3 - AR No. # - Centralize Exhaust Fan Controls

Recommendation

Centralize the controls on all four 1/2 HP fans and the two 10 HP fans associated with ventilating the paint booths. This will allow for all motors to be shut off simultaneously, increasing their downtime and reducing associated annual energy consumption by 47.5%.

Annual Savings Summary

Source	*Quantity*	*Units*	*Cost Savings*
Electrical Consumption	86,524	kWh (site)	$5,088
Total	**295**	**MMBtu**	**$5,088**

Implementation Cost Summary

Description	*Cost*	*Payback (yrs)*
Before Incentives	$2,200	0.4
After Incentives	$660	0.1

Facility Background

The facility has two paint booths used to paint and cure product. Both booths are equipped with one 10 HP and two 1/2 HP exhaust fans. Facility personnel explained that all fans run 24/7 regardless of booth and facility operation, for a total of 8,760 hours in a year.

Nameplate data were recorded for the 1/2 HP fans. The nameplate of the 10 HP fans was inaccessible. No live readings were taken and no data loggers were placed due to inaccessibility.

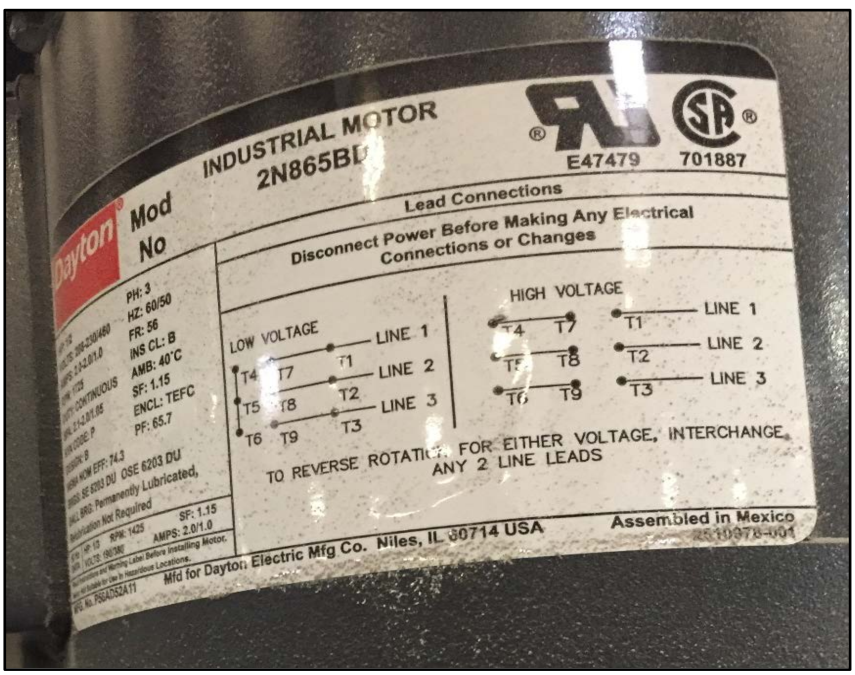

Figure 1: 1/2 HP motor nameplate

Opportunity Background

Fan motors that are allowed to run during all hours of the day consume excessive amounts of energy. This overconsumption of energy can be easily avoided if there are times of the day when airflow is not required. Centralizing controls means to rewire the fans such that they are all powered from one switch board or, better yet, a single switch. This promotes facility personnel to power off all fans simultaneously because the controls are in a single area as opposed to spread across the facility.

Proposal

Rewire the exhaust fans associate with the paint booths such that the controls are on a single switchboard. This will promote the shutdown of exhaust fans and reduce annual energy consumption. Annual cost savings are estimated at $5,088 after an implementation cost of $2,200 resulting in a simple payback period of 0.4 years.

Implementation

Contract an electrician to rewire the paint booth fan's electrical system so all fans are operated from the same switch board. This will allow all fans to be operated from one area, making it easier to turn them off when not in use.

Incentives

Companies paying a public purpose charge may qualify for Puget Sound Energy cash incentives. Incentives are calculated on a case-by-case basis and are based on the results of a technical analysis study. Electricity trimming projects may qualify for an incentive of $0.05 per annual kWh saved, up to 70% of the project cost.

Calculation Methodology

The current energy consumption of all the fans was calculated based on their rated power and their motor efficiency. The brake horsepower divided by the motor efficiency provided the required input power. This value was converted into kW and multiplied by the number of hours in a year because the fans are running constantly. This produced the annual energy consumption in kWh/yr.

The proposed energy consumption was developed using the ratio of current operating hours to the proposed operating hours. The proposed operating hours were equal to the hours that the facility works each year, 16 hours per day multiplied by 5 days per week multiplied by 52 weeks per year. The proposed annual operation hours divided by the current annual operation hours provided the operation time reduction percentage. This value multiplied by the current energy consumption yields the proposed energy consumption.

Next Steps

The next steps in pursuing the savings outlined in this analysis are to contact an electrician and discuss the current layout of the fan's electrical system.

Notes

Analysts assumed the facility would implement a program to ensure the switches are used as outlined in this recommendation and that they are turned off at the end of each shift to ensure energy savings.

Analysts assumed a motor efficiency of 89.5% for the 10 HP fans based on the U.S. DOE requirement to be considered as an energy efficient motor [1]. This value was used as conservative estimate because the actual motor efficiency is unknown.

References

[1] "Buying An Energy-Efficient Electric Motor," Energy.Gov. [Online]. Available: https://www.energy.gov/sites/prod/files/2014/04/f15/mc-0382.pdf. [Accessed 17 Apr 2018].

[2] ERSMeans electrical cost data 2015. Norwell, MA: RS Means, 2014, pp. 109.

3 - AR No. # - Data Preparation

Oregon State University | Energy Efficiency Center

Centralize Exhaust Fan Controls, style 2018 v1.0

Data Collected

Facility Data

Operating Hours	(t_C)	*8,760*	hrs/yr	**(N. 1)**

0.5 HP Fan Data

Rated Horsepower	(P_{F1})	*0.5*	HP	**(N. 2)**
Motor Efficiency	(η_{F1})	*69.5%*		**(N. 2)**
Electrical Input Power	(EP_{F1})	*0.54*	kW	**(Eq. 1)**
Individual Energy Consumption	(E_{F1})	*4,700*	kWh/fan-yr	**(Eq. 2)**
Number of Fans	(n_{F1})	*4*		**(N. 3)**
Energy Consumption	(E_{C1})	*18,798*	kWh/yr	**(Eq. 3)**

10 HP Fan Data

Rated Horsepower	(P_{F2})	*10.0*	Hp	**(N. 3)**
Motor Efficiency	(η_{F2})	*89.5%*		**(N. 4, Rf. 1)**
Electrical Input Power	(EP_{F2})	*8.33*	kW	**(Eq. 1)**
Individual Energy Consumption	(E_{F2})	*72,987*	kWh/fan-yr	**(Eq. 2)**
Number of Fans	(n_{F2})	*2*		**(N. 3)**
Energy Consumption	(E_{C2})	*145,974*	kWh/yr	**(Eq. 3)**

Proposed Conditions

Fan Operation Data

Daily Operating Hours	(t_d)	*16*	hrs/day	**(N. 3)**
Annual Operating Hours	(t_P)	*4,160*	hrs/yr	**(Eq. 4)**
Percent of Original Operation	(X)	*47.5%*		**(Eq. 5)**

Energy Analysis

Current Conditions

Fan 1 Energy Consumption	(E_{C1})	*18,798*	kWh/yr	**(Eq. 3)**
Fan 2 Energy Consumption	(E_{C2})	*145,974*	kWh/yr	**(Eq. 3)**
Total Energy Consumption	(E_C)	*164,772*	kWh/yr	**(Eq. 6)**

Proposed Conditions

Fan 1 Energy Consumption	(E_{P1})	*8,927*	kWh/yr	**(Eq. 7)**
Fan 2 Energy Consumption	(E_{P2})	*69,321*	kWh/yr	**(Eq. 7)**
Total Energy Consumption	(E_P)	*78,248*	kWh/yr	**(Eq. 6)**

Equations

Eq. 1) Electrical Input Power ($EP_{F1,2}$)

$$\frac{P_{Fi}}{\eta_{Fi}} \times \frac{0.7547\ kW}{1\ hp}$$

Eq. 2) Individual Energy Consumption ($E_{F1,2}$)

$$EP_{Fi} \times t_C$$

Eq. 3) Energy Consumption ($E_{C1,2}$)

$$E_{Fi} \times n_{Fi}$$

Eq. 4) Annual Operating Hours (t_P)

$$t_d \times \frac{5\ days}{1\ wk} \times \frac{52\ wk}{1\ yr}$$

Eq. 5) Percent of Original Operation (X)

$$\frac{t_p}{t_C}$$

Eq. 6) Total Energy Consumption ($E_{C,P}$)

$$E_{i1} + E_{i2}$$

Eq. 7) Proposed Fan Consumption ($E_{P1,2}$)

$$E_{Ci} \times X$$

Notes

N. 1) During the assessment, facility personnel informed analysts that the paint booth exhaust fans run all hours of the day, regardless of facility operation.

N. 2) Recorded from fan motor nameplate.

N. 3) Provided by facility personnel.

N. 4) Motor efficiency was assumed to be equal to the US DOE standard for an energy efficient 10 HP motor [1].

Key Input Data

Recommendation Data

Current Operation Time	(t_C)	*8,760*	hrs/yr	**(N. 5)**
Proposed Operation Time	(t_P)	*4,160*	hrs/yr	**(N. 6)**

Utility Data

Incremental Electricity Cost	(IC_E)	*$0.0588*	/kWh	**(N. 7)**

Energy Analysis

Current Conditions

Current Energy Consumption	(E_C)	*164,772*	kWh/yr	**(N. 6)**
Current Energy Cost	(C_C)	*$9,689*	/yr	**(Eq. 8)**

Proposed Conditions

Proposed Energy Consumption	(E_P)	*78,248*	kWh/yr	**(N. 6)**
Proposed Energy Cost	(C_P)	*$4,601*	/yr	**(Eq. 8)**

Savings

Energy Savings	(E_S)	*86,524*	kWh/yr	**(Eq. 9)**
Cost Savings	(S)	*$5,088*	/yr	**(Eq. 10)**

Equations

Analysis Equations

Eq. 8) Energy Cost ($C_{C,P}$)

$$E_i \times IC_E$$

Eq. 9) Energy Savings (E_S)

$$E_C - E_P$$

Eq. 10) Cost Savings (S)

$$C_C - C_P$$

Notes

N. 5) Current operating hours of the energy consuming system.

N. 6) Developed on the Data Preparation page of this recommendation.

N. 7) Developed in the Utility Analysis section of this report.

Vendor Data

Electrician Crew Size	(n_C)	*2*		**(N. 8)**
Electrician Labor Rate	(L_R)	*$55.00*	/hr	**(N. 8)**
Project Time	(t_L)	*20*	hrs	**(N. 8)**

Economic Results

Annual Cost Savings	(S)	***$5,088***	/yr	**(N. 9)**
Implementation Cost	(C_I)	***$2,200***		**(Eq. 11)**
Simple Payback	(t_{PB})	***0.4***	yrs	**(Eq. 12)**

Incentive Data

Annual Energy Savings	(E_s)	***86,524***	kWh	**(N. 9)**

Equations

Eq. 11) Implementation Cost (C_I)

$$n_C \times L_R \times t_L$$

Eq. 12) Simple Payback (t_{PB})

$$\frac{C_I}{S}$$

Notes

N. 8) Based on RSMeans handbook for electrician labor [2].

N. 9) Developed in the Analysis page of this recommendation.

Incentive Analysis Summary

Description	*Incentive*	*After*	*Payback*	*Notes*
			(yrs)	
Puget Sound Energy	***$1,540***	***$660***	***0.1***	*$0.05 per annual kWh saved*
Totals	***$1,540***	***$660***	***0.1***	

3 - AR No. # - Incentive Analysis

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Incentive Analysis template September 2016, Style 2016

Incentive Data

Annual Energy Savings	(E_s)	*417*	MMBtu	**(Rf. 1)**
Annual Energy Savings	(E_s)	*4,170*	Therms	**(Rf. 2)**
Annual Cost Savings	(S)	*$357,967*	/yr	**(Rf. 1)**
Implementation Cost	(C_I)	*$669,217*		**(Rf. 1)**
Simple Payback	(t_{PB})	*1.9*	years	**(Rf. 1)**

Incentive Analysis Summary

Description	*Incentive*	*After Incentive*	*Payback*	*Notes*
			(yrs)	
Energy Trust of Oregon	*$8,340*	*$660,877*	*1.8*	*$2.00 per annual therm saved*
Totals	*$8,340*		*0.0*	

No Incentives Found

This recommendation does not reduce utility consumption and will likely not qualify for typical incentives. This does not necessarily mean incentives are unavailable; custom incentives can sometimes be arranged.

Energy Trust of Oregon (ETO)

Companies paying a public purpose charge may qualify for Energy Trust of Oregon cash incentives. Incentives are calculated on a case-by-case basis and are based on the results of a technical analysis study. Natural gas trimming projects may qualify for an incentive of $2.00 per annual therm saved, up to 50% of the project cost.

Energy Smart Industrial (ESI)

Bonneville Power Administration's Energy Smart Industrial reimbursement incentive is available to help pay for implementation of energy saving measures that are deemed cost effective and have a minimum 10-year life span. Incentives can be anticipated to equal minimum of 70% of total project cost or $0.25 per kWh saved.

Investment Tax Credit (ITC)

You may also be eligible for a Federal Business Investment Tax Credit. These grants are available to industrial producers and the credit is equal to 27.4% (as of March 1st, 2013 the incentive was reduced from 30% to its current value) of expenditures for solar, fuel cells, small wind turbines, and 10% of expenditures for geothermal systems, microturbines and combined heat and power with no maximum credit. The credits are for eligible systems placed in service on or before December 31, 2016.

References

Rf. 1) Developed in this recommendation on the previous pages.

Rf. 2) 1 MMBtu is approximately equivalent to 10 Therms.