CATALYST MEETS THE ECONOMIZER FDD REQUIREMENTS IN TITLE-24

Since 2013, the CATALYST Advanced Rooftop-unit (RTU) Controls solution – or "ARC" – meets the Fault Detection & Diagnostic (FDD) requirements for Economizers in California's Title-24 standards. California adopted these requirements based on studies that found the majority of RTU economizers – 64% according to one independent assessment[1] - were not operating properly. An unfortunate reality, broken economizers will increase summer utility bills by 20-30%[2]. The Table below walks through how the CATALYST meets each of these requirements.

Subsection 120.2(i)	How the CATALYST meets each subsection
1. The following temperature sensors shall be permanently installed to monitor system operation: outside air, supply air, and when required for differential economizer operation, a return air sensor.	The CATALYST installs and monitors real-time an outside air, supply air and return air temperature sensor. For customers that need humidity control (ie supermarkets), outdoor air dewpoint is installed and monitored to enforce a dew-point lockout.
2. Temperature sensors shall have an accuracy of ±2°F over the range of 40°F to 80°F.	All CATALYST temperature sensors have a +/- 0.36°F accuracy. The outside air dew-point is calculated based on the temperature and relative humidity (RH) sensors. The RH sensor is +/-3% which translates to a +/- 2.5°F dew-point accuracy.
3. The controller shall have the capability of displaying the value of each sensor.	Figure 1 below shows how the eIQ platform displays the real-time operation of each unit. Figure 2 shows the eIQ dashboard of each unit's economizer health.
4. The controller shall provide system status by indicating the following conditions: • Free cooling available • Economizer enabled • Compressor enabled • Heating enabled, if the system is capable • Mixed air low limit cycle active	Figure 1 displays the unit's current operation including fan speed since the CATALYST adds a VFD to the supply fan, economizer status and mode (heating, cooling, economizing or ventilating). Figure 2 provides a more detailed view of the economizer health, clearly indicating if there is an issue.
5. The unit controller shall manually initiate each operating mode so that the operation of compressors, economizers, fans, and heating systems can be independently tested and verified.	The CATALYST can be overridden into any operational mode over the internet through the eIQ platform. A technician can override while onsite using the CATALYST's Service Switch which is described below.
6. Faults shall be reported in one of the following ways: A. Reported to an Energy Management Control System regularly monitored by facility personnel B. Annunciated locally on one or more zone thermostats, or a device within five (5) feet of zone thermostat(s) **C.** Reported to a fault management application which automatically provides notification of the fault to remote HVAC service provider.	The eIQ platform meets requirement 6A by displaying economizer faults real-time on each unit's economizer health dashboard (Figure 2). The eIQ platform also meets requirement 6C. When an economizer fault occurs, an email is sent out with a description of the fault, time it occurred and a link to a trouble shooting page as shown in Figure 3 below.
7. The FDD system shall detect the following faults: A. Air temperature sensor failure/fault; B. Not economizing when it should; C. Economizing when it should not; D. Damper not modulating; and E. Excess outdoor air.	The eIQ platform's economizer health dashboard for each unit clearly indicates any existing faults (Figure 2). The CATALYST also goes beyond the Title-24 requirements. If the economizer has not been used in awhile, an automatic diagnostic check is done to identify if the damper is not modulating properly or excess air is being brought in.

[1] Cowan, Alan. *Review of Recent Commercial Roof Top Unit Field Studies in the Pacific Northwest and California*. New Buildings Institute. Oct 2004.

[2] Heinemeier, Kristin. *Free Cooling: At What Cost.* UC Davis. 2014 ACEEE publication.

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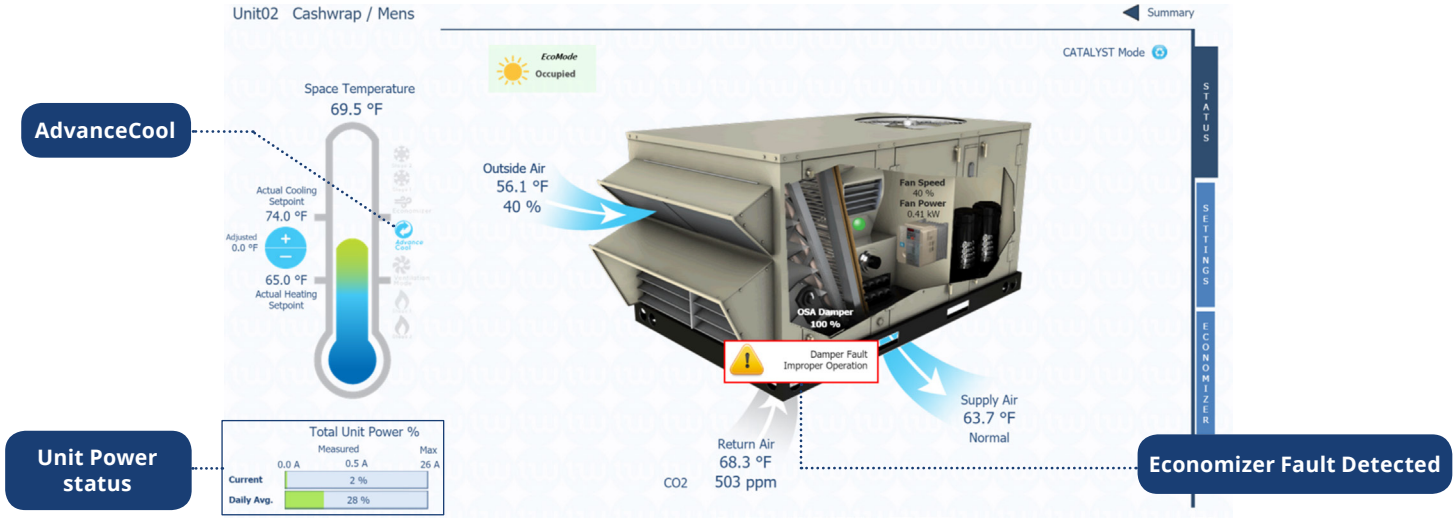

Figure 1. Real-Time Operation Dashboard

Figure 1 shows the display of each unit's real-time operation. Our example here looks at Unit 02 serving the sales floor and checkout of a California clothing retailer. This dashboard is the first to pop-up when looking at an individual unit on the eIQ Platform. The status of Unit 02 exemplifies how the CATALYST goes beyond Title-24. In addition to showing the current mode – cooling, heating, ventilating or economizing per subsection 102.2 (i) 4 – the CATALYST is enabling its patented AdvanceCool logic. It recognizes that the space is slowly warming up and therefore has a cooling disposition. Consequently, the CATALYST economizes early, even before the space temperature (currently 69.5°F) has reached the cooling setpoint (74°F).

Another way to think of AdvanceCool is predictive economizing. Cool outdoor air, particularly in the morning, is utilized to delay that initial compressor stage to later in the day, or on a mild day no compressors are needed at all. The "Total Unit Power %" in the lower left corner shows that Unit 02's current power draw is minimal for two reasons. First and foremost, the CATALYST is using 'free cooling' in lieu of compressors. Second, the CATALYST is still harvesting fan energy savings by keeping the fan speed at 40%, trickling in the cool outdoor air to keep the space comfortable.

Yet there is something wrong with unit 04's economizer, indicated by the 'damper fault' box. eIQ users can then dive deeper in the economizer health looking at the dashboard in Figure 2 below. Each RTU has its own economizer health page, clearly indicating when its economizer is not functioning properly.

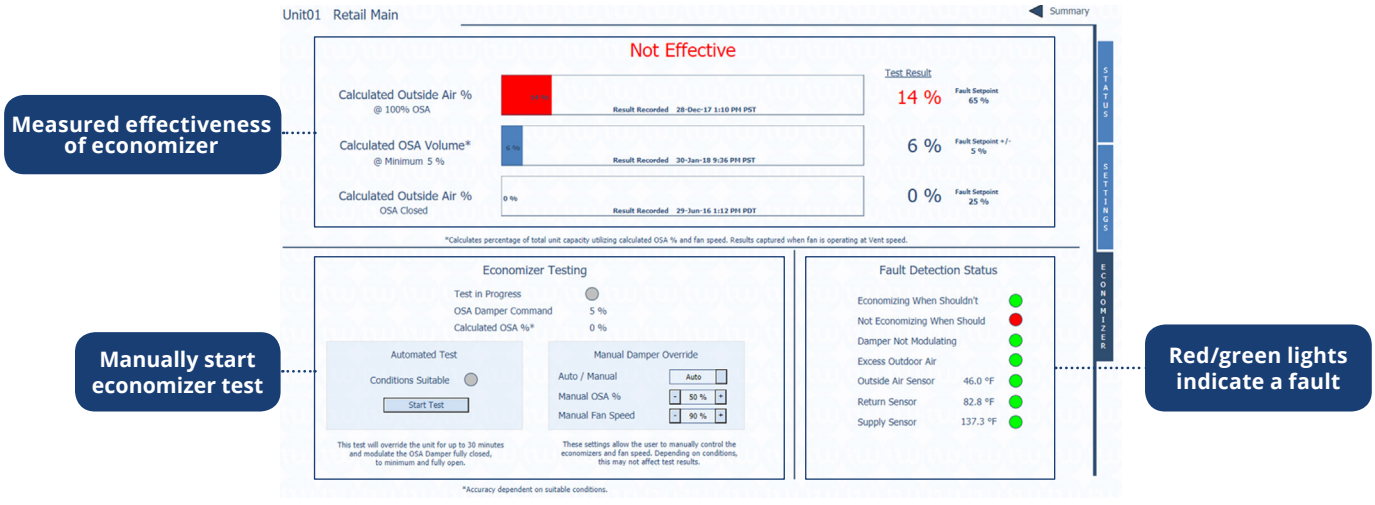

Figure 2. Economizer Health Dashboard

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In Figure 2's example, unit 01 that serves the main sales floor of a California Supermarket is unable to economize. On Dec 28, the CATALYST automatically tested the economizer, fully opening the damper and using the temperature sensors (supply, return, outdoor) to measure the economizer's effectiveness. When fully open, at least 65% of the air moving through the unit should be outdoor air, the rest being return air. This unit is only showing 14%. The fault is flagged in red, quantifying the measured effectiveness along with a red light next to 'Not Economizing When Should'. As soon as this fault occurred, the eIQ Platform automatically sends an email notification to the correct stakeholder. These are usually the building manager themselves and/or the HVAC service provider. Beyond indicating the site and unit number with the fault, the email also contains a link to a troubleshooting page (shown below) that quickly walks through the Fault Description, Possible Causes and Trouble Shooting tips.

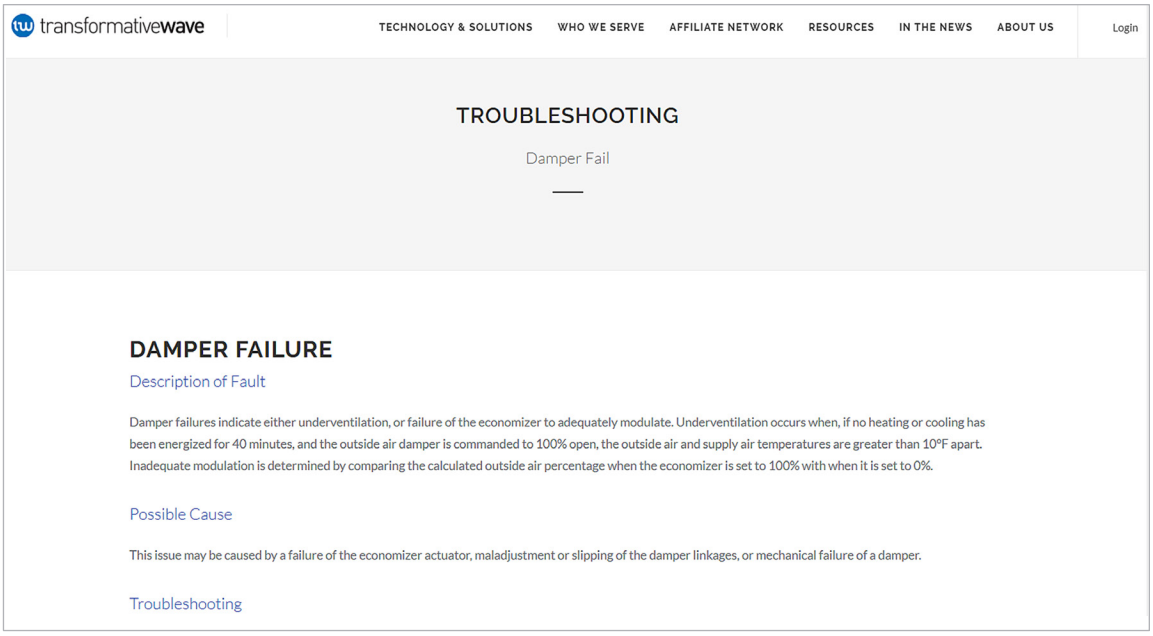

Figure 3. Troubleshooting Pages for Each Type of Fault

To avoid unnecessary truck rolls, most of the troubleshooting can be done remotely, through the eIQ platform. The building manager or service tech can manually adjust and measure the economizer from their computer or smart phone within the economizer health dashboard.

Once onsite, a technician can easily override the operation of the unit to troubleshoot the economizer fault using the CATALYST's Service Switch. Shown in Figure 4, the Service Switch is a simple dial that is easy to use.

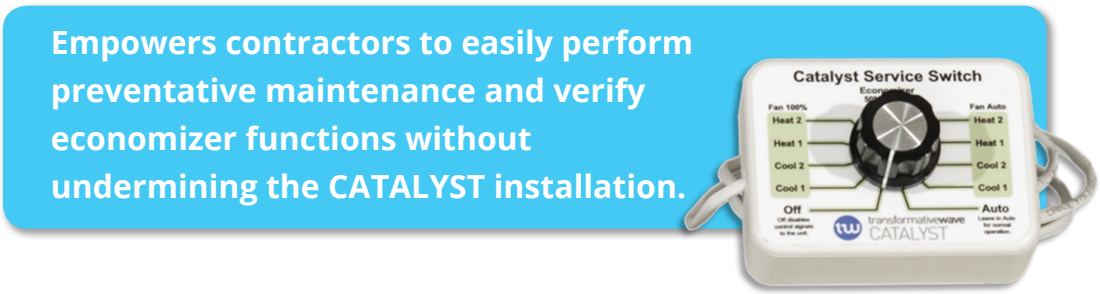

Figure 4. Service Switch

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