) terminal.
- From “RUN PWR GND” to chiller control circuit ground connection.

AND

Power to the alert circuit only when the oil pump is running:

- From “ALERT PWR L1” to chiller oil pump control (if 115 v control voltage is used, connect it to the oil pump relay. If 115 v control voltage is not used, add a relay so that the coil voltage matches the control voltage. The relay should be used to connect the 115 v power source to the circuit board.)
- Jumper “ALERT PWR L2” to “RUN PWR L2” (or run to chiller neutral).
- Jumper “ALERT PWR GND” to “RUN PWR GND” (or run to chiller ground).

OPTIONAL REMOTE MONITORING WIRING CONNECTIONS, WHEN USED

Dialog, or separate alert indicator, 115 v to selected slave point:

- Jumper “DISCRETE” in switch to “RUN PWR L1” for 115 v switch power.
- From “DISCRETE” out switch to DIALOG “+”, or indicator “+” terminal.
- From DIALOG “-”, or indicator neutral, to chiller neutral.

OR

CCN (Carrier Comfort Network) ON/OFF, self-powered low voltage alert signal to selected point:

- From “DISCRETE” in switch to CCN discrete “+” terminal.
- From “DISCRETE” out switch to CCN discrete “-” terminal.

OR

CCN FID 4 to 20 mA current analog signal to selected point:

- Set up and wire point for externally powered (4 wire) input.
- From “4 to 20 +” terminal to FID “+” input signal terminal.
- From “4 to 20 -” terminal to FID “-” input signal terminal.

OR

CCN SCM 0 to 5 vdc analog signal to selected point:

- From “0 to 5 vdc SIG” terminal to CCN “+” signal terminal.
- From “0 to 5 vdc GND” terminal to CCN “-” ground terminal.

Fig. 3 — OIL-SENSE-2 Circuit Board
REMOTE MONITORING APPLICATION

DIALOG® Monitoring (Optional) — When DIALOG monitoring is used for remote ON/OFF reporting of an oil quality alert condition, select an unused DIALOG point for that chiller. Connect the wiring from the oil sensor unit DISCRETE switch terminals to the DIALOG slave and master point terminals as shown in the Electrical Wiring Connections section on page 3. Verify that the voltage selection jumper for that point is on 115 v.

Configure the DIALOG point as:
- Decision 100 — point number
- Decision 103 — code 1 (ALERT)
- Decision 108 — code 0, for an alert with the presence of power when the alert switch closes

NOTE: The oil sensor signal circuitry performs the RUN mode dependency, start inhibit time delay, and ALERT signal redundancy verification, so these functions do not have to be configured in the DIALOG set-up.

To ensure that the correct point identification appears on data reports for the chiller site, the following information must be forwarded to the National Monitoring Center: the remote ID number and name for the site; the point number; the point application code G48 (for “Poor Oil Quality”) and type 01 (for Alert). The equipment number, if available, should also be provided.

CCN Discrete Signal Monitoring (Optional) — An oil quality alert condition can be reported by CCN by using the DISCRETE (ON/OFF) signal as shown in the DIALOG Monitoring section above. This is easier to set up than for analog monitoring, but does not provide the actual oil quality values and history. For DISCRETE CCN monitoring, select an unused input point and connect two wires from the DISCRETE input terminals on the CCN element to both sides of the normally open DISCRETE alert switch in the OIL-SENSE®-2 unit. These will be low-voltage wires, so they should not be placed in the line voltage wiring conduit to the oil sensor unit. Configure the point as an alert with the presence of power (when the ALERT switch closes) and give it an appropriate point name for Building Supervisor message and report identification. Set up the point for normal alert and history reporting to a selected Carrier Building Supervisor computer.

CCN Analog Signal Monitoring (Optional) — See Fig. 3. For reporting CCN analog values, the 4 to 20 mA signal must be used for FID input points, but the 0 to 5 vdc signal can be used with an SCM. For either type, run two wires from the CCN input terminals to the appropriate SIG and GND, or ‘+’ and ‘-’ terminals in the oil sensor unit, per the previous wiring instructions for the two signal types. These will be low voltage wires so they should not be placed in the line voltage wiring conduit to the oil sensor unit. For the alert status limit settings, configure the point to be an alert state when the signal falls below a value of 4.0 v or 17 mA, with a 4 percent hysteresis. Set up the point for normal alert and history reporting to a Carrier Building Supervisor.

On-Site Remote Alert Annunciation (Optional) — A separate 115 vac ALERT light or bell can be used to announce a poor oil condition at a location away from the chiller by wiring the ALERT light or bell to the DISCRETE switch terminals, as described in the DIALOG Monitoring section. A silence switch also should be included because OIL-SENSE-2 will latch an alert condition until it is cleared with the OIL-SENSE-2 RESET switch (after the oil quality has returned to an acceptable level).

START-UP AND CHECKOUT

Pre-Start Verification — Before the oil sensor unit is started, visually check the wiring to be sure all wires are securely fastened and connected to the correct terminals with the correct voltage. Also verify that the oil lines are correctly connected and have been leak tested. Make sure the isolation valves are closed. The green RUN light and the sensor circuit will be energized whenever the chiller control circuit is energized. The ALERT indication will latch in only while the oil pump is running.

Oil Flow — When the oil pump is running, fully open the inlet side oil valve. See Fig. 2. Slowly crack open the return side oil valve until a slight oil pressure decrease is noticed. Then reclose the valve slightly until the oil pressure goes back to normal. DO NOT CLOSE THIS VALVE COMPLETELY. This will ensure some bypass flow through the oil sensor without significantly reducing the oil flow to the bearings. With the oil flow set, remove both oil valve handles and install the valve stem caps to prevent tampering. Verify that oil is flowing through the OIL-SENSE-2 device. When oil is flowing, the oil bypass line connected to the OIL-SENSE-2 device will feel warm.

Calibration and Sensing Checks — The oil quality sensor unit is factory calibrated and, normally, does not require field adjustment. However, its operation should be checked at start-up to be sure there has been no shipping or installation damage. With the oil pump running, conduct the following operating checks:

POWER ON — The oil sensor circuit should be powered, as shown by the green RUN light on the front of the sensor unit.

ANALOG OUTPUT SIGNAL AND OIL QUALITY CALIBRATION — While the green RUN light is on, a dc voltmeter connected to the 0 to 5.0 vdc SIG and GND terminals will show the relative oil quality as determined by the amount of transmitted sensor light. See Fig. 3. The vdc measurement is also used to check and adjust the calibration set point.

When the oil flow block and sensor assembly is in the closed position, the unit is factory calibrated to 2.0 vdc for new oil quality. See Fig. 1. The 2.0 vdc measurement may vary slightly (± 0.2 vdc) for different types of oil. The 2.0 vdc value will decrease as the quality of the oil decreases.

For calibration checks and adjustments with either no oil or an unknown oil quality in the oil flow block, an oil quality measurement must be calibrated with the oil flow block and sensor assembly in the open position. To reach the open position, remove the locking screw on the oil flow block and rotate the sensor assembly 90 degrees to the left, away from the sight glass. See Fig. 4. The pivoting screw should be just tight enough to keep the sensor assembly in the 90 degree open position.

In the open position, the sensor light passes through air only, using air as the calibration standard. Since light transmittance through air is different that light transmittance through oil and two sight glasses, a lower vdc measurement of 4.3 vdc is used. The open position new oil quality set point of 4.3 vdc is equivalent to the closed position set point of 5.0 ± 0.2 vdc. When taking a reading, place cloth over the sensor assembly so that external light is excluded.

Unless there is a problem and the measured calibration (sensor assembly in open position) is off by more than 0.1 vdc, no adjustment is needed.
If an adjustment is required, use a small screwdriver to reposition the GAIN potentiometer (on top of the circuit board) until the voltmeter on SIG and GND reads 4.3 vdc.

Return the sensor assembly back to the closed position and replace the locking screw.

![Image of OIL-SENSE®-2 in Calibration Position]

**Alert Threshold Calibration** — The low voltage limit setting to create an alert signal can be checked at the TP2 meter test point (located at the top of the circuit board) and ground. It is factory set at 4.0 vdc. See Fig. 3.

**Test Switch** — To test the operation of the sensor circuitry with its alert light and switch when the light is off, press the TEST switch on the front cover for 5 seconds. Wait for the amber LED (light-emitting diode) to light and the DISCRETE switch to close. See Fig. 1.

If optional DIALOG® monitoring is being used, turn the mode key switch to INSPECT/TEST during this check.

**Reset Switch** — When an alert condition has been triggered, whether by the test switch or poor oil, the amber light and DISCRETE switch will remain latched until cleared by momentarily pressing the RESET switch, located on the front cover, after the sensor has seen a good oil condition.

See Fig. 1. Return the DIALOG mode key switch to NORMAL when the test alert has been cleared.

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**Operation and Maintenance**

**Poor Oil Quality Alert** — OIL-SENSE®-2 unit automatically and continuously monitors the overall quality of the chiller lubricating oil while the chiller is running. When the oil becomes contaminated or degraded below an acceptable level and the condition is verified by measurements taken continuously for 10 minutes, an alert status is annunciated by lighting the amber ANALYZE OIL SAMPLE light on the oil sensor unit and by closing a DISCRETE ON/OFF switch for remote monitoring. The alert state will then remain latched (even when the chiller stops operating) until it is cleared either by pressing the RESET switch on top of the oil sensor unit or by an interruption of power to the chiller control circuit. When the RESET switch is pressed, the alert light will remain on if the oil condition is still poor or clear if the oil condition is acceptable.

**Oil Analysis** — When a poor oil condition is indicated by the amber ANALYZE OIL SAMPLE light or by a remote monitoring alert, an oil sample should be taken for a normal, quantitative laboratory analysis. The oil sensor monitors the overall oil condition for the effects of inhibitor depletion, thermal breakdown, corrosion, wear, hydrolysis, water, etc., but it does not show the specific type or cause of deterioration. One of the primary advantages of continuous oil quality monitoring is that poor oil quality can be recognized immediately. It is no longer necessary to wait for a scheduled laboratory analysis to detect poor oil quality. It also provides early detection of a potentially damaging chiller condition, such as a water leak, that affects the oil quality.

If an oil sample appears to have good color and to be satisfactory, even though the oil sensor has indicated a poor oil condition, check the oil sensor operation with the procedures described in the following Performance Checks section on page 6. Failure of the sensor will generate a low measurement voltage, indicating very poor oil quality. While a failure of these components would be unusual, it is preferable to have a sensor failure identified by a false alert than to have no indication of a failure and to miss a poor oil condition.

**Service Visits** — At each visit to the job site, the service technician should check the status of the amber ANALYZE OIL SAMPLE light on the sensor unit. If the light is on, an oil sample should be taken for laboratory analysis. If not, the TEST switch should be pressed for 5 seconds while the oil pump is operating to verify the sensor and circuit operation. The green RUN light should be on when the chiller control circuit is powered. When the amber light is on, the RESET switch should be pressed to clear the alert state if the oil quality is acceptable. Verify that oil is flowing through the OIL-SENSE®-2 device. When oil is flowing, the oil bypass line connected to the OIL-SENSE®-2 device will feel warm.
Performance Checks — Other than the routine status checks to be done at service visits, these performance checks would usually be done only if there was some indication of a problem.

GREEN RUN LIGHT — This light should be on whenever the chiller control circuit is powered. It indicates when the oil sensor and analyzer circuitry are powered. If the RUN LED (light-emitting diode) is off while there is a dc voltage, the LED is not functioning properly.

OIL FLOW — Temporarily remove the caps on the bypass line isolation valves to check the valve positions. The inlet oil supply line valve (high-pressure side) should be wide open. The outlet oil return line valve (low-pressure side) should be partly open. To check the return line setting, close the valve, and slowly crack it open until a slight oil pressure decrease is noted. Then, reclose the valve slightly until the oil pressure goes back to normal. DO NOT CLOSE THIS VALVE COMPLETELY.

Verify that oil is flowing through the OIL-SENSE®-2 device. When oil is flowing, the oil bypass line connected to the OIL-SENSE®-2 device will feel warm.

SENSOR AND CALIBRATION CHECK — The sensor output and its related conditioning can be checked by using the procedure explained in the Analog Output Signal and Oil Quality Calibration section on page 4. If the vdc measurement is acceptable, no adjustment is required. However, if the measured calibration is off by more than 0.1 vdc, recalibration adjustments must be made. See Analog Output Signal and Oil Quality Calibration section on page 4 for adjustment instructions.

A very low voltage reading when the oil quality is not extraordinarily poor reveals a malfunction or improper connection. See Table 1 for specific information.

ALERT THRESHOLD — See Fig. 3. The voltage setting for the alert signal can be measured with a voltmeter connected to the circuit board test points, TP2 (top of the board) and ground, while the RUN light is on. The alert should be about 4.0 vdc with a drop in voltage (deteriorating oil quality). Unless there is a problem and the voltage is off by more than 0.1 volts, no adjustment is needed. If an adjustment is needed, use a small screwdriver to reposition the T-HOLD potentiometer until it reads 4.0 vdc.

TEST SWITCH — The sensor unit TEST switch artificially simulates a poor oil condition to verify the operation of the signal conditioning circuit, the signal latching, the DISCRETE switch, and the amber ANALYZE OIL SAMPLE light. To conduct this test, press the TEST switch for approximately 5 seconds when the RUN light is on. Verify that the alert light comes on, and that the DISCRETE switch closes. If the amber alert LED (light-emitting diode) does not light when the DISCRETE switch closes, the LED, its connections, and/or the circuitry are not functioning properly.

RESET SWITCH — When the alert condition has been triggered, whether by the TEST switch or poor oil quality, the amber light and the DISCRETE switch will remain latched until cleared by momentarily pressing the RESET switch or by a power interruption, if the oil quality is sensed as acceptable. It will not clear while the analyzer continues to sense poor oil. To clear an alert condition following the use of the TEST switch, press the RESET switch.

Maintenance and Repairs — No scheduled maintenance is required. No attempt should be made in the field to repair the circuit board or sensor block assembly. Replacement switches, indicator lights, and the sensor and light assembly can be ordered from the OIL-SENSE®-2 distribution source. For other problems, return the complete unit to the distribution source for analysis and repair.

REPLACEMENT PARTS

Complete OIL-SENSE®-2 unit — 327-4400504-2

Light/Switch Kit, includes:
2 — Switches (Test and Reset)
1 — "RUN" LED
1 — "ANALYZE OIL SAMPLE" LED

Light and Sensor Assembly
Circuit Board Assembly
<table>
<thead>
<tr>
<th>PROBLEM/SYMPTON</th>
<th>POSSIBLE CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>No DC output signal — RUN light off.</td>
<td>Chiller control circuit not powered on.</td>
</tr>
<tr>
<td></td>
<td>Open wiring connection to RUN POWER.</td>
</tr>
<tr>
<td></td>
<td>Transformer on circuit board not functioning properly.</td>
</tr>
<tr>
<td>No DC output signal — RUN light on.</td>
<td>Sensor assembly malfunction.</td>
</tr>
<tr>
<td></td>
<td>Circuit board malfunction.</td>
</tr>
<tr>
<td></td>
<td>Sensor wires not connected properly.</td>
</tr>
<tr>
<td>No sensor light with RUN light on.</td>
<td>Sensor wires not connected properly.</td>
</tr>
<tr>
<td>(sensor assembly rotated to open position)</td>
<td>Sensor LED light source failed.</td>
</tr>
<tr>
<td></td>
<td>Malfunctioning circuit board.</td>
</tr>
<tr>
<td>Low DC signal voltage with good oil.</td>
<td>Sensor wires not connected properly.</td>
</tr>
<tr>
<td></td>
<td>Detector or sensor LED light source failed.</td>
</tr>
<tr>
<td></td>
<td>Sensor LED and detector are not locked into the closed position.</td>
</tr>
<tr>
<td></td>
<td>Extremely dirty sight glass.</td>
</tr>
<tr>
<td></td>
<td>Malfunctioning circuit board.</td>
</tr>
<tr>
<td></td>
<td>Gain set point out of calibration.</td>
</tr>
<tr>
<td>No alert light with manual test switch</td>
<td>Did not press switch for 8 seconds.</td>
</tr>
<tr>
<td>(DISCRETE switch also does not close)</td>
<td>Chiller control circuit power off (RUN light off).</td>
</tr>
<tr>
<td></td>
<td>Open wiring connection to ALERT POWER.</td>
</tr>
<tr>
<td></td>
<td>Oil pump off.</td>
</tr>
<tr>
<td></td>
<td>Malfunctioning circuit board.</td>
</tr>
<tr>
<td>No alert light with manual test switch</td>
<td>Alert LED not functioning.</td>
</tr>
<tr>
<td>(DISCRETE switch does close)</td>
<td>Indicator wires are not connected properly.</td>
</tr>
<tr>
<td>Alert state will not clear with RESET.</td>
<td>Oil quality still poor.</td>
</tr>
<tr>
<td></td>
<td>Malfunctioning circuit board.</td>
</tr>
<tr>
<td>No oil flow through OIL-SENSE®-2 unit (</td>
<td>Oil pump off.</td>
</tr>
<tr>
<td>bypass lines not warm)</td>
<td>Bypass line isolation valve closed.</td>
</tr>
</tbody>
</table>

**LEGEND**

LED — Light-Emitting Diode
<table>
<thead>
<tr>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of Tables</td>
</tr>
<tr>
<td>List of Figures</td>
</tr>
<tr>
<td>Introduction</td>
</tr>
<tr>
<td>Installation</td>
</tr>
<tr>
<td>Field-Supplied Material Requirements</td>
</tr>
<tr>
<td>Sensor Unit Mounting</td>
</tr>
<tr>
<td>Oil Line Connections</td>
</tr>
<tr>
<td>Electric Wiring Connections</td>
</tr>
<tr>
<td>Remote Monitoring Application</td>
</tr>
<tr>
<td>DIALOG® Monitoring</td>
</tr>
<tr>
<td>CCN Discrete Signal Monitoring</td>
</tr>
<tr>
<td>CCN Analog Signal Monitoring</td>
</tr>
<tr>
<td>On-Site Remote Alert Annunciation</td>
</tr>
</tbody>
</table>
Start-Up and Checkout
  Pre-Start Verification
  Oil Flow
  Calibration and Sensing Checks

Operation and Maintenance
  Poor Oil Quality Alert
  Oil Analysis
  Service Visits
  Performance Checks
  Maintenance and Repairs
List of Tables

Table 1 — Troubleshooting
List of Figures

Figure 1 — OIL-SENSE-2 Unit
Figure 2 — OIL-SENSE-2 Wiring Connections
Figure 3 — OIL-SENSE-2 Circuit Board
Figure 4 — OIL-SENSE®-2 in Calibration Position