Fan Regulation Update for DOE

October 28, 2014

Exhibit 4: Product Selection

Operating Performance
80,000 CFM
3.0" SP

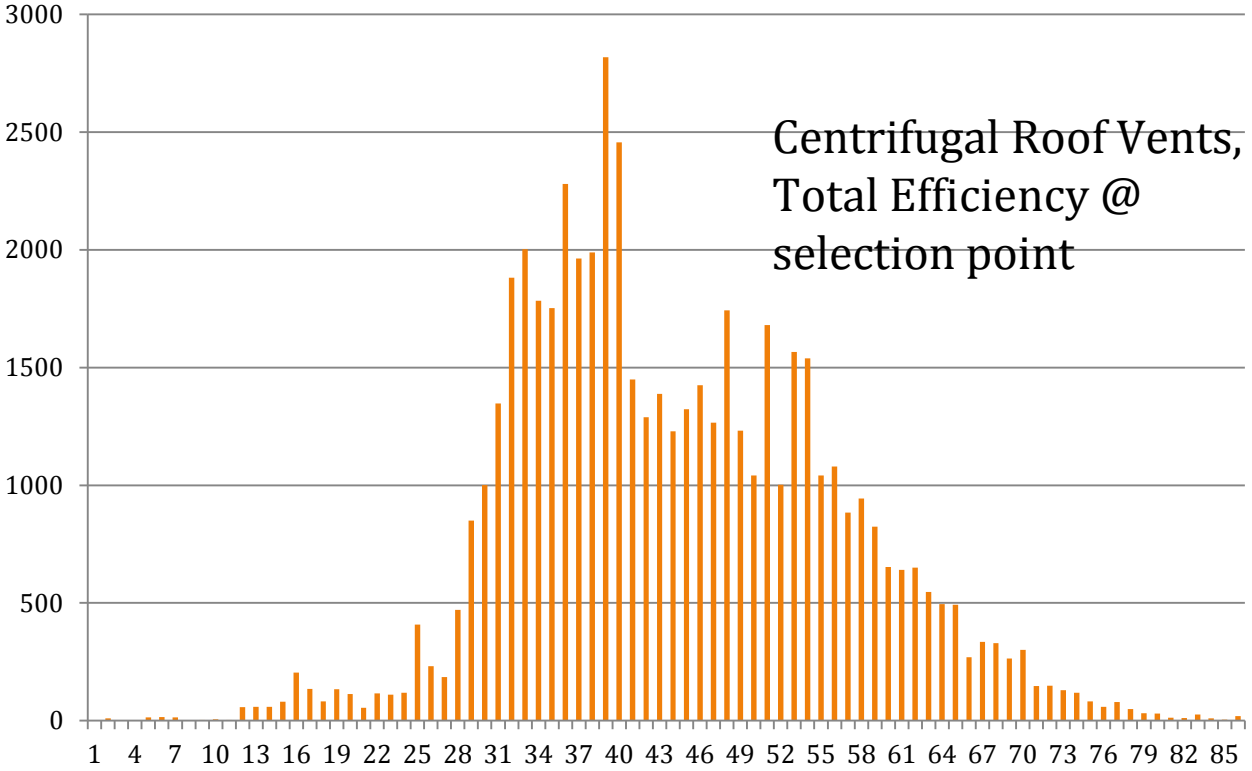
Data from Cookware v6.0 (Loren Cook Company)

Model	FEG	Total Efficiency	Operating Power (HP)	Budget Price	Operating Cost/Yr	Weight
365CADWDI	85	56%	114	$21,100	$37,797	2330
402CADWDI	85	62%	90	$16,100	$29,939	2850
445CADWDI	85	68%	74	$16,900	$24,402	3570
490CADWDI	85	77%	60	$17,600	$19,926	4170
540CADWDI	85	78%	56	$20,300	$18,401	5200
600CADWDI	85	81%	51	$23,800	$16,976	6310
660CADWDI	85	81%	50	$27,400	$16,478	7490

Operating cost based on 16 hrs/day, 250 days/year and $0.10/kw-hr

- **All sizes are FEG85** (represents the energy efficiency potential)
- **Actual efficiency at the operating point varies greatly** (larger sizes are operating close to peak efficiency)
- **This illustrates the impact proper selection has on energy efficiency**

- Fan efficiency varies widely with selection



Based on AMCA data base of 1.3 million fan selections, 45% of USA market

Fan Efficiency Ratio
Fan Efficiency @ design pt. / Required Efficiency

$$\text{Required Efficiency} = \left[\text{Target Efficiency}\right] \text{ x } \left[\text{CFM Factor}\right] \text{ x } \left[\text{Pressure Factor}\right]$$

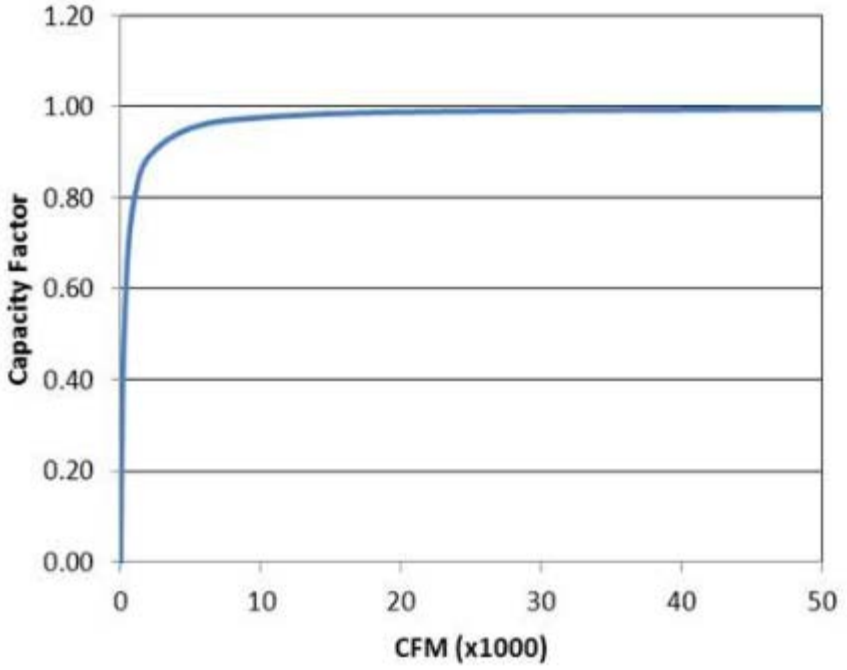
FER calculates a minimum required efficiency based only on CFM and pressure at the design point of operation.

1. **Target Efficiency –** establishes the "upper" limit of efficiency
2. **CFM Factor –** reduces efficiency at low CFM
3. **Pressure Factor –** reduces the efficiency at low pressures

FER Capacity Factor

- Reduces efficiency requirements for small diameter fans, just like the banana curves in AMCA 205

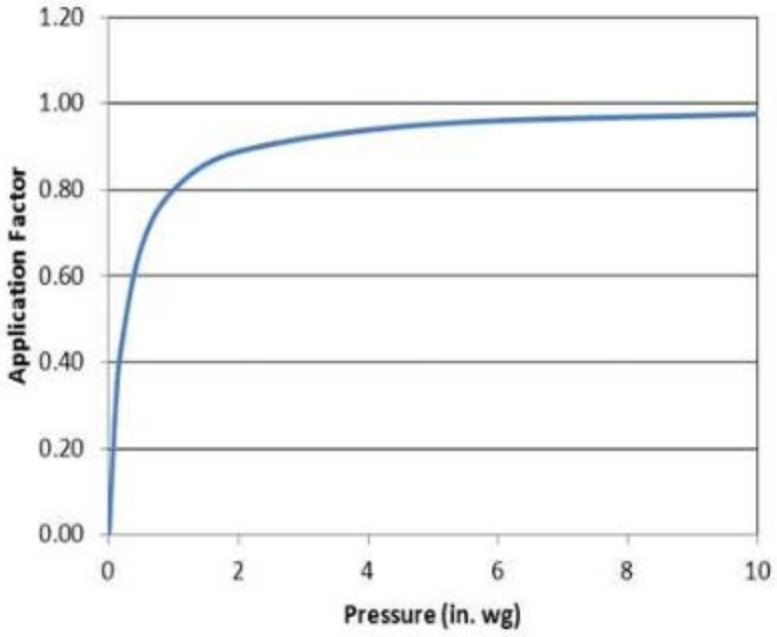
$$\text{Capacity Factor} = \left[\frac{\text{CFM}}{(\text{X}+\text{CFM})}\right]$$



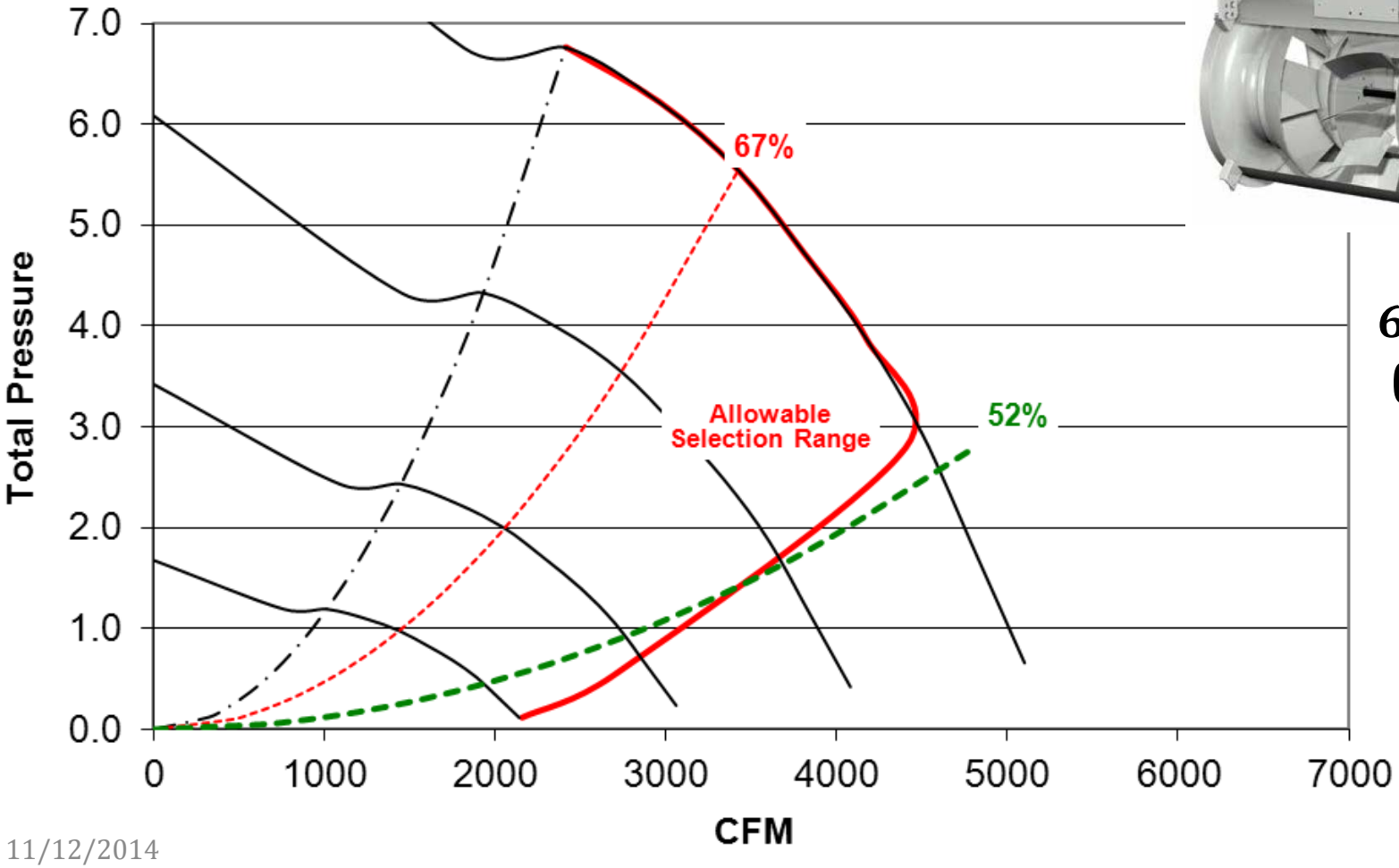
FER Application Factor

- Accounts for reduced efficiency for low pressure applications

$$\text{Application Factor} = \left[\frac{Ps}{(Y+Ps)}\right]$$

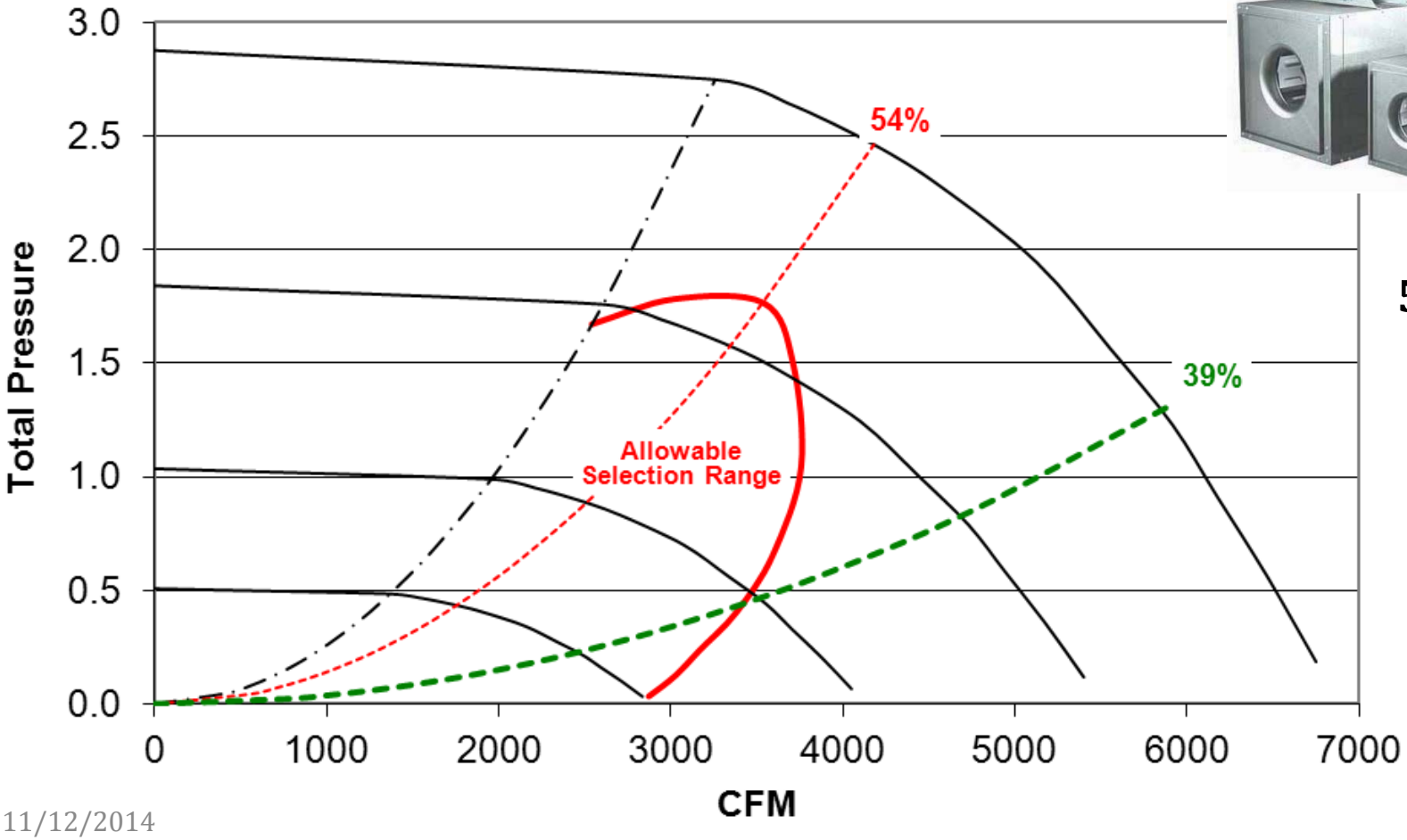


Ex. Inline Fan with high efficiency



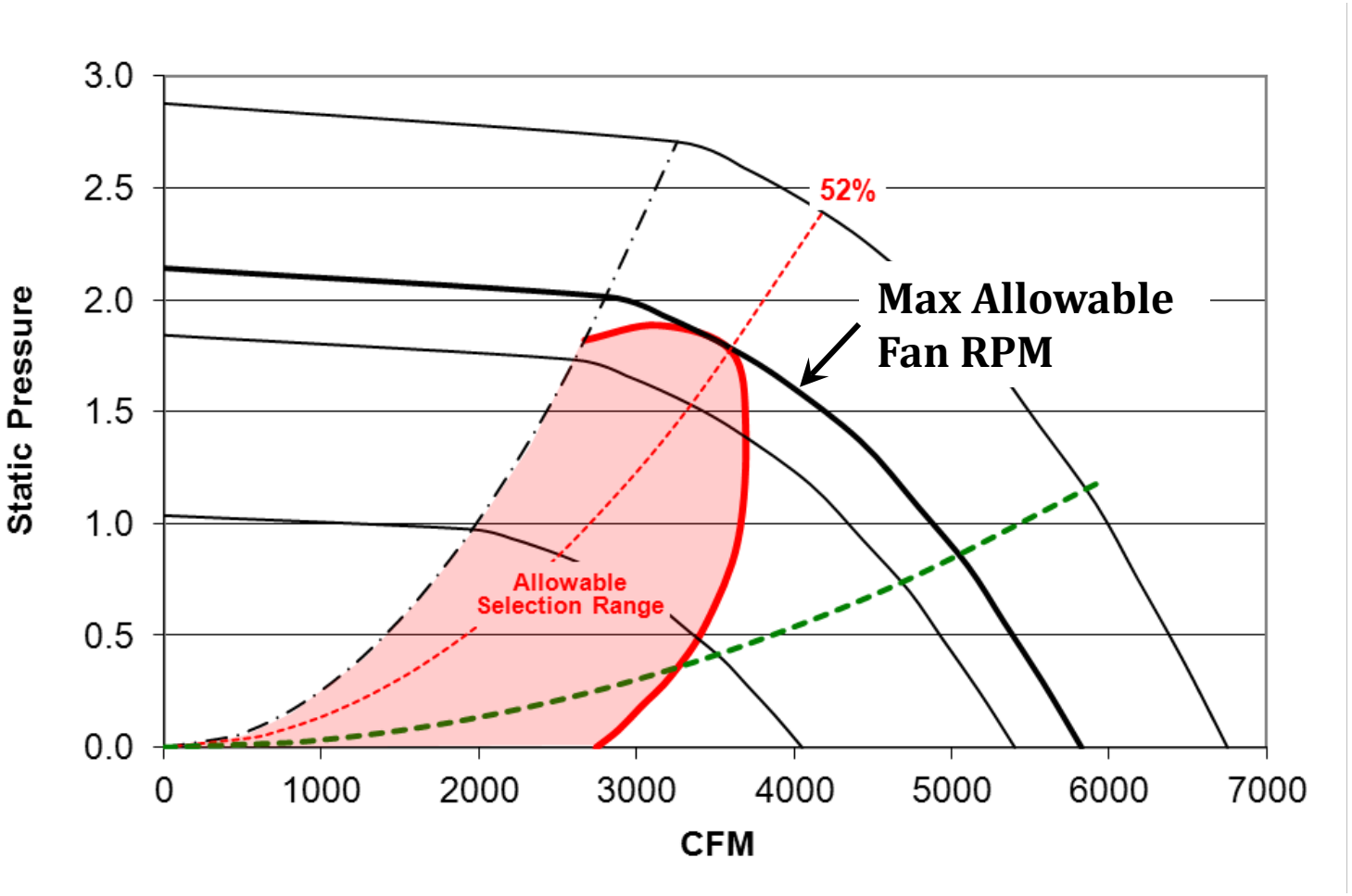
67% TE (peak)

Ex. Inline Fan with low efficiency



54% TE (peak)

PBER – Application Independent



DOE would control the maximum allowable fan RPM!

What are the drivers to redesign for more efficient fans, motors and drives?

1. Natural market pressure!
   - More aerodynamic fans will have a larger "compliance bubble" –
   - EVERY fan/motor is impacted, not just marginal fans at one test point or points.
   - More aerodynamic fan designs will be compliant using a smaller diameter, and be more cost competitive

2. Over time, regulators and building codes will increase "Fan Efficiency Ratios" (identical to raising target efficiency values)

FAN EFFICIENCY RATIO - SIMPLE

How could FER be used?

Body	FER Requirement
DOE	FER ≥ 1.0 at Peak & Design Point
ASHRAE 90.1	FER ≥ 1.0 at Design Point
ASHRAE 189.1	FER ≥ 1.1 at Design Point
Rebates	FER = Savings over Baseline

FER = 1.10 means 10% energy savings over baseline

Thank you.

Questions?