The Effects of Neglected Maintenance

The table below shows the results of a study conducted by Southern California Edison (SCE) in 2010. Neglecting maintenance for these HVAC unit core components account for 10% of A/C energy use.*

Dirty Air Filter	**Cooling Capacity**	**Efficiency**	
	Reduced by as much as 30%	EER reduced by as much as 20%	
Fouled Evaporator Coil	**Cooling Capacity**	**Efficiency**	
	Reduced by as much as 40%	EER reduced by as much as 35%	
Fouled Condenser Coil	**Cooling Capacity**	**Efficiency**	**Power**
	Reduced by as much as 40%	EER reduced by as much as 60%	Compressor power increased by as much as 70%

*The information in this table is taken from the following SCE study excerpts.

HVAC - Maintenance and Technologies

Federal Utility Partnership Working Group Meeting

Providence, Rhode Island

April 15, 2010

BY

Ramin Faramarzi, P.E.

Technology Test Centers (TTC)

Design and Engineering Services

Southern California Edison (SCE)

www.sce.com/rttc

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Outline

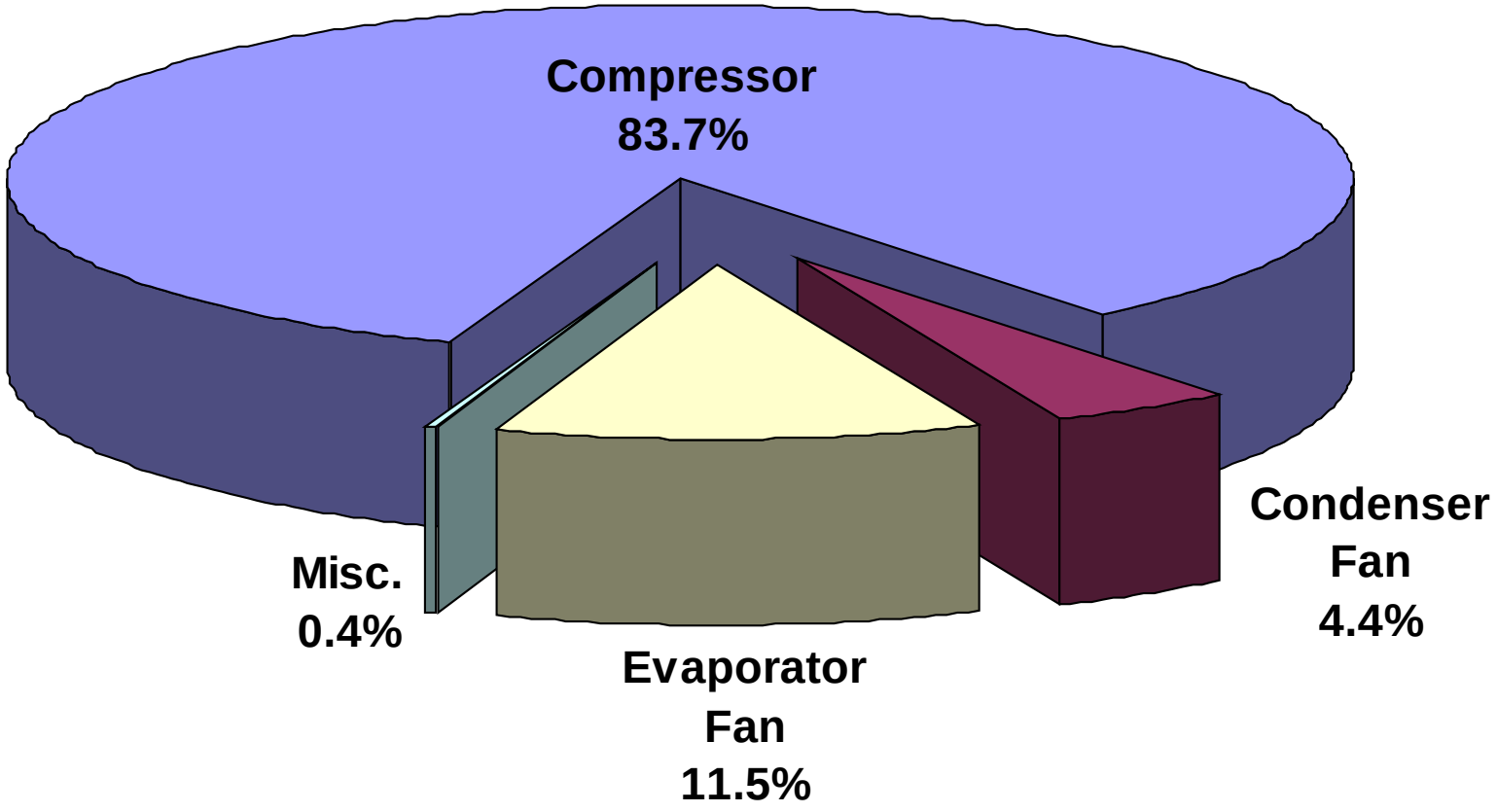
- Introduction to SCE's TTC
- Overview of energy challenges in California (CA)
- Role of HVAC in CA's energy and demand equations
- Factors affecting HVAC performance
  - Focus on SCE's research on maintenance faults
- Next generation of HVAC equipment
- HVAC technologies on SCE's TTC radar
- Black boxes – do they all work?

California and HVAC Facts...

- Peak electric demand nearly ~50,000 MW and is increasing ~1-3.5% annually
- Air conditioning constitutes ~30% of CA's peak electric load
- Air conditioner compressor consumes the most power
- Compressor power consumption increases when the ambient temperature is high
- Overlooked maintenance accounts for ~ 10% of A/C energy use
- Refrigerant leakage from A/C units is equivalent to 8.8 million metric tons of CO_2 per year

Typical RTU Power Demand

(SCE's test data measured for ARI 115°F ambient test – average of six units)

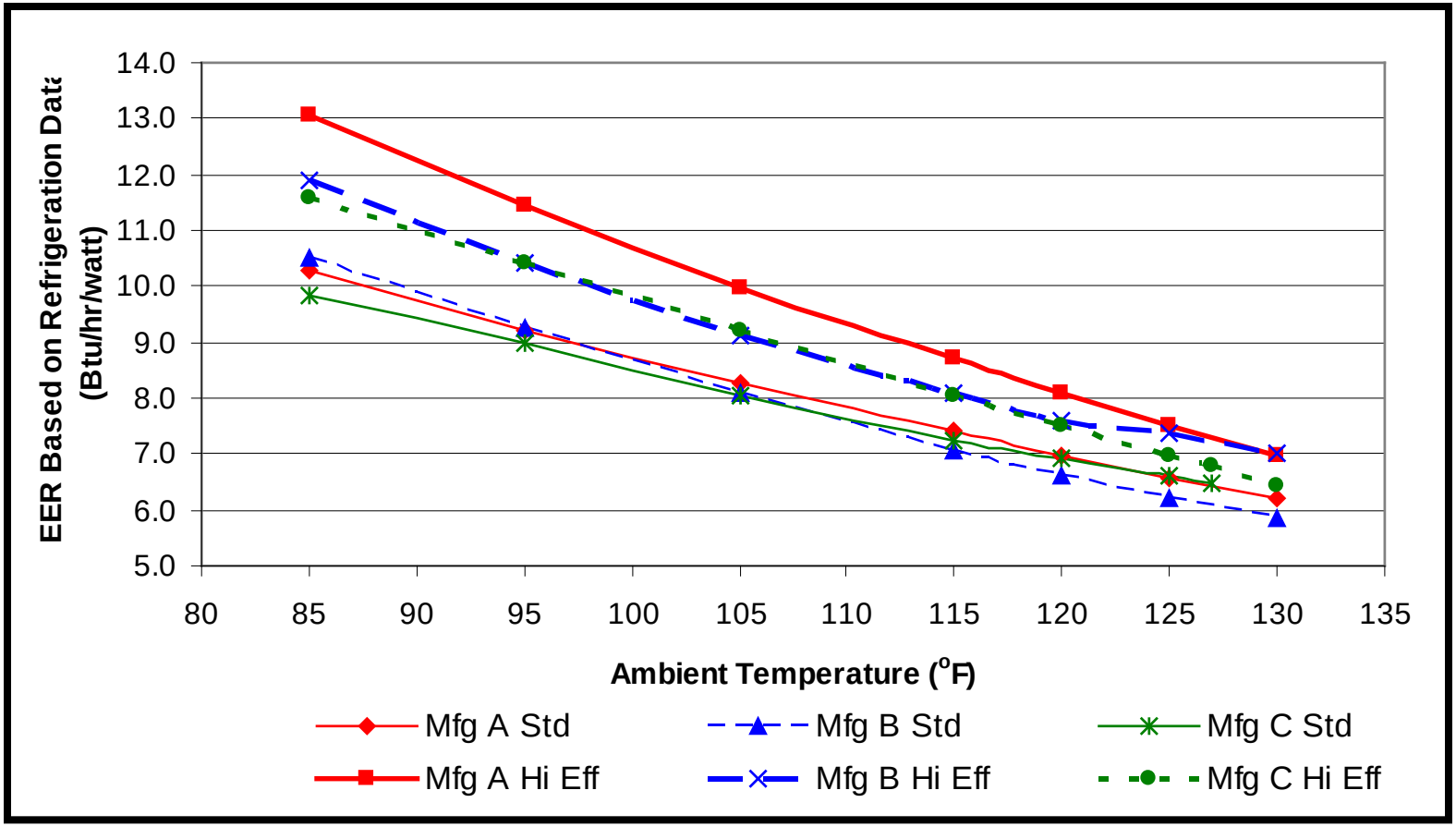


Key Parameters Affecting HVAC Performance

- Ambient Conditions
- Maintenance
- Effectiveness of energy efficiency features

Effects of High Ambient Temp on EER

(SCE's test results)



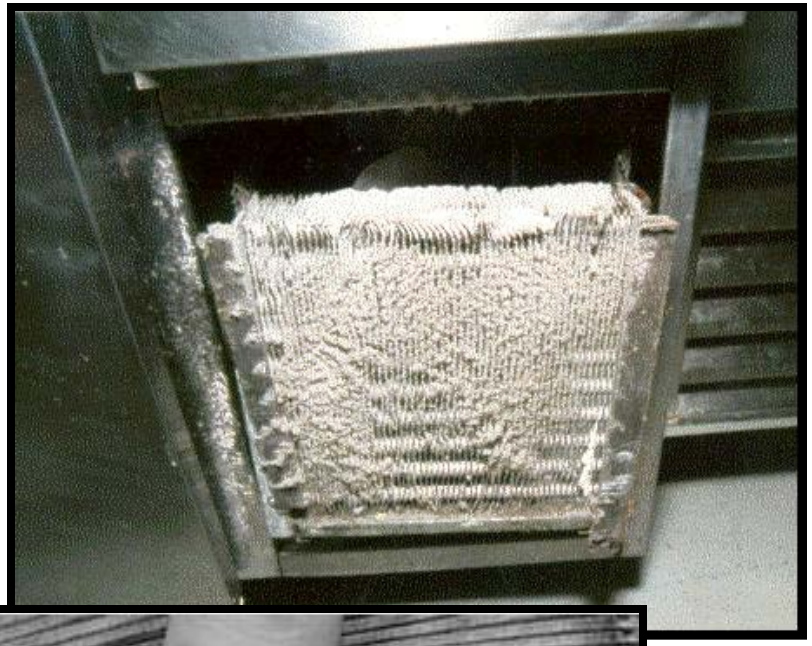
- At high ambient temperatures:
  - Compressor power increases
  - Cooling capacity decreases

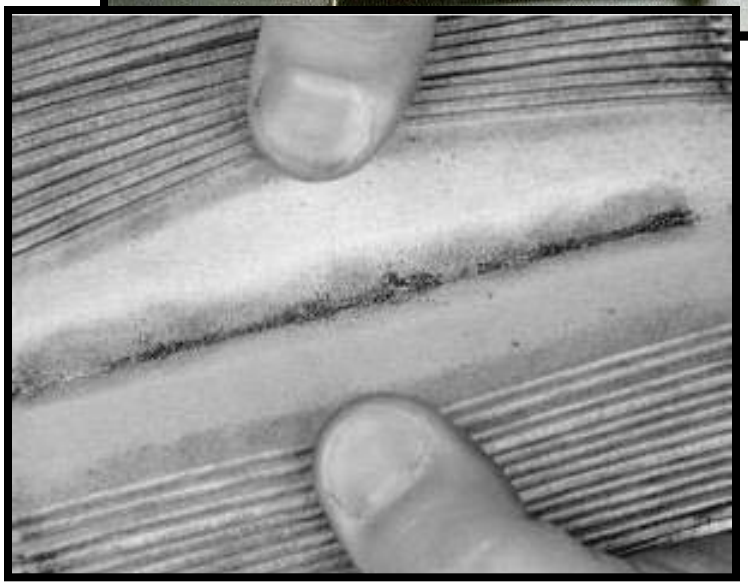
Effects of Overlooked Maintenance

(based on tests conducted at SCE's TTC)

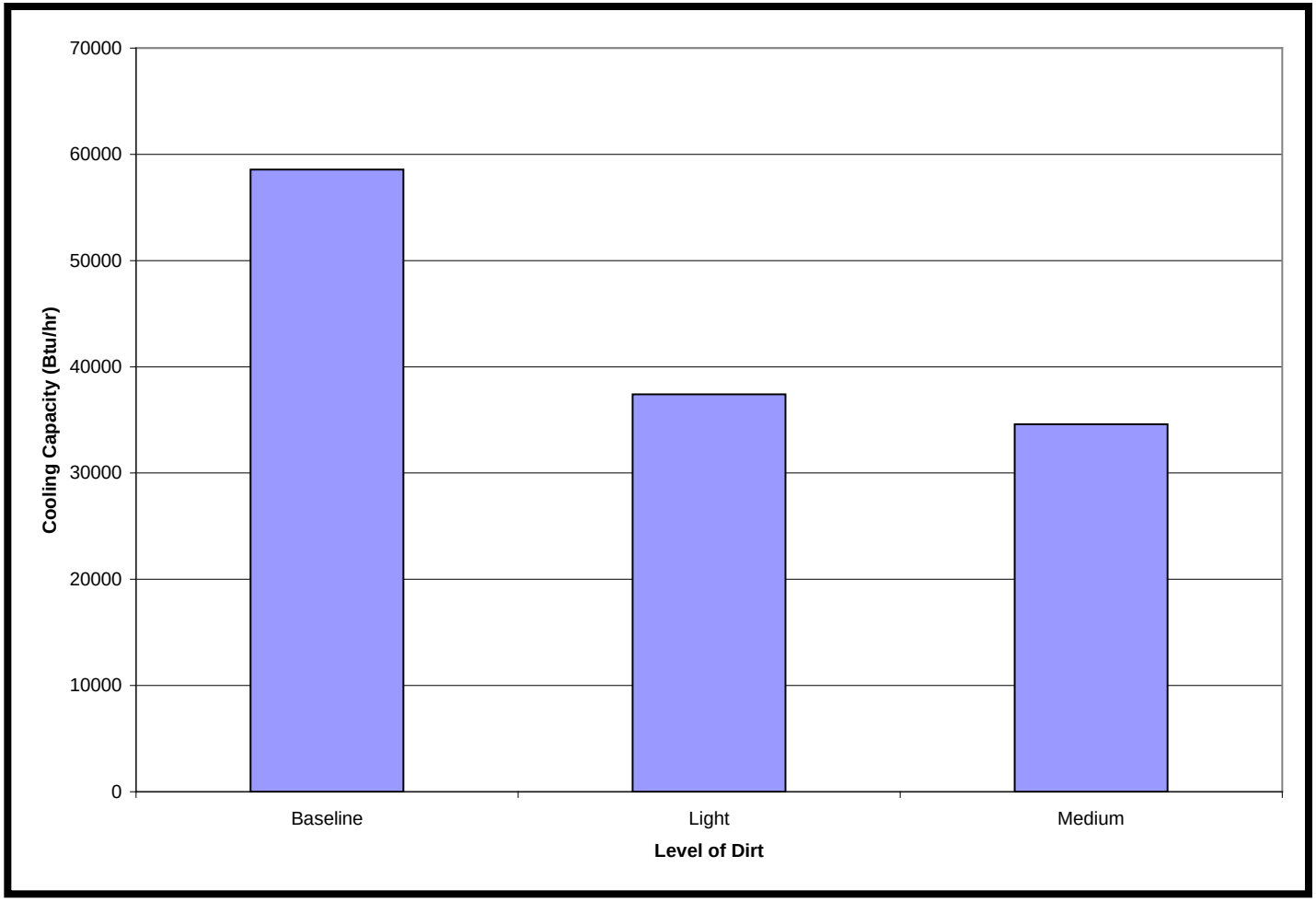
Common HVAC Faults

- Dirty evaporator coils
- Dirty air filters
- Dirty condenser coils
- Improper refrigerant charges
- Malfunctioning economizers
- Incorrect fan settings
- Refrigerant line cloggage



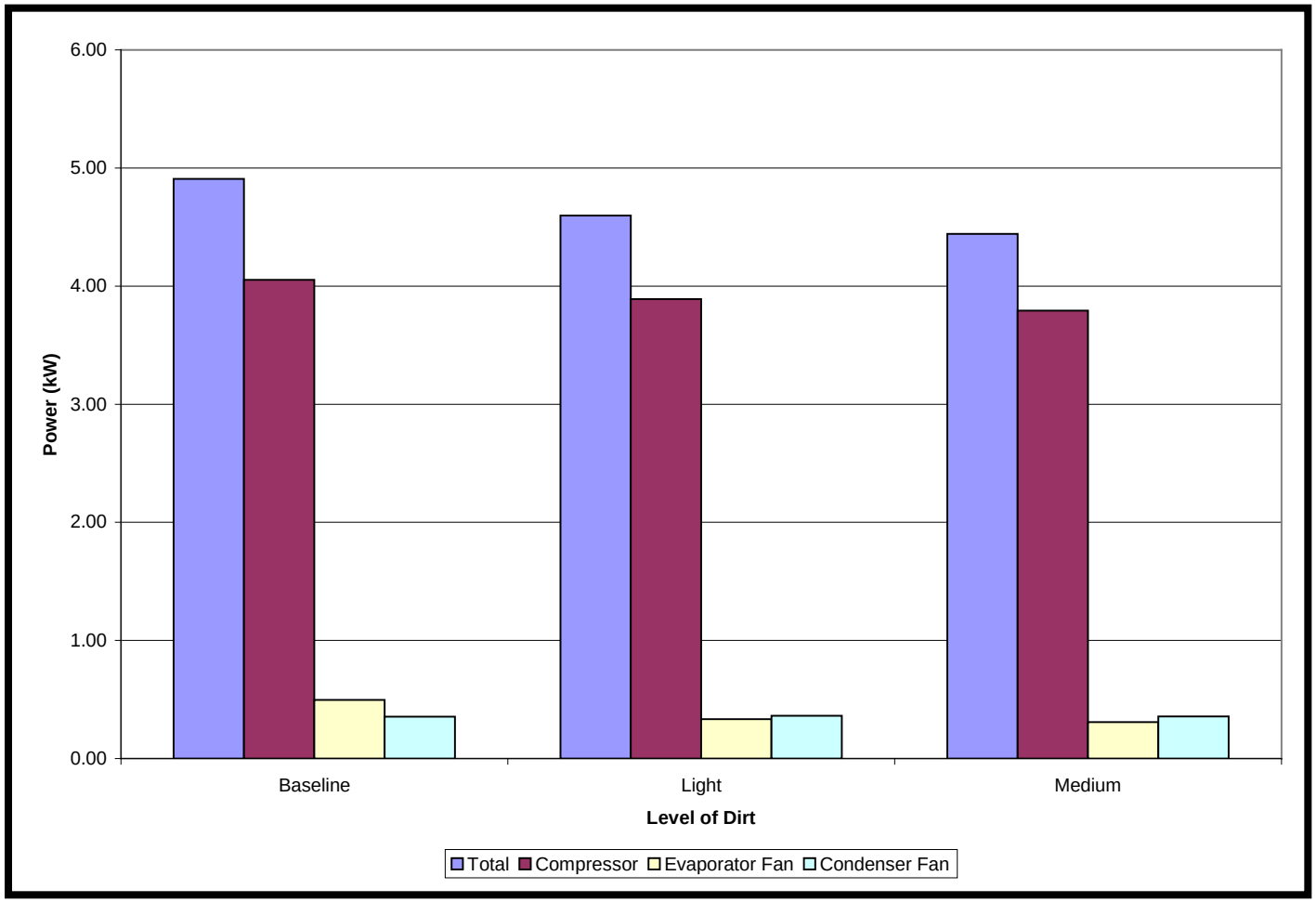


Dirty Evaporator Coil Impact on Cooling Capacity



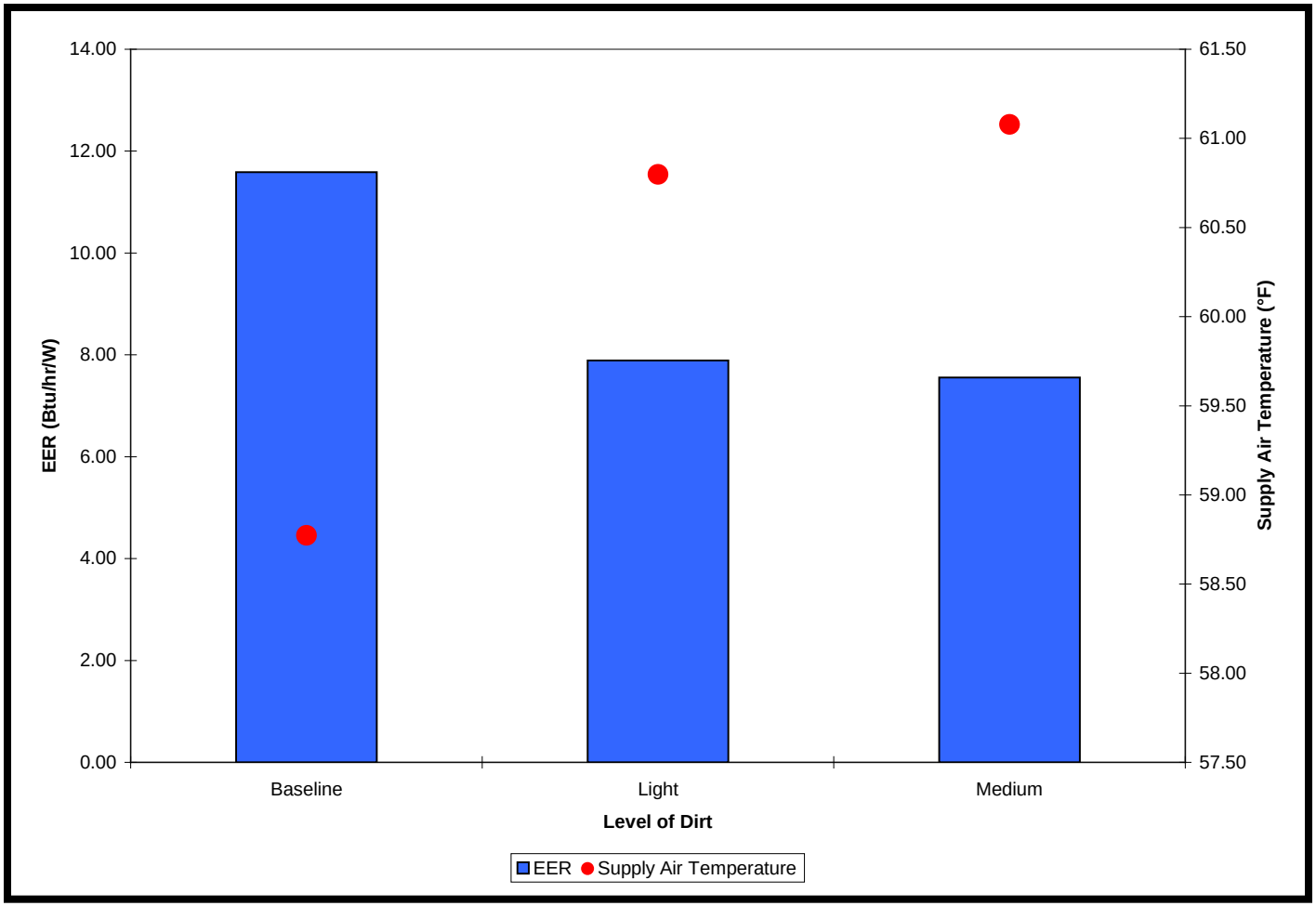
- Cooling capacity was degraded by as much as ~40%

Dirty Evaporator Coil Impact on Power



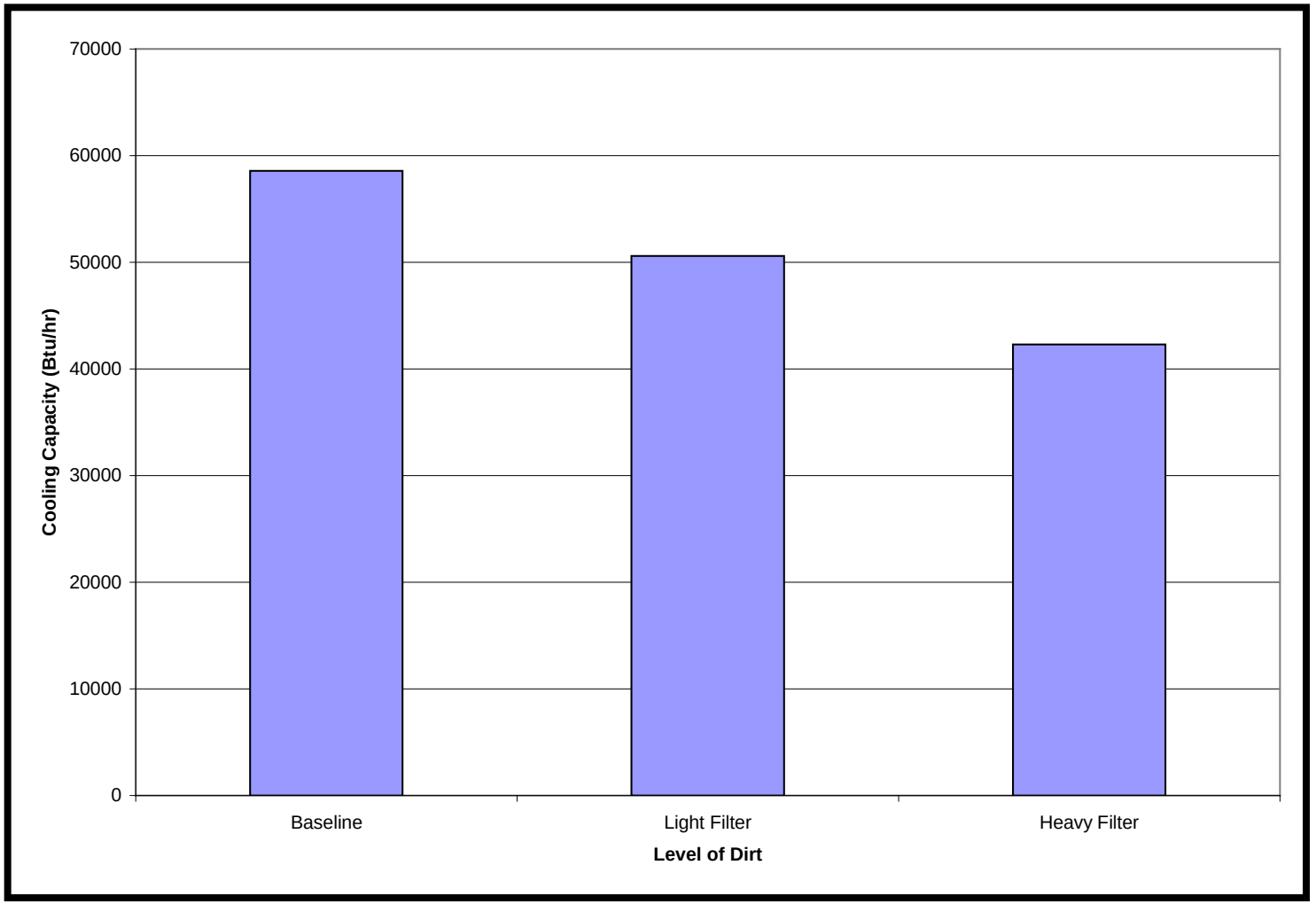
- Compressor power was reduced by as much as ~7%
- Evaporator fan power was reduced by as much as ~40%
  - Supply CFM was reduced by ~75% due to evaporator cloggage

Dirty Evaporator Coil Impact on Efficiency and Supply Air Temperature



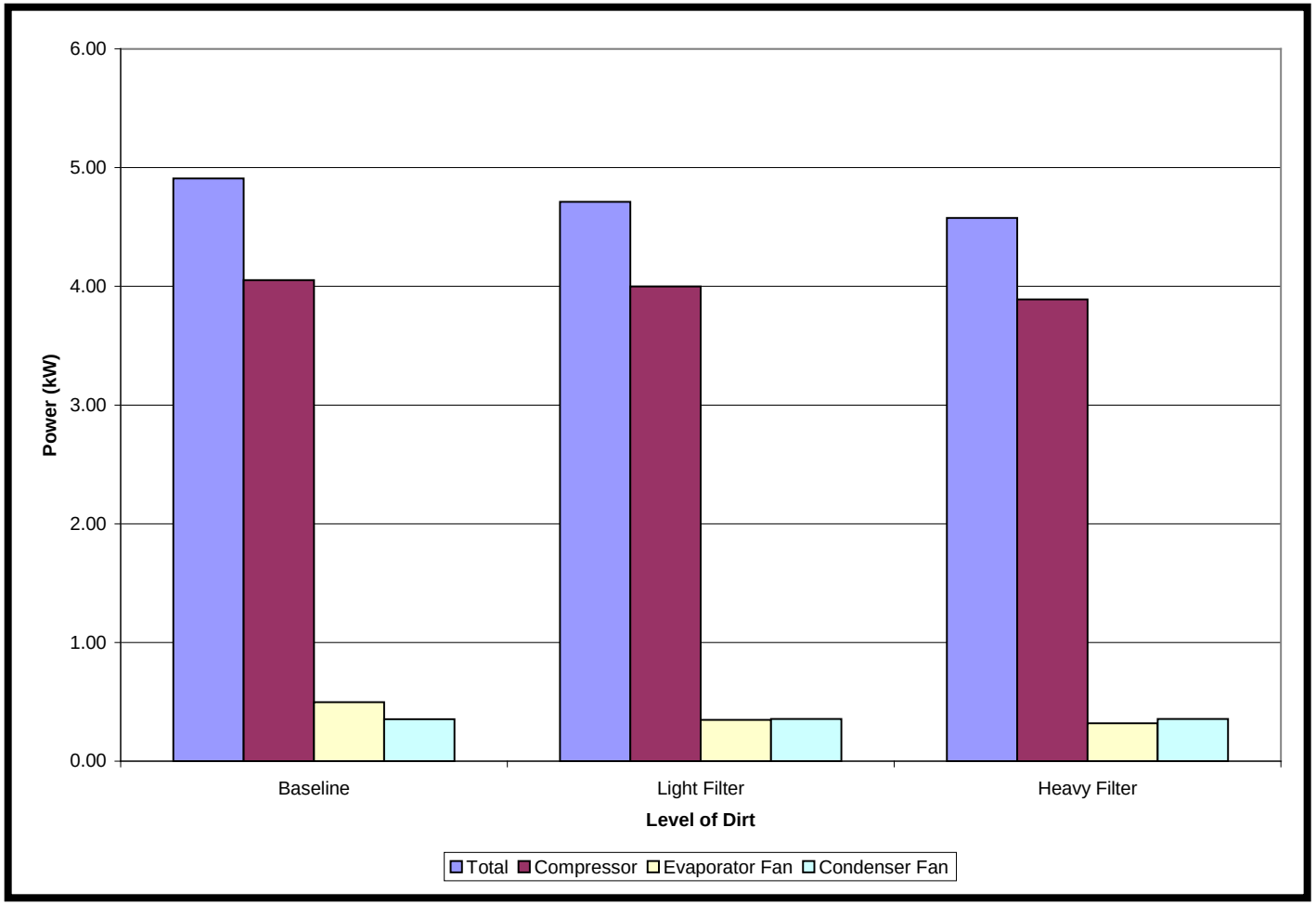
- EER was reduced by as much as ~35%
- Supply air temperature was increased by ~2ºF

Dirty Air Filter Impact on Cooling Capacity



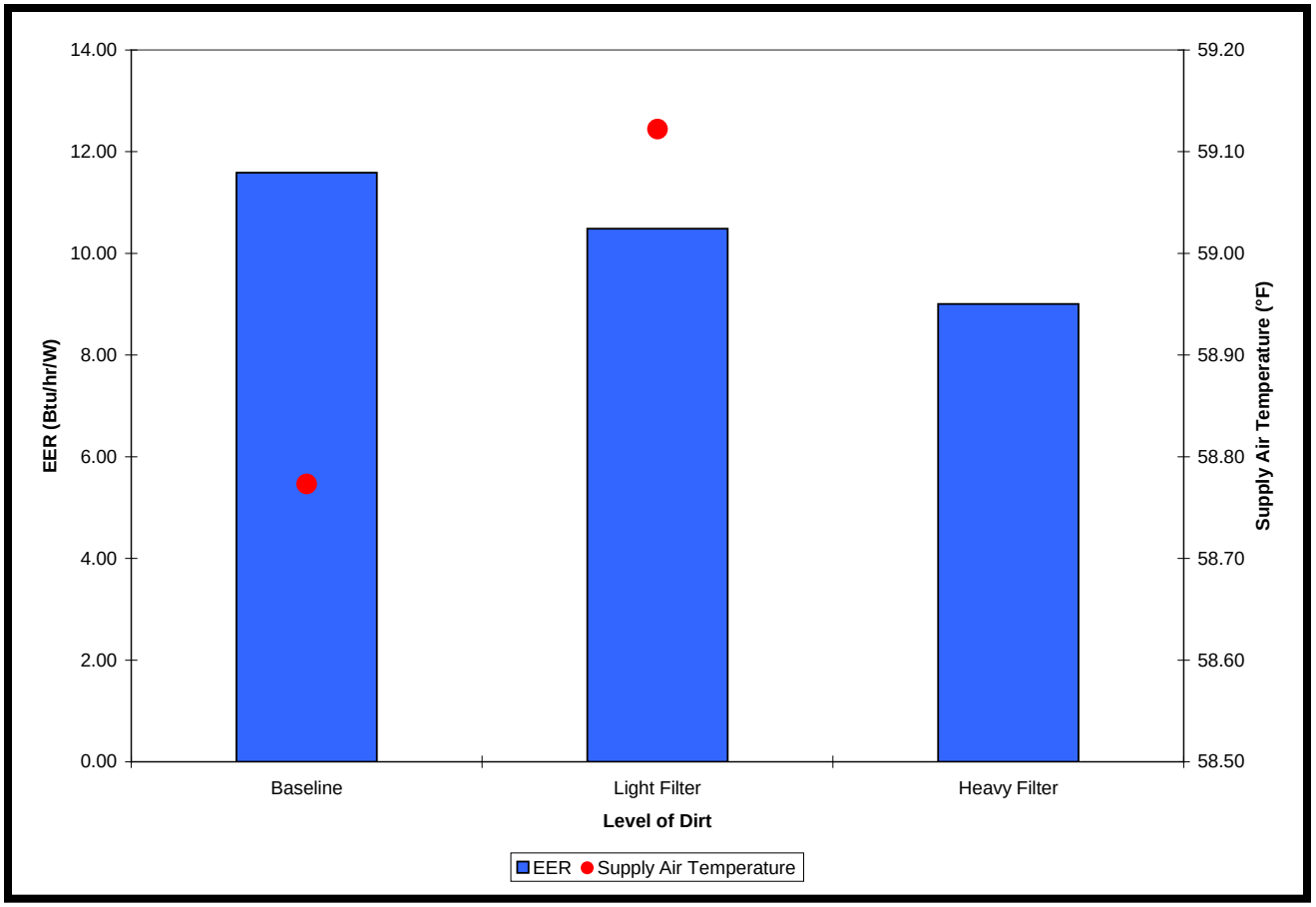
- Cooling capacity was degraded by as much as ~30%

Dirty Air Filter Impact on Power



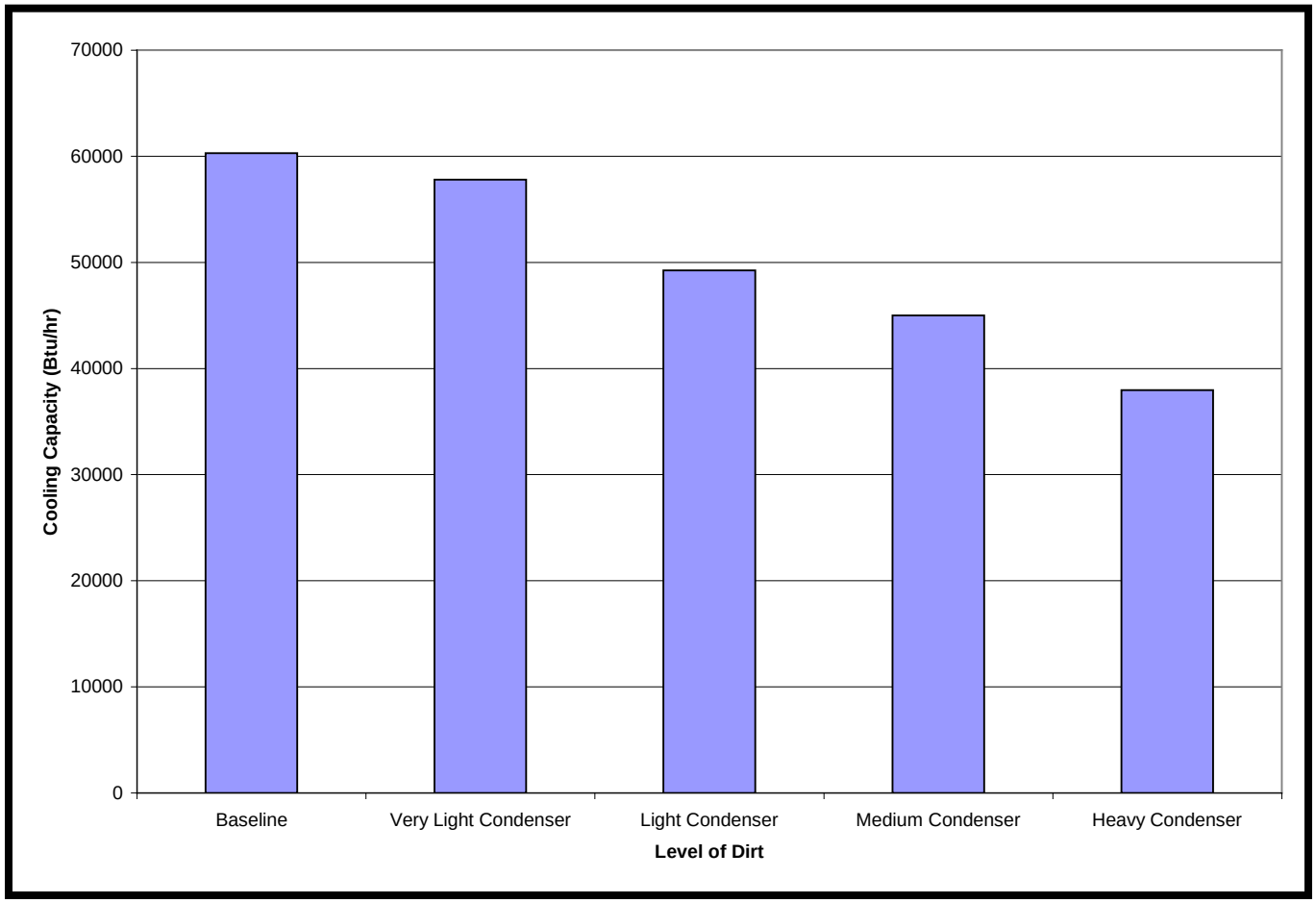
- Compressor power was reduced as much as ~4%
- Evaporator fan power was reduced by as much as ~35%
- Condenser fan power remained constant

Dirty Air Filter Impact on Efficiency and Supply Air Temperature



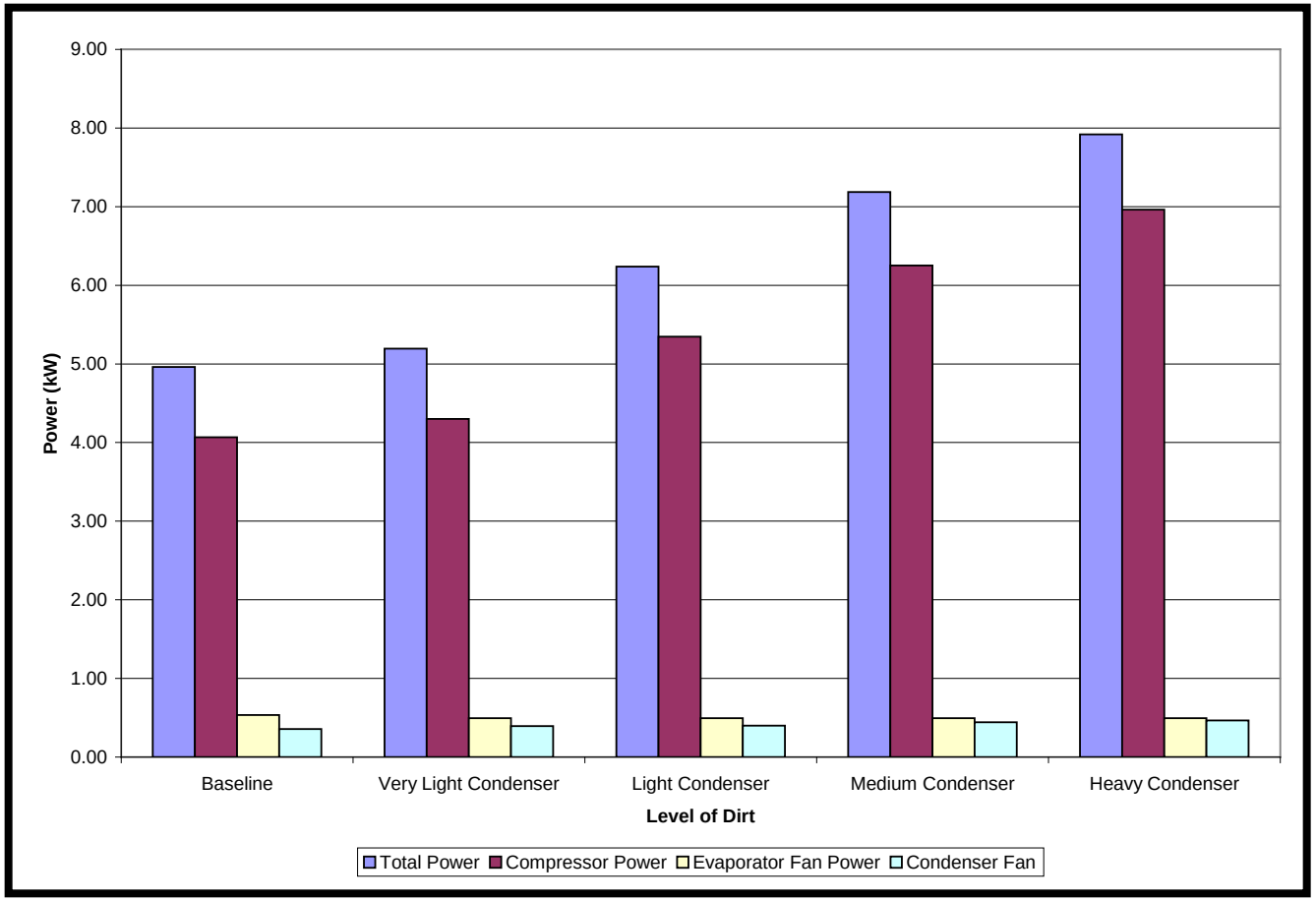
- EER was reduced by as much as ~20%
- SAT was increased ~0.5ºF at the light condition, at grater levels of dirt this data determined to not be valid

Dirty Condenser Coil Impact on Cooling Capacity



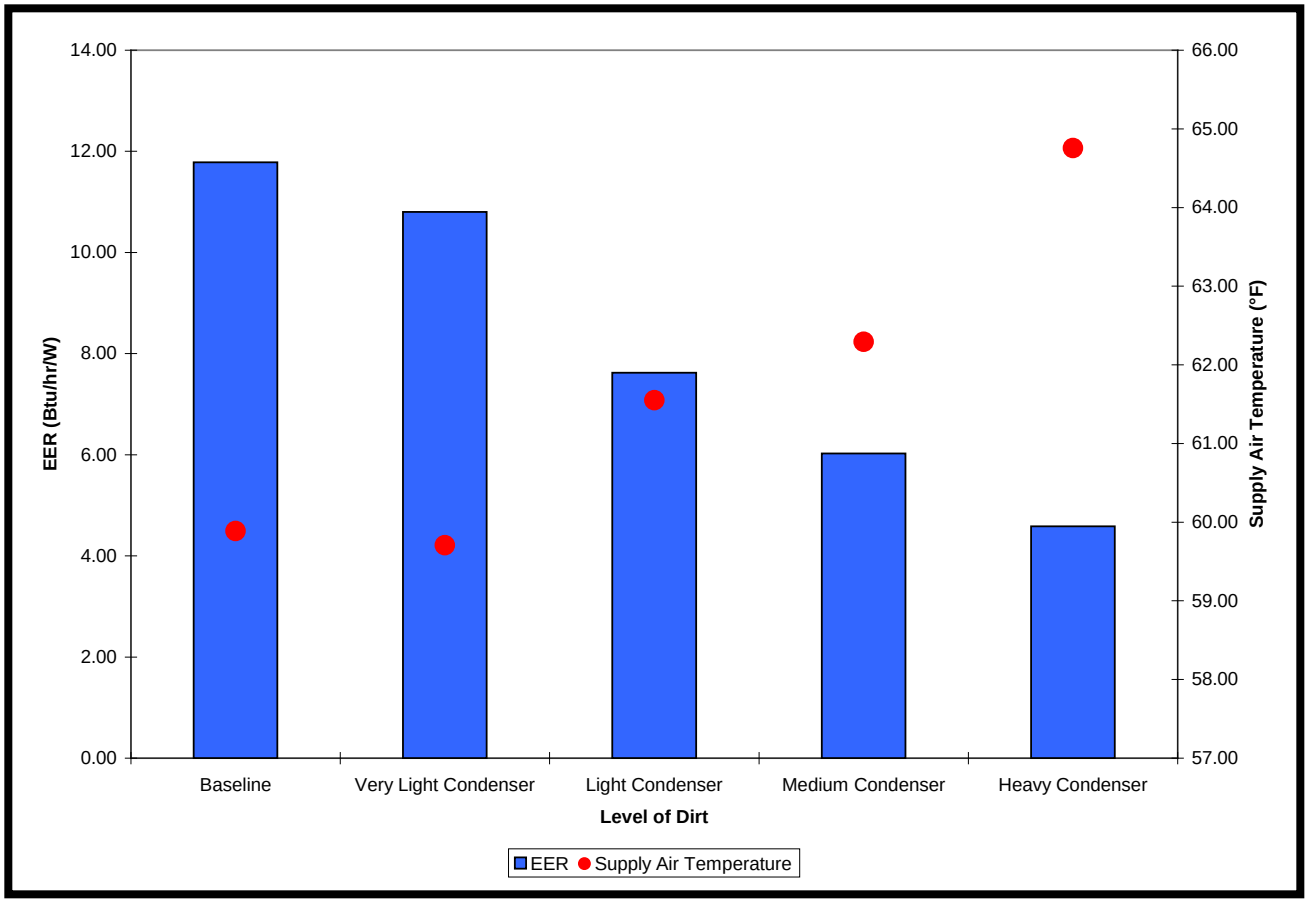
- Cooling capacity was degraded by as much as ~40%
  - An increase of ~60% in discharge pressure caused a decrease in refrigeration effect of ~30%, impacting capacity

Dirty Condenser Coil Impact on Power



- Compressor power was increased by as much as ~70%
  - Compression ratio increased by ~60%
- Evaporator fan power remained constant
- Condenser fan was increased by as much as ~30%

Dirty Condenser Coil Impact on Efficiency and Supply Air Temperature



- EER was reduced by as much as ~60%
- Supply air temp increased by ~5ºF