Overview

The CAT-1™ Dynamic Line Rating System monitors the mechanical tension of an overhead transmission line conductor. Because the tension of a line section between dead-end structures can be directly related to average conductor temperature, the CAT-1 system – utilized with IntelliCAT™ for Windows (ICW) Real-Time Rating Software – can calculate line ratings and ruling span sags, along with tracking trends in ratings and load to provide advance warning of impending clearance violations.

The current design is the fourth generation ("Series 4") of CAT-1 systems. Since first being introduced in 1991, over 500 CAT-1 systems have been installed worldwide. The robust design has performed reliably in extreme hot and cold climates. The enhancements of Series 4 have further hardened CAT-1 systems to survive in the high-voltage transmission line environment, including a very high – independent laboratory-tested – resistance to lightning strikes.

Table 1: System components

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<th>Component</th>
<th>Load cells</th>
<th>Net Radiation Sensors</th>
<th>CAT-1 Remote Monitor</th>
<th>Yagi antenna</th>
<th>CATMaster Base Station</th>
<th>ICW server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
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<tr>
<td>Location</td>
<td>Tower/Pole</td>
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<td>Tower/Pole</td>
<td>Tower/Pole</td>
<td>Substation</td>
<td>Control center</td>
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</table>

Major components

The major components of the CAT-1 system are shown in Table 1.

- Custom-designed **load cells** measure the mechanical tension of the overhead conductor. In most applications, two (2) load cells are installed at a dead-end structure, each measuring a different line section. Load cells are mounted between the structure and the insulator, on the de-energized side of the insulator. Standard load cell ratings (measurement ranges) are from zero to 2500, 5000, 10000, 25000, and 50000 pounds (11.1, 22.2, 44.5, 111.2, 222.4 kN).

- **Net Radiation Sensors** (NRS) provide a proxy of the conductor temperature if the line were de-energized, an important component of simplified, accurate rating calculations; by using the NRS, no individual weather parameters need to be monitored. Mounted near the actual conductor, and aligned in the same direction, the NRS closely approximates the same emissivity, absorptivity, thermal mass, and time constant of the conductor; it experiences the same ambient temperature, solar heating, wind speed and
wind direction as the conductor, if it experienced zero current.

- **CAT-1 Remote Monitor** equipment consists of one or two weatherproof aluminum NEMA 4X enclosures installed at a dead-end structure. The **CAT-1 Main Unit** includes the main processor and communications equipment (typically spread spectrum radio, cellular, or fiber modem). The **CAT-PAC Power Module** provides power supply to the CAT-1 Main Unit for real-time rating applications; it includes two (2) 20W solar panels, two (2) high-temperature, sealed, lead-acid batteries, and a temperature-compensating solar-charging unit. The CAT-PAC module provides enough power to keep a typical system operational for three (3) weeks without any solar input.

- An **ambient temperature sensor** (not shown) is housed inside an aspirated shield and mounted on the CAT-1 Main Unit. The difference between the readings of NRS and ambient temperature sensor is the solar gain.

- 50-foot or 100-foot (15-meter or 30-meter) ½-inch low-loss Heliax jumper cables connect the CAT-1 Main Unit to a 10dB **Yagi antenna** in spread spectrum radio applications. The antenna must be within line-of-sight of the receiving antenna; otherwise, a Repeater can be utilized to complete the communications link between the locations.

- In real-time rating applications, tension and temperature data are transmitted to a **CATMaster™ Base Station** located at a nearby substation; the data is passed along to the EMS/SCADA system using existing RTU communication channels. The CATMaster Base Station can receive data from up to four (4) CAT-1 Remote Monitors; it provides translation to the customer’s protocol.

- **IntelliCAT™ for Windows Real-Time Rating Software** (ICW) calculates Dynamic Line Ratings (DLR) based on inputs from CAT-1 systems along with line loading information from the utility.

### Applications

- **Dynamic Line Rating (DLR)**, typically provides 15-30% more capacity 95%+ of the time
  - Better operating decisions
  - Postponing construction
  - Avoiding unnecessary contingency actions
  - Fastest transmission solution for accommodating new generation

- **Ice monitoring**
- **Annealing monitoring**
- **High-temperature creep monitoring**
- **Wind load monitoring**
- **Studies of advanced conductors**