

Economizers: Design, Performance, and Commissioning Issues

Packaged Economizers



Instructor:

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- Senior Engineer
- Facility Dynamics Engineering
- February 6, 2018

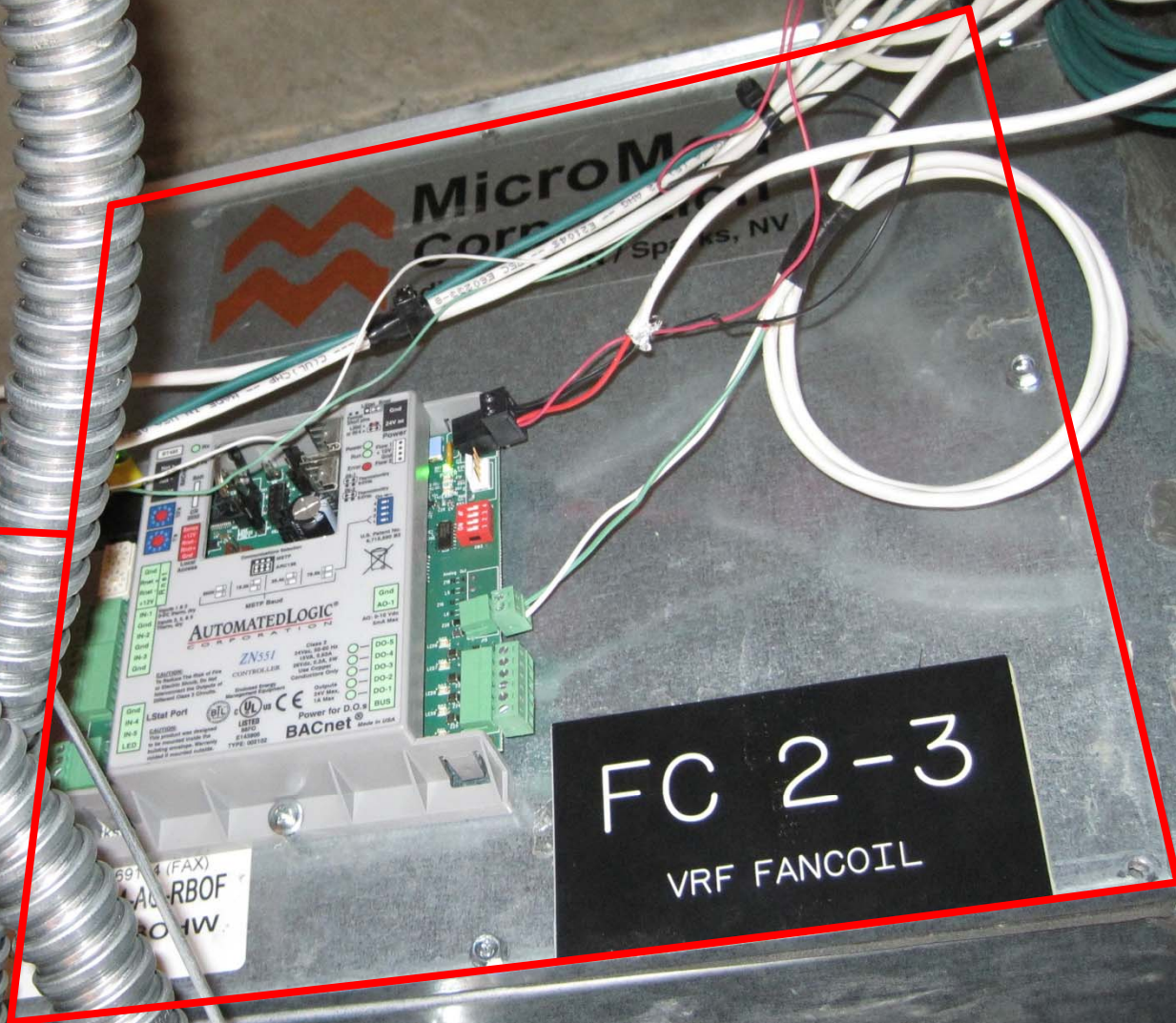
What's In This Module?

- Packaged Economizer Equipment
- The Nuances of Applying Packaged Economizers

Filter Access

Filter Access Door:
Typical access interval

- Open once every 6 to 12 months to change filters

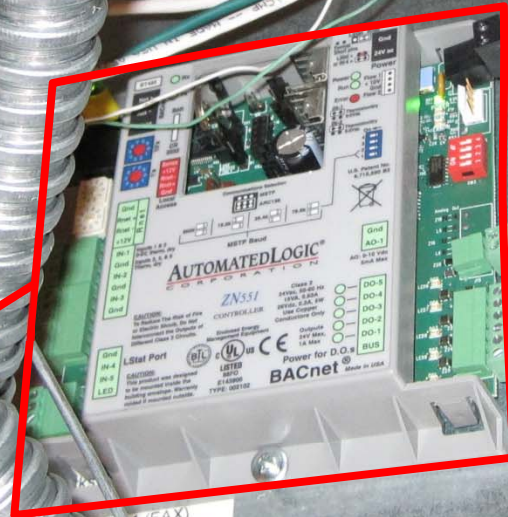


Filter Access

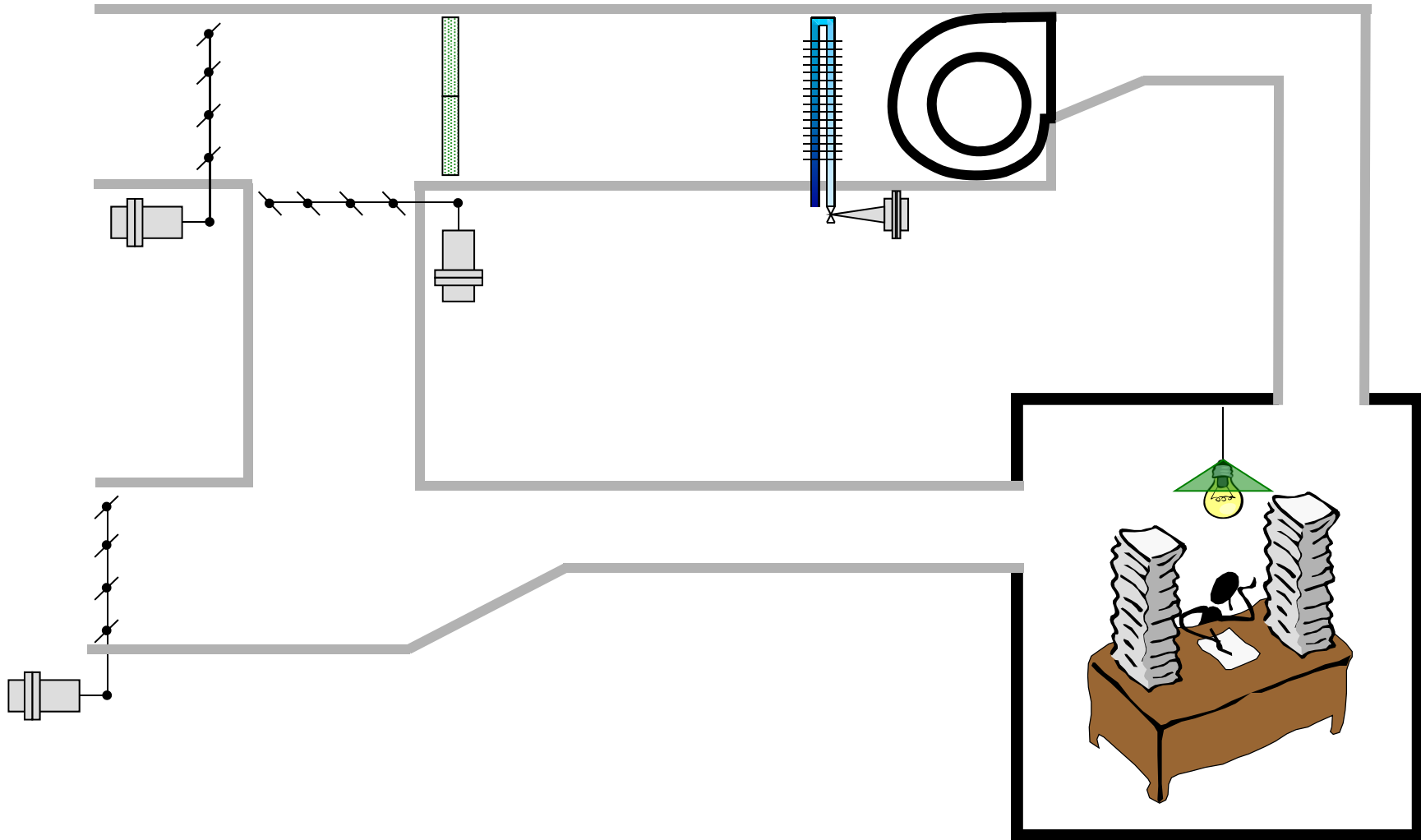
DDC Panel:

Typical rewire and/or recommission interval

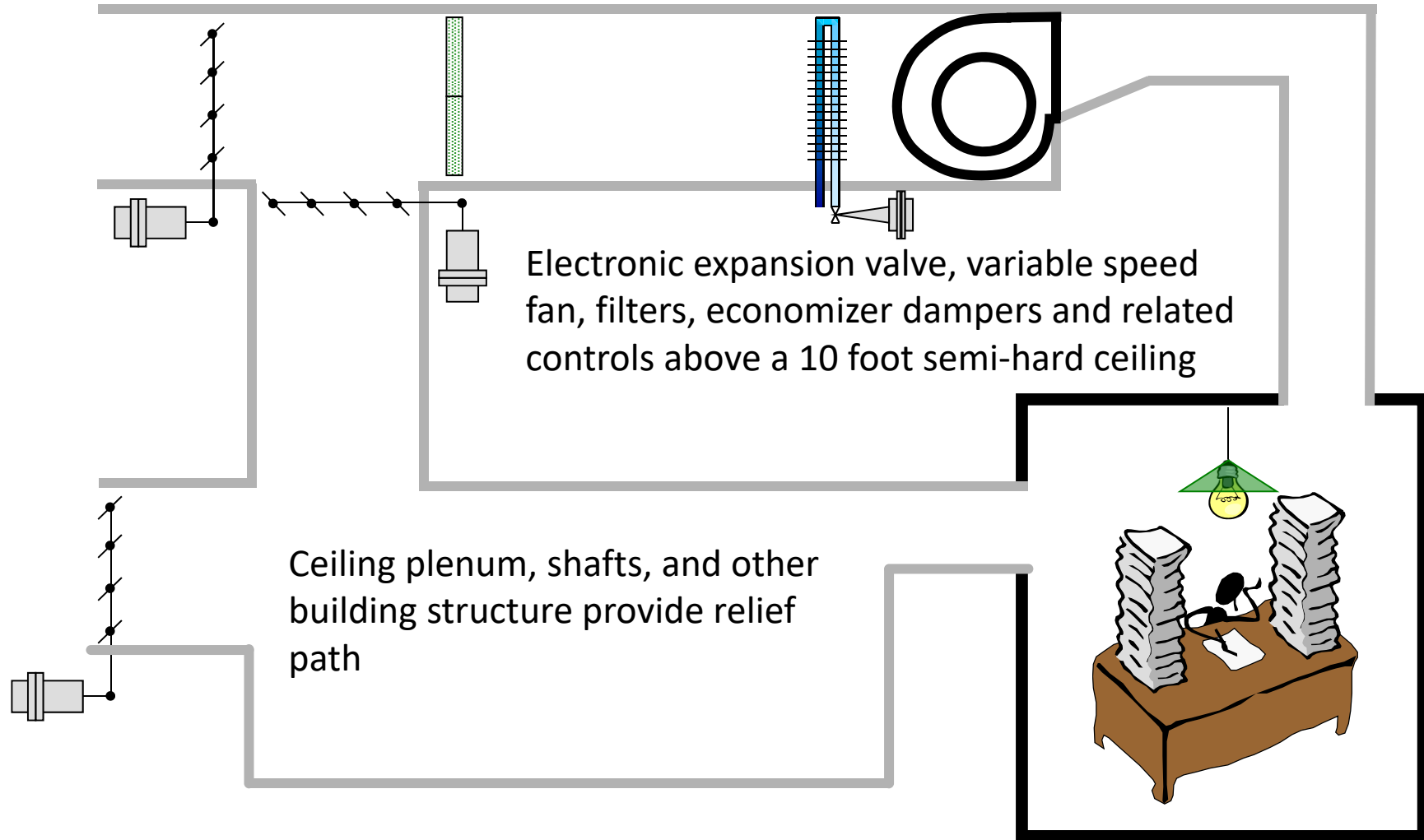
- Once every 6 to 12 months if mounted on filter access door
- Once every 6 to 12 years if mounted somewhere else



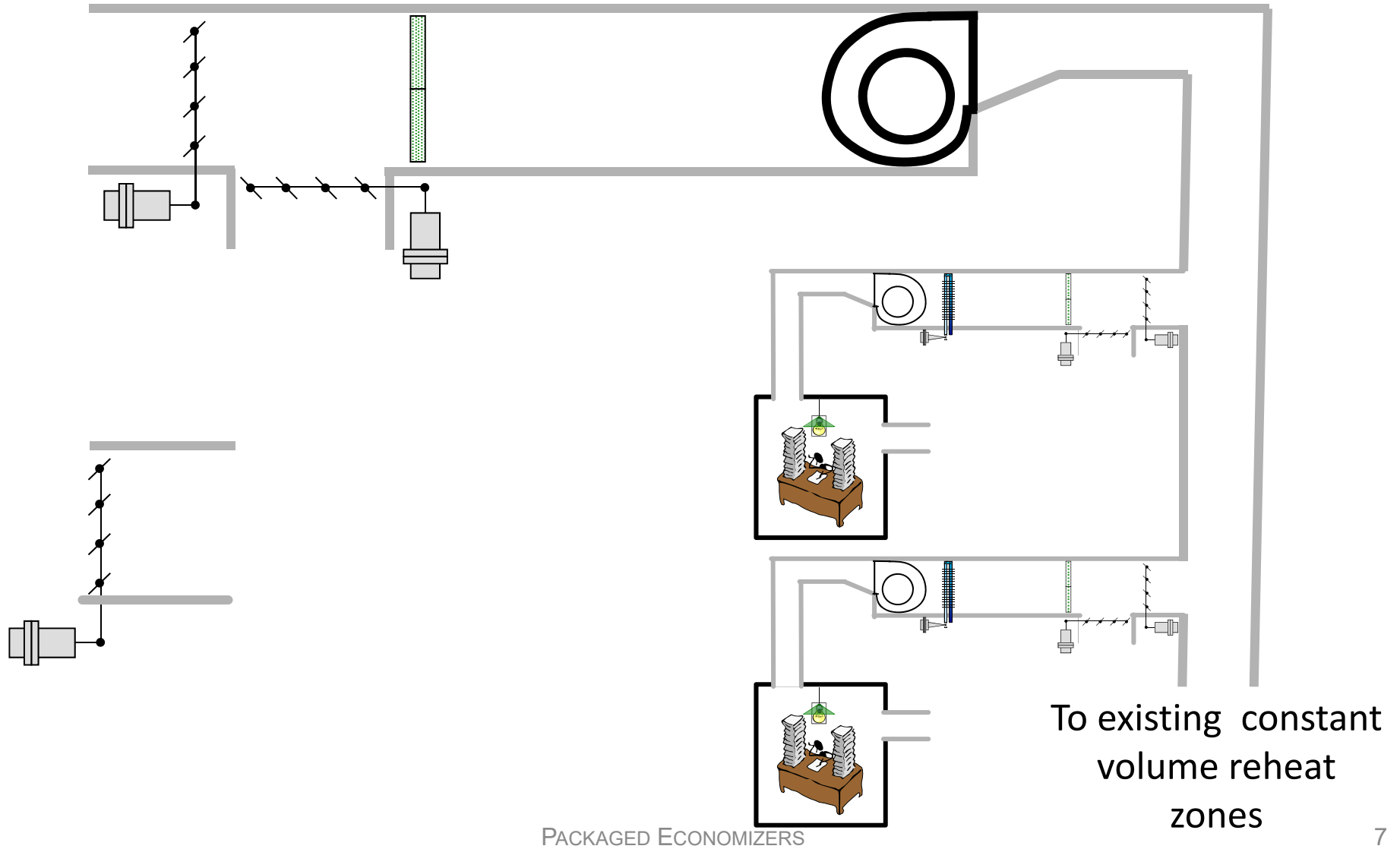
Simple Constant Volume AHU System Diagram



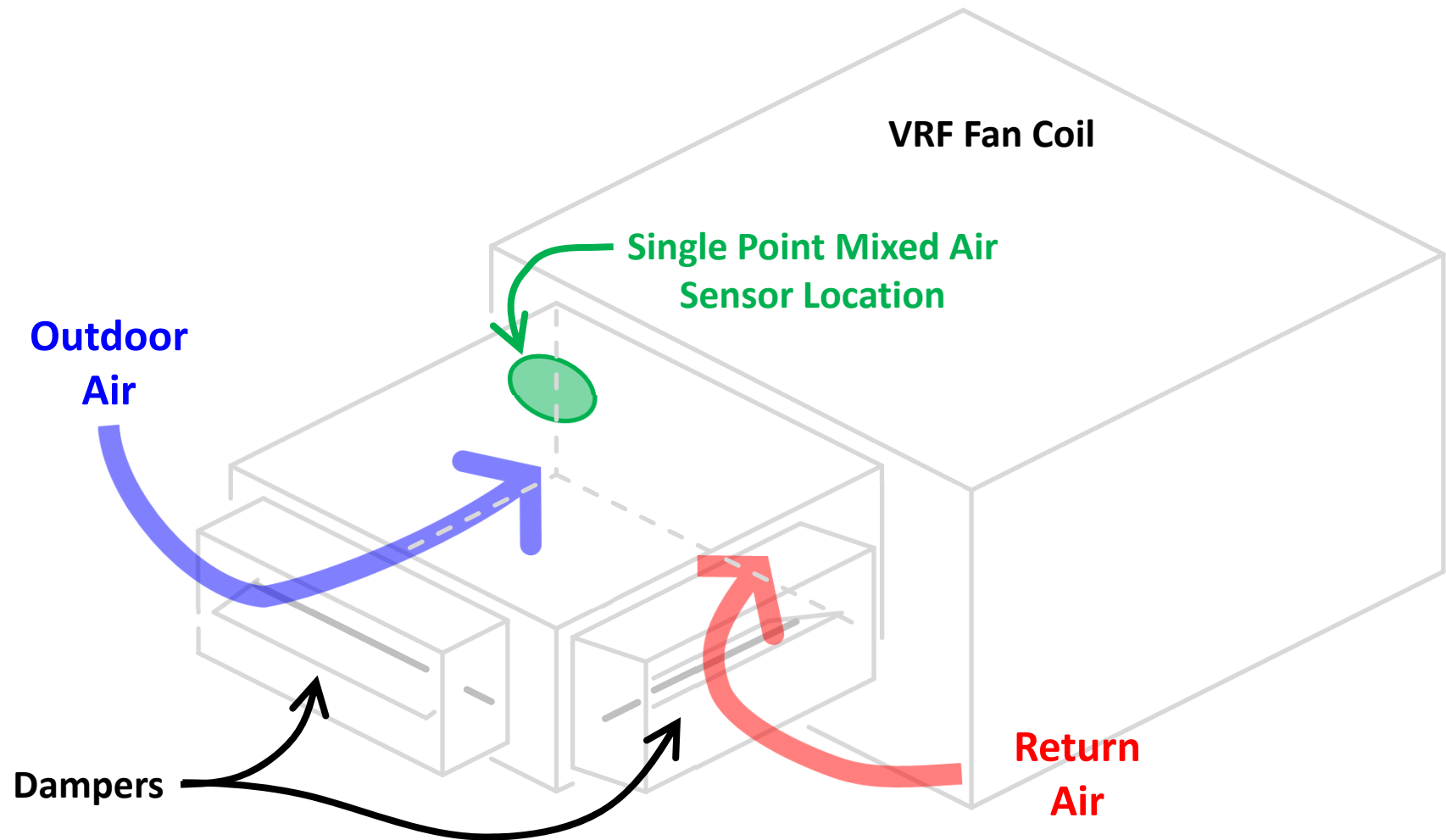
VRF System Diagram



The Actual VRF System Diagram



Control Sensor Installation



Integrated vs. Non-integrated for a Packaged System



Integrated vs. Non-integrated for a Packaged System

- *It all comes down to where you put this sensor*

Economizer Outdoor Air Enthalpy Change-over Sensor



Economizer Outdoor Air Enthalpy Change-over Sensor



Economizer Outdoor Air Enthalpy Change-over Sensor



Economizer Outdoor Air Enthalpy Change-over Sensor

Are there any issues with this enthalpy sensor installation given:

- The duct is the outdoor air duct
- The sensor is lying on the bottom of the duct, unsecured



The Improved installation

Image courtesy Brian Nixon



The Improved installation

Image courtesy Brian Nixon



The Improved installation

Image courtesy Brian Nixon

VRF Unit Economizer Design Intent

- Provide an economizer cycle
- No mechanical cooling until the economizer is on 100% outdoor air (Code requirement; integrated economizer)
- Supplement the outdoor air cooling as required (Code requirement; integrated economizer)
- Continue to use outdoor air until the outdoor air is not suitable for cooling (Code requirement; integrated economizer)
- Use minimum outdoor air if the outdoor air enthalpy is not suitable for cooling (Code requirement; integrated economizer)
- Do not heat until the economizer is on minimum outdoor air (i.e. no simultaneous heating and cooling)
- Position to full return air if the VRF system is off (critical given the OA source)
- Use no outdoor air in warm-up mode if the space is not occupied
- Use outdoor air in the cool-down mode only if outdoor air is suitable for cooling
- Minimum outdoor air flow matches contract document requirements for minimum occupancy and maximum occupancy
- The demand controlled ventilation system can over-ride the temperature based control of the economizer cycle if necessary to maintain adequate ventilation.

Design Intent Documentation

- Required accessory on the VRF unit schedule
- Code compliance required
- Economizer supplier uses Honeywell W7212 which:
 - Can perform integrated economizer cycle (but also can do a non-integrated economizer cycle)
 - Can do warm-up/cool down if configured properly
 - Can close the dampers when the system is off if configured properly
 - Can do either/or demand controlled ventilation cycle
 - Minimum occupancy air flow if CO₂ below threshold
 - Maximum occupancy air flow if CO₂ above threshold

Design Intent Documentation vs. Intent

Covered by Documents

- Provide an economizer cycle
- No mechanical cooling until the economizer is on 100% outdoor air (Code requirement; integrated economizer)
- Supplement the outdoor air cooling as required (Code requirement; integrated economizer)
- Continue to use outdoor air until the outdoor air is not suitable for cooling (Code requirement; integrated economizer)
- Use minimum outdoor air if the outdoor air enthalpy is not suitable for cooling (Code requirement; integrated economizer)

Covered by Code

Covered by Code

Covered by Code

Covered by Code

- Do not heat until the economizer is on minimum outdoor air (i.e. no simultaneous heating and cooling)

- Position to full return air if the VRF system is off (critical given the OA source)

Covered by W7212 if Implemented

- Use no outdoor air in warm-up mode if the space is not occupied

Covered by W7212 if Implemented

- Use outdoor air in the cool-down mode only if outdoor air is suitable for cooling

Covered by W7212 if Implemented

- Minimum outdoor air flow matches

Covered by Documents; Probably requires TAB RFI to clarify

- The demand controlled ventilation system can over-ride the temperature based control to the economizer, if necessary to maintain adequate ventilation.

Covered by W7212 if Implemented

Economizer Procurement

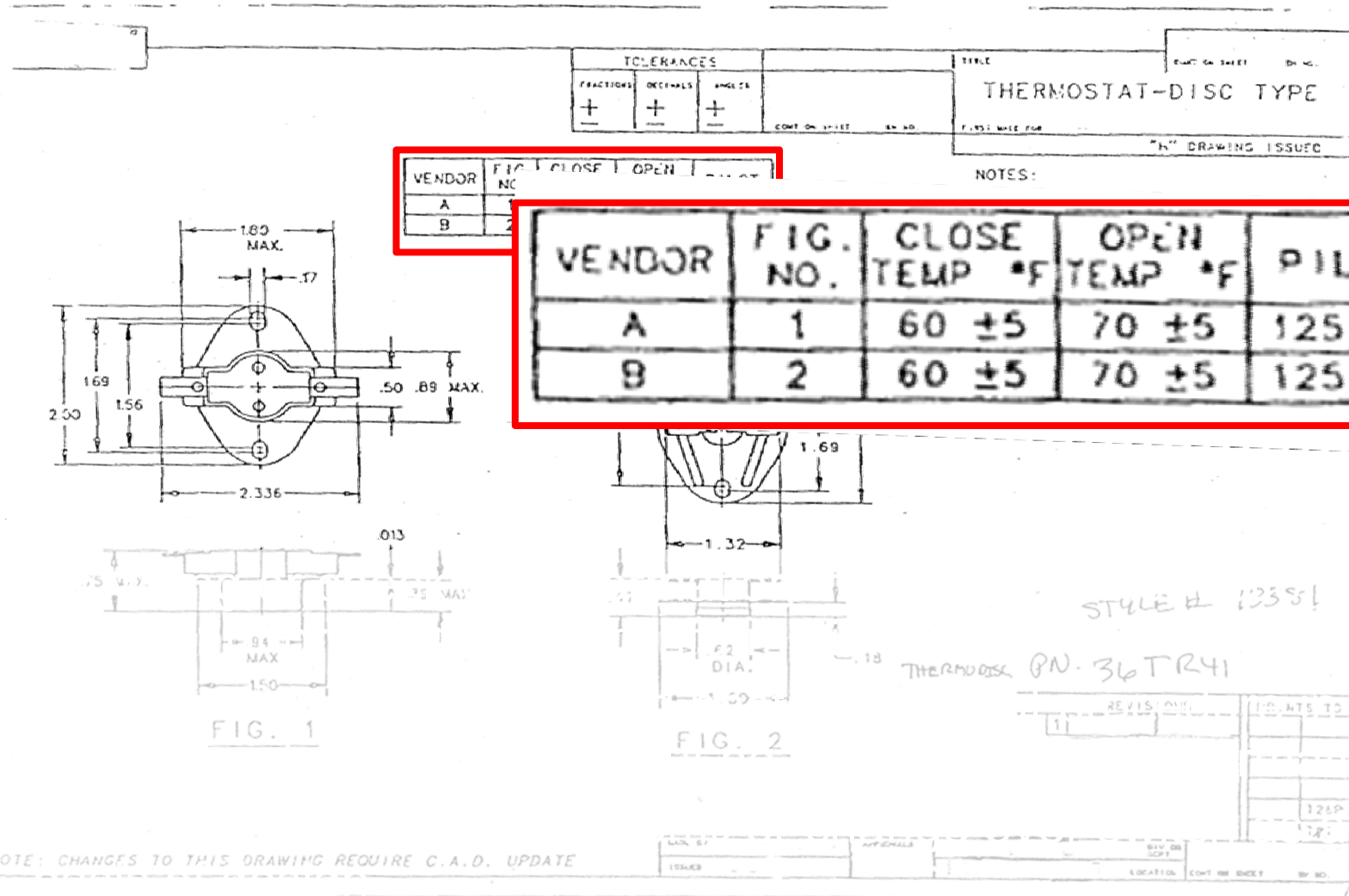
- VRF Fan coil unit provided by 1st party
 - Includes wiring harness for economizer interface
- Economizer package provided by 2nd party
 - Includes generic wiring diagram
 - Capable of a number of change over strategies
- Economizer mixing box and controls provided by a 3rd party
 - Includes multiple product specific data sheets with a wide range of capability
- Economizer mixing box installed by a 4th party
- Economizer controls installed by a 5th party
- Economizer must interface to a building wide automation system by a 6th party to do demand controlled ventilation
- Verification of design intent by a “independent” 7th party



The Result: The Economizer Doesn't Work

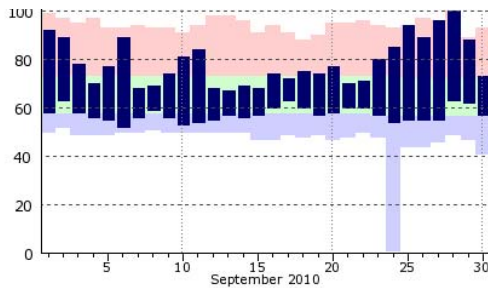
- Confusion regarding the pre-functional testing requirements
- Must reference:
 - Contract documents (contractor charged with developing and executing start-up and functional tests with spot checks by the Cx provider after completion)
 - Economizer package documents (generic in nature)
 - Economizer controller documents (product specific in nature but no project specific details)
 - Control system submittals (retransmits demand controlled ventilation signal and BACnet interface)
 - California energy code (very thick book)

Generic Economizer Package Documents



Generic Economizer Package Documents

[Text Only](#)
[Current Hazards](#)
[RSS](#) [XML](#)
[Local](#)
[National](#)
[Outlooks](#)
[Tsunami](#)
[Inundation Maps](#)
[Storm Reports](#)
[Fast Page](#)
[Current Conditions](#)
[RSS](#) [XML](#)
[Observations](#)
[Buoy Reports](#)
[Satellite](#)
[Radar](#) [KML](#)
[Rivers and Lakes AHPs](#)
[Rainfall Totals](#)
[Google® Maps Data](#)
[Forecasts](#)
[Activity Planner](#)
[Discussion](#)
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[Severe Weather](#)
[CA / NV RFC](#)
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[Tsunami Ready](#)
[Storm Ready](#)
[Storm Spotters](#)



KOAK September, 2010										
Date	Observed Low (F)	Observed High (F)	Normal Low (F)	Normal High (F)	Record Low (F)	Year	Record High (F)	Year	Observed Precipitation (inches)	Record Precipitation (inches)
1	58	92	58	73	50	1984	99	1952	0	.16 2000
2	63	89	58	73	52	1957	97	1950	0	0
3	58	78	58	73	49	2000	95	1961	0	0
4	56	70	58	73	49	2000	97	1961	0	.01 2001
5	55	77	58	73	49	2000	93	2008	0	.01 2005
6	52	89	58	73	50	2001	93	2004	0	0
7	56	68	58	73	50	2001	94	1957	0	.96 1998
8	59	69	58	73	51	2002	93	1976	T	.18 1985
9	56	74	58	73	50	2002	93	1951	0	.19 1978
10	53	81	58	73	50	2000	91	1984	0	.01 1985
11	54	84	58	73	50	1961	94	1979	0	0
12	55	68	58	73	50	2000	98	1979	0	.28 1963
13	57	67	58	73	50	1955	98	2003	0	.17 2009
14	56	69	58	73	50	1970	96	1971	0	.01 1954
15	57	68	58	73	47	1955	91	1971	0	0
16	60	74	58	73	47	2006	94	1968	T	.32 1961
17	63	72	58	73	49	2006	91	2000	T	.09 1985
18	60	75	58	73	48	2008	88	2003	.01	3.17 1959
19	57	74	58	73	49	1955	90	1983	0	.48 1977
20	58	77	58	73	47	2004	95	1949	0	.35 1973
21	60	70	58	73	48	2004	95	2003	0	.03 1983
22	60	71	58	73	50	2008	96	1949	0	.07 1958
23	57	80	57	73	48	1960	94	1997	0	.01 2001
24	54	85	57	73	1	2009	93	1997	0	.29 2001
25	55	94	57	72	44	1948	94	2010	0	.14 1972
26	55	89	57	72	44	1948	97	1958	0	.57 1972
27	55	96	57	72	46	1955	96	2010	0	.58 1957
28	63	100	57	72	49	1948	100	2010	0	.32 1976
29	62	88	57	72	47	1950	89	1978	0	.04 1971
30	57	73	57	72	41	1950	93	1980	0	.45 1983
Average	57.4	78.7	57.7	72.8					0.01	Normal = 0.31

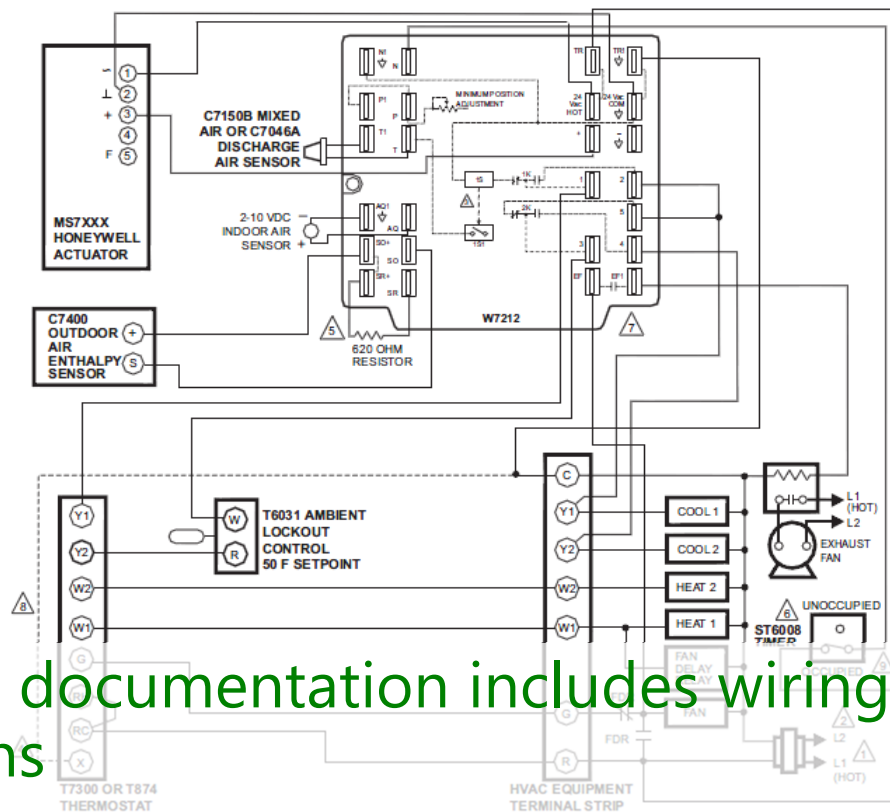
In the normal Berkeley climate, it would be possible for a “clicks-on” with the tolerances shown to disable the economizer in the afternoon of the first day of August and not re-enable it until September some time

Generic Economizer Package Documents



There are many days in many other months were the same thing could happen (the light green band on the graphs is the normal range)

Product vs. Project Specific Wiring Information



- Honeywell documentation includes wiring diagrams for 9 applications

- None are Mitsubishi systems

- None are VRF systems

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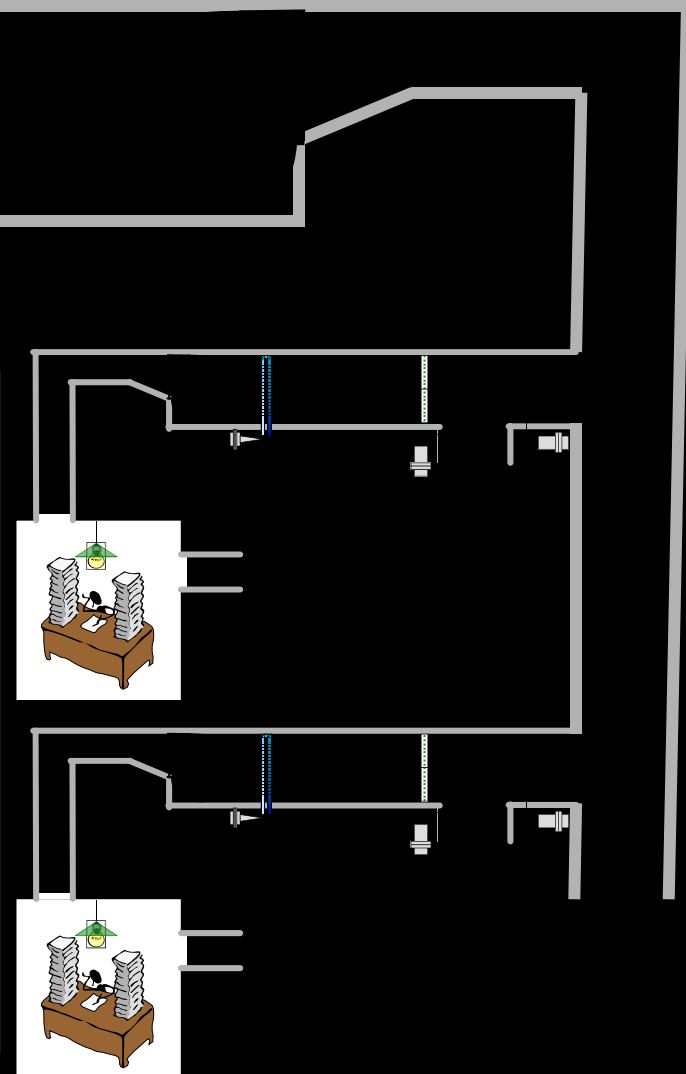
Fig. 13. W7212 used in two-stage cooling system with Honeywell Series 72 Actuator and time clock for occupancy.

PACKAGED ECONOMIZERS

The Actual VRF System Diagram

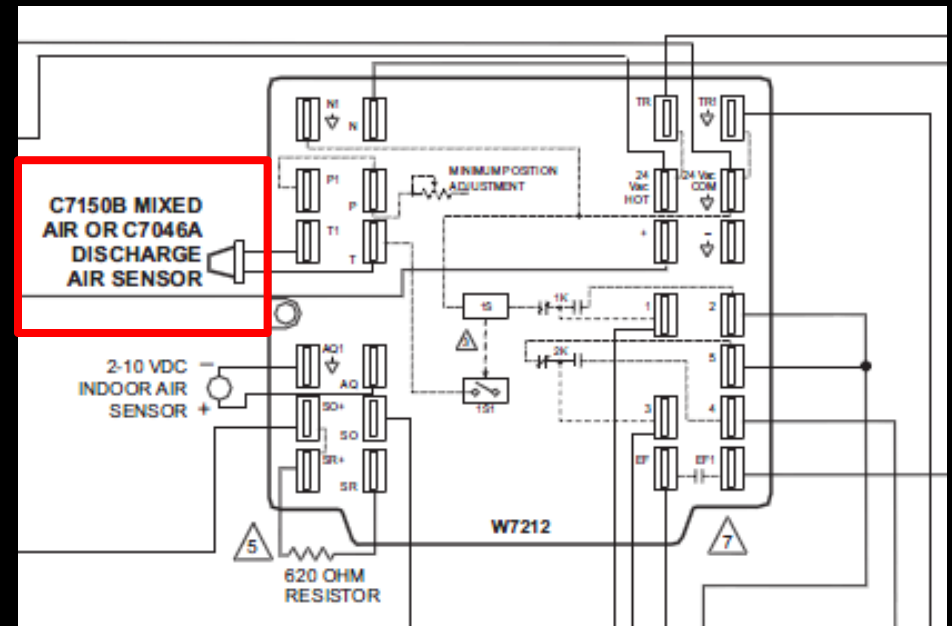
Outdoor air provided by an economizer equipped constant volume reheat system

- VRF zones are variable volume and require system control strategy change
- VRF zones potentially interactive with each other and constant volume zones
- Must balance economizer benefits with reheat penalty
- VRF dampers currently not interlocked to close with VRF shut down



Conflicting Sensor Location Information

- Discharge air vs. mixed air
- Either will work but discharge air location will cause the economizer to generally function like a non-integrated economizer
 - **Bad for maximizing energy savings**
 - **Good for compressor replacement costs in packaged equipment with limited or no turn-down capability**

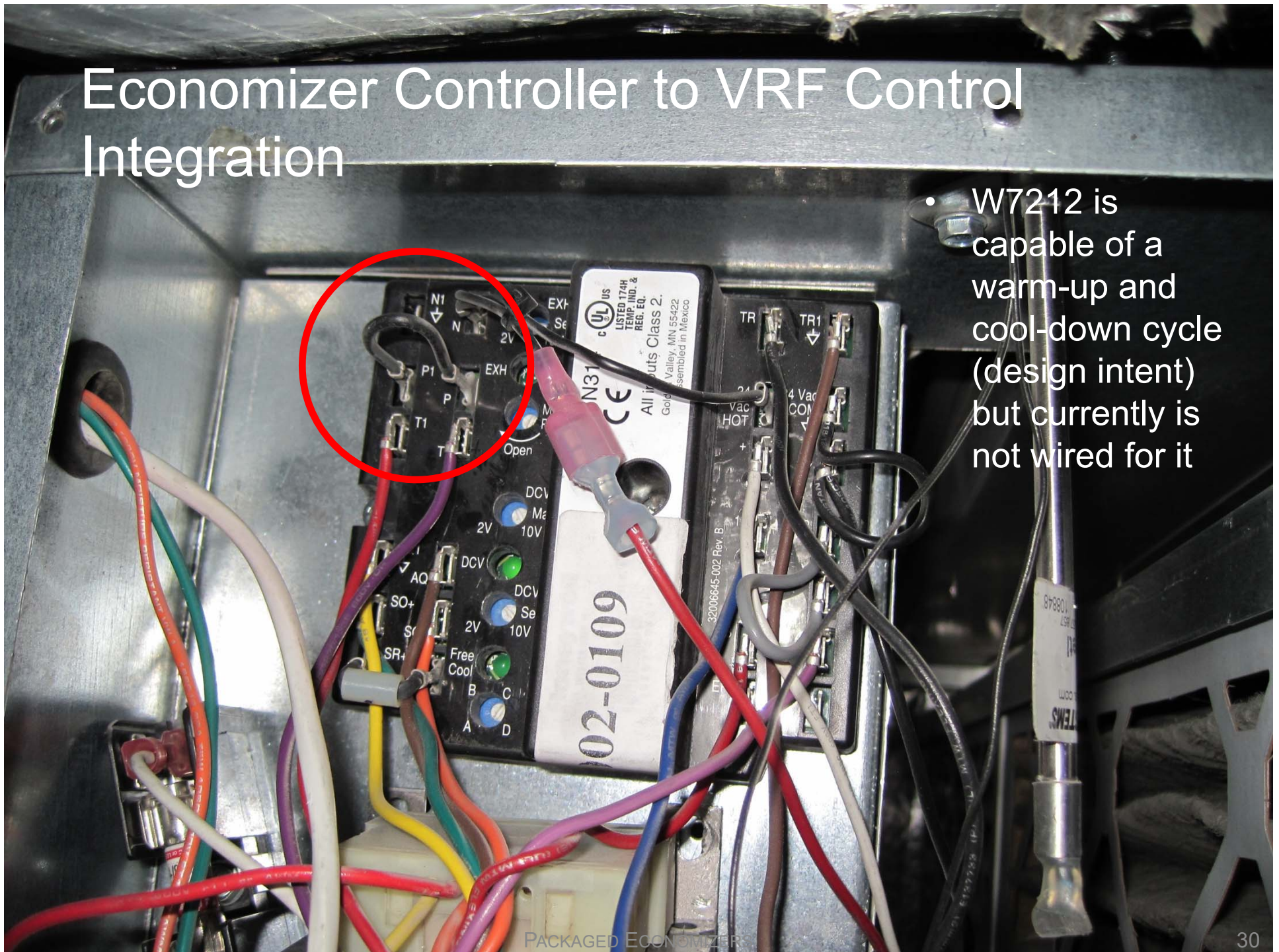


Economizer Controller to VRF Control Integration

- W7212 designed to interlock with the mechanical cooling and keep it off until the economizer has a chance to work
- Economizer package wiring diagram shows no interlocks
- Field wiring for intelock is there, but where's it going?

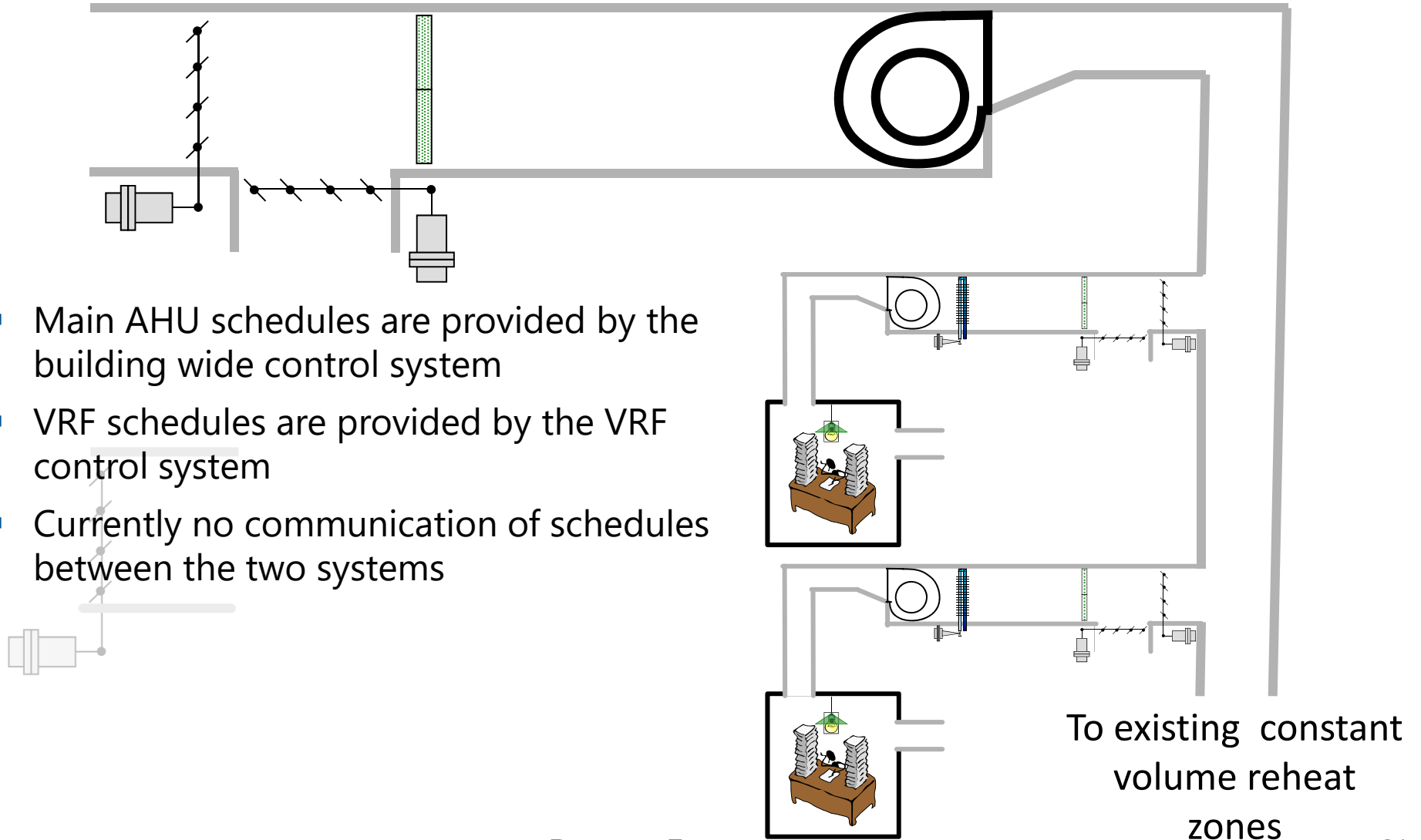
Economizer Controller to VRF Control Integration

- W7212 is capable of a warm-up and cool-down cycle (design intent) but currently is not wired for it

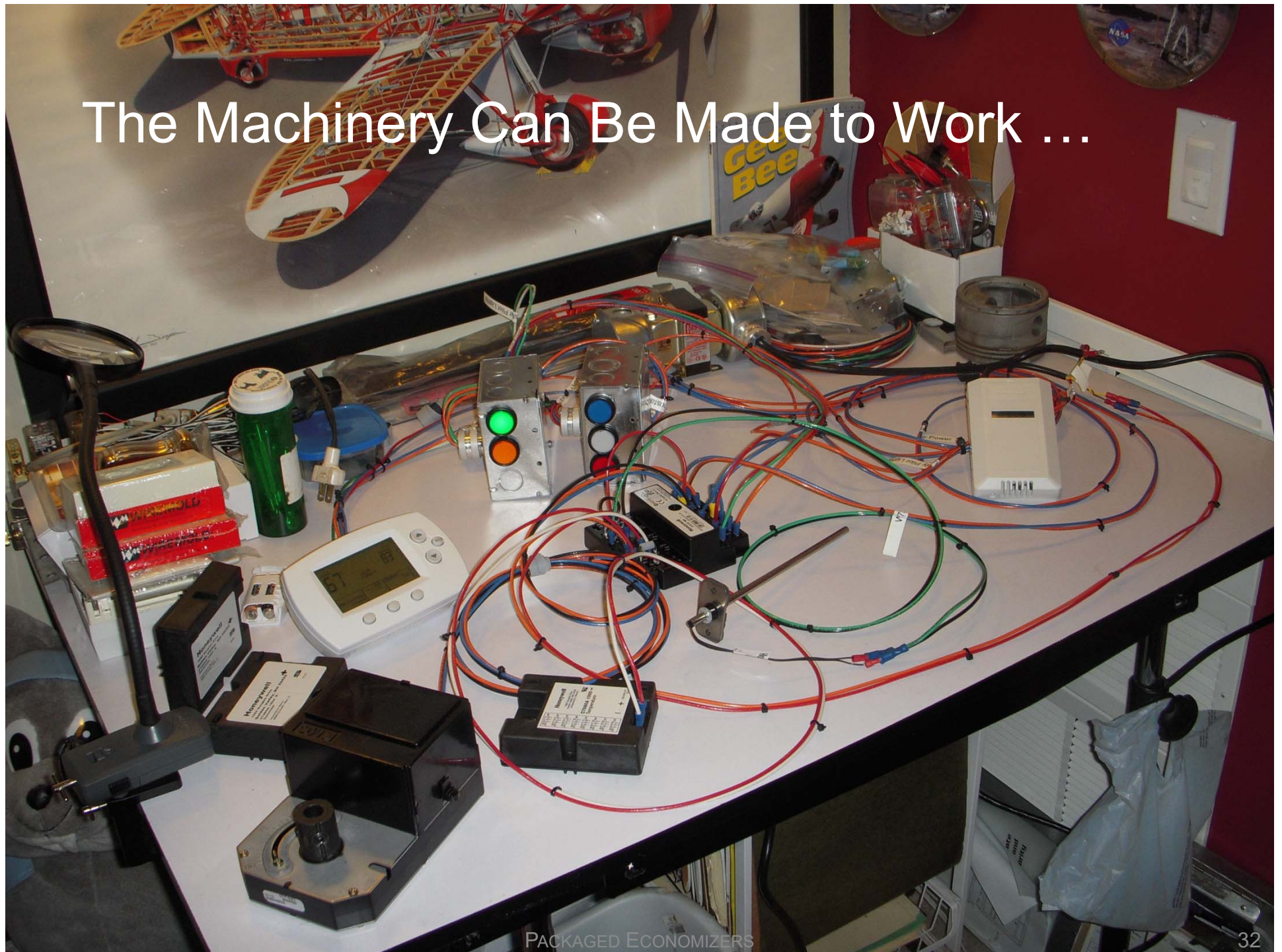


The Actual VRF System Diagram

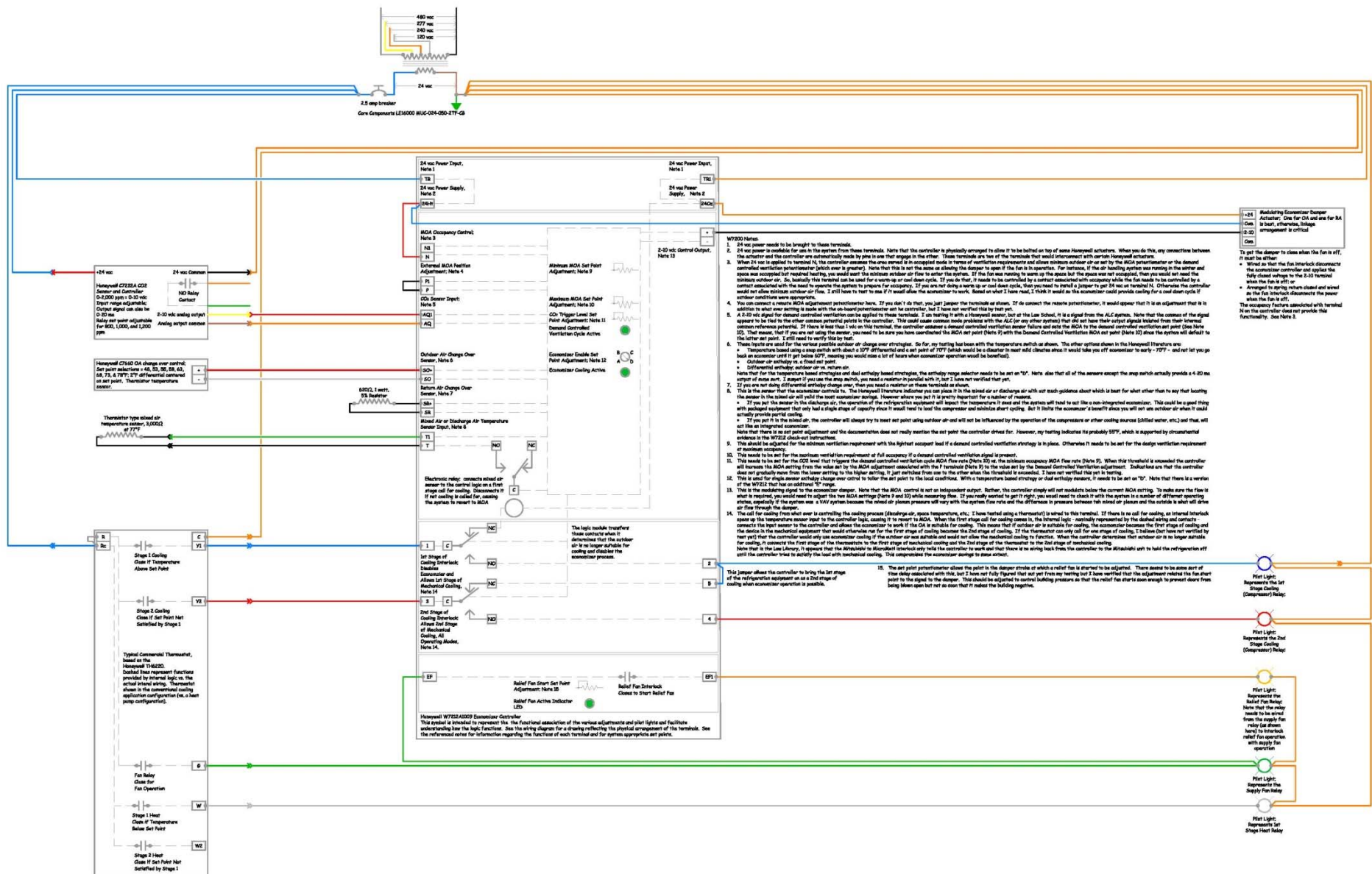
- Main AHU schedules are provided by the building wide control system
- VRF schedules are provided by the VRF control system
- Currently no communication of schedules between the two systems



The Machinery Can Be Made to Work ...



... But it Requires Attention to Detail ...



... And Taking the Time to Integrate Things

