

# BASIC AC

## Specifications vs. Reality

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**As reported in *Home Energy*,  
the magazine of home performance**



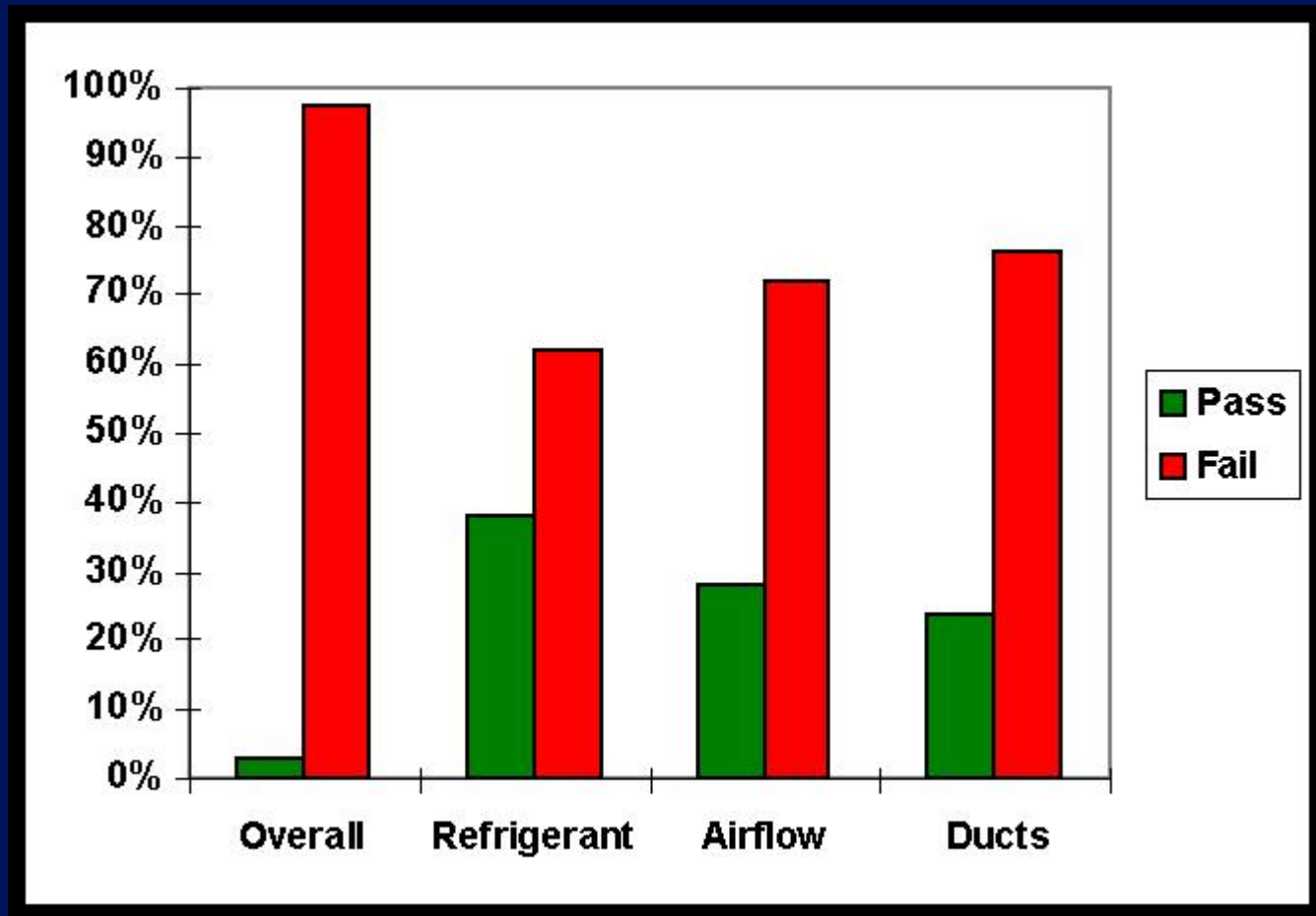
1-888-455-5742 mail@proctoreng.com www.proctoreng.com

# This Session

- Air Conditioning – a lot
- Heat Pumps – less
- Systems to “get it right” – some if there is time
- Answering your questions – a lot if you ask them

# AC Installations

Now Produce Over 95% Failure Rate



# What Does an Air Conditioner DO?

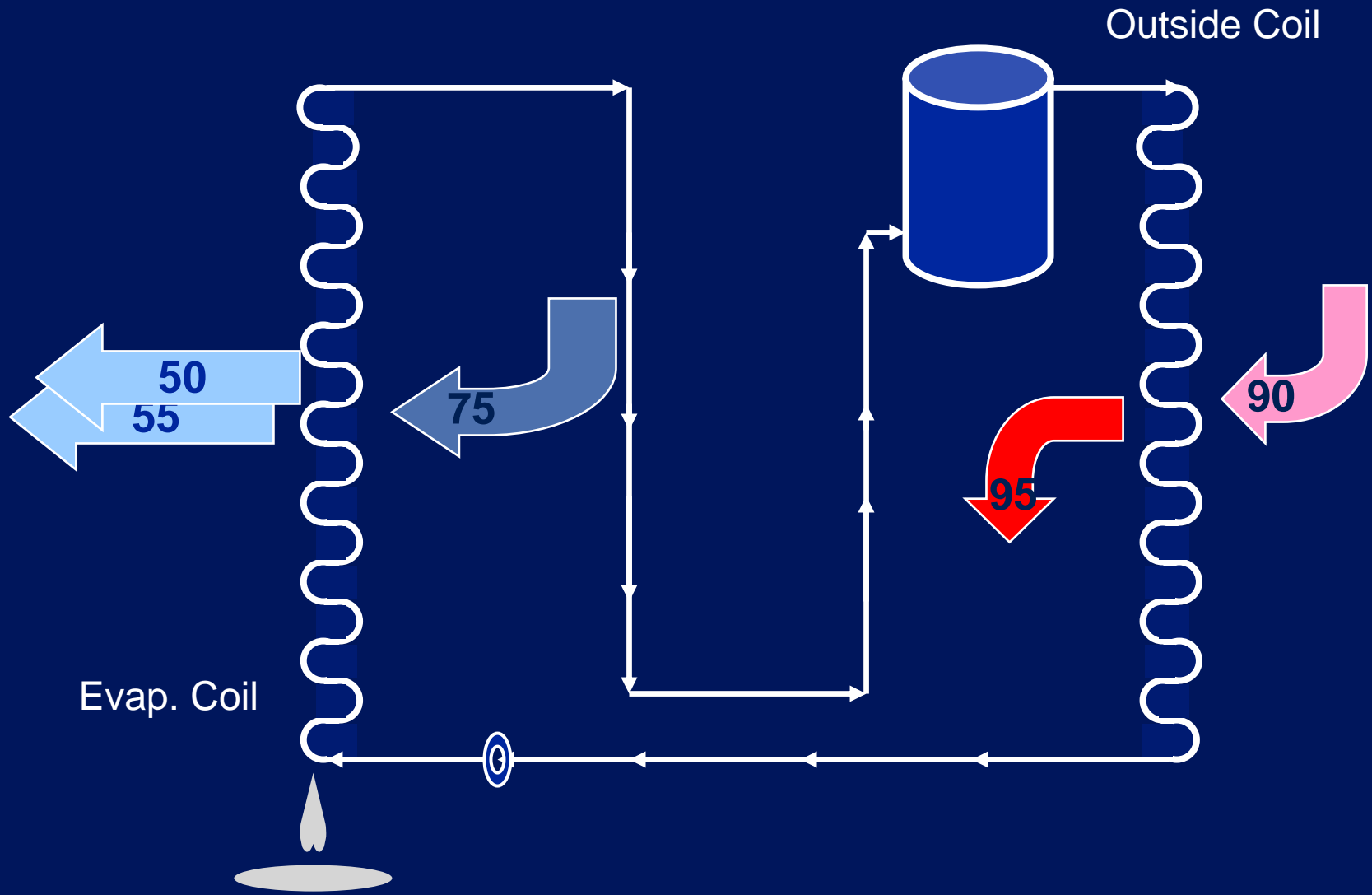
- Removes Moisture – Latent Capacity
- Reduces the Temperature – Sensible Capacity

# Latent Cooling

- Dehumidification (reducing moisture) is Latent Cooling
- This is measured by a reduction in the amount of moisture in the air  
ABSOLUTE HUMIDITY
- Absolute Humidity and Relative Humidity are different.

# Sensible Cooling

- Cooling (reducing temperature) is Sensible Cooling
- This is measured by a drop in dry bulb temperature
- If we only provide sensible cooling the RELATIVE HUMIDITY goes up



# Efficiency vs. Efficiency Ratings

## ■ SEER – EER – Actual

- SEER 3 tests at 82°F outside 80°F inside (50% and lower Rh)
- EER Steady State – 1 test at 95°F outside 80°F inside (50% Rh) (or any other test condition)
- Actual various temperatures and moisture content

As well as actual air conditioner as found

# Efficiency vs. Efficiency Ratings

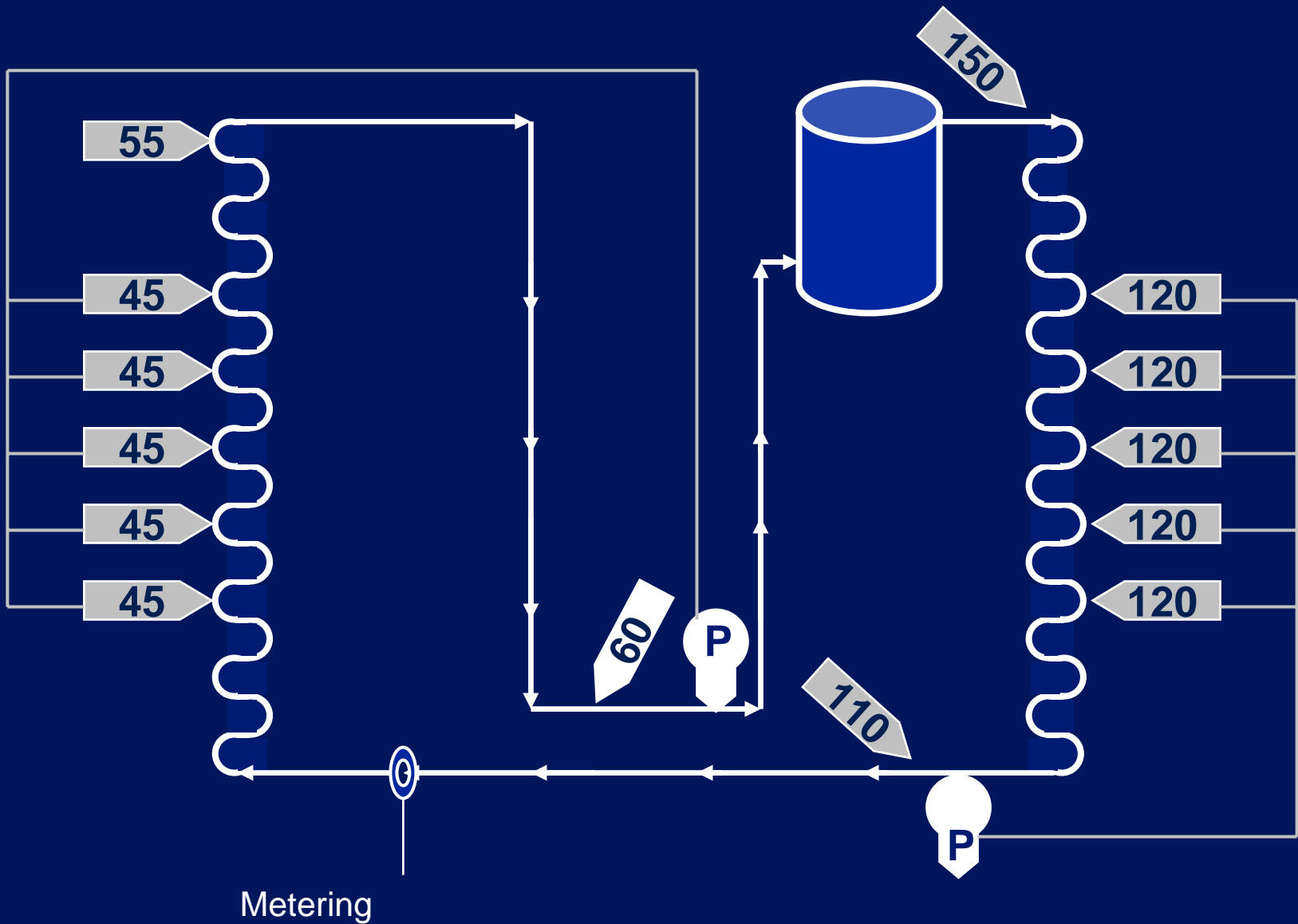
## ■ HSPF – COP – Actual

- HSPF equivalent to SEER
- COP Steady State – test at 17°F and 47°F outside  
(or any other test condition)
- Actual various temperatures  
As well as actual heat pump as found

# Efficiency vs. Efficiency Ratings

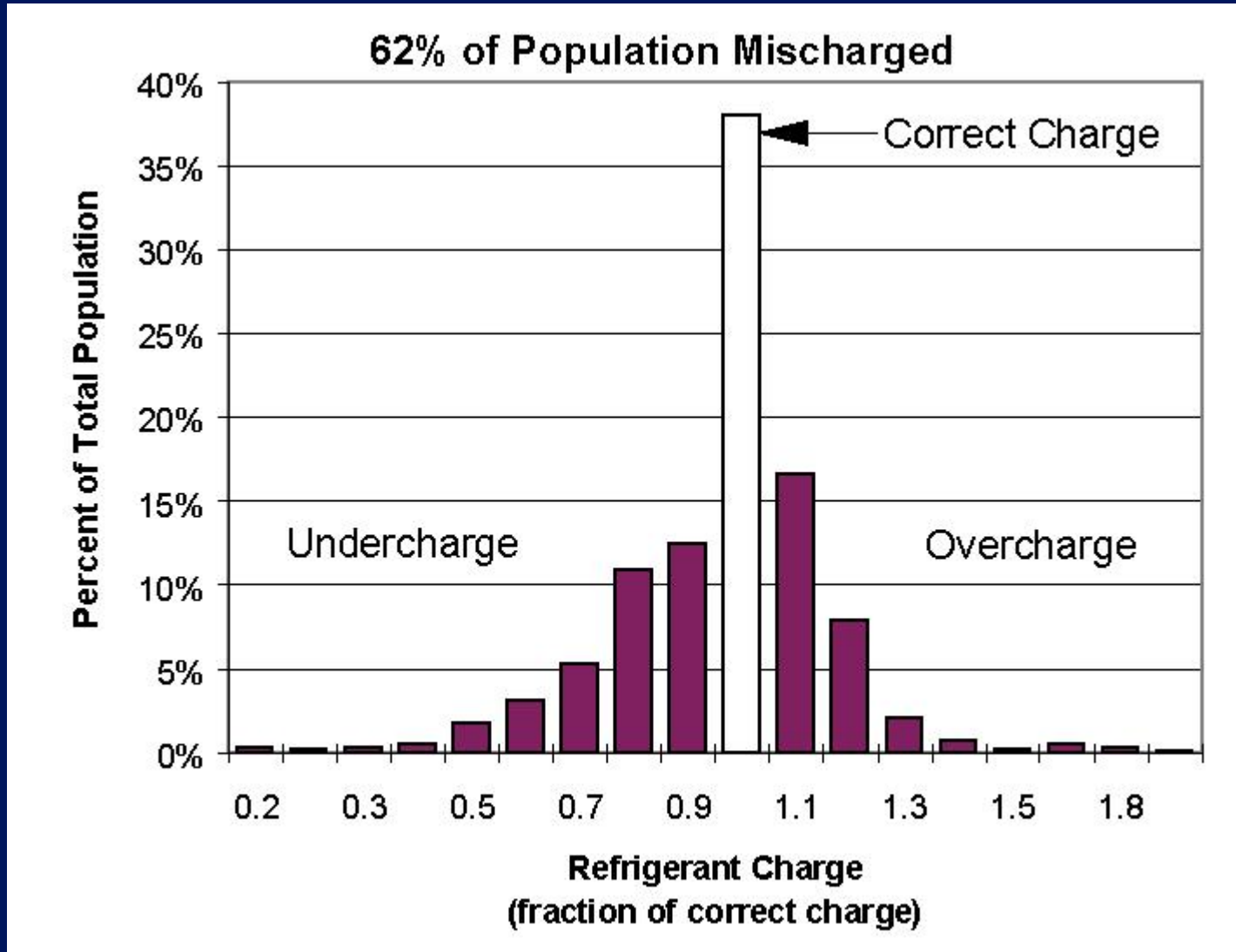
## ■ Heating/Cooling Delivered

- Substantial portions of the air heated or cooled comes from outside, not from inside the home (Leakage)
- Substantial portions of the air heated or cooled is not delivered to the rooms intended (Leakage and Delivery)

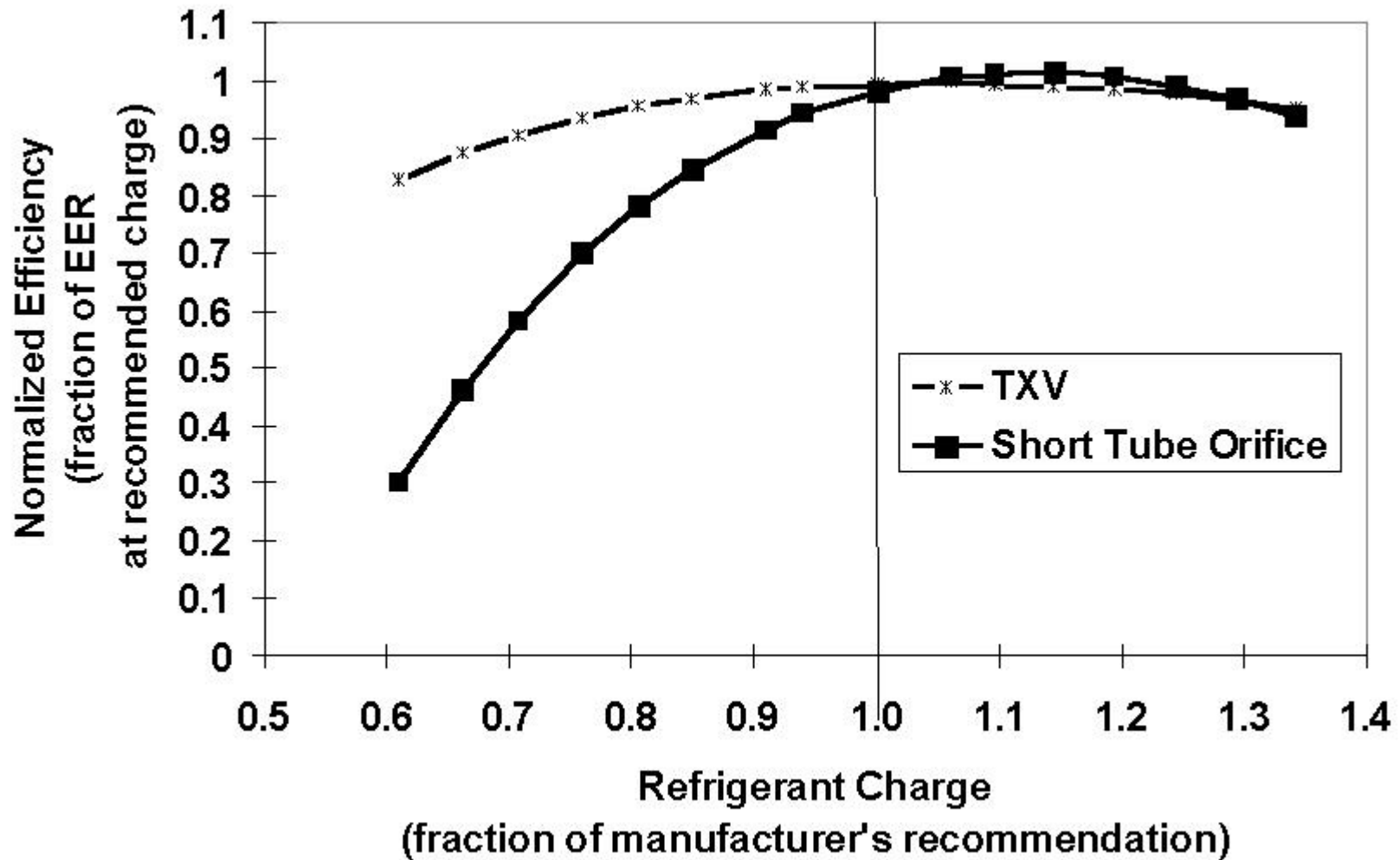


# **55,462 Tests from CheckMe!® Database**

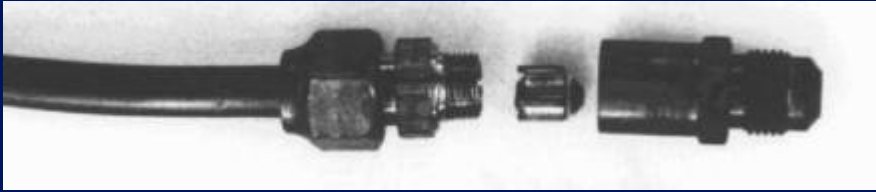
# Charge Incorrect 62% of Time



# Refrigerant Level Effect

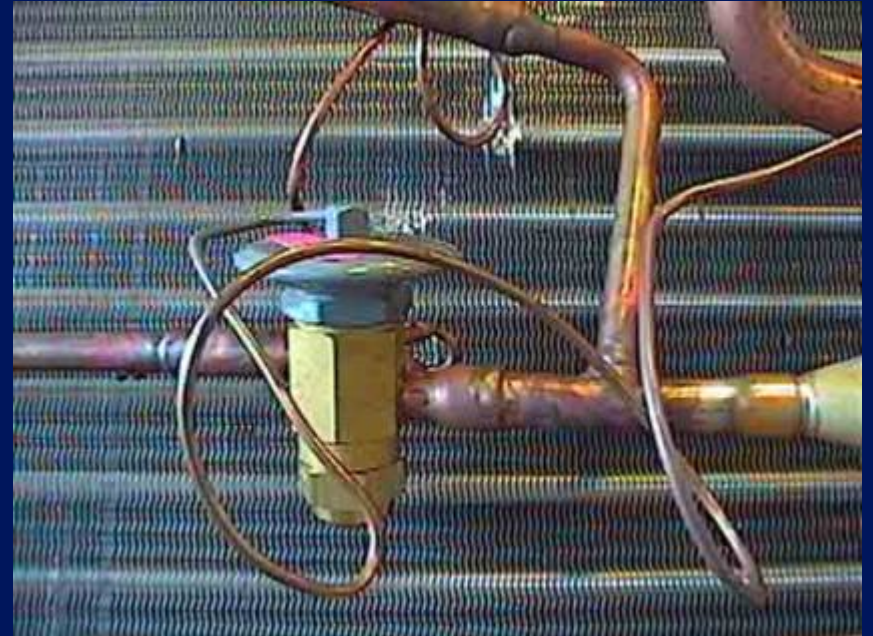


# Metering Devices

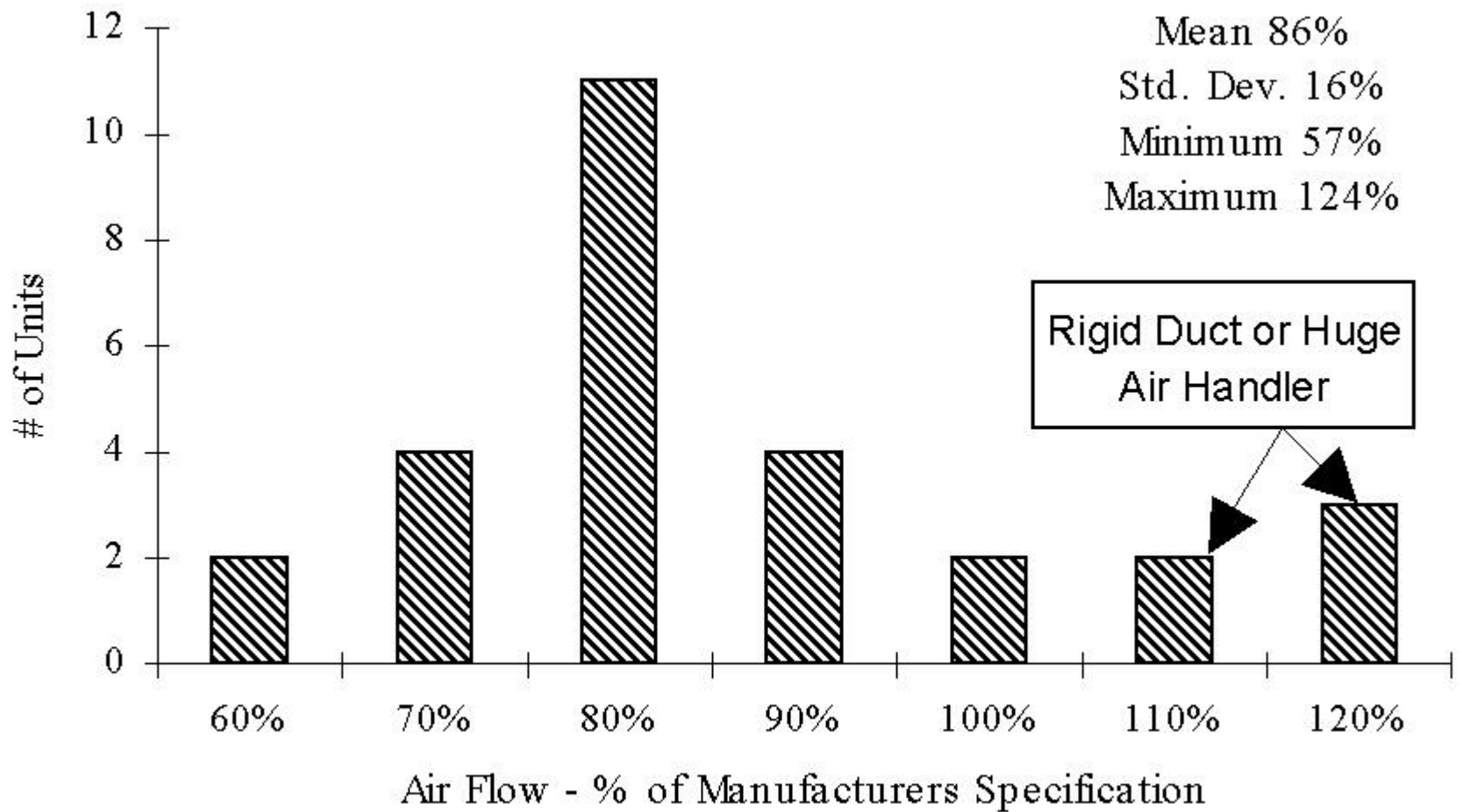


**Orifice**

**TXV**

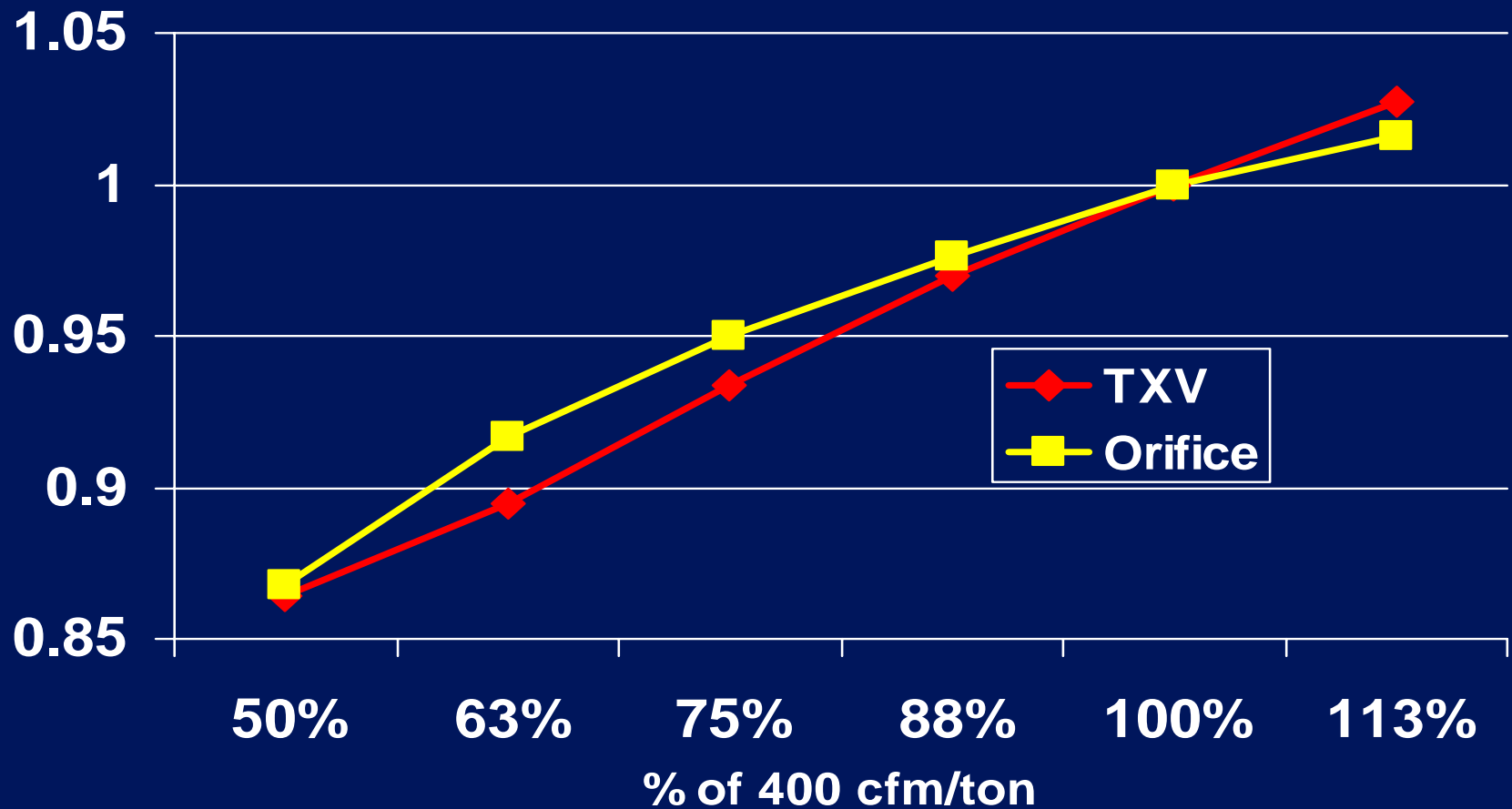


# Low Airflow Measured in New Construction



# Efficiency Effect of Low Airflow

Normalized Gross EER (fan heat & power removed)



PG&E Lab Test Data

# Airflow Affects Sensible/Latent Capacity

- In humid climates the air flow should be lower to remove more moisture (wet bulb)
- In dry climates the airflow should be higher to increase the sensible cooling (dry bulb)

# To Achieve Design Efficiency

- Any equipment installed must perform as intended
- Adjustments must be accurately completed

**These items are accomplished by human beings and are subject to error.**

# Refrigerant Charge & Airflow Test Methods

## Common but not Recommended

- Charge Tests
  - Pressures
  - “Beer can cold” suction line
  - Blowing cold air
- Airflow Tests
  - Nothing

## Manufacturers’ Recommendations

- Charge Tests
  - Superheat for non-TXV’s
  - Subcooling for TXV’s and Lennox non-TXV’s
  - Approach for Lennox TXV’s
- Airflow Tests
  - Temperature split to verify airflow

# Existing Technicians Fail to Follow Standard Recommendations

## National Training Directors' Estimates

- Courtesy of Philip Wemhoff

- Failure to use Recommended Evacuation Method (Refrigerant Lines and Coil)

**72%**

- Failure to Confirm 350 to 450 CFM/Ton

**72%**

- Failure to Use Recommended Charging Method

**74%**

# **Charge Testing for non-TXV (orifice) Superheat**



# Determining Target Superheat Value

- Target superheat value is not constant
  - Target superheat varies with
    - Condenser entering dry bulb
    - Return wet bulb
- Determine the target superheat value
  - Based on chart or “slide rule”

# Superheat Charging Table

		Return Air Wet-Bulb Temperature (°F)													
		50	52	54	56	58	60	62	64	66	68	70	72	74	76
Condenser Air Dry-Bulb Temperature (°F)	55	8.8	11.5	14.2	17.1	20.0	23.1	26.2	29.4	32.4	35.1	37.7	40.2	42.7	45.0
	60	7.0	9.8	12.6	15.4	18.2	21.0	23.8	26.6	29.6	32.4	35.1	37.8	40.4	42.9
	65	-	7.0	10.0	12.9	15.8	18.5	21.2	23.8	26.7	29.7	32.5	35.3	38.1	40.8
	70	-	-	6.4	9.7	12.7	15.7	18.4	20.9	23.9	27.0	30.0	33.0	35.9	38.7
	75	-	-	-	5.6	9.2	12.4	15.3	18.0	21.1	24.3	27.5	30.6	33.7	36.7
	80	-	-	-	-	-	8.7	12.0	15.0	18.3	21.7	25.0	28.3	31.6	34.8
	85	-	-	-	-	-	-	8.5	11.9	15.5	19.0	22.6	26.0	29.5	32.9
	90	-	-	-	-	-	-	-	8.8	12.8	16.5	20.1	23.8	27.5	31.1
	95	-	-	-	-	-	-	-	5.6	10.0	13.9	17.8	21.6	25.5	29.4
	100	-	-	-	-	-	-	-	-	7.3	11.4	15.4	19.5	23.6	27.7
	105	-	-	-	-	-	-	-	-	-	8.8	13.1	17.4	21.7	26.0
	110	-	-	-	-	-	-	-	-	-	6.4	10.8	15.3	19.9	24.4
115	-	-	-	-	-	-	-	-	-	-	8.6	13.3	18.1	22.9	

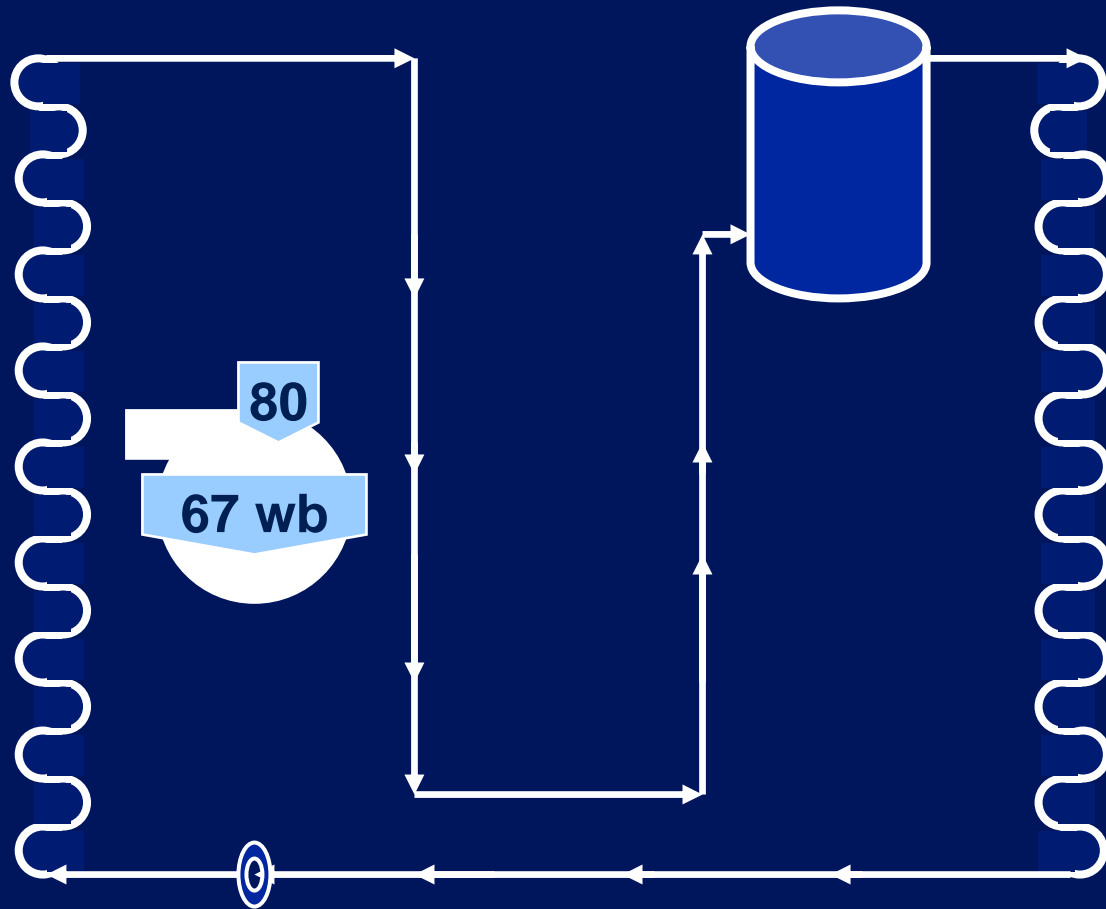
# Measuring Airflow

- Temperature Split Method
- **Duct Blaster™**
- **Flow Capture Hood**
- **Flow Grid**
- Coil Pressure Drop
- Fan Curve
- Pitot Tube Traverse
- Anemometer

# AC Temperature Split

- Run to steady state (15 minutes)
- Measure return “wet bulb” and dry bulb temperatures
- Measure the supply dry bulb temperature
- This is the most critical part of the procedure
  - System stabilized
  - The measured temperatures as close to the mixed **PLENUM AIR TEMPERATURES**

55



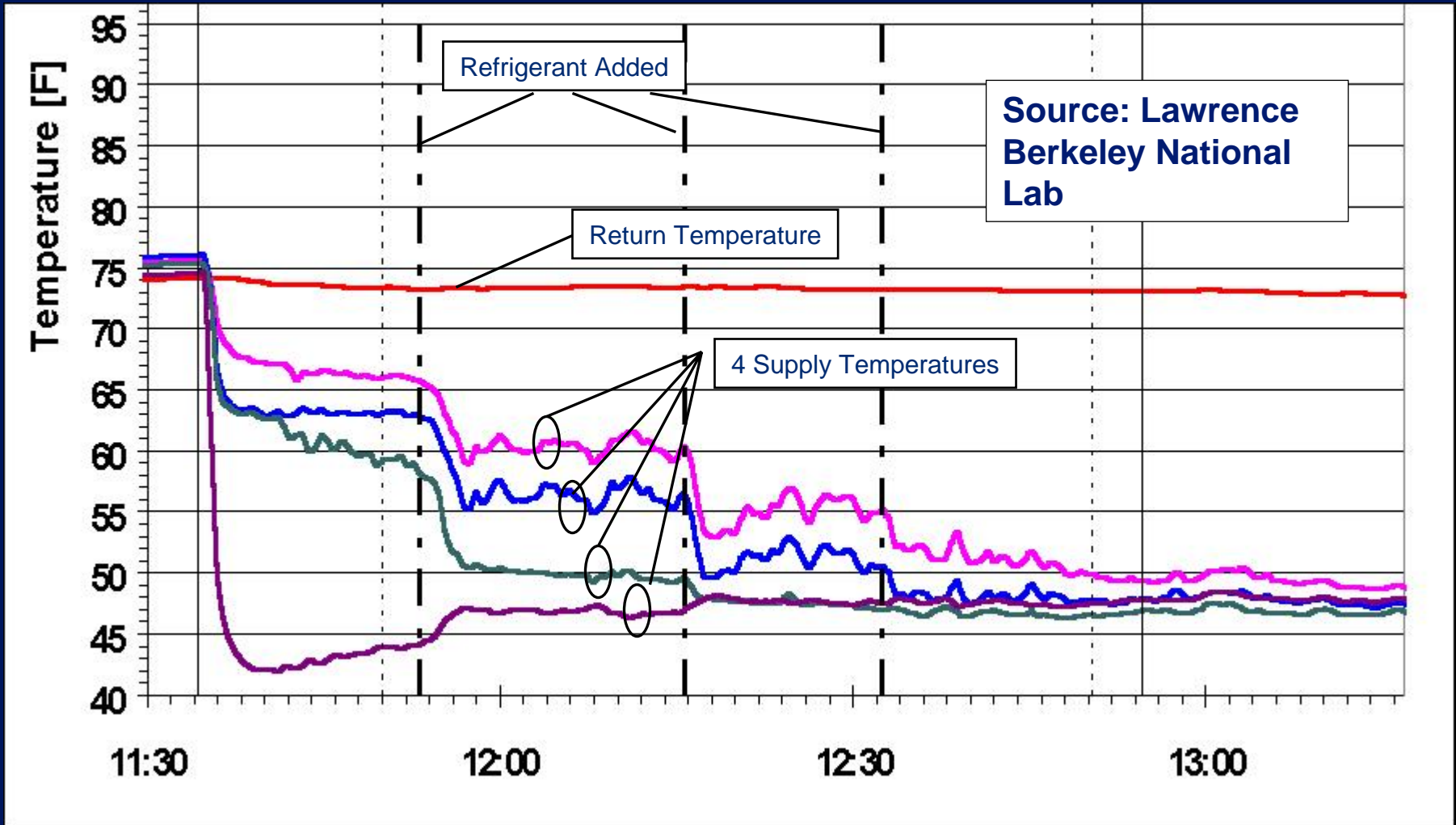
# Determining Target Temperature Split

- Target temperature split is not constant
  - Target temperature split varies with
    - Return dry bulb
    - Return wet bulb
- Determine the target temperature split
  - Based on chart or “slide rule”

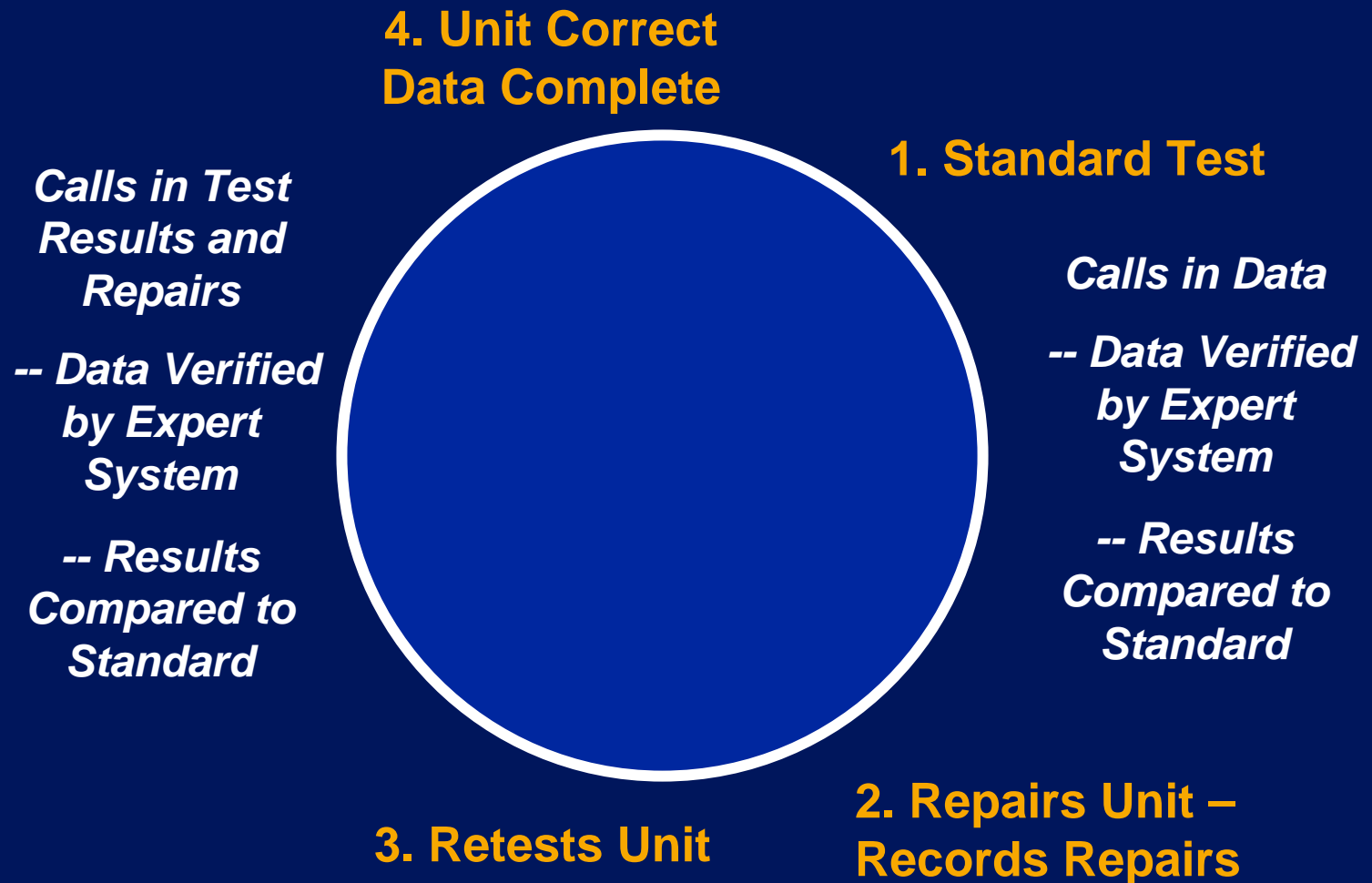
# Maximum Temperature Split Table

Return Air Dry-Bulb (°F)	Return Air Wet-Bulb (°F)													
	50	52	54	56	58	60	62	64	66	68	70	72	74	
70	23.9	23.6	23.1	22.5	21.7	20.7	19.5	18.2	16.7	14.9	13			
72	24.9	24.7	24.2	23.6	22.8	21.8	20.6	19.3	17.7	16	14.1	12		
74	26	25.8	25.3	24.7	23.9	22.9	21.7	20.4	18.8	17.1	15.2	13.1		
76	27.1	26.9	26.4	25.8	25	24	22.8	21.5	19.9	18.2	16.3	14.2	11.9	
78	-	-	27.5	26.9	26.1	25.1	23.9	22.5	21	19.3	17.4	15.3	13	
80	-	-	-	28	27.2	26.2	25	23.6	22.1	20.4	18.5	16.4	14.1	
82	-	-	-	-	28.2	27.2	26.1	24.7	23.2	21.5	19.6	17.5	15.2	
84	-	-	-	-	-	28.3	27.2	25.8	24.3	22.5	20.6	18.6	16.3	

# Temperatures Stabilized & Mixed

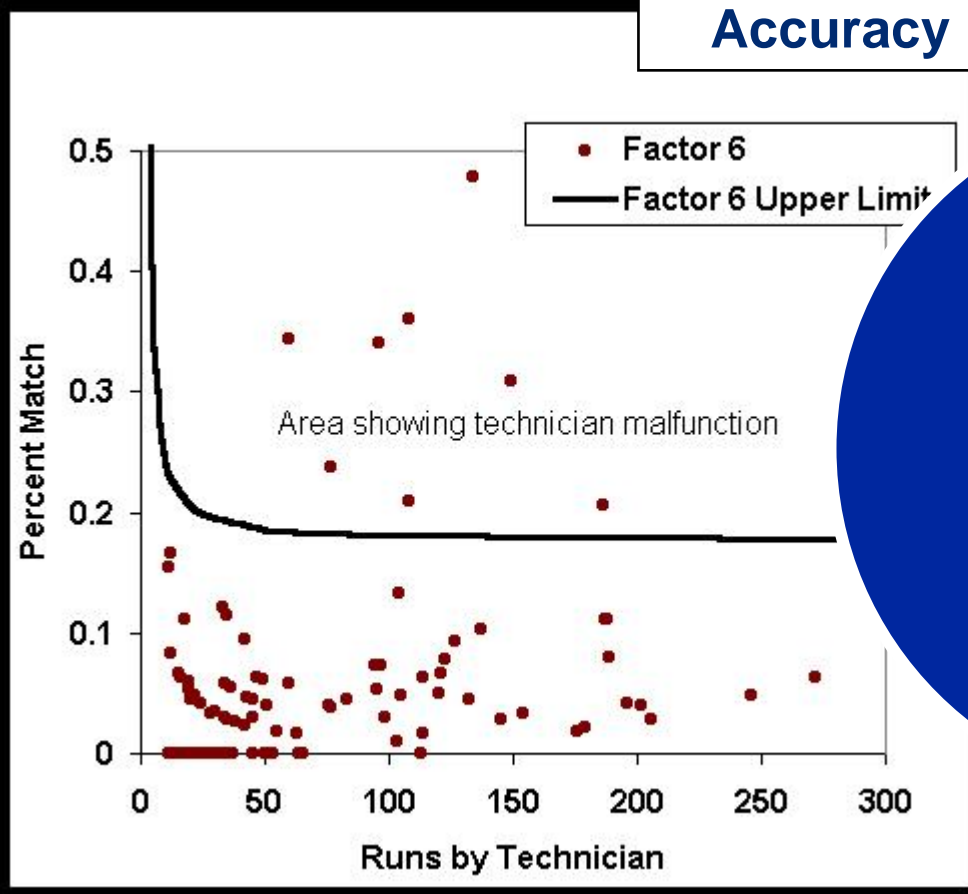


# **“The Rubber Meets the Road”**



# Closed Loop with Customer, Technician, Contractor

Technician Accuracy

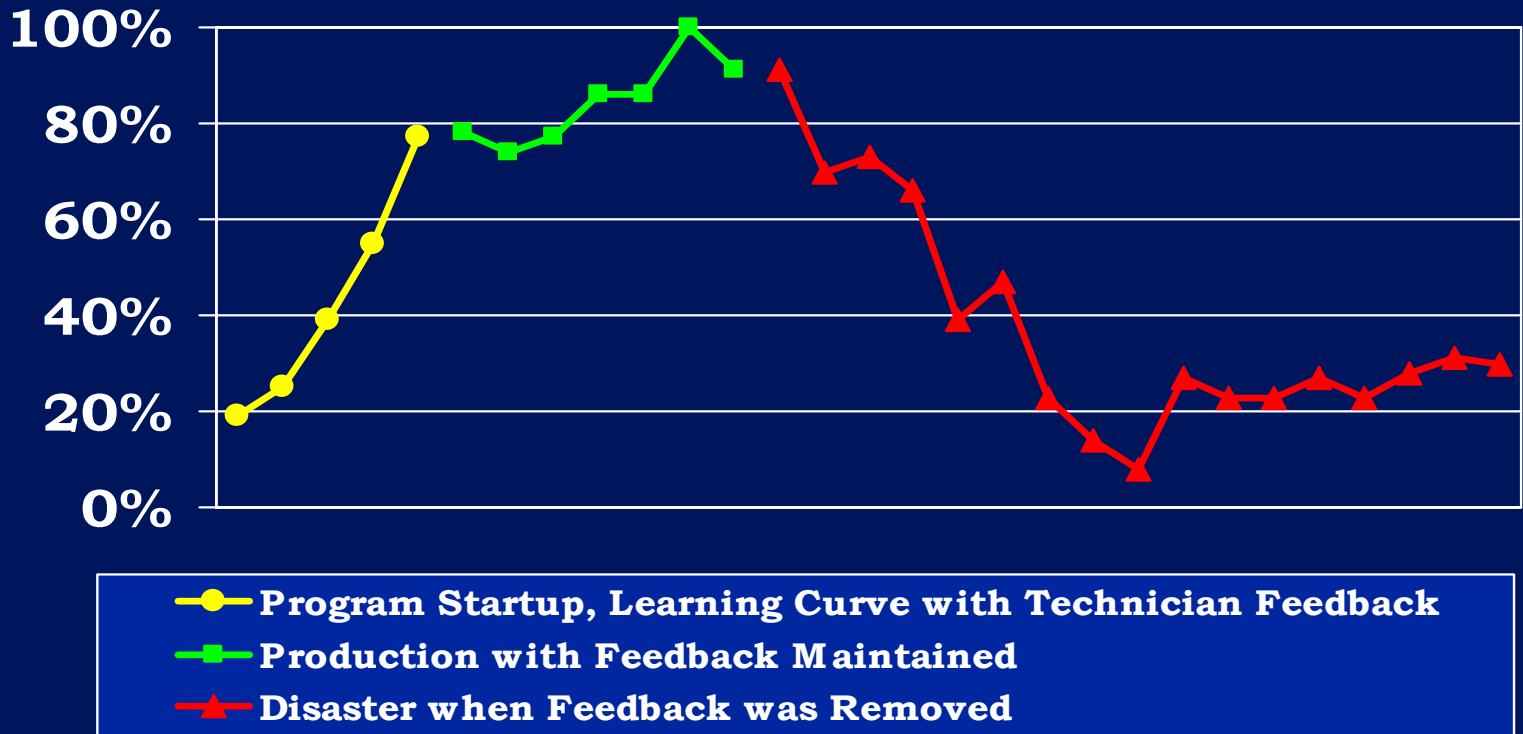


Customer Certificate

Customer Satisfaction Survey

# Feedback and Project Effectiveness

Measured Savings  
as a Percent of Achievable Savings  
(running average)



# **An Air Conditioner Delivers High Efficiency Only If:**

- All the specified equipment is installed usually a “TXV” and a “Time Delay Relay”
- The duct system is well sealed
- The duct system is properly sized for the air flows needed to each room
- The indoor coil is matched with the outdoor unit