# Achieving ENERGY EFFICIENCY with Standard Air-Conditioning Units


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# Standard Air Conditioning Unit

Packaged Unit

Split System

DX (not chilled water)

Air-cooled

# ENERGY EFFICIENCY

- **EER**
  - single point *Energy Efficiency Ratio*
  - MBH per kW
- **SEER** (5 tons and less)
  - *Seasonal Energy Efficiency Ratio*
  - kBtu per kWh
- **IPLV** (10 tons and up)
  - Seasonal *Integrated Part-Load Value*
  - MBH per kW

# FEMP Recommendation*

| Efficiency Recommendation | | |
|---|---|---|
| Product Type[a] and Size | Recommended | Best Available |
| < 65 MBtu/h (3 phase) | 12.0 SEER or more[b] | 14.5 SEER |
| 65 – 135 MBtu/h | 11.0 EER or more<br>11.4 IPLV or more | 11.8 EER<br>13.0 IPLV |
| > 135 – 240 MBtu/h | 10.8 EER or more<br>11.2 IPLV or more | 11.5 EER<br>13.3 IPLV |

**How to Buy an Energy-Efficient Commercial Unitary Air Conditioner*
NOVEMBER 2001

# CEE Recommendation

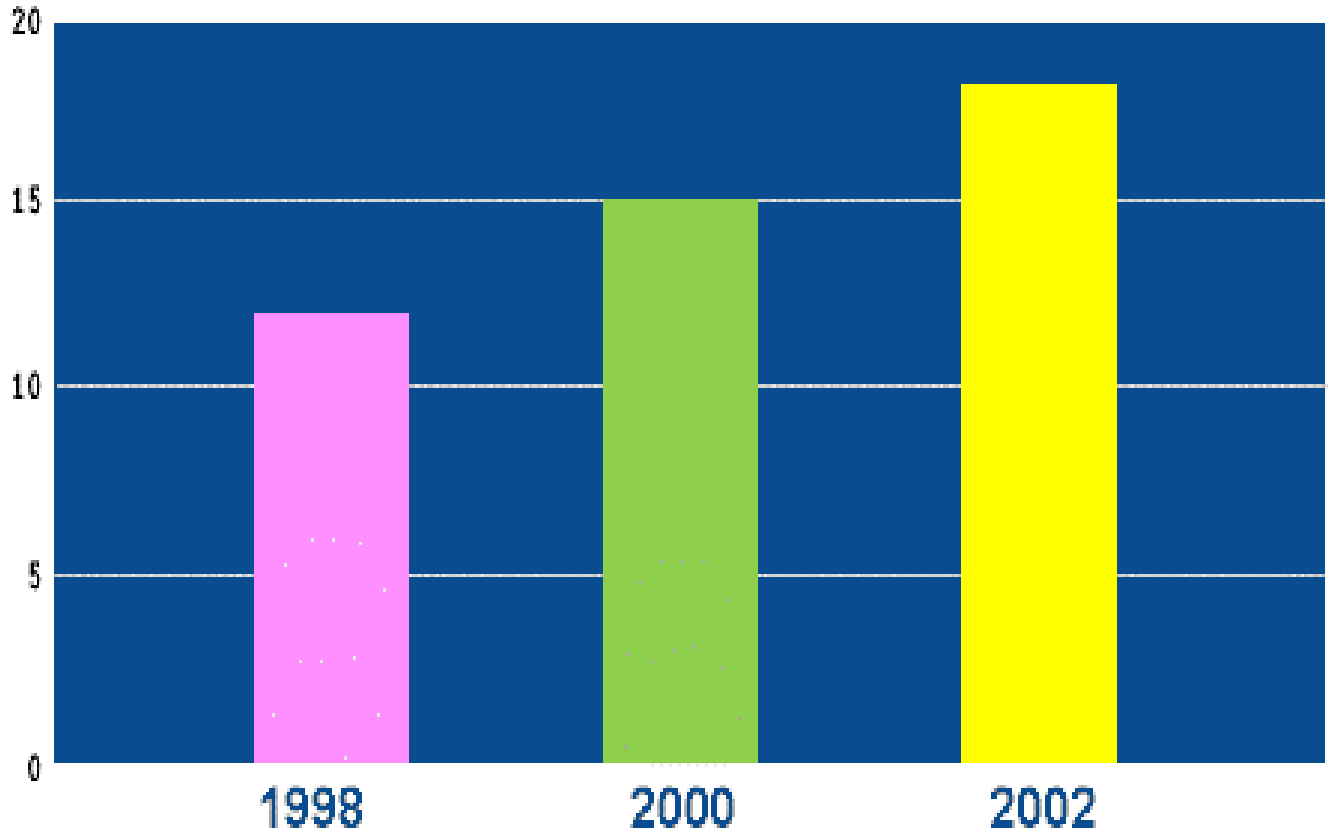
CEE's Tier I level is minimum industry standard. CEE's Tier II is the new "high efficiency" requirement, promoted by ENERGY STAR® and FEMP.

**Minimum Allowable EER Ratings**
MBH per kW

| MBH | 65-135 | 135-240 |
|---|---|---|
| ASHRAE 90.1-1999 (Effective 10/29/2001) | 10.3 | 9.7 |
| CEE - Tier I | 10.3 | 9.7 |
| CEE - Tier II and EPA Energy Star | 11.0 | 10.8 |
| FEMP (as of 1/1/2002) | 11.0 | 10.8 |
| FEMP (after 1/3/2006) | **12.0** | **12.0** |

*MBH = kBtu/hr (1 ton = 12 MBH)*
*(65 = 5.4 tons, 135 = 11.3 tons, 240 = 20 tons)*
*CEE - Consortium for Energy Efficiency*
*EER - Energy Efficiency Rating*
*FEMP – Federal Energy Management Program*

# Percent Meeting CEE Tier II*




*http://www.cee1.org/resrc/updates/02-08hecac/02-08hecac.html

# What is available *today*?

- "Standard Efficiency" IPLV **8.5** to **10.0**
- "High Efficiency" IPLV **9.5** to **14.0**
  - So-called "High Efficiency" unitary products are 10% to 40% more energy efficient than "Standard Efficiency."

**Systems 5-tons and smaller are as high as SEER 18**

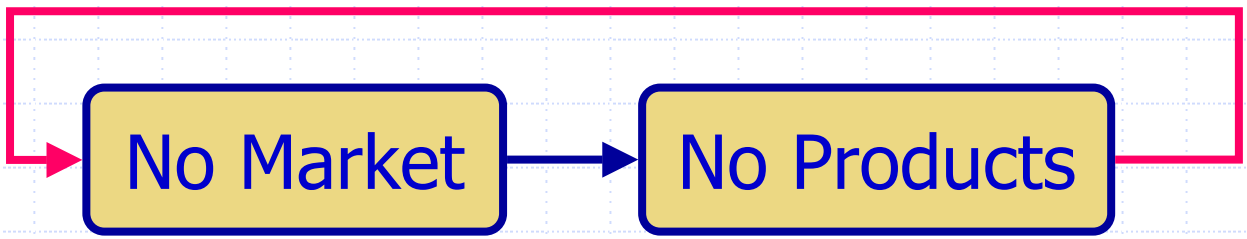
**Water cooled-chiller systems are as high as IPLV 20**

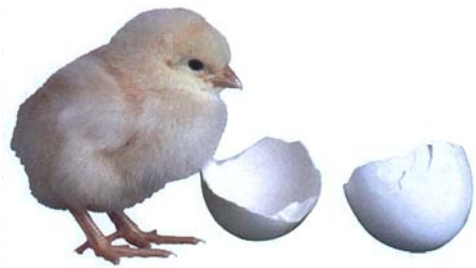
# "High Efficiency … "

… is really not very high

… is 20% to 60% **LESS efficient** than the best

- small split systems
- water cooled chiller systems
- they could be made *(given a market)*



# Achieving ENERGY EFFICIENCY

- CAPACITY / SIZE
- SYSTEM DESIGN
- MODEL SELECTION
- INSTALLATION
- DUCTS
- OPERATION
- MAINTENANCE

# CAPACITY / SIZE

Avoid Over-sizing

- Frequent cycling shortens component life
- Efficiency ratings are at steady-state
- Costs more & uses more power

*Example: compare power draws of 2 units*

15 ton: 15.7 kW

17½ ton: 18.9 kW

Added electric demand of 3.2 kW ~ $300 per year

Insist that documented sizing calculations be performed using accepted ACCA or ASHRAE procedures. ACCA methods have sufficient built-in safety factors. Use ASHRAE design conditions.

# SYSTEM DESIGN

- Use manufacturer's performance tables to determine real unit capacity (not nominal rating)
  - Select the model closest in capacity to the load
- Specify that TAB shall include supply air CFM, fan RPM, External SP, and EAT–LAT
- OA CFM must meet ASHRAE 62, provide exhaust makeup, *and* pressurize the building 0.02 to 0.04 in.wg [5 to 10 Pa]
- Consider price to avoid value-*un* engineering

# SYSTEM DESIGN

- Factory Equipment Options
  - Filter pressure drop sensor
  - Motorized fresh-air damper with Economizer
  - Communications interface
  - ~~High Static Drive~~ – Use *static regain* duct design
- After-market Add-ons
  - ***LPA*** liquid pressure amplification
  - ***EER-Plus*** desuperheater / subcooler

# MODEL SELECTION

- Efficiency Rating (IPLV, SEER, or EER)
- Fan motor efficiency rating
  - Fan is 10 to 20% of unit power draw [kW]
  - Fan is 20% to 50% of unit energy usage [kWh]
- Number of Stages
- Ease of Maintenance
- Price

# MODEL SELECTION

## ROOFTOP AIR CONDITIONING SCHEDULE

| RAC NO. | SERVING | FAN | | | COOLING | | | | HEATING | | | | ELECTRIC | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CFM | O.A. CFM | E.S.P. (IN. W.C.) | EAT DB/WB (F) | AMB. AIR (F) | SENS. CAP. (MBH) | TOT. CAP. (MBH) | EAT (F) | REQD. CAP. (MBH) | GAS INPUT (MBH) | PIPE SIZE (IN) | INDOOR FAN (HP) | EER RATINGS | COMPRESSOR | OUTDOOR FAN (FLA) | VOL |
| 1 THRU 8 | SALES AREA | 9000 | 3800 | 0.5 | 83.6/69.7 | 95 | 215 | 306 | ----- | ----- | ----- | ----- | 7.5 | 10.0 | (4) @ 9.0 EACH (RLA) | (6) @ 7.8 EACH | 4 |
| 9 | OFFICE MEZZANINE | 2400 | 0.80 | 0.5 | 77.8/64.3 | 95 | 58.6 | 73.2 | 64.0 | 62.4 | 78.0 | NOTE 1 | 1.5 | 9.5 | 8.2 | 8.2 | 4 |

NOTES :
1. REFER TO GAS PIPING RISER DIAGRAMS FOR PIPE SIZES.

## SPLIT SYSTEM HEAT PUMP SCHEDULE

| SSHP NO. | SERVING | FAN | | | COOLING | | | | HEATING | | | OUTDOOR UNIT ELECTRIC | | | MANUFACTURER OUTDOOR UNIT / INDOOR UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CFM | S.P. (IN.W.C.) | MIN. O.A. CFM | EAT DB/WB (F) | AMB. AIR (F) | SENS. CAP. (MBH) | TOT. CAP. (MBH) | EAT (F) | REQD CAP. (MBH) | RESIST. HTR.ELEC. (KW,VOLTS-PH) | FAN (FLA) | COMP (RLA) | VOLTS-PH | |
| 1 | TIRE SALES | 480 | 0.15 | 40 | 76.8/63.8 | 95 | 14.5 | 17.0 | | | 3.0, 208-1 | 0.8 | 12.0 | 208-1 | CARRIER 58QKE024 |
| 2 | RECEIVING OFFICE | 480 | 0.15 | 40 | 76.8/63.8 | 95 | 14.5 | 17.0 | | | 3.0, 208-1 | 0.8 | 12.0 | 208-1 | CARRIER 58QKE024 |
| 3 | COMPUTER OFFICE | 480 | 0.15 | 40 | 76.8/63.8 | 95 | 14.5 | 17.0 | | | 3.0, 208-1 | 0.8 | 12.0 | 208-1 | CARRIER 58QKE024 |

**NOTE:**

1. REFRIGERANT PIPE SIZES SHALL BE AS RECOMMENDED BY EQUIPMENT MANUFACTURER.
2. COOLING AND HEATING CAPACITIES LISTED ARE CALCULATED REQUIRED CAPACITIES.
3. INDOOR SECTIONS OF SSHP-2 AND SSHP-3 SHALL BE WALL MOUNTED.
4. PROVIDE LOW AMBIENT CONTROLS FOR EACH UNIT.

# MODEL SELECTION

ROOFTOP

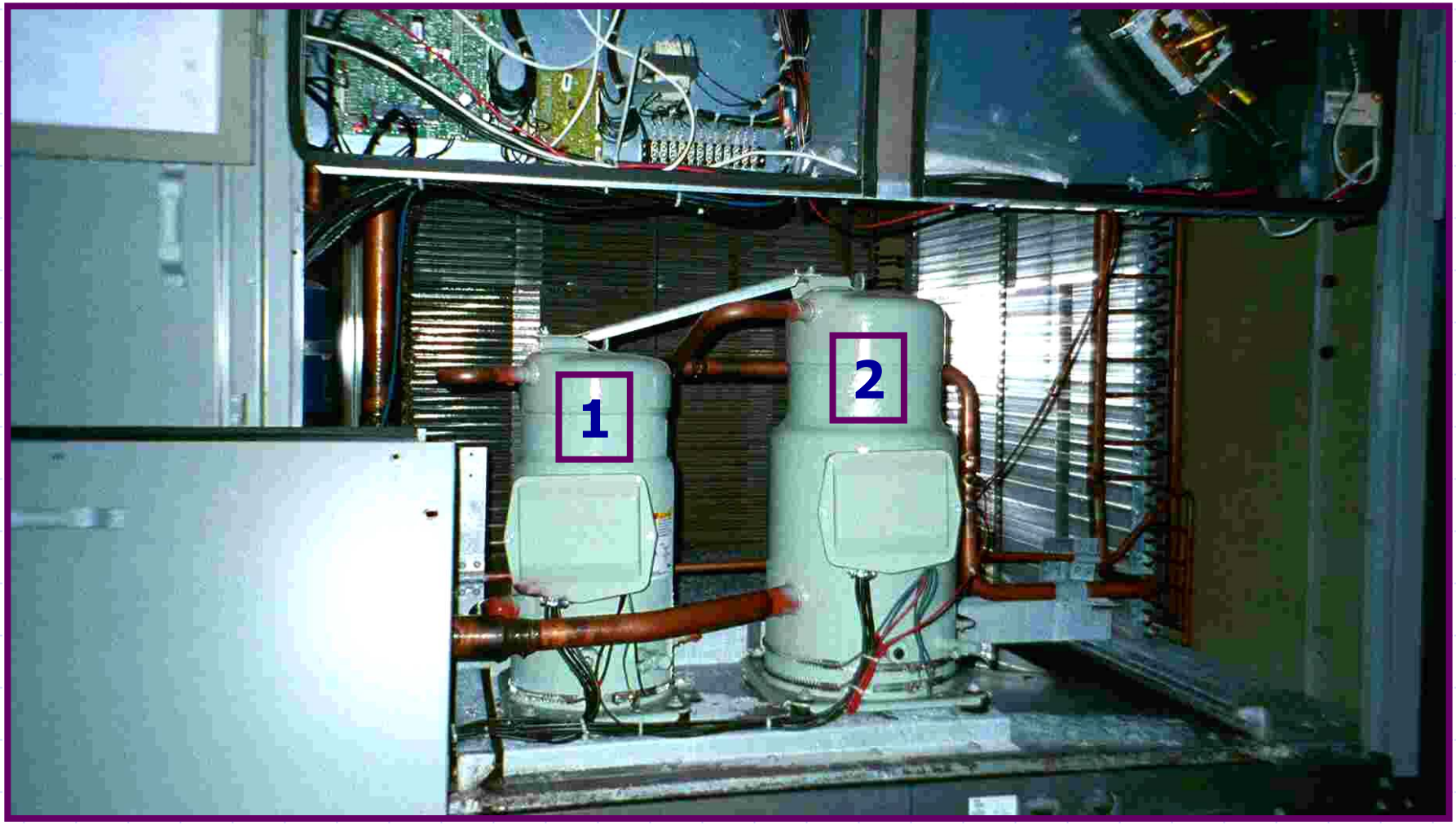
| FAN | | | COOLING | | | | |
|---|---|---|---|---|---|---|---|
| CFM | O.A. CFM | E.S.P. (IN. W.C.) | EAT DB/WB (F) | AMB. AIR (F) | SENS. CAP. (MBH) | TOT. CAP. (MBH) | |
| 9000 | 3800 | 0.5 | 83.6/69.7 | 95 | 215 | 306 | - |
| 2400 | 0.80 | 0.5 | 77.8/64.3 | 95 | 58.6 | 73.2 | |

ULE

| EER RATING |
|---|
| 10.0 |
| 9.5 |

# MODEL SELECTION

This unit has 2-compressors, but only 1 refrigerant circuit

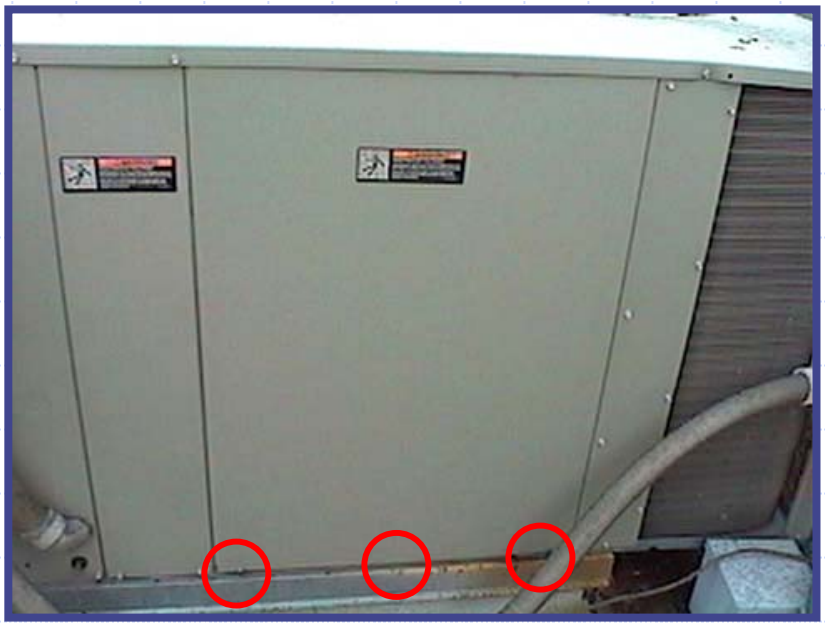


# MODEL SELECTION

This unit has 4 compressors, but only 2 control stages

# MODEL SELECTION

## Ease of Maintenance

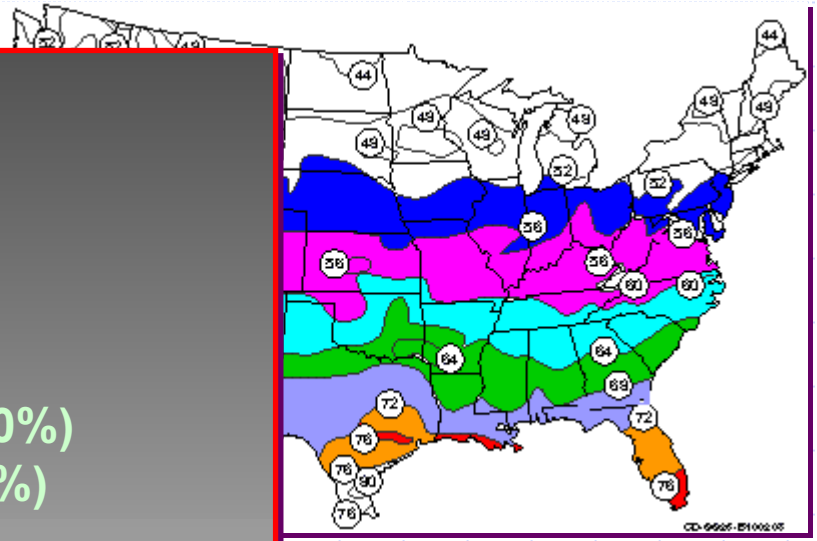


vs.

# MODEL SELECTION

*Dual Source* - the energy efficiency of ground-source with the low first cost of air-source

- Uses ground-coupling to extend the delta-T available from ambient air




**Application Example:**
**MS Naval Training Classroom Building**

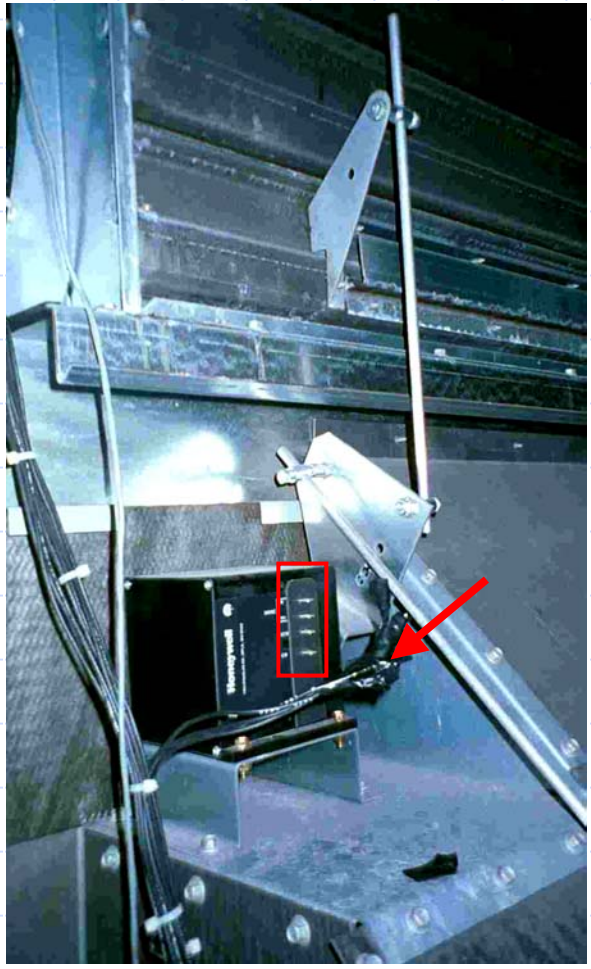
24,730 square feet
Two 35-ton Roof Top Package Units

**Electric Cost:**
STANDARD AC: $17,600
DUAL-SOURCE: $12,400 (30%)
GEOTHERMAL: $8,000 (55%)

**Installed Cost / Payback**
STANDARD AC: $30,000
DUAL-SOURCE: $49,000 / 3.6 years
GEOTHERMAL: $125,000 / 9.9 years

# INSTALLATION

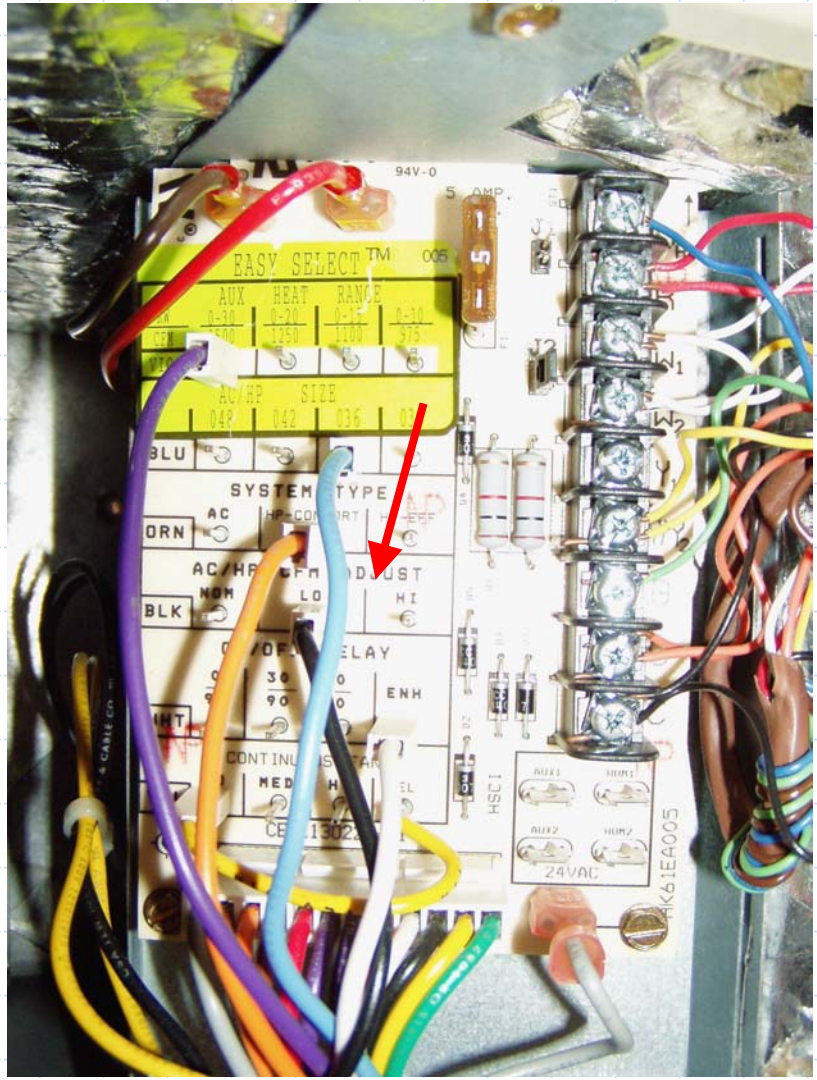
## Motorized Fresh-air damper with Economizer



# INSTALLATION

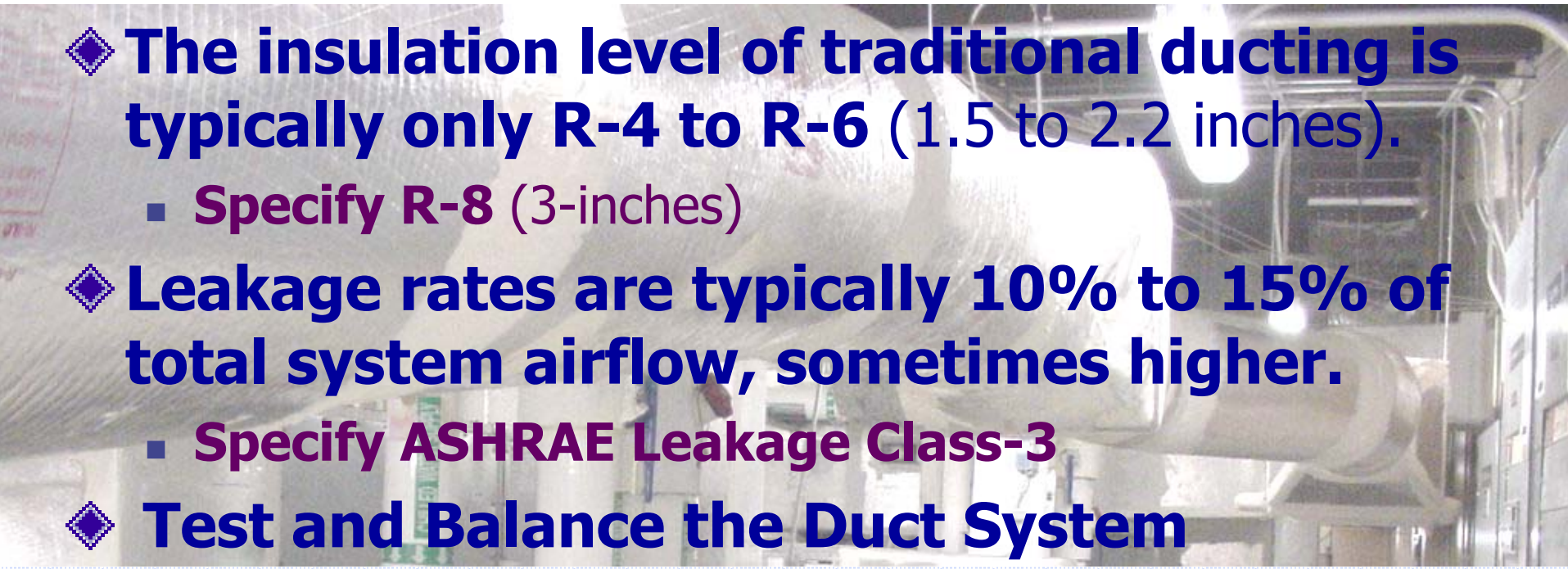
Operating EER can vary up or down by one point with the fan speed setting and proper matching of indoor and outdoor unit sections.

**Check these details to ensure the rated EER is realized.**



# DUCTS

Air leakage and heat gain rob air-conditioning system efficiency.



- **The insulation level of traditional ducting is typically only R-4 to R-6** (1.5 to 2.2 inches).
  - **Specify R-8** (3-inches)
- **Leakage rates are typically 10% to 15% of total system airflow, sometimes higher.**
  - **Specify ASHRAE Leakage Class-3**
- **Test and Balance the Duct System**

# OPERATION

- Select a thermostat that will retain settings through a power outage, and that has a lockout or adjustment limits
- Program temperatures and occupied / unoccupied periods

# MAINTENANCE

… critical to realizing rated EER for the life of the unit

# MAINTENANCE

- Numerous energy surveys clearly show that ***lack of preventative maintenance is by far the major cause of air conditioning energy waste in FEDERAL buildings***.
- Common and costly problems include:
  - clogged, corroded cooling and condenser coils
  - sizeable duct leaks and cabinet air leaks
  - low refrigerant, *even in brand-new units*
  - maladjusted air dampers
  - un-calibrated or nonfunctioning thermostats

# RECOMMENDED ACTION PLAN

1. **Determine** the **actual operating efficiency** of installed equipment. Compare with the best new equipment.
2. Identify units that are **candidates for replacement**
   - if existing EER is 4 or more points less than the best new units.
3. Identify units that are **candidates for upgrades**
   - existing EER is 2 to 4 points less than the best new units.
4. Identify units for a **thorough** preventative maintenance **check and tune-up** when the existing EER is within 2 points of the best available units.

# Achieving ENERGY EFFICIENCY With Standard Air-Conditioning Units

Thank you!

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