BUILDING A WORLD OF DIFFERENCE

1/26/2015

SAVING ENERGY AND SPACE WITH TURBO BLOWERS – LESSONS FROM TWO PROJECTS

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NEW ENGLAND WATER ENVIRONMENT ASSOCIATION
NEWEA
WORKING FOR WATER QUALITY

BLACK & VEATCH
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OUTLINE

1. Turbo Blower Basics
2. Technology Selection
3. Performance Verification
4. West Haven, CT
5. UOSA
6. Performance Contracting
7. Commissioning

THANK YOU TO

- Mario Francucci, PE Black & Veatch
- Peter Thomson, PE Black & Veatch
- Mike Hanna, PE Black & Veatch

TURBO BLOWER BASICS

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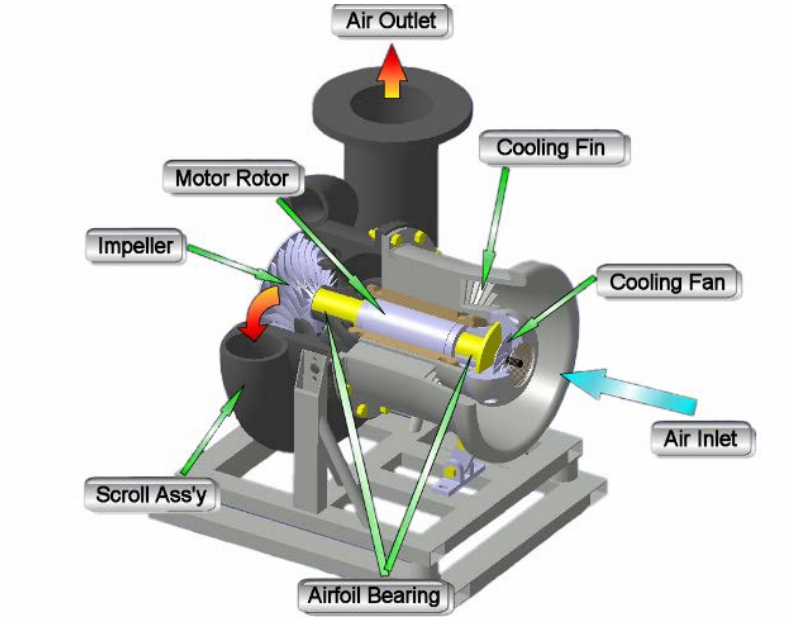
TWO "FIRSTS" IN TURBO BLOWERS

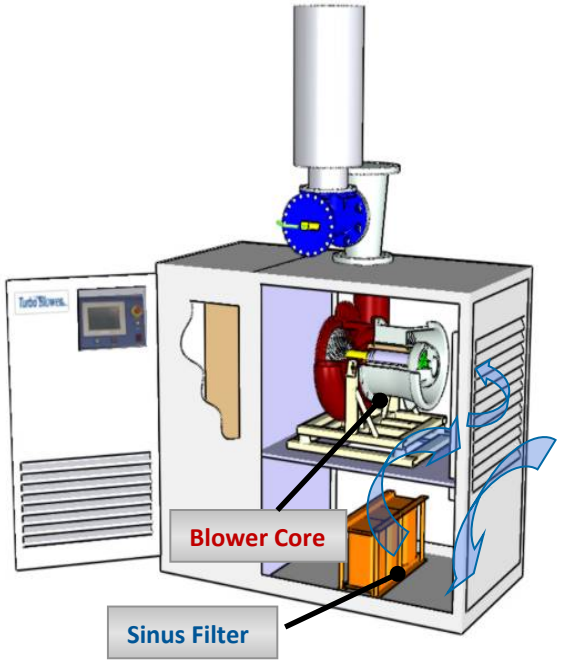
- **UOSA, Centreville, VA**
  - Largest Turbo units installed in North America to date!
- **West Haven, CT**
  - One of the first Turbo installations in New England!

SCOPE OF INSTALLATIONS

- **UOSA**
  - Two 600 hp “dual core” units started up in 2013
- **West Haven**
  - Five 200 hp turbo packages started up in 2011-2012

HIGH SPEED GEARLESS TURBO BLOWERS





WHY THESE BLOWERS WERE SELECTED

- Minimal mechanical maintenance
- No lubricant required
- Turndown to about 50% of rated capacity
- Small footprint
- Dual core arrangement for UOSA
- Experience & installation list in comparison to other turbo vendors
- Lowest life cycle costs

KEYS TO SUCCESSFUL TURBO BLOWER DESIGN

- Specify experienced turbo vendors
- Specify better quality inlet air filters
- Ensure steepness to performance curves for stable performance at turned down conditions
- Require single source responsibility for system controls whenever possible

TECHNOLOGY SELECTION BY LIFE CYCLE COST EVALUATION

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TECHNOLOGY SELECTION PROCESS

- **Always perform a life cycle cost evaluation.**
  - Compares capital costs and operating costs of several blower technologies
  - Considers operation through a typical year and through the useful life of the blowers
  - Includes power cost and interest rate for weighted operating points
  - Determines most cost effective technology
  - Either specifies “not to exceed” power numbers or requires vendor to write in power numbers on bid day

TECHNOLOGY SELECTION PROCESS

- Turbo blowers selected for both West Haven & UOSA
- One key to success: length of vendor installation list
- APG-Neuros selected for both projects due to installation list, footprint, and energy efficiency

PERFORMANCE VERIFICATION

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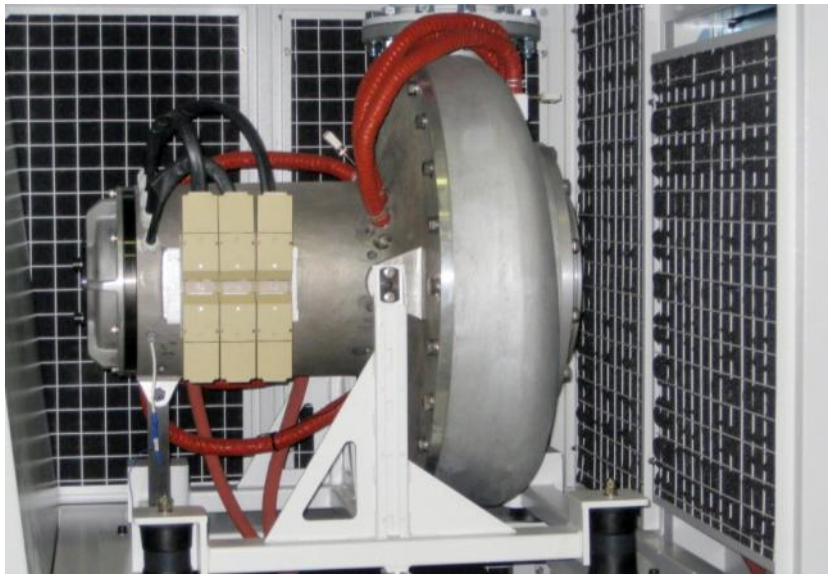
PERFORMANCE VERIFICATION

- Establish guarantee points and weighting factors
- Establish power penalties
- Shop witness test the machines to verify compliance with guarantees
  - Limit operating points to a reasonable number

Photos courtesy of APG-Neuros



PERFORMANCE VERIFICATION-GUARANTEE TABLE

Table from Original Specification									
	A	B	C	D	E	F (C ÷ E)	G	H	I (G x H)
	Temp (°F)	RH (%)	Total Inlet Flow (ICFM)[1]	Blower Discharge Pressure (psig)	# Cores Operating	Inlet Flow per Core[3] (ICFM)[1]	Guaranteed Power per Core[2] (kW)	Weight Factor (%)	**Factored Power per Core (kW)**
1	100	85	26,520	8.5	4	6,630		20	
2	60	30	25,210	8.5	4	6,303		10	
3	100	85	25,370	8.5	4	6,343		15	
4	60	30	22,370	8.5	4	5,593		25	
5	100	85	20,760	8.5	3	6,920		5	
6	60	30	18,300	8.5	3	6,100		10	
7	0	10	16,450	8.5	3	5,483		10	
8	0	10	12,800	8.5	2	6,400		5	
								TOTAL	

8 guarantee points – too many!!

PERFORMANCE VERIFICATION

- **ASME Test Code PTC10 not ideal for turbo blowers**
  - Intended to measure shaft power
  - Intended for constant speed machines
  - Does not capture ancillary losses
- **ASME PTC 13 is coming this Fall!!**
  - Package test code to measure wire power
  - Not yet issued
- **For West Haven and UOSA**
  - Tested core per PTC10
  - Tested again in package to capture ancillary losses

WEST HAVEN, CT

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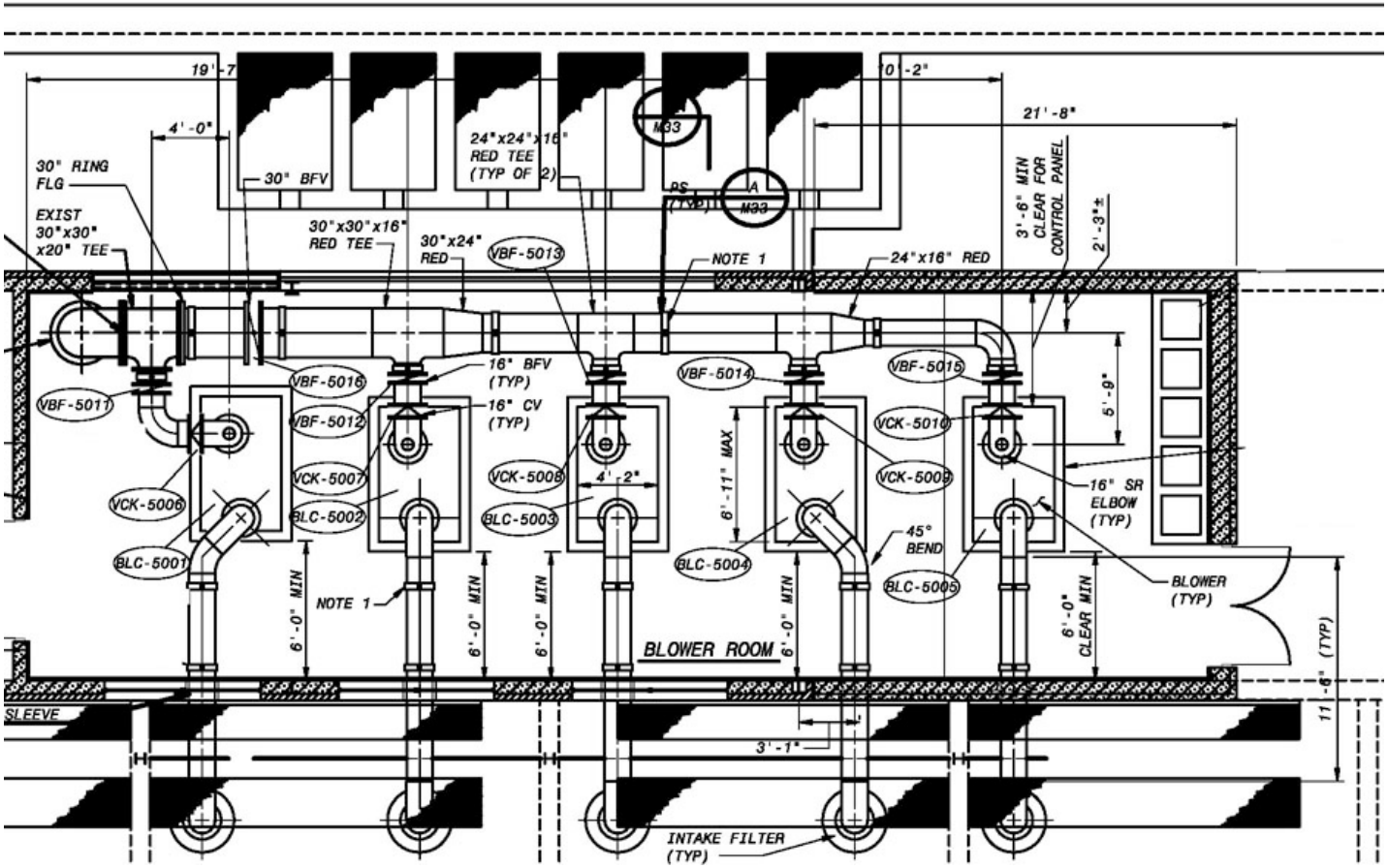
EARLY TURBO MARKET – CLAIMS & COUNTERCLAIMS ABOUT EFFICIENCY

- Since energy savings not proven when technology was new, many early installations driven by small footprint

WEST HAVEN–LAND LOCKED BLOWER BLDG



WEST HAVEN–LAND LOCKED BLOWER BLDG

WEST HAVEN–LAND LOCKED BLOWER BLDG

WEST HAVEN SYNOPSIS

- Plant upgrade and expansion to tertiary treatment and full nitrification/denitrification
- Energy savings of 10% despite plant upgrade!

UPPER OCCOQUAN SERVICE AUTHORITY (UOSA)

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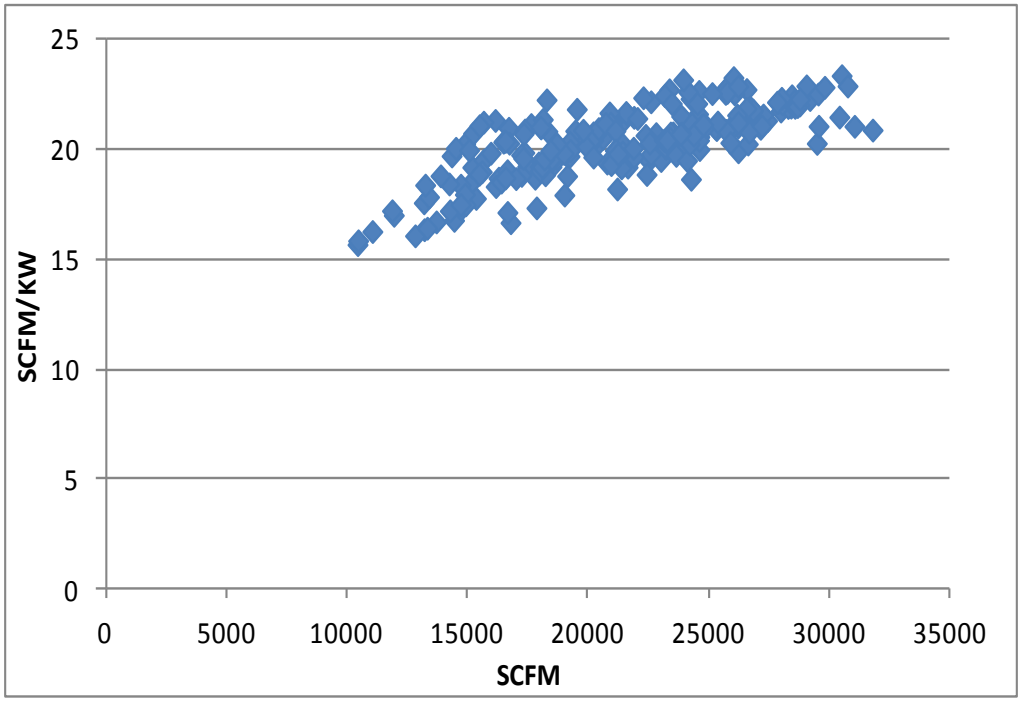
UOSA PLANT BACKGROUND

- **Plant capacity: 54 mgd**
- **Daily Flows: 30 to 35 mgd**
- **Original blowers**
  - Constant speed multistage centrifugal
  - 6 @ 350 hp, 2 @ 800 hp, 2 @ 1000 hp
  - Total available capacity: 96,200 scfm @ 7.5 psig
  - Ave air flow requirement for past 5 years: 19,530 scfm

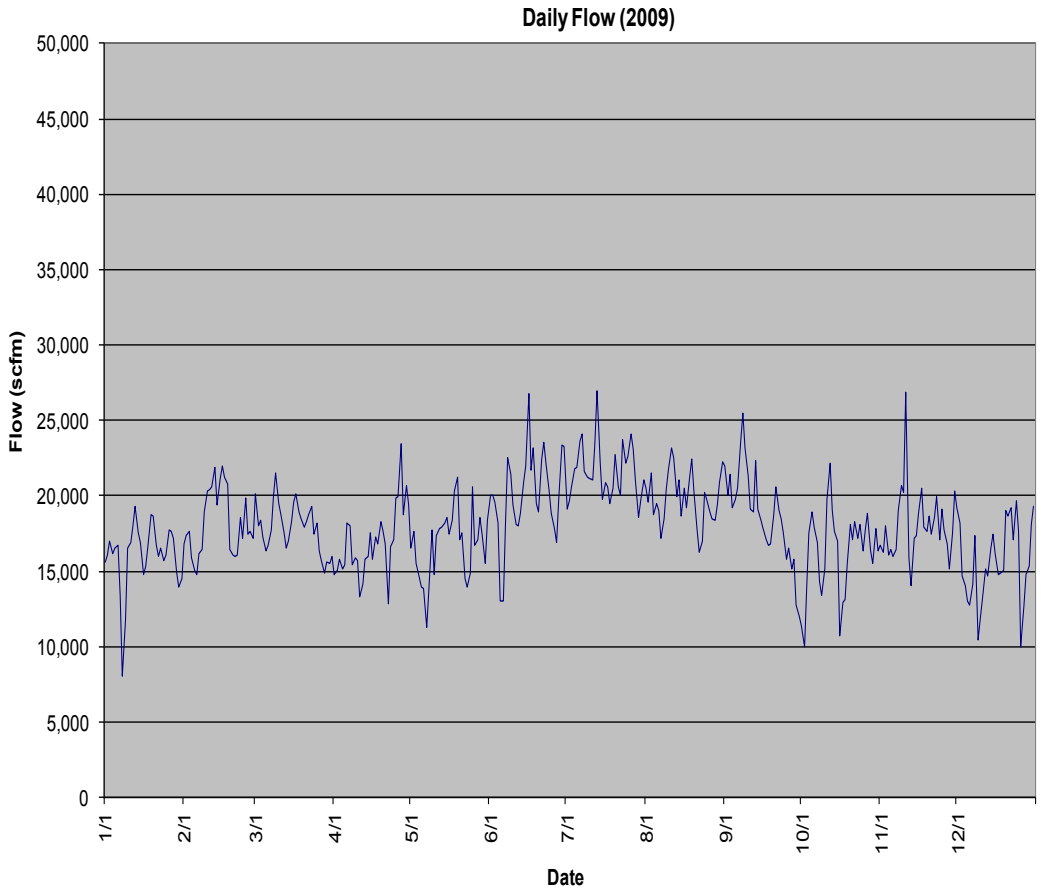
POWER CONSUMPTION – ORIGINAL MULTISTAGE BLOWERS

- 23 scfm/kW theoretically. Actual averaged 20.4 scfm/kW due to blower starting difficulties, operating ranges, and oversizing



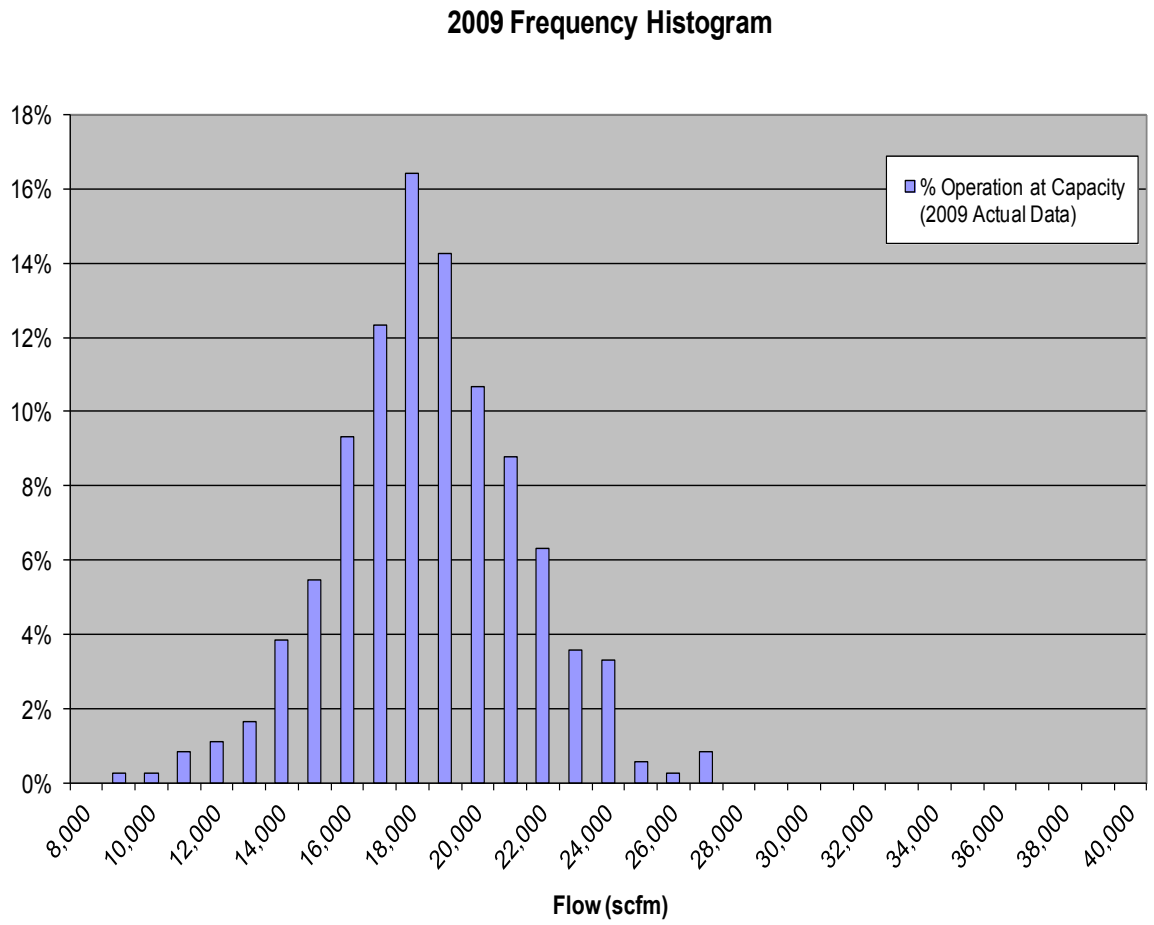
PLANT BACKGROUND – UOSA HISTORICAL AIR FLOW REQUIREMENTS

- One year of daily & hourly data from DCS system was analyzed



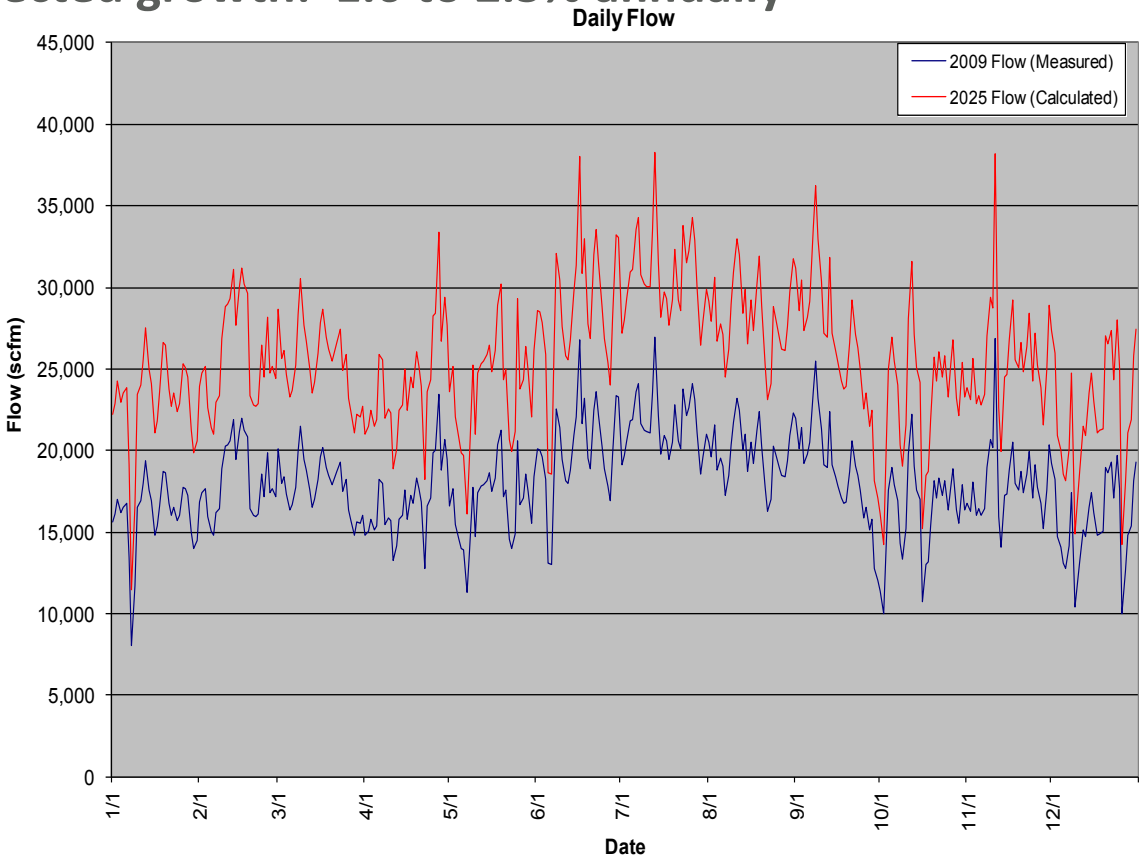
HISTORICAL AIR FLOW REQUIREMENTS

- Conclusion: 10,000 – 25,000 scfm average daily range



COMPARISON OF CURRENT AND FUTURE AERATION DEMANDS

- Projected growth: 1.6 to 2.5% annually



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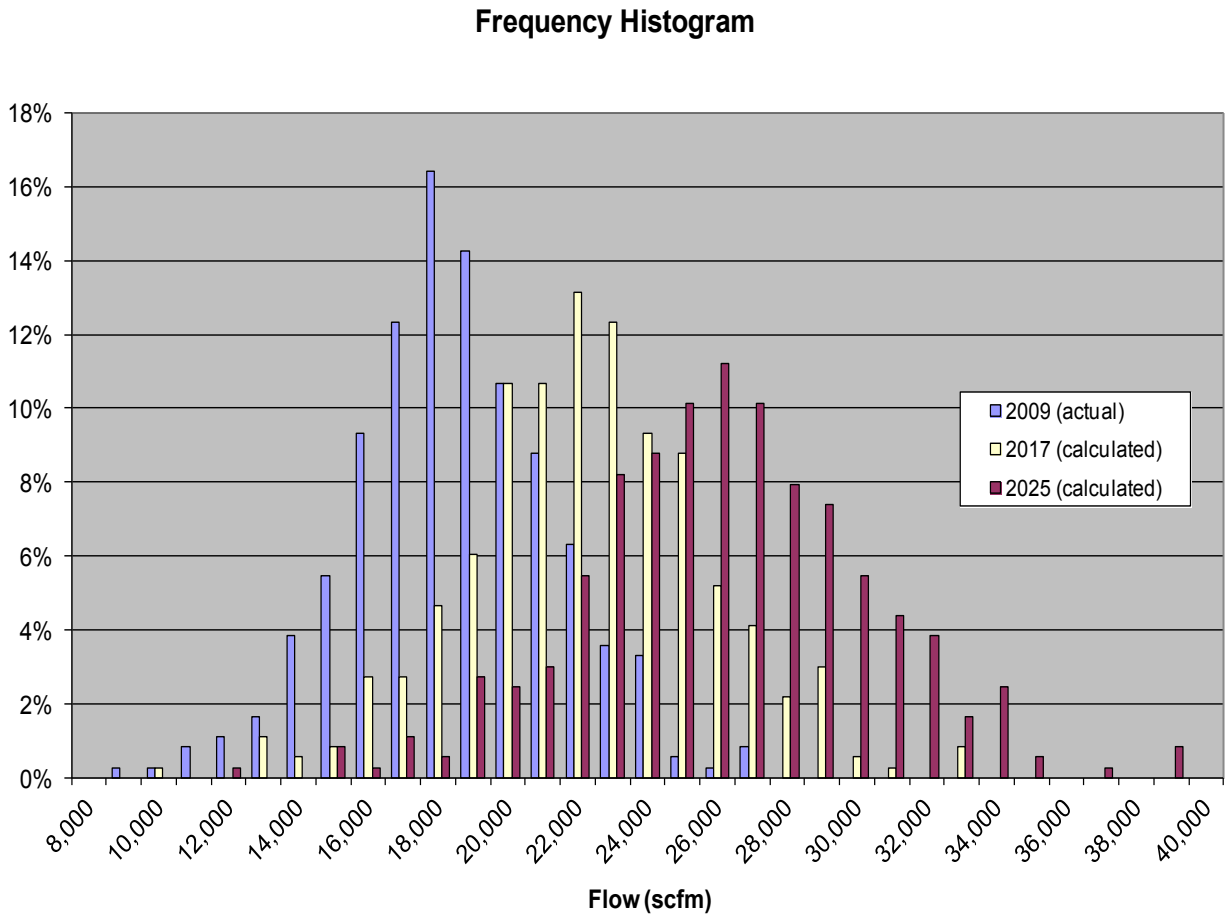
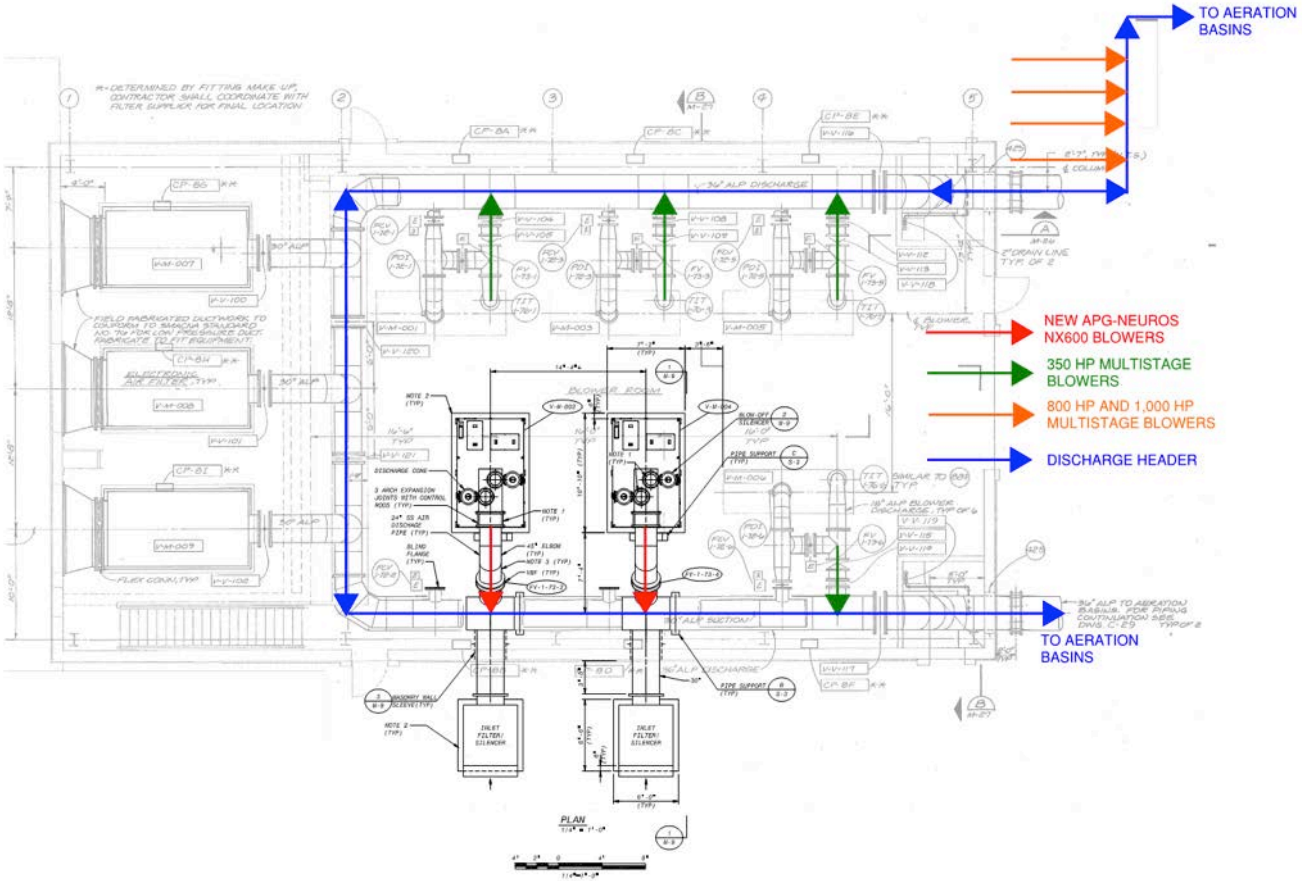


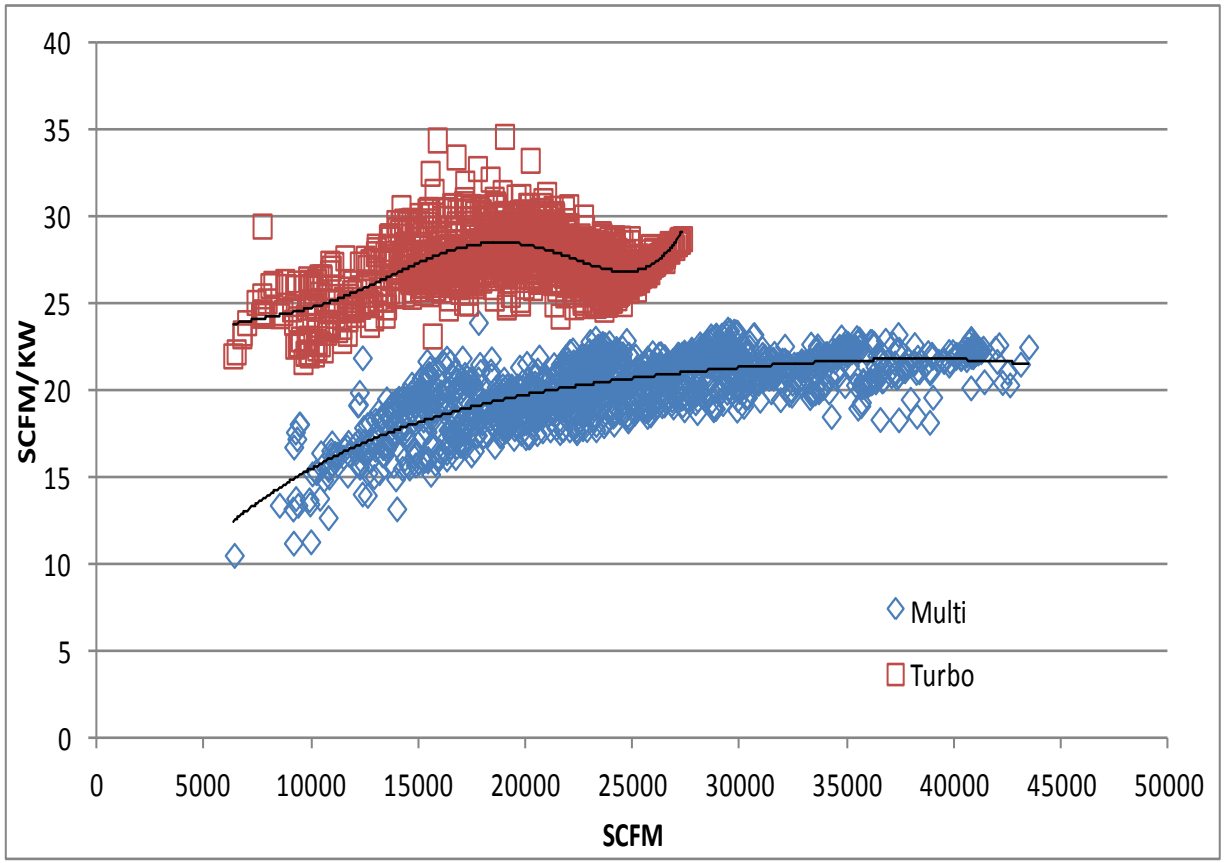
TOTAL INSTALLED NEW BLOWER CAPACITY

- 25,000 scfm summer capacity with future unit planned
- Maximizes efficiency gains while minimizing capital expenditure

LAYOUT FOR BLOWER REPLACEMENT



COMPARISON OF BLOWER EFFICIENCIES



YEARLY POWER CONSUMPTION COMPARISON

Year	Air Flow, scfm	Power, kW	scfm/kW
2010	16,073	888	18.1
2011	21,148	1066	19.8
2012	22,726	1104	20.6
2013	18,344	944	19.5
2014	16,945	606	28.0

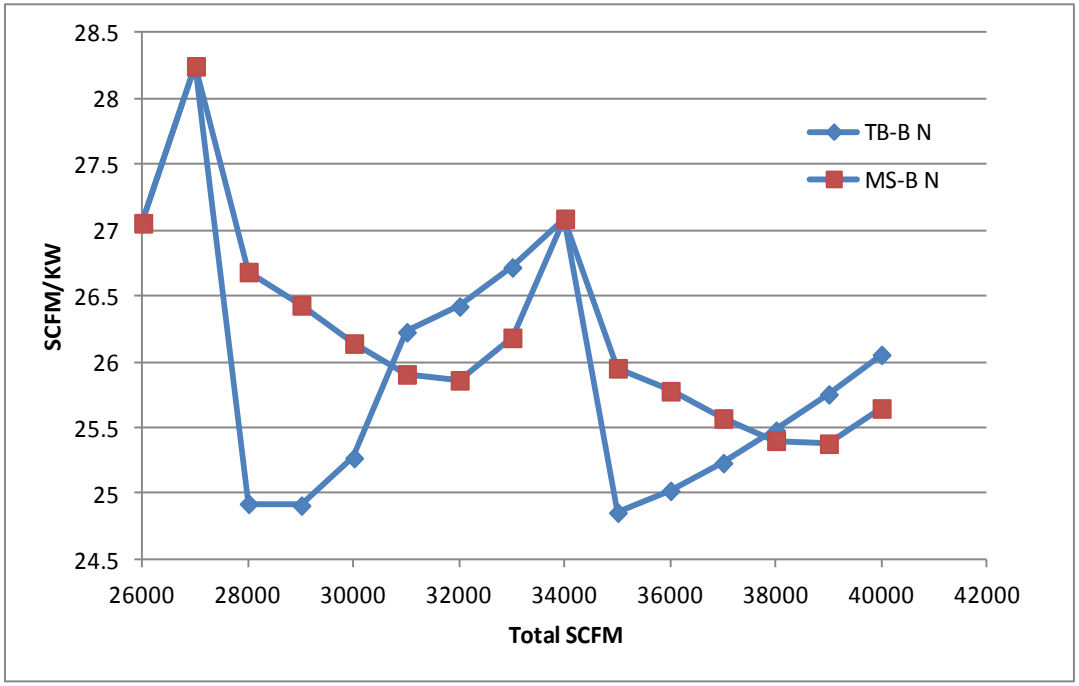
- **19.5 scfm/kW for multistage vs 28 scfm/kW for turbos.**
- **Gain of 30%! Resulting annual savings of $141,000 with power cost of only $0.0529/kWh**

SIMPLE PAYBACK

- Simple payback calculation results in a 14.1 year payback but it should be noted existing blowers were nearing the end of their useful life

BASELOADING STRATEGIES

- Baseloading multistage generally thought to be better due to poorer turndown and efficiency decline at low flows.
- 2.3% difference between best and worst strategies. Neither is ideal across the range.



PERFORMANCE CONTRACTING

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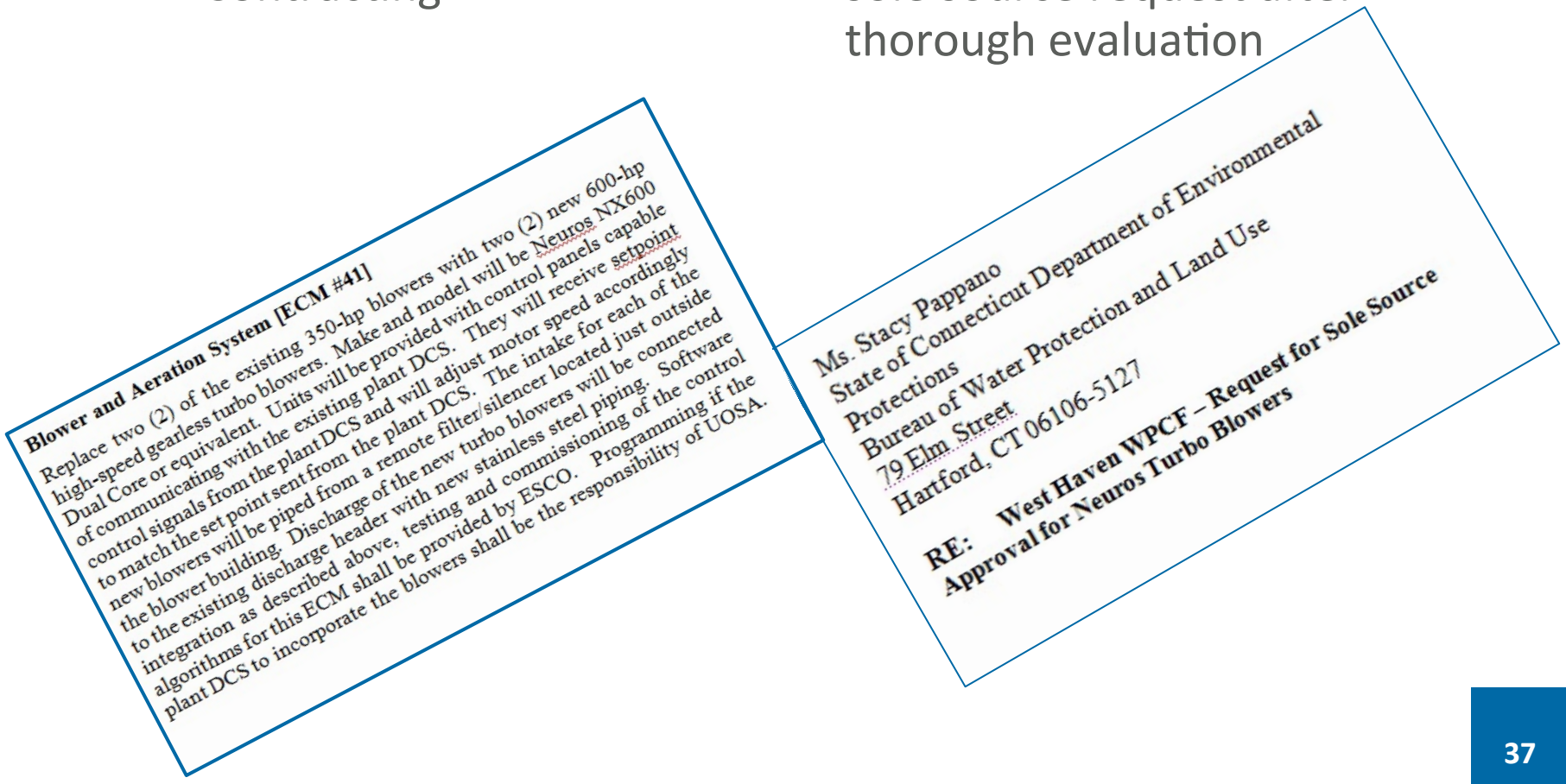
PROJECT DELIVERY METHOD

- **UOSA**
  - Energy Performance Contracting
- **West Haven**
  - Connecticut DEP granted sole source request after thorough evaluation



Blower and Aeration System [ECM #41]

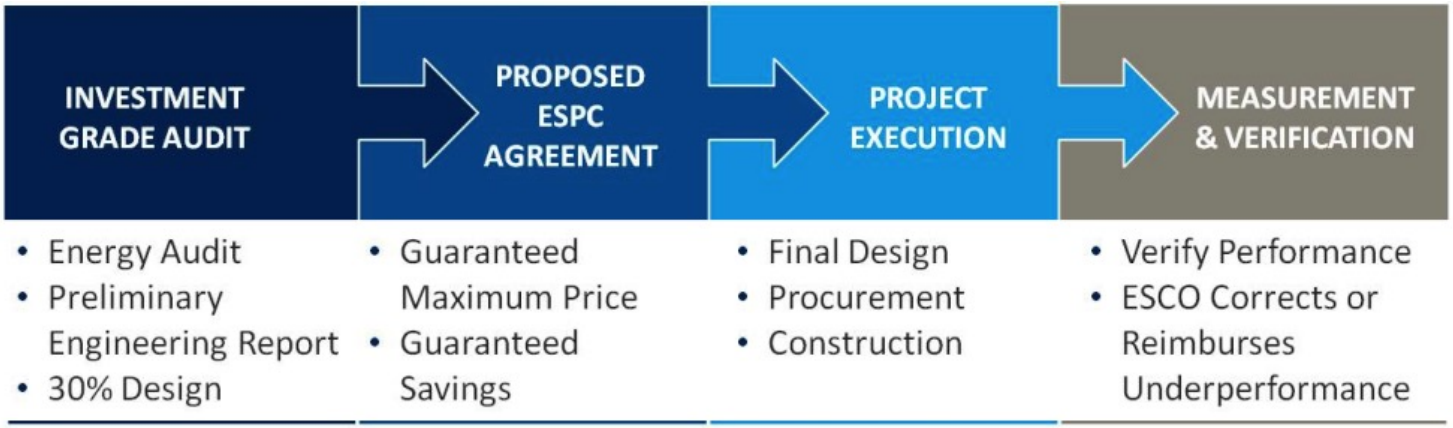
Replace two (2) of the existing 350-hp blowers with two (2) new 600-hp high-speed gearless turbo blowers. Make and model will be Neuros NX600 Dual Core or equivalent. Units will be provided with control panels capable of communicating with the existing plant DCS. They will receive setpoint control signals from the plant DCS and will adjust motor speed accordingly to match the set point sent from the plant DCS. The intake for each of the new blowers will be piped from a remote filter/silencer located just outside the blower building. Discharge of the new turbo blowers will be connected to the existing discharge header with new stainless steel piping. Software integration as described above, testing and commissioning of the control algorithms for this ECM shall be provided by ESCO. Programming if the plant DCS to incorporate the blowers shall be the responsibility of UOSA.

Ms. Stacy Pappano
State of Connecticut Department of Environmental Protections
Bureau of Water Protection and Land Use
79 Elm Street
Hartford, CT 06106-5127

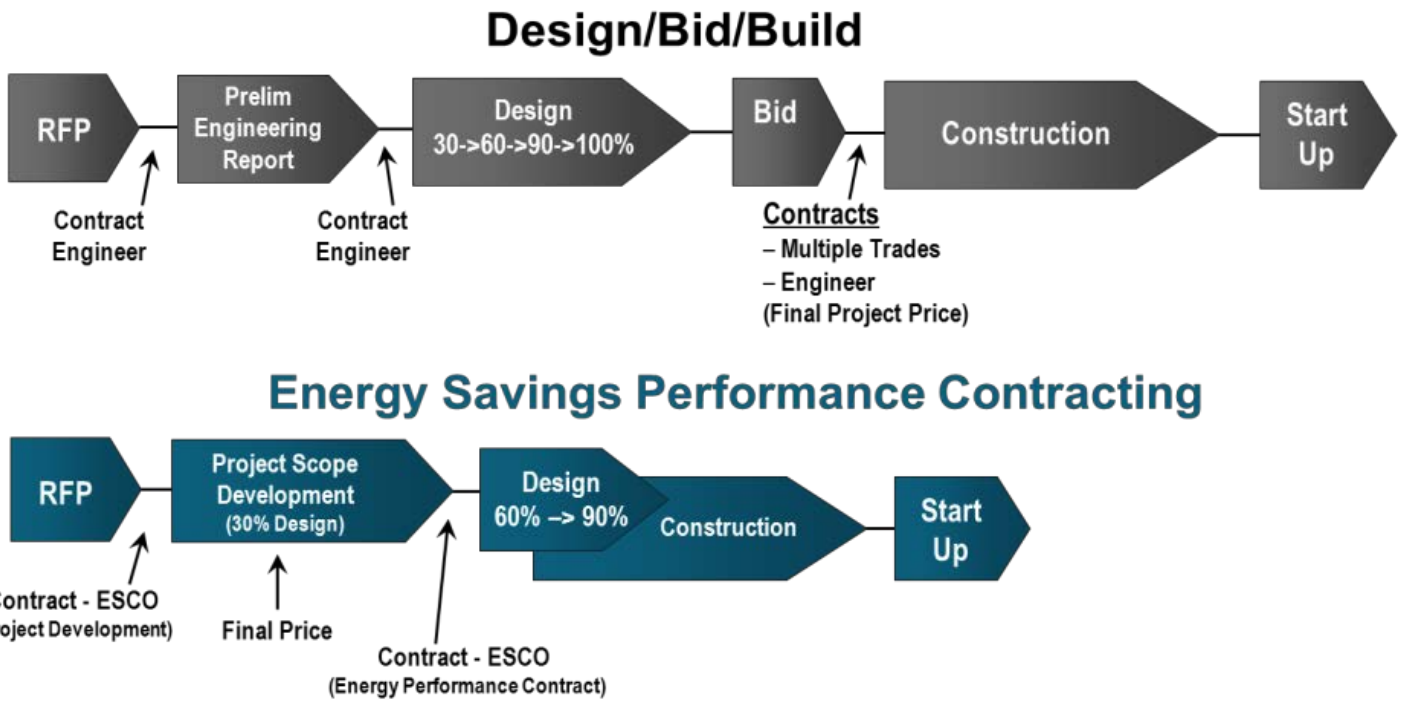
RE: West Haven WPCF – Request for Sole Source Approval for Neuros Turbo Blowers

PERFORMANCE CONTRACTING

- **UOSA chose performance contracting as an alternative to conventional project delivery**



PERFORMANCE CONTRACTING



COMMISSIONING

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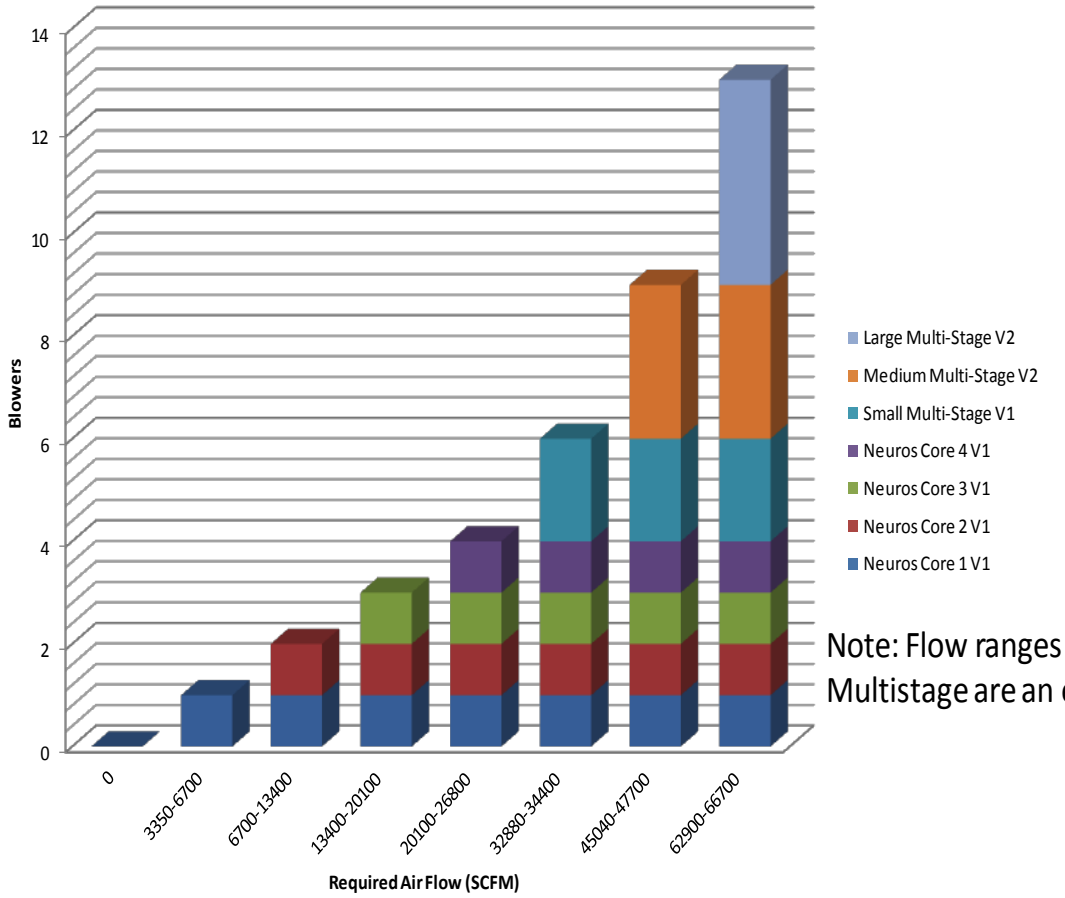
COMMISSIONING – CHECKING OPERATION OF EXISTING AND NEW UNITS IN PARALLEL



Note: Flow ranges for medium Multistage are an estimate

CONCLUSIONS

1. New technology blowers can be small footprint & efficient.
2. Controllability improved at both plants.
3. Performance verification crucial to success.
4. Consider system efficiency instead of unit efficiency.

CONCLUSIONS

5. Field data shows that efficiency improvement is about 30 percent for both plants and is $141,000 annually for UOSA!
6. Consider performance contracting for energy savings, financing needed improvements, and accelerated delivery.
7. Further gains in energy savings possible with system optimization.

QUESTIONS?