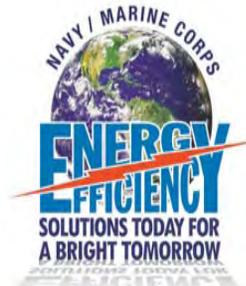




# Navy Technology Validation (Techval) Monitoring Results



**Techval**

FUPWG

May 3, 2006

Atlanta, GA

Paul Kistler, PE CEM

Naval Facilities Engineering Service Center

Port Hueneme CA

# Navy Energy Techval



## This presentation will:

- Briefly explain what the Navy Techval Program is.
- Identify the technologies that Techval is currently working with or has worked with in the past.
- Provide information on technologies where Techval has sufficient favorable data to recommend using the technology in other Navy installations.



Techval

# Navy Energy Techval



## Techval Web Site Features

- ❖ Explains Navy Techval Program
- ❖ Describes past and current demonstration projects
- ❖ Provides for on-line submission of project proposals
  - ❖ On-line nomination of sites for projects
- ❖ On-line comments and voting for both TWG
  - ❖ Tracking of projects as they happen
  - ❖ Technology Reports Section
  - ❖ Tech Assist



Techval

<http://techval-energy.nfesc.navy.mil>

# Navy Techval



## CURRENT PROJECTS

- 80 Ton Turbocor Chiller Compressor
  - *NUWC Newport RI*
  - *NRSW San Diego CA*
  - *NAS Jacksonville FL*
- Wrap around heat pipe for humidity control
  - *NS Pearl Harbor HI*
  - *NAS Pensacola FL*
- Duct Sealants
  - *NSA Orlando FL*
  - *NS Newport RI*
  - *NSY Puget Sound WA*
  - *NB San Diego CA*
- Cool Roof reflective roof coating
  - *NS Pearl Harbor HI*
- EER+ Retrofit
  - *NSWC Corona CA*
  - *NB San Diego CA*
  - *NWS Yorktown VA*
  - *NAWC China Lake CA*



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## CURRENT PROJECTS

- Extended Surface Area Air Filters
  - NAVSUPPACT MID-SOUTH Millington
  - USNA Annapolis MD
  - NBVC Port Hueneme CA
  - NAS Oceana VA
- Boiler Combustion Control
  - NSWCCD-SSES Philadelphia PA
  - USNA Annapolis MD
  - NB Kitsap-Bangor WA
- Sand Filters
  - NAS Lemoore CA
  - NAS Oceana VA
- Thermal destratifier for high bay warehouses and hangers
  - NAS Oceana VA
- Spectrally Enhanced Lighting
  - NBVC Port Hueneme CA



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## CURRENT PROJECTS

- CO2 Ventilation Control
  - NAB Little Creek VA
  - NAVSUPPACT Mid-South, Millington TN
  - NB Kitsap WA
- Occupancy HVAC Control
  - NAS Oceana VA
  - FCTCL Dam Neck VA



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## COMPLETED PROJECTS

- Power conditioner
  - *SUBASE New London CT*
- Fuel oil fired 30KW Microturbine with boiler feed water pre-heat.
  - *SUBASE New London CT*
- Thermal destratifier for high bay warehouses and hangers
  - *NSWC Crane IN*
  - *NSWCCD West Bethesda MD*



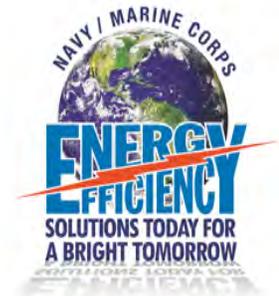
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## TECHNOLOGY REPORTS

- Internal Storm Window
- Super T8 Lighting
- Day Lighting
- Vending Machine Power Control
- Airfield LED Lighting
- VSD Chiller
- Photo Luminescent Exit Signs



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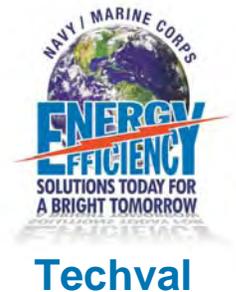
## Turbocor

- 80 Ton Chiller Compressor
- Oil Free Magnetic Bearings
- Integral VFD and Micro Processor

Navy Techval has found simple pay backs between 4 and 8 years.  
40% to 65% energy savings.

**Navy Techval recommends installing oil free magnetic bearing chiller compressors at other Navy sites where:**

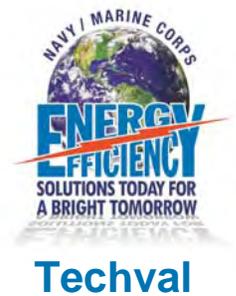
- ✓As a retrofit of a recip chiller but consider screw retrofits
- ✓Where electric rates are high
- ✓Where there is year round cooling load



# Navy Techval



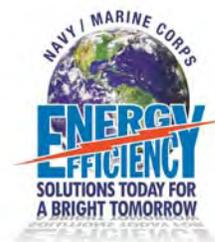
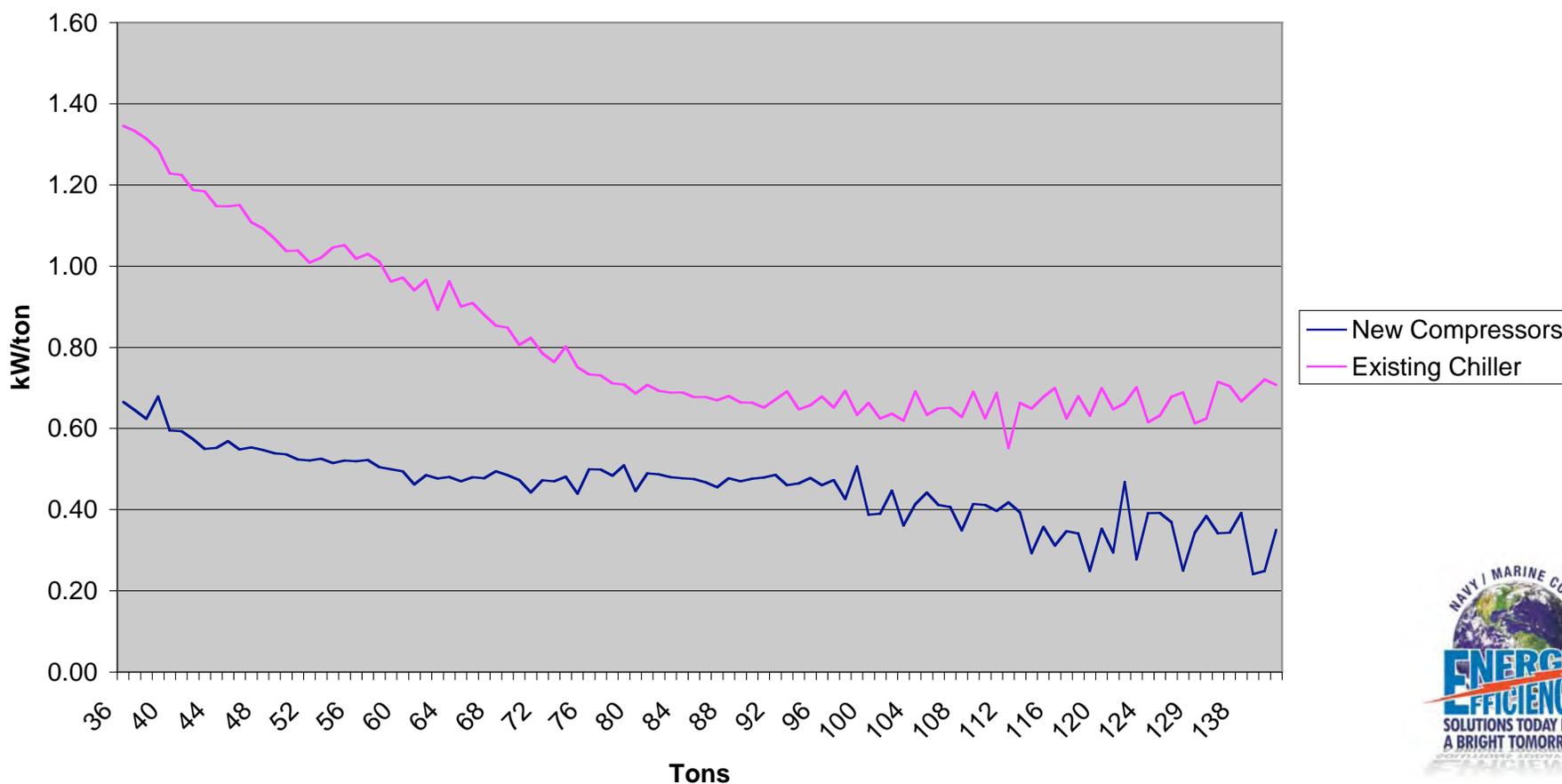
80 ton Turbocor chiller compressor with magnetic bearings  
*NRSW San Diego CA*



# Navy Techval



GRAPH NUMBER 6  
AVERAGE OF ALL DATA POINTS AT SAN DIEGO CA  
kW/ton VS LOAD NEW COMPRESSORS VS OLD CHILLER

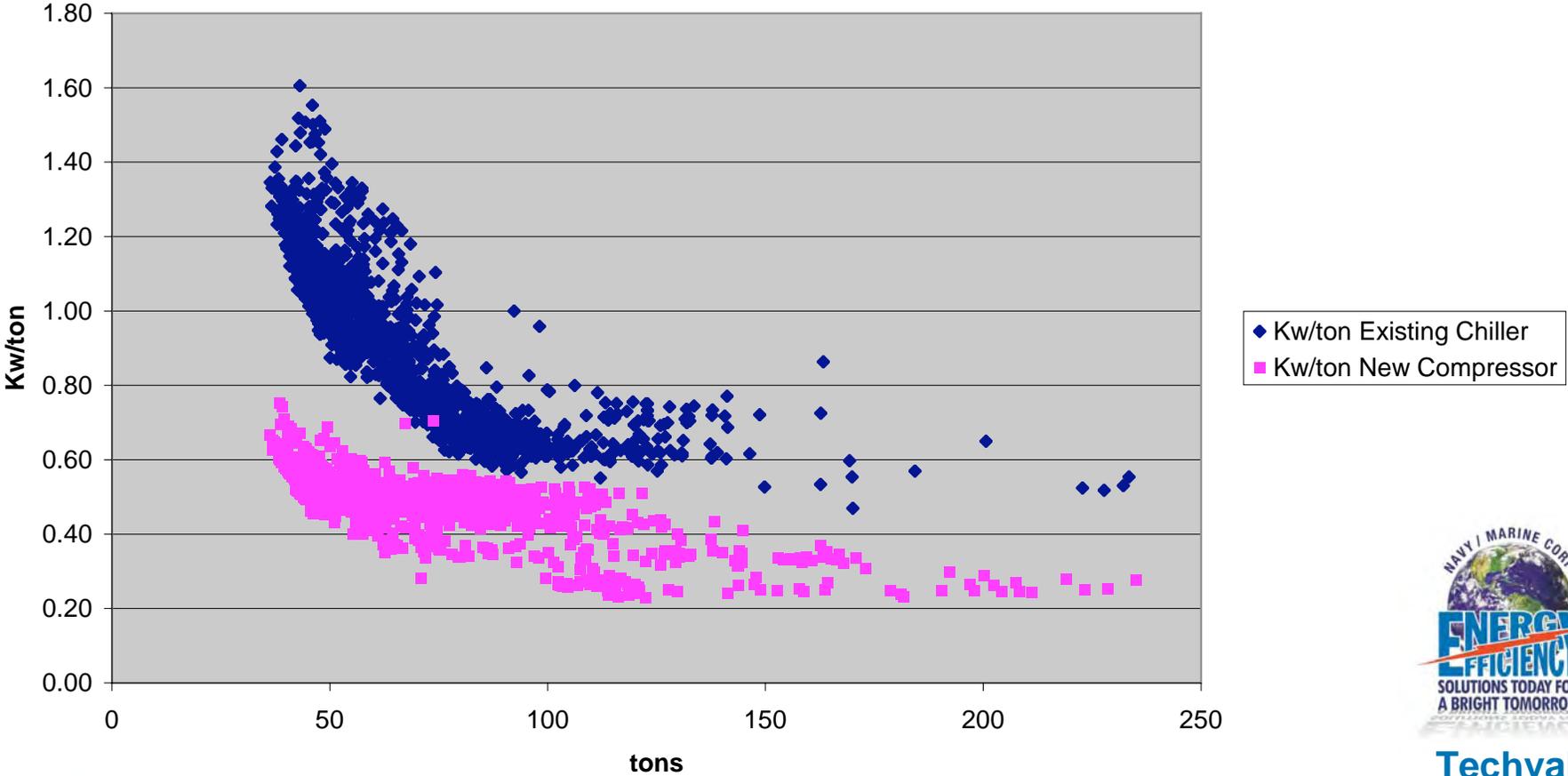


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# Navy Techval



GRAPH NUMBER 5  
ALL DATA POINTS FOR SAN DIEGO CA  
Kw/TON VS LOAD FOR NEW COMPRESSORS VS OLD CHILLER



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# Navy Techval



SAN DIEGO DATA APRIL / MAY 2005								
Existing Chiller								
	Chilled Water Flow Rate (gpm)	Chilled Water Temp. in (°F)	Chilled Water Temp. out (°F)	Chilled Water Temp. Delta	Load (tons)	Condensing Water Temp. (°F)	Electrical Demand (Kw)	Efficiency (Kw/ton)
<b>Minimum</b>	588	42	40	0	0	70	0	0.30
<b>Maximum</b>	726	63	63	8.9	264	83	141	1.87
<b>Average</b>	636	47	44	2.4	64	75	<b>56</b>	<b>0.93</b>
Turbocor								
<b>Minimum</b>	585	46	44	1.4	36	70	20	0.23
<b>Maximum</b>	713	54	51	8.1	235	86	65	0.75
<b>Average</b>	651	47	45	2.7	71	76	<b>33</b>	<b>0.49</b>

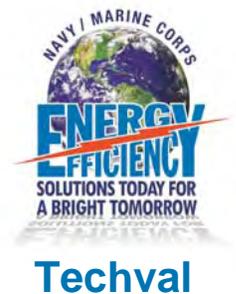


# Navy Techval



## Cost for original Turbocor installation in San Diego

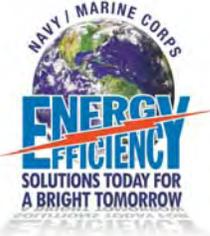
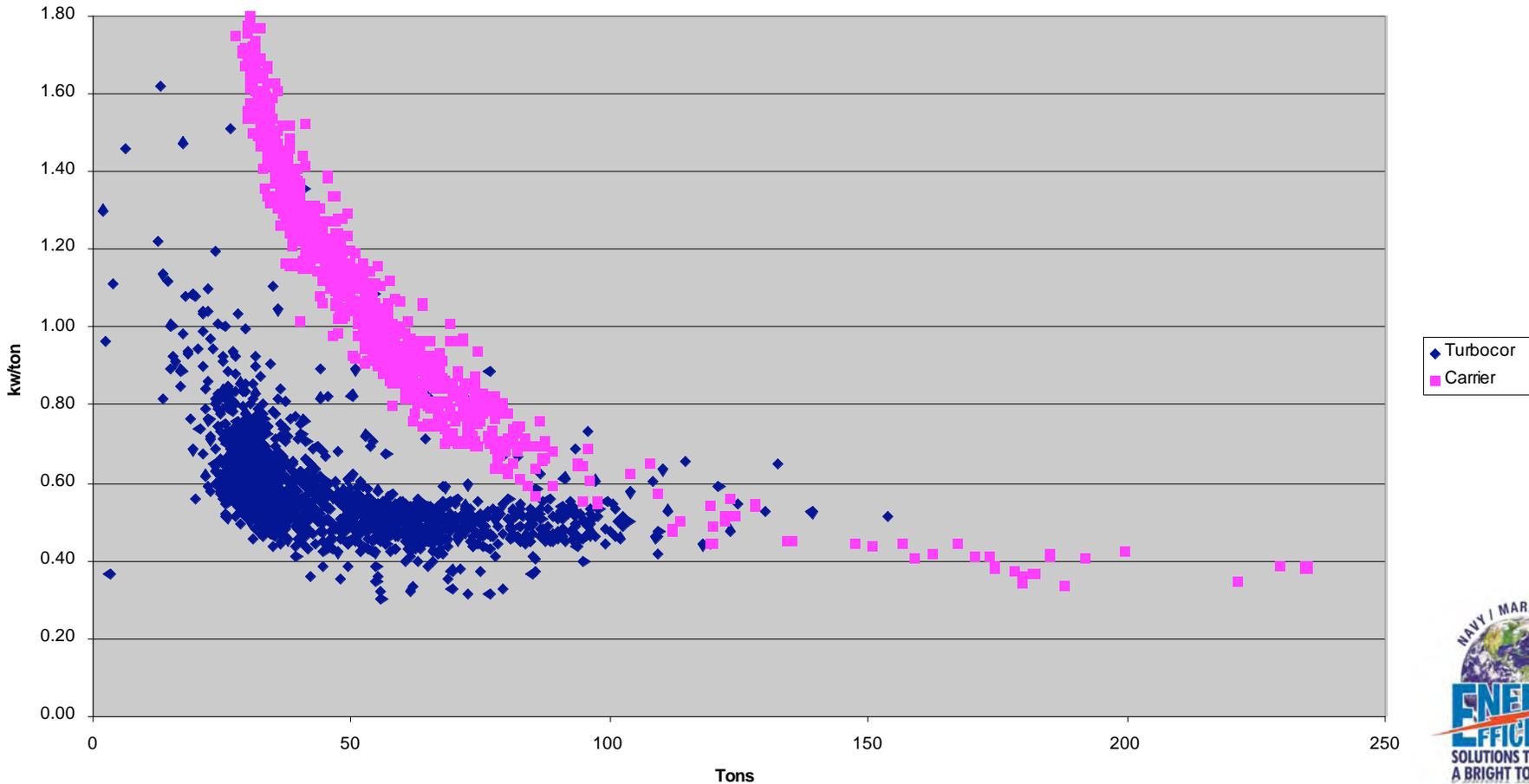
	Included	\$5,572
Design		
Installation Planning and Procurement		\$1,590
Mechanical Subcontractor (for retrofit)	\$23,580	\$94,980
Compressor Purchase (for retrofit)		Included
Controls Subcontractor (for retrofit)		
Controls Subcontractor (for misc. items)		
Installation Management		<u>\$12,996</u>
		\$138,718



# Navy Techval



Turbocor vs. Carrier Jan 06



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# Navy Techval



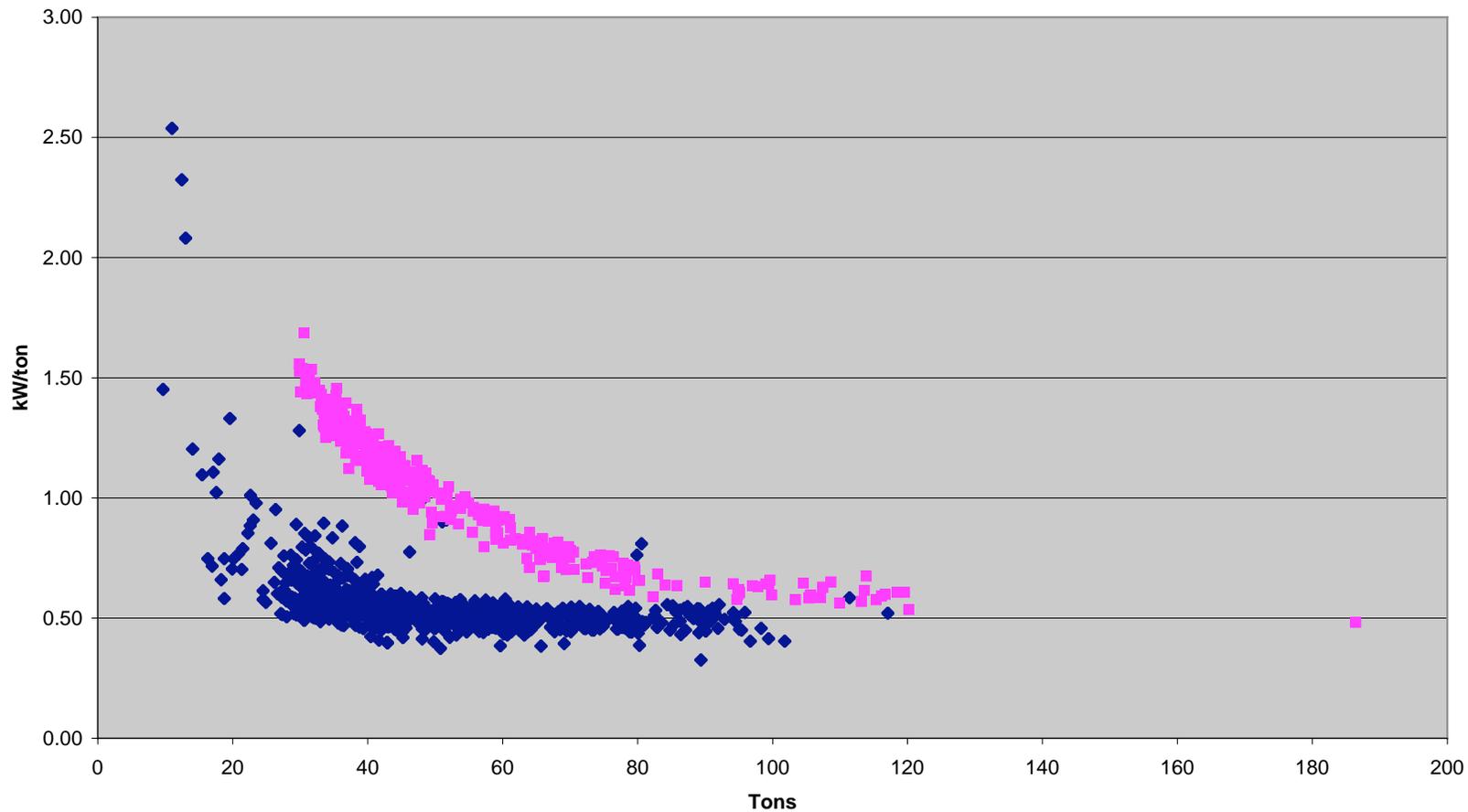
SAN DIEGO DATA								
JANUARY 2006								
Existing Chiller								
	Chilled Water Flow Rate (gpm)	Chilled Water Temp. in (°F)	Chilled Water Temp. out (°F)	Chilled Water Temp. Delta	Load (tons)	Condensing Water Temp. (°F)	Electrical Demand (Kw)	Efficiency (Kw/ton)
Minimum	427	45	43	0.0	0	70	0	0.32
Maximum	511	59	54	14.7	290	76	94	2.53
Average	485	47	45	2.4	48	74	<b>47</b>	<b>1.11</b>
Turbocor								
Minimum	421	44	40	0.5	0	65	0	0.31
Maximum	484	52	47	7.8	153	76	86	2.69
Average	462	47	44	2.5	44	69	<b>25</b>	<b>0.59</b>



# Navy Techval



San Diego Turbocor Vs. Existing Chiller April 2006



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SAN DIEGO COMPARISON APRIL 2006								
Existing Chiller								
	Chilled Water Flow Rate (gpm)	Chilled Water Temp. in (°F)	Chilled Water Temp. out (°F)	Chilled Water Temp. Delta	Load (tons)	Condensing Water Temp. (°F)	Electrical Demand (Kw)	Efficiency (Kw/ton)
<b>Minimum</b>	447	46	44	1.5	30	70	42	0.48
<b>Maximum</b>	728	55	46	9.0	186	78	90	1.69
<b>Average</b>	486	47	44	2.7	54	74	<b>51</b>	<b>1.03</b>
Turbocor								
<b>Minimum</b>	432	45	41	0.6	10	65	11	0.33
<b>Maximum</b>	483	50	47	6.1	117	73	65	2.54
<b>Average</b>	460	47	45	2.6	50	69	<b>27</b>	<b>0.55</b>



# Navy Techval



## Cost for third Turbocor and condensing water reset installation in San Diego

\$10,259

Design

Installation Planning and Procurement

~~\$38,000~~  
\$40,529

Chiller Purchase

Mechanical Subcontractor (for chiller)

\$95,690

Controls Subcontractor (for chiller)

\$7,550

Controls Subcontractor (for misc. items)

\$16,140

Installation Management

\$11,519

\$178,687

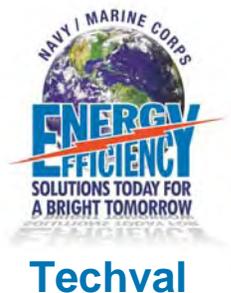


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# Navy Techval



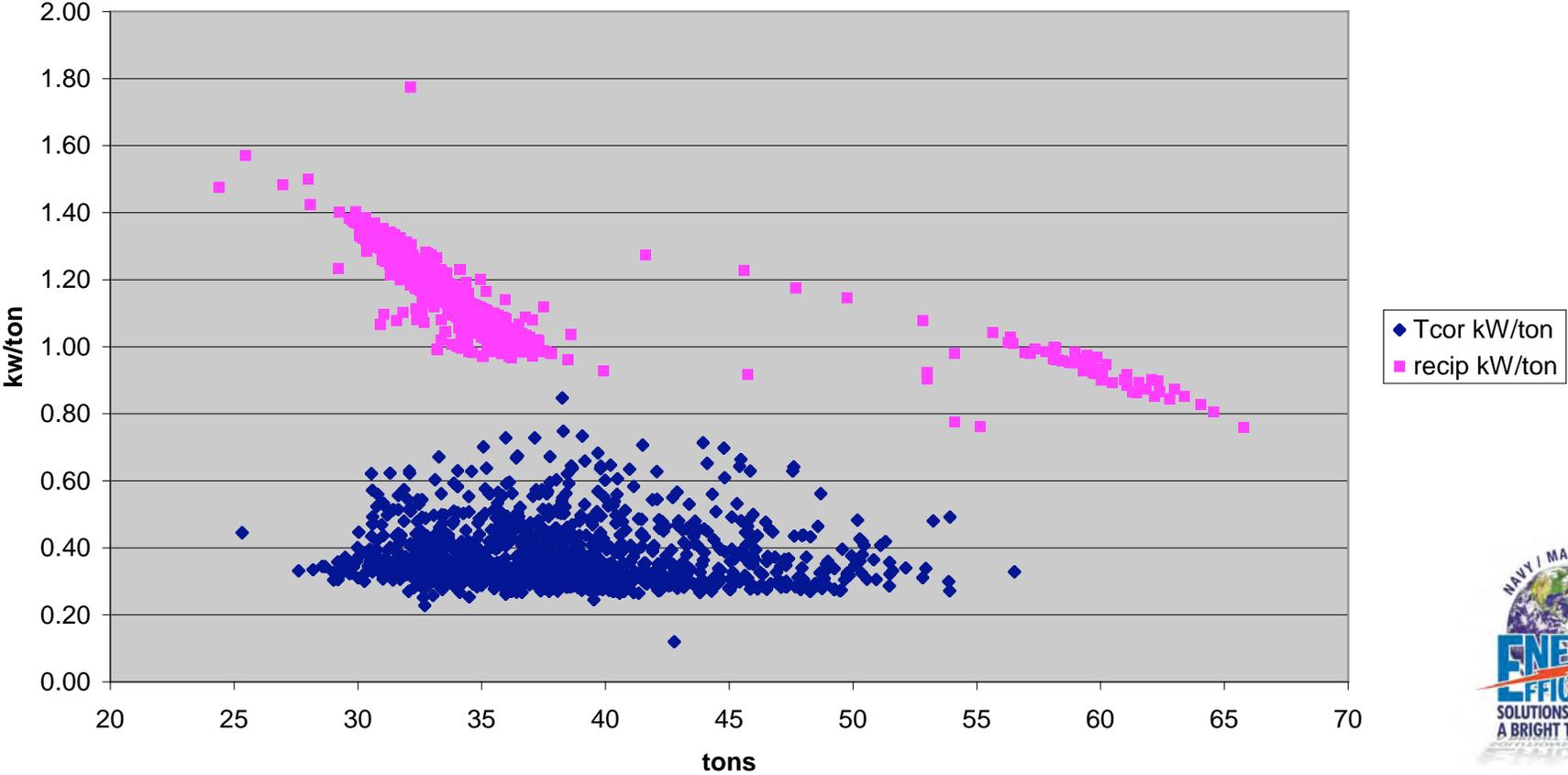
80 ton Turbocor chiller compressor with magnetic bearings and integral VFD  
*NUWC Newport RI*



# Navy Techval



All Data Points For Newport RI  
Kw/Ton vs. Load  
New Chiller vs. Old Chiller



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NEWPORT DATA SEP – NOV 2005								
Existing Chiller								
	Chilled Water Flow Rate (gpm)	Chilled Water Temp. in (°F)	Chilled Water Temp. out (°F)	Chilled Water Temp. Delta	Load (tons)	Condensing Water Temp. (°F)	Electrical Demand (Kw)	Efficiency (Kw/ton)
<b>Minimum</b>	187	52	48	2.5	24	48	33	0.76
<b>Maximum</b>	250	56	52	6.6	66	70	58	1.77
<b>Average</b>	231	54	50	3.7	36	60	<b>40</b>	<b>1.13</b>
Turbocor								
<b>Minimum</b>	180	45	41	3.2	25	48	5	0.12
<b>Maximum</b>	206	53	47	7.3	57	78	32	0.65
<b>Average</b>	192	50	45	4.7	37	59	<b>14</b>	<b>0.37</b>

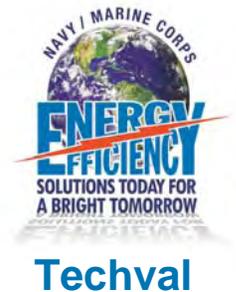


# Navy Techval



## Cost for Turbocor installation in Newport \$10,259

Design		
Installation Planning and Procurement		\$4,529
Chiller Purchase	\$16,140	\$33,000
Mechanical Subcontractor (for chiller)	\$100,783	\$29,305
Controls Subcontractor (for chiller)		\$7,550
Controls Subcontractor (for misc. items)		
Total		



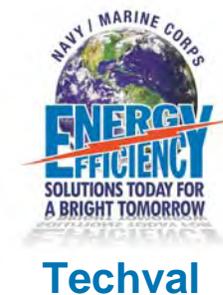
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## Turbocor Maintenance

- |   |  |
|---|--|
| 1. Quarterly tightening of terminal screws<br>(could be done in conjunction with #2<br>once per year) | 2 man-hours per service                              |
| 1. Annual blowing dust off circuit boards   | 2 man-hours per service                              |
| 2. Change capacitors every five years   | 8 man-hours per service plus \$250<br>for capacitors |

**Over 10 years that would be 96 man-hours plus \$500 for capacitors.**



# Navy Techval



## Turbocor Problems

### Newport

- Thermister failed. Thermister was replaced and problem has not recurred.
- Automatic Expansion Valve not tuned properly. Valve was adjusted and problem has not recurred.

### San Diego

- Insulated Gate Bipolar Transistor (IGBT) failed. Decision was made to replace compressor since it was relatively easy to do. Replacement took two hours. Problem has not recurred.
- Power surge damaged one of three Turbocors. Compressor was replaced. Waiting final report on incident. Turbocor has stated that electronics have been improved since this compressor was installed.



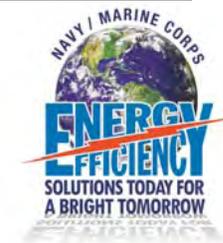
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The Table below presents a synopsis of the data collected for these two projects:

Project Site	Project Type	Site Characteristics	\$/KWH	Tons	Annual Kwh savings	Annual Energy \$ Savings	% Savings	Cost	\$/Ton	Payback (years)
San Diego April/May 2005	Compressor Retrofit	Year round cooling, old compressors screw	\$0.121	160	199,000	\$24,000	41%	\$138,718	\$867	5.8
San Diego January 2006	Add 3 <sup>rd</sup> compressor and Condensing water reset	Year round cooling, old compressors screw	\$0.121	240	193,596	\$23,232	47%	\$178,687	\$744	7.7
San Diego April 2006	Add 3 <sup>rd</sup> compressor and Condensing water reset	Year round cooling, old compressors screw	\$0.121	240	210,240	\$25,229	47%	\$178,687	\$744	7.1
Newport Sep/Nov 2005	New Chiller	Year round cooling, old chiller recip	\$0.115	80	227,760	\$26,192	65%	\$100,783	\$1260	3.8



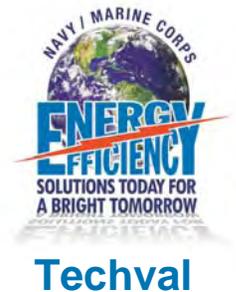
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## Other advantages of the Turbocor compressor

- Quiet – In San Diego the chilled water pumps make more noise than the chiller. Could be a plus if installation is in an area where noise is an issue.
- Light weight – If compressor needs to be changed out, can be accomplished manually by two persons.
- Low startup draw – about 2 amps. Could be a plus if you are replacing or installing a backup generator since generator can be downsized to handle full load draw, not startup. Smaller generator may pay for incremental cost of Turbocor.



## Final Thoughts

- Best place to install a Turbocor
  - ✓ As a retrofit of a recip chiller but consider screw compressors also
  - ✓ Where electric rates are high
  - ✓ Where there is year round cooling load
  - ✓ Consider installing condensing water re-set
- Techval has found that sites where we have installed Turbocors often have other issues that need to be addressed and present an opportunity for savings by themselves.

# Navy Techval



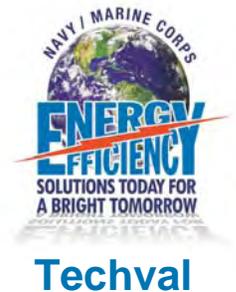
## Thermal Destratifier

Moves warm air from the ceiling of high bay buildings down to the floor level where the personnel are, and more important from an energy saving standpoint, where the thermostat is. This reduces the average temperature in the building.

Navy Techval found savings of \$1369 (~95 MBtu) per year net savings and a 6 year simple payback

## Navy Techval recommends installing thermal destratifiers in other Navy facilities where:

- ✓ Where there are buildings with significant stratification
- ✓ Where there are high bay buildings with high heating loads
- ✓ Where the cost for energy used to heat is high



# Navy Techval



## Thermal Destratifier



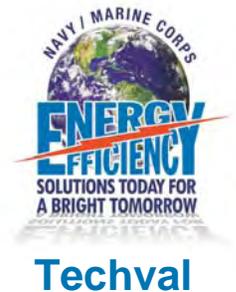
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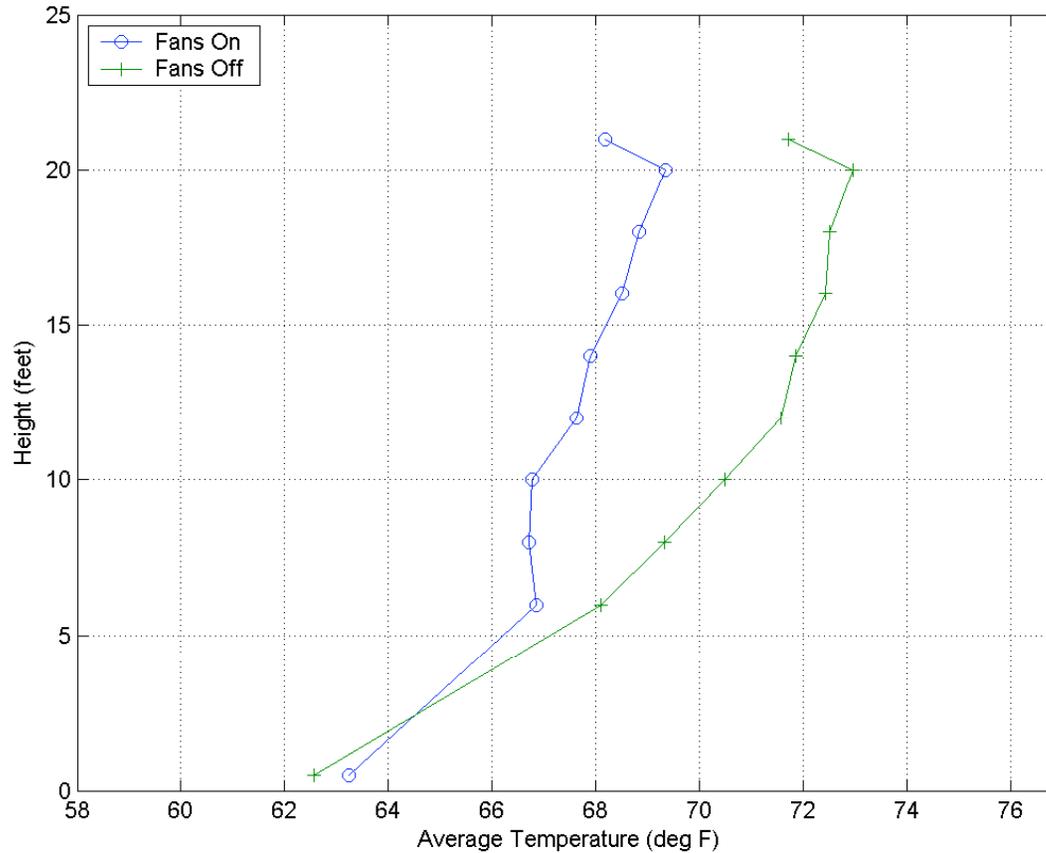


## West Bethesda

- 7000 ft<sup>2</sup> covered by 6 fans
- Ceiling is 27 ft at it's highest point
- Metal frame building with a concrete floor and metal siding on the roof and walls. Building is insulated
- Serviced by a single electric heat pump
- Heat diffusers (14) are at the ceiling
- The space is a machine shop



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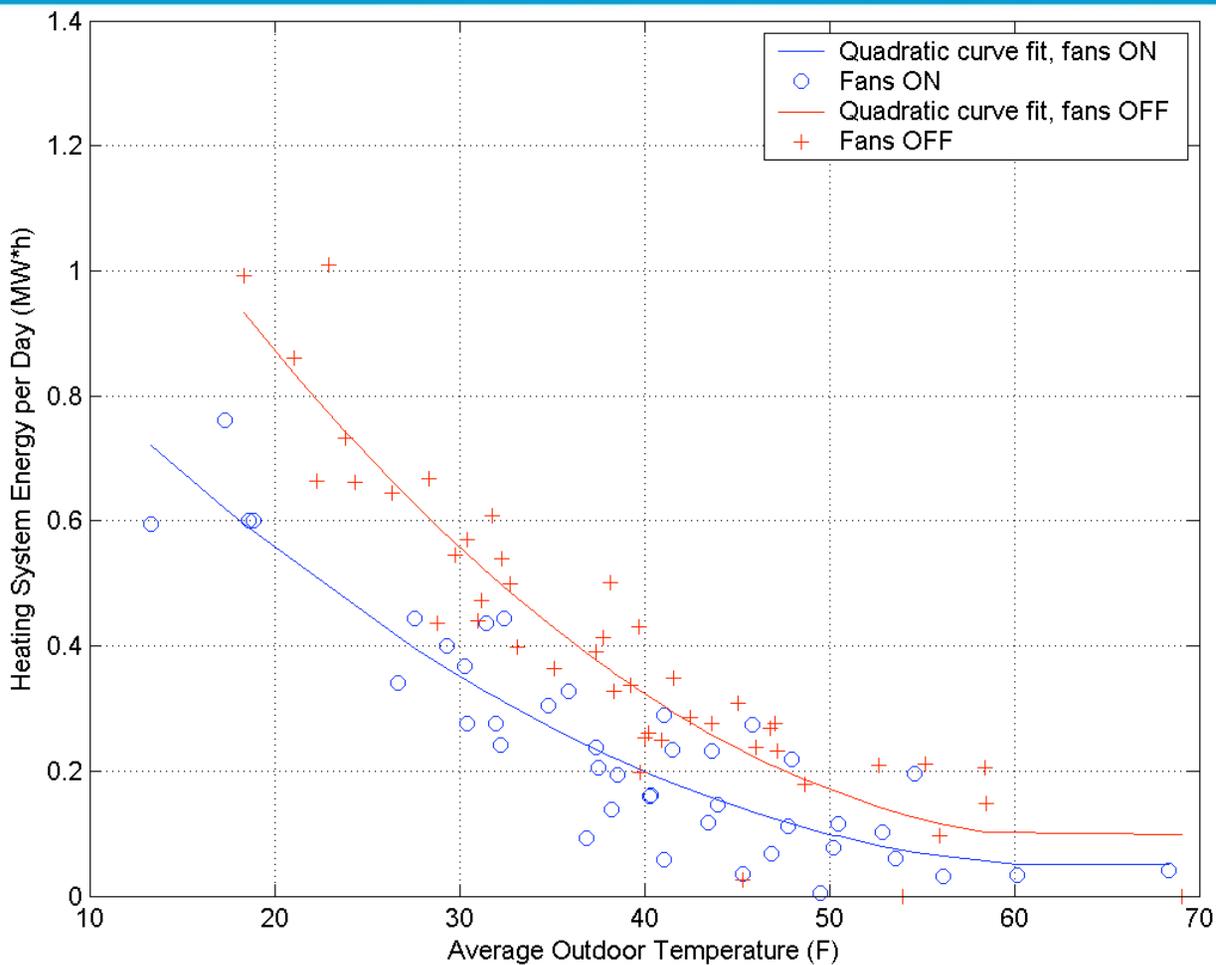


Average Temperature Over Test Duration vs. Height for Bethesda



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Heating System Energy Usage per Average Outdoor Temperature for Bethesda



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# Navy Techval



## West Bethesda Analysis

- \$0.056/kWh
- 4,240 Heating Degree Days.
- \$71 to operate per year
- \$1,466 per year gross savings
- \$1369 (~95 MBtu) per year net savings
- \$5,917 cost to install fans
- \$2,188 cost for the fan
- \$8,105 installed cost for all six fans or \$1351/fan.
- 6-year simple payback.



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## Operational Problems

### Fan Blade Cracking

- Four Crane fans and one Bethesda fans
- No material was ejected
- All fans were replaced by the manufacturer
- Change in QA process instilled
- No subsequent incidents



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## Final Thoughts

- Where to install Thermal Destratifiers
  - ✓Where there are buildings with significant stratification
  - ✓Where there are high bay buildings with high heating loads
  - ✓Where the cost for energy used to heat is high

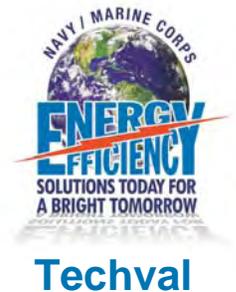
## Cool Roof

Both reflects heat from the sun and readily re-emits heat that is absorbed thus reducing heat gain from the sun and reducing the load on the building's air conditioning system.

Navy Techval has found \$0.17 to \$0.50 savings / sf /year at a cost less than traditional roofs.

## Navy Techval recommends installing cool roofs in other Navy facilities where:

- ✓Where a roof needs to be replaced
- ✓In warm weather climates
- ✓Where the cost for cooling is high
- ✓Buildings with poor insulation in the roof



# Navy Techval



## Cool Roof NS Pearl Harbor



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	Before: 5/19/04 to 7/9/04	After: 5/19/05 to 7/9/05	Delta	
<b>Weather</b>				
Cooling Degree Days (CDD)	883.13	850.30	32.83	3.7%
<b>Building 57</b>				
Total Building Power (kWh)	15,709	12,137	3,572	22.7%
Total Power per CDD (Wh/CDD)	17,787	14,273	3,514	19.8%
<b>Building 258 (excluding chillers)</b>				
Total Building Power (kWh)	161,247	156,366	4,881	3.0%
Total Power per CDD (Wh/CDD)	182,586	183,895	-1,309	-0.7%
<b>Building 258 Chillers</b>				
Total Chiller Power (kWh)	27,727	23,672*	4,055	14.6%
Chiller Total Power per CDD (Wh/CDD)	31,396	27,840*	3,556	11.3%
Note: positive delta numbers reflect a decrease in value				
* Estimate based on model of Building 396A				



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## Cool Roof Demonstration, NAVSTA Pearl Harbor, HI

	Building 57 TOTALSHEILD	Building 258 Duro-Last	Building 251 Traditional Built-Up Roof
<b>Given</b>			
Roof Area (ft <sup>2</sup> )	5,000	16,800	29,500
Installation Cost	29,886	79,803	193,166
Installation Cost per ft <sup>2</sup>	5.98	4.75	6.55
Electric Rate (\$/kWh)	\$0.10	\$0.10	\$0.10
<b>Results</b>			
Savings (kWh/year)	25,114	28,501	0
Savings (\$/year)	\$2,511	\$2,850	\$0
Savings per year per ft <sup>2</sup>	\$0.50	\$0.17	\$0
Simple Payback (years)	11.9	28.0	n/a
<b>Incremental Savings Compared to Traditional Built-Up Roof</b>			
Δ Installation Cost per ft <sup>2</sup>	-\$0.57	-\$1.80	n/a
Savings per year per ft <sup>2</sup>	\$0.50	\$0.17	n/a
Simple Payback (years per ft <sup>2</sup> )	-1.1 (instantaneous)	-10.6 (instantaneous)	n/a



## Final Thoughts

- Where to install Cool Roofs
  - ✓ Where a roof needs to be replaced
  - ✓ In warm weather climates
  - ✓ Where the cost for cooling is high
  - ✓ Buildings with poor insulation in the roof

DOE Cool Roof Calculator

<http://www.ornl.gov/sci/roofs+walls/facts/CoolCalcEnergy.htm>



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# Navy Techval



## Contact Info

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