

Economizer Actuator Fault



*Economizer actuator disconnected after CQM services

Economizer Filter Fault



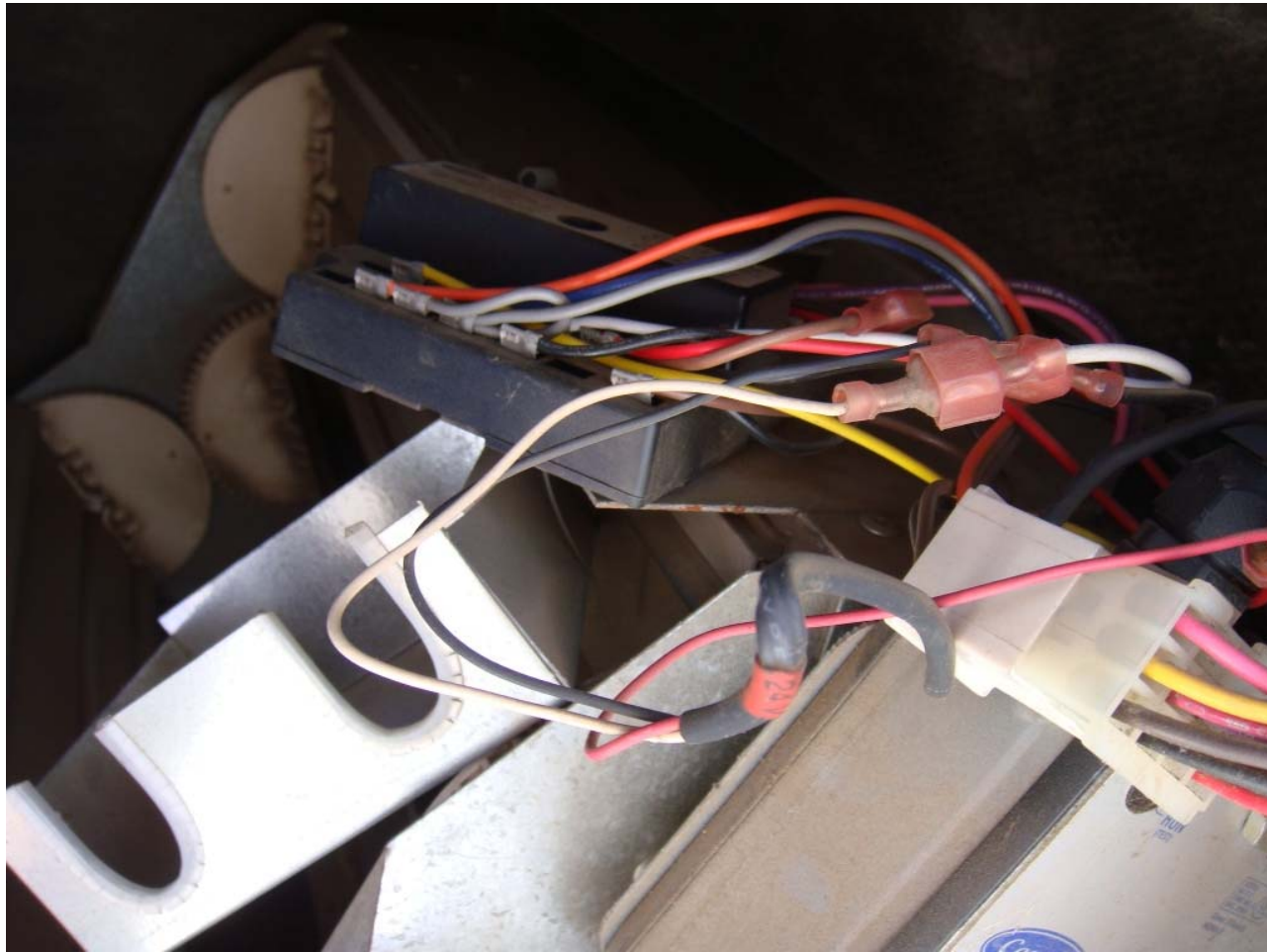
*Economizer filters dirty/damaged/missing after CQM services

Economizer Disabled Fault



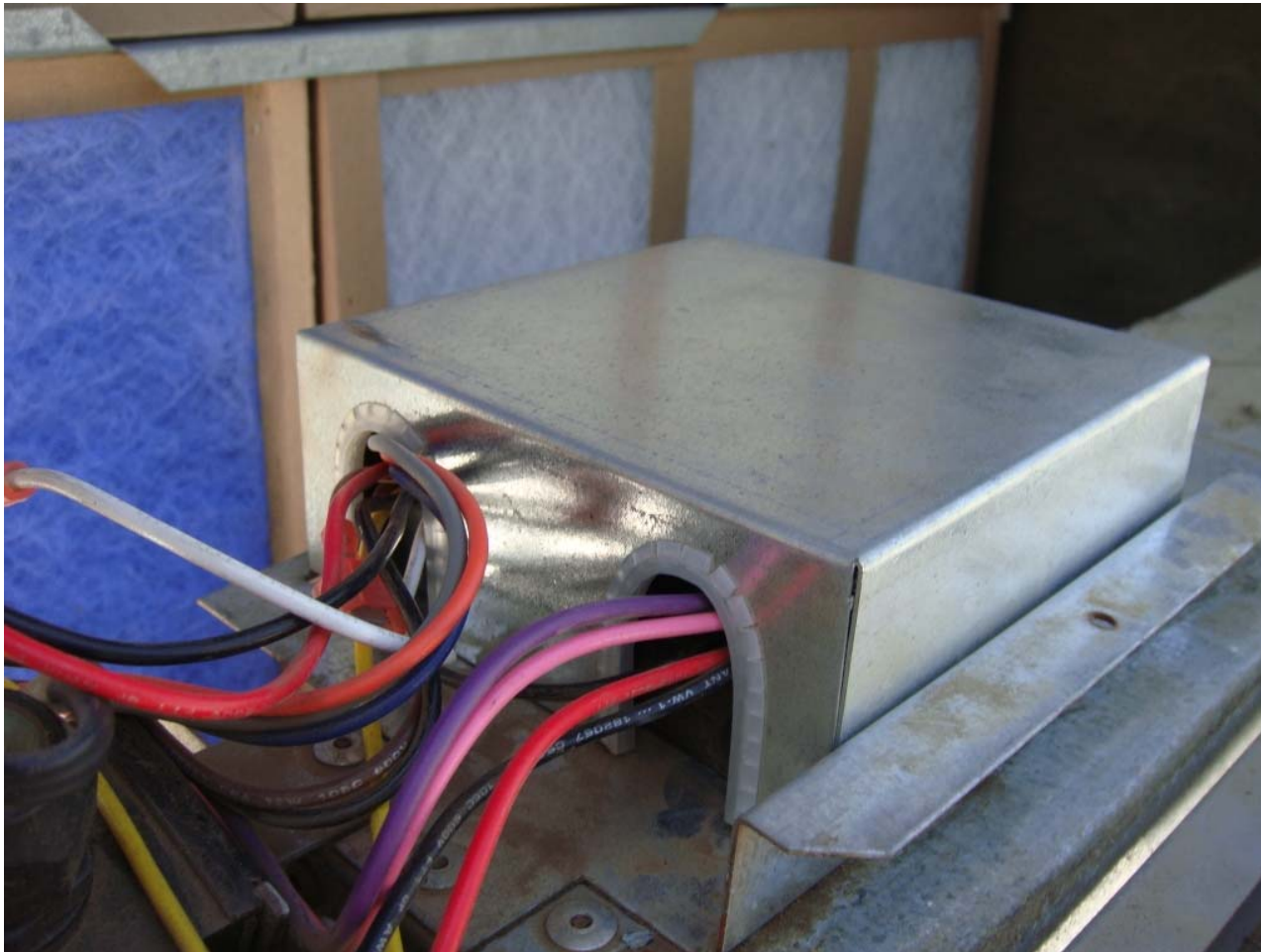
*Rusted economizers with missing dampers after CQM services

Economizer Control Fault



*Control fault after CQM services

Economizer Control Repair



*Control repaired by technicians at request of WO32 team

Multiple Sticker Fault



*RTU serviced in 3 programs



*RTU serviced in 2 programs

Statewide Data Collection

- Technicians collect data on paper and office personnel or implementers enter data 30 to 180 days after work was completed
- Data collection software includes 110 to 160 questions and 290 to 425 fields per unit
- Observations and interviews of 10 technicians working for 8 contractors performing work on 64 units indicated that it takes an additional 2 to 4 hours to enter all required data fields into the online data collection system

Statewide Database Issues

- Mistakes are often made by office personnel when entering data into program database
- Technician name and date are not required
- Most questions are unrelated to saving energy
- 80% of participants said programs ask too many redundant or irrelevant questions
- Without program, technicians indicated they would not answer so many questions to perform maintenance services

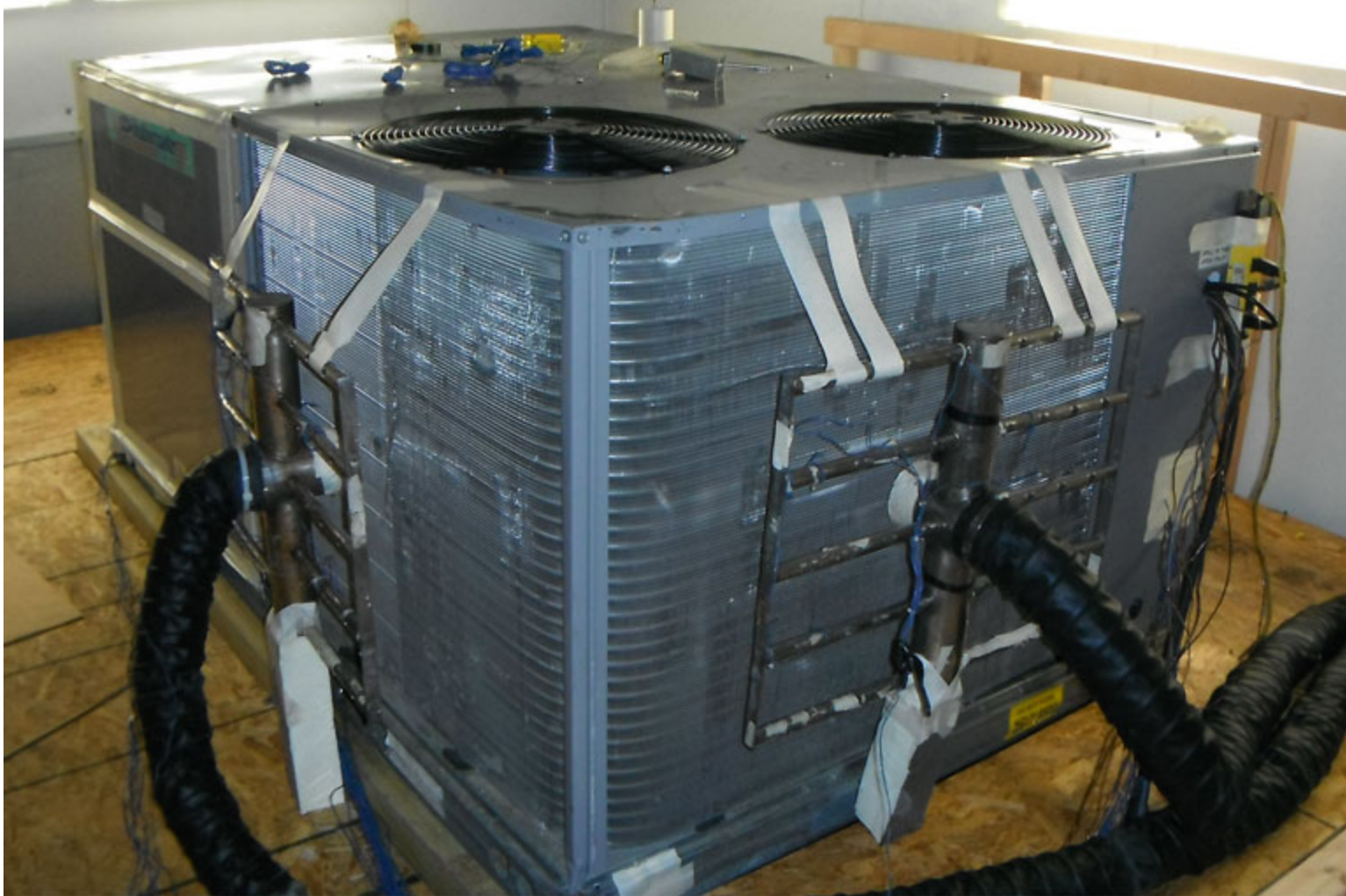
Bias Distorts Data and Results

- Sample, referral, follow-up, and examination bias
- One program recruited contractors who received less than 6% of incentives
- 2 performed services before observations
- Implementers intervened 9 times to assist technicians or stopped work in middle of repairs
- Study recruited more contractors who received 67% of incentives in order to overcome bias
- Future studies will work cooperatively with program personnel to mitigate bias

Laboratory Tests

- Tests are performed in an AHRI-certified laboratory per AHRI 210/240 or AHRI 340/360
- Tests results for two 7.5-ton RTUs with ASHRAE 90.1 economizer and varying damper positions, refrigerant charge, and airflow
- Program market share of the test models is 25%
- AHRI indoor test conditions are 80°F db/67°F wb and outdoor conditions are 95°F and 82°F
- Non-AHRI indoor conditions are 75/62°F outdoor conditions 95/75°F, 82F/68°F, and 115F/80°F

7.5-ton Dual-Compressor RTU



Out of Box Tests 7.5-ton RTU1

Test	Rated EER	Out of Box EER	Optimized EER
Verification "A" Test Sealed Cabinet 10" Pulley 95°F OD 80/67°F ID	11.0	9.6	10.5*
2 Stages "A" Test Unsealed Cabinet 7" Pulley 95°F OD 80/67°F ID	11.0	8.4	8.9
2 Stages "B" Test Unsealed Cabinet 7" Pulley 82°F OD 80/67°F ID	13.1	9.8	10.9
1 st Stage "A" Test Unsealed Cabinet 7" Pulley 95°F OD 80/67°F ID		6.0	6.5
1 st Stage "B" Test Unsealed Cabinet 7" Pulley 82°F OD 80/67°F ID		6.8	8.0

*Test within 95% of AHRI tolerance for EER and Cooling Capacity

Out of Box Tests 7.5-ton RTU2

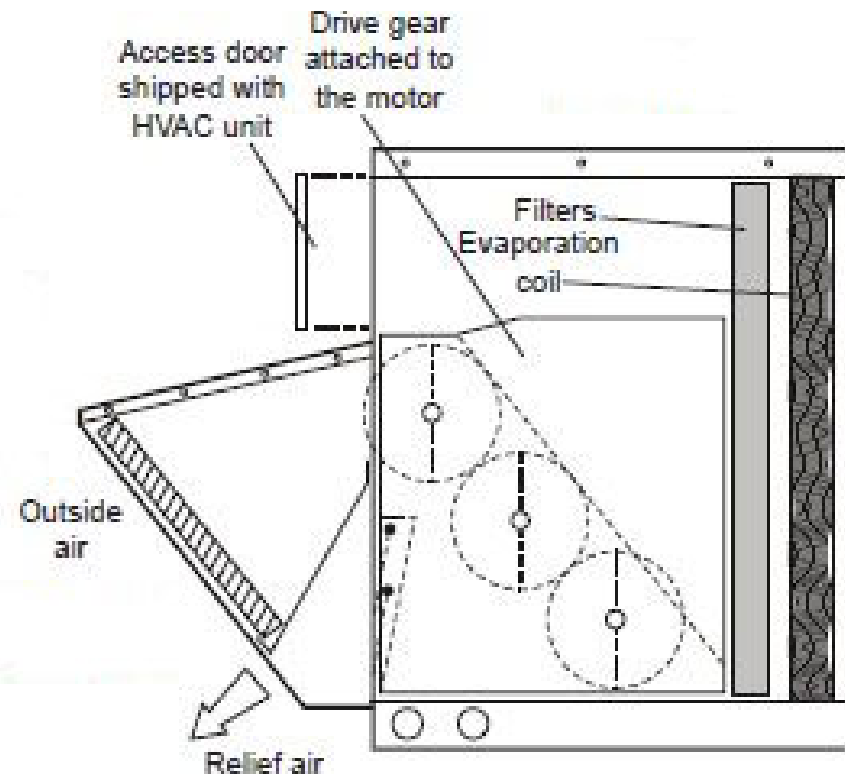
Test	Rated EER	Out-of-Box ¹ EER	Optimized ² EER
Verification EER Test Sealed Cabinet 5.375" Pulley 95°F OD 80/67°F ID	11.4	NA	11.5*
2 Stages "A" Test Unsealed Cabinet 5.375" Pulley 95°F OD 80/67°F ID	11.4	10.3	11.2
IEER Test Sealed Cabinet ANSI/AHRI Standard 340/360-2007	12.2	NA	11.9
IPLV Test Sealed Cabinet ANSI/AHRI Standard 340/360-2007	11.5	NA	11.4

¹Out-of-box test performed with R22 factory charge of 6.4 lbs (CK1) and 6.2 lbs (CK2) and factory fan speed of 924 RPM (3 turns). ²Optimized tests performed with factory charge and fan speed of 757 RPM (6 turns).

*AHRI performance verification tests are within 95% of AHRI tolerances for EER, IEER, IPLV, and Cooling Capacity.

Economizer Test Setup

- Tests performed with no economizer and with four new ASHRAE 90.1 economizers rated at 10 cfm/ft² or 67.1 cfm at 3,000 cfm per AMCA Standard 511-10
- Indoor conditions are 75°F drybulb/62°F wetbulb for all tests
- Outdoor conditions are 95°F/75°F, 82°F/68°F, and 115°F/80°F



EER* vs. Damper Position

Test	OA %	EER* 82/68°F	EER* 95/75°F	EER* 115/80°F
Rated w/o Economizer		12.0	10.0	7.5
Closed Dampers	15	8.7	6.4	3.7
1 Finger "10% OA"	20	8.3	5.7	2.9
2 Fingers "20% OA"	23	8.0	5.1	2.1
3 Fingers "30% OA"	30	7.8	4.5	1.4
Fully Open	62	6.6	1.9	-1.4