2015 Electric Integrated Resource Plan

Appendix D – Avista Generation Energy Efficiency Studies

Energy Efficiency Improvements Audit Report

Prepared for
Boulder Park Generating Facility

Prepared by
Andy Paul, PE
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Energy Solutions Engineers

January 16, 2015

Overview

Facility: Boulder Park Thermal Generation Facility
Audited by:, Andy Paul PE, Bryce Eschenbacher PE and Levi Westra PE
Onsite Staff: James Mittlestadt and Mike Mecham
Facility Audited on: January 8th, 2015

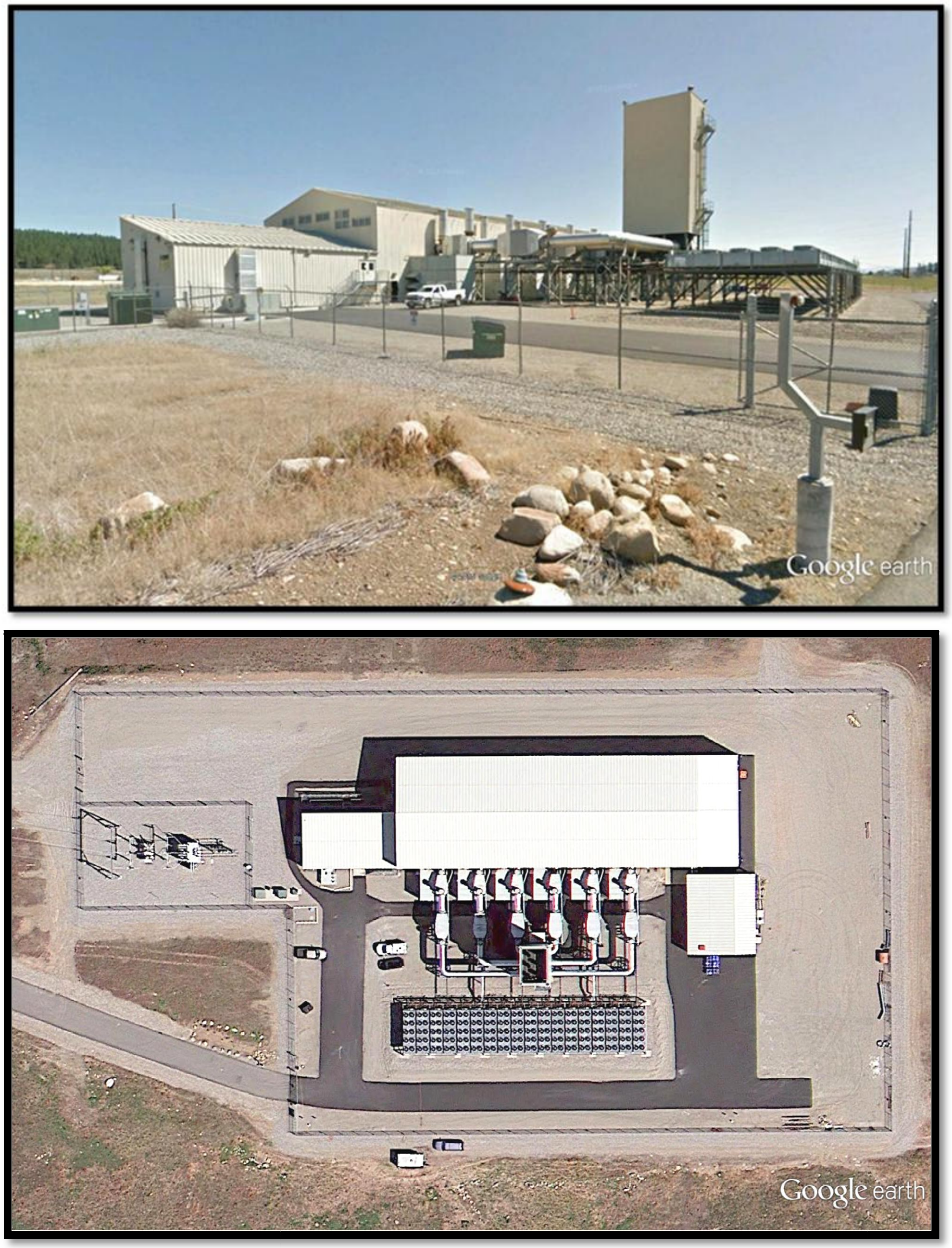


Figure 1 Google Earth Images of the Boulder Park Generation Facility

Avista's DSM Engineering staff visited the Boulder Park generating facility to review their current building systems and discuss several concerns that the user's encountered during typical operation. Specifically, this audit was conducted to identify all possible energy efficiency improvements not related to the power generation process.

After completing a tour of the facility, potential improvement measures were identified for consideration including capital projects as well as low-cost no-cost measures. This report is intended to provide a cursory review of possible energy savings. Each listed recommendation and costing is based upon historical experience and costing projections. Equipment life and performance will vary and a Statement of Work (SOW) for the capital project will determine the actual project costs and performance.

The facility consists of an office, network room, and large high bay warehouse which houses (6) sound isolated natural gas burning compression-ignition 4-stroke engine generator sets; with a 7th unit available for parts.

Shell

There are several areas around the facility where additional weatherization work can be conducted.

1. The roll up doors could use new weather stripping along the outside edges of the doors and along the bottom. A noticeable draft can be felt when you stand next to the doors.

2. The man doors would also benefit from additional weather stripping.

3. There are several areas along where the foundation and exterior walls meet that daylight can be seen from the inside. These gaps in the wall construction should be sealed; a closed cell foam product would work well here.

While these measures will conserve energy, those savings will be negligible in comparison to the measures listed further in this report.

Lighting

The site employs T12, T8 and T5 linear fluorescent lighting as well as 400 Watt Metal Halide (MH) high-bay and 250 Watt MH exterior lighting on dusk to dawn sensors. No parking lot lighting was observed.

Table 1 Capital Project Lighting Opportunity Summary

	Brief EEM* Description	EEM Cost	Measure Life	Electric kWh Savings
1	Control Room Lighting	**$13,850**	**20 yrs**	**3,931**
2	Generating Floor High Bays	**$16,848**	**20 yrs**	**16,099**
3	Replacing Engine Bay Lights	**$17,976**	**20 yrs**	**6,739**
4	Replace Exterior Wall Packs	**$10,702**	**20 yrs**	**16,054**

*EEM – Energy Efficiency Measure

1. Proposed Project #1: The facility currently has (x40) two lamp F32T8 fluorescent fixtures lighting the control room, break room, and restroom. The fixtures average 2,600 hrs of operation a year. The proposed project looks at replacing these fixtures with (x40) 40W linear LED fixtures. A simple lumen calculation shows that the overall lumens for the job were decreased by 7%.
    - The provided project is $13,850, this cost was calculated using fixture and install costs for these fixtures at Noxon Rapids HED.
2. Proposed Project #2: The facility currently has (x24) single lamp 400W Metal Halide fixtures lighting the main generation facility. The fixtures average 2,080 hrs of operation a year. The proposed project looks at replacing these fixtures with (x24) 200W linear LED high bay fixtures. A simple lumen calculation shows that the overall lumens for the job were decreased by 23%.
    - The provided project is $16,484, this cost was calculated using fixture and install costs for these fixtures at Noxon Rapids HED.
3. Proposed Project #3: The facility has six engine bays; each bay is lit by (x8) two lamp F96T12 fixtures. The fixtures average 2,080 hrs of operation a year. The proposed project looks at replacing all (x48) fixtures with 50W linear LED fixtures. A simple lumen calculation shows that the overall lumens for the job were decreased by 59%.
    - The provided project is $17,976, this cost was calculated using fixture and install costs for these fixtures at Noxon Rapids HED.
4. Proposed Project #4: The facility currently has (x16) single lamp 250W Metal Halide wall packs on the exterior of the plant. The fixtures average 4,288 hrs (dusk to dawn) of operation a year. The proposed project looks at replacing these fixtures with (x16) 52W LED wall packs. A simple lumen calculation shows that the overall lumens for the job were decreased by 66%.

    - The provided project is $10,702, this cost was calculated using fixture and install costs for these fixtures at Noxon Rapids HED.

5. It should be noted that while the total system lumens decrease for each of these projects, the actual lumens that reach the working space will more the likely increase. LED fixtures are very directional in the way they deliver lighting lumens. We recommend replacing a few light fixtures to make sure that they will meet your lighting needs. If you would like to see the fixtures in operation we recommend a trip to Noxon Rapids HED.

Low Cost No Cost Opportunities

In addition to the lighting replacement projects listed above we discussed a few re-circuiting projects that would help further reduce the electric load.

1. The three rows of lights on the generating floor are currently controlled by one switch. We recommend separating them out to one switch per row. This would allow the operators to leave the center row of lights off except during maintenance above the engine rooms.

2. The lights in the engine rooms are turned on when the engines are running and remain on for the duration. We recommend that these lights be put on bi-level switching. When the engines are running half the lights would come on, an occupancy sensor would turn the other half on when an operator entered a room.

HVAC

1. The control room, restroom, break room, and the MCC room are conditioned by two heat pump roof top units mounted on grade outside the building. Each of these units appears to be original to the building, based on the age they are in the 13 SEER (seasonal energy efficiency rating) range. While there are newer units available that have efficiencies closer to SEER 19, the cost to purchase and install these units outweighs the potential energy savings. Our recommendation is to replace these units when they have reached their end of life. When you do replace these units purchase the most efficient units that can be afforded.

   You may also consider replacing these units with gas fired units. When these units were purchased and installed the price of gas was high enough that it made heat pumps the more economical choice for heating. Now the price of gas is low enough that gas furnaces and roof top units, down to 80% efficient, is the more economical option. Currently the most efficient roof top unit on the market is around 82%. A few companies are working on 90+% efficient models, but none have come to market.

2. The generation floor has two 80% efficient natural gas fired unit heaters to provide supplemental heat in the winter. Currently Reznor makes a 90% efficient unit heater. While replacing the existing heaters with a new higher efficiency unit would generate gas savings, the price of these units is high enough that the project would more than likely not make financial sense. In addition the staff stated that these units do not operate all that often. In the future when these units are at end of life we recommend purchasing and installing the most efficient units that can be afforded.

3. The low speed/high volume destratification fan on the east end of the generating floor was making a rattling noise during our site visit. We recommend having the fan and motor be serviced before more serious damage is incurred.

Process

- **Compressed Air System**

	Brief EEM Description	EEM Cost	Electric kWh Savings	Residential energy retail value	Simple Payback
	Instrument Air Cycling Air-Dryers	**$6,600**	**10,074**	**$891/yr**	**14.8 yr**

Scope of Work:

- Proposed Project - Boulder Park Generating facility employs a single Kaeser SM 15 (15 hp, 53 scfm @ 100psi) rotary screw air-compressor supplying air to instruments and controls. The air is dried using two non-cycling Zeks NC 75 (75 cfm) refrigeration dryers. The EEM replaces those units with one appropriately sized Hankison HES90 (90 cfm) cycling refrigeration dryer. The analysis is based upon observed air-compressor operation (run time during audit) manufacturer's specifications and assumed annual hours of operation (24/7/365). A copy of the analysis is appended to this document in a SMath Studio Worksheet.
- Mitch Johnson, of Rogers Machinery, provided a cost estimate of $3,300 for a non-cycling unit. This does not include install costs; the facility's excellent maintenance staff will have no problem installing this unit.
- **Oil reservoir heaters**
- Currently the facility uses 5 kW thermal elements for the engine oil heating system. There are two elements per tank and six engines for a total of 60 kW. This is a purely resistive load that operates continuously to maintain a tank oil temperature of 120 ºF. The estimated annual energy consumed by this system is approximately 525,600 kWh (this type of system is nearly 100% efficient). The cost associated with this type of heating is about $36,800 (using Avista WA rate schedule 21 and $0.07/kWh). The opportunity here is to investigate the possibility of replacing the electric resistive elements with an NG hydronic system that would circulate heated water

through the tank via some type of finned tube arrangement. On a strictly "per BTU" basis, the cost savings would approximately be as follows:

- 525,600 kWh*(3412 BTU/kWh) = 1,800 MMBTU*(therms/1E5BTU) = 17,933 therms

- Assuming a heating (tube) efficiency effectiveness of about 75%, the final NG consumption is expected to be 23,911 therms per year. Using a per therm cost of $0.69 (WA natural gas schedule 111) this translates to an operating cost of approximately $16,500 per year, giving a reduction of 55% in operating costs. Depending on the final system, piping, materials, and circulation pump sizing, the final energy cost reduction could be expected to be 50%. The 5% "conservative" factor also includes the initial energy required to raise the water temp from 52oF to 120oF and standby losses. There may (and probably will) also be some additional maintenance costs associated with regular tube inspections and cleaning. Obviously, whether or not this is a prudent investment depends largely on the equipment, installation, and commissioning costs associated with the project. Once estimates are provided, project simple paybacks and return on investments can be calculated.

We hope that this report helps to identify some areas that the generating facility can gain some operational efficiency and reduce the parasitic load that these systems represent. If you decide to pursue any of these potential energy savings projects please let the Energy Solutions team know ahead of the start of the project.

Respectfully,

Andy Paul, Bryce Eschenbacher, and Levi Westra - January 19, 2015

Name: Boulder Park Generating Facility - Control Room Lighting		
Acct#		
Existing Annual Consumption: (kilowatt hours)	7,706.40	
Lighting Energy Savings:(kilowatt hours)	3,650.40	
Lighting Demand Savings: (kilowatt demand)	1.15	
Cooling System Savings: (kilowatt hours)	281.08	
Cooling System Demand Savings: (kW demand)	0.09	
Lumen Comparison New/Existing	93.03%	
Total Energy Savings: (kilowatt hours)	3,931.48	
Total Demand Savings: (kilowatt demand)	**1.24**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**(31.76)**	
Maintenance Savings:	($30.69)	

Name: Boulder Park Generating Facility - Generating Floor **Acct#**		
Existing Annual Consumption: (kilowatt hours)	28,392.00	
Lighting Energy Savings:(kilowatt hours)	16,099.20	
Lighting Demand Savings: (kilowatt demand)	4.95	
Cooling System Savings: (kilowatt hours)	0.00	
Cooling System Demand Savings: (kW demand)	0.00	
Lumen Comparison New/Existing	76.92%	
Total Energy Savings: (kilowatt hours)	16,099.20	
Total Demand Savings: (kilowatt demand)	**4.95**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	$238.60	

Name: Boulder Park Generating Facility -Engine Room

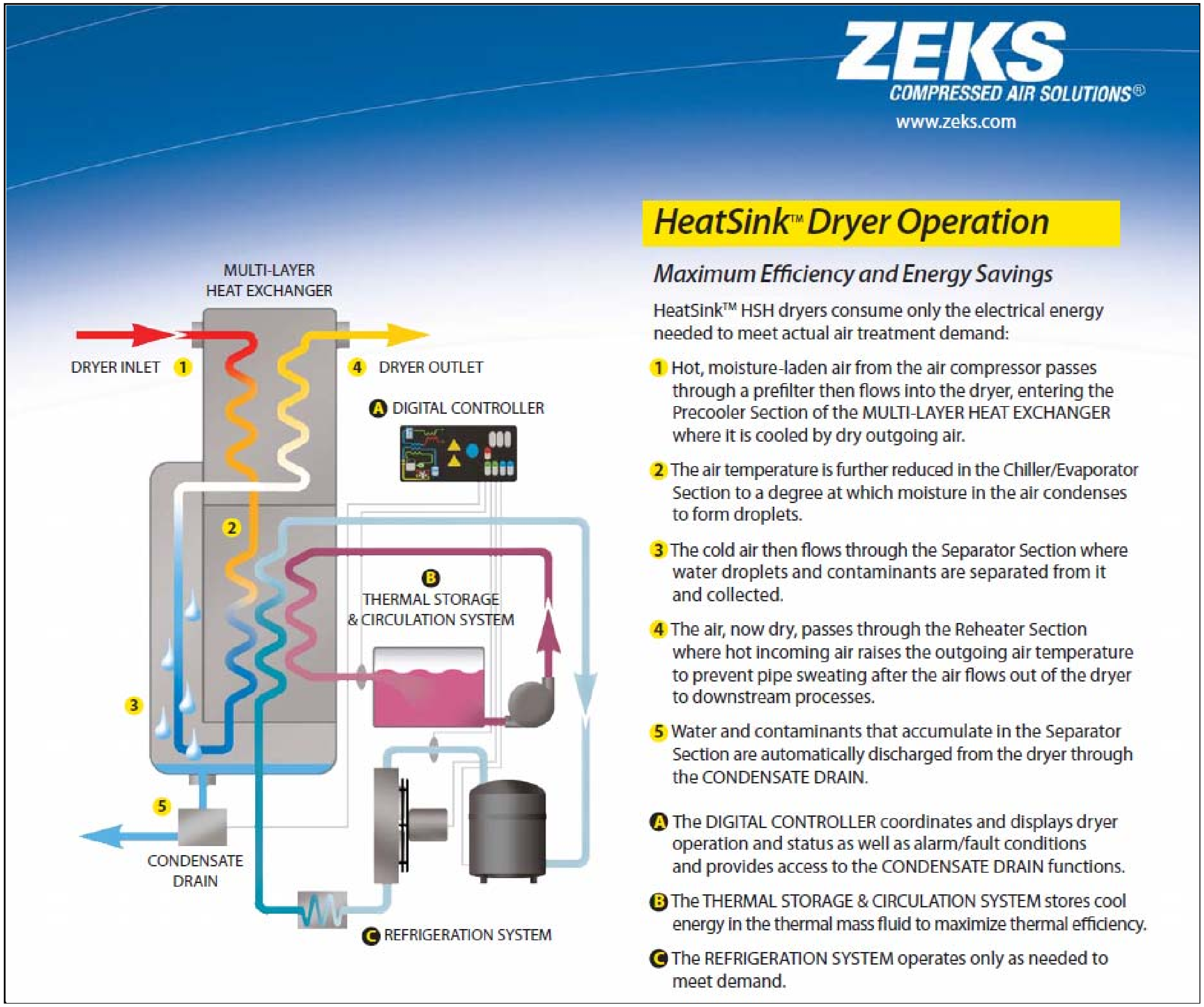
Acct#

Existing Annual Consumption: (kilowatt hours)	9,859.20	
Lighting Energy Savings:(kilowatt hours)	6,739.20	
Lighting Demand Savings: (kilowatt demand)	4.15	
Cooling System Savings: (kilowatt hours)	0.00	
Cooling System Demand Savings: (kW demand)	0.00	
Lumen Comparison New/Existing	41.29%	
Total Energy Savings: (kilowatt hours)	6,739.20	
Total Demand Savings: (kilowatt demand)	**4.15**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	$117.10	

Name: Boulder Park Generating Facility - Wall Packs **Acct#**		
Existing Annual Consumption: (kilowatt hours)	19,621.89	
Lighting Energy Savings:(kilowatt hours)	16,054.27	
Lighting Demand Savings: (kilowatt demand)	3.00	
Cooling System Savings: (kilowatt hours)	0.00	
Cooling System Demand Savings: (kW demand)	0.00	
Lumen Comparison New/Existing	33.69%	
Total Energy Savings: (kilowatt hours)	16,054.27	
Total Demand Savings: (kilowatt demand)	**3.00**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	$306.46	

Customer: Avista Generation; Boulder Park Internal Combustion Topping Plant
Project State: EEM Evaluation
Date: 01/08/15
Analysis Description: The facility employs a single Kaeser SM 15 rotary screw compressor operating with on/off controls with (2) Zeks NC 75 non-cycling refrigeration air-dryers for the facility's controls.

$pct := \frac{1}{100}$ input: assign "percent" to SMath Studio



HeatSink™ Dryer Operation

Maximum Efficiency and Energy Savings

HeatSink™ HSH dryers consume only the electrical energy needed to meet actual air treatment demand:

① Hot, moisture-laden air from the air compressor passes through a prefilter then flows into the dryer, entering the Precooler Section of the MULTI-LAYER HEAT EXCHANGER where it is cooled by dry outgoing air.

② The air temperature is further reduced in the Chiller/Evaporator Section to a degree at which moisture in the air condenses to form droplets.

③ The cold air then flows through the Separator Section where water droplets and contaminants are separated from it and collected.

④ The air, now dry, passes through the Reheater Section where hot incoming air raises the outgoing air temperature to prevent pipe sweating after the air flows out of the dryer to downstream processes.

⑤ Water and contaminants that accumulate in the Separator Section are automatically discharged from the dryer through the CONDENSATE DRAIN.

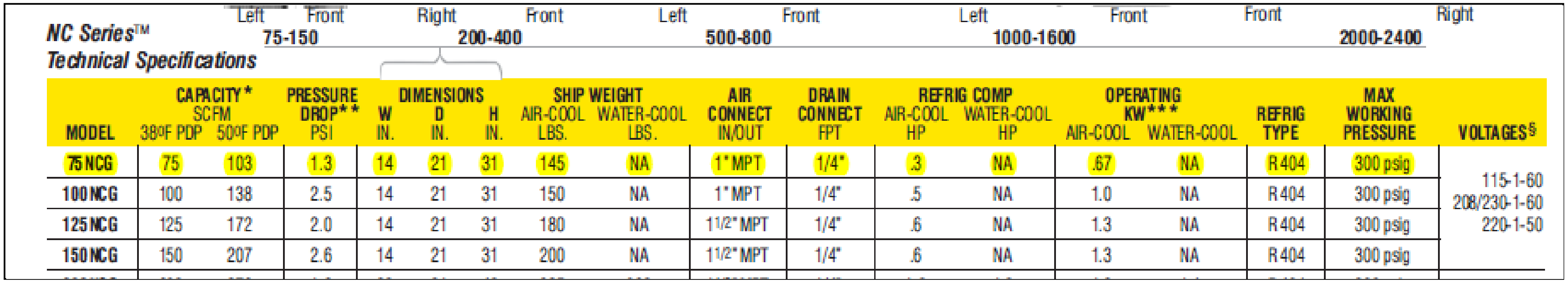
Ⓐ The DIGITAL CONTROLLER coordinates and displays dryer operation and status as well as alarm/fault conditions and provides access to the CONDENSATE DRAIN functions.

Ⓑ The THERMAL STORAGE & CIRCULATION SYSTEM stores cool energy in the thermal mass fluid to maximize thermal efficiency.

Ⓒ The REFRIGERATION SYSTEM operates only as needed to meet demand.

Figure 1. Explanation of cycling air-dryer technology

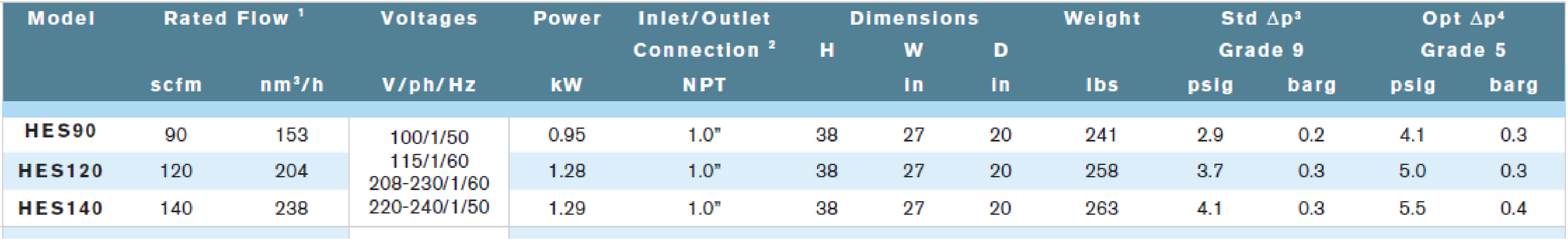
Table 1. Technical specifications for existing non-cycling refrigeration air-dryers



NC Series™
Technical Specifications

MODEL	CAPACITY* SCFM 38ºF PDP	CAPACITY* SCFM 50ºF PDP	PRESSURE DROP** PSI	DIMENSIONS W IN.	DIMENSIONS D IN.	DIMENSIONS H IN.	SHIP WEIGHT AIR-COOL LBS.	SHIP WEIGHT WATER-COOL LBS.	AIR CONNECT IN/OUT	DRAIN CONNECT FPT	REFRIG COMP AIR-COOL HP	REFRIG COMP WATER-COOL HP	OPERATING KW*** AIR-COOL	OPERATING KW*** WATER-COOL	REFRIG TYPE	MAX WORKING PRESSURE	VOLTAGES§
75 NCG	75	103	1.3	14	21	31	145	NA	1" MPT	1/4"	.3	NA	.67	NA	R404	300 psig	115-1-60 208/230-1-60 220-1-50
100 NCG	100	138	2.5	14	21	31	150	NA	1" MPT	1/4"	.5	NA	1.0	NA	R404	300 psig	
125 NCG	125	172	2.0	14	21	31	180	NA	11/2" MPT	1/4"	.6	NA	1.3	NA	R404	300 psig	
150 NCG	150	207	2.6	14	21	31	200	NA	11/2" MPT	1/4"	.6	NA	1.3	NA	R404	300 psig	

Table 2. Technical specifications for proposed cycling refrigeration air-dryers



Model	Rated Flow [1] scfm	Rated Flow [1] nm³/h	Voltages V/ph/Hz	Power kW	Inlet/Outlet Connection [2] NPT	Dimensions H	Dimensions W in	Dimensions D in	Weight lbs	Std Δp³ Grade 9 psig	Std Δp³ Grade 9 barg	Opt Δp⁴ Grade 5 psig	Opt Δp⁴ Grade 5 barg
HES90	90	153	100/1/50 115/1/60 208-230/1/60 220-240/1/50	0.95	1.0"	38	27	20	241	2.9	0.2	4.1	0.3
HES120	120	204		1.28	1.0"	38	27	20	258	3.7	0.3	5.0	0.3
HES140	140	238		1.29	1.0"	38	27	20	263	4.1	0.3	5.5	0.4

Inputs:

$P_{base\_nom} := 0.67\ kW$ input: basline power consumption; manufacturer specified, see Table 1.

$Qty := 2$ input: number of baseline 75 scfm air dryers; assume two needed for n+1 redundancy

$P_{EEM\_nom} := 0.95\ kW$ input: EEM power consumption; manufacturer specified, see Table 2.

$U_{ave} := 10 \cdot pct$ input: assumed utilization rate; based on air-compressor operation observed during site audit; air compressor cycled on once for a few minutes during the hour long visit.

$t_{op} := 8760\ \frac{hr}{yr}$ input: assumed annual hours of operation

Calculations:

$E_{base} := Qty \cdot P_{base\_nom} \cdot t_{op}$ calc: energy consumed annually by the baseline non-cycling units

$E_{base} = 11738.4 \frac{kW\ hr}{yr}$

$E_{EEM} := Qty \cdot P_{EEM\_nom} \cdot t_{op} \cdot U_{ave}$ calc: energy consumed annually by the EEM cycling units

$E_{EEM} = 1664.4 \frac{kW\ hr}{yr}$

$E_{savings\_annual} := E_{base} - E_{EEM}$ calc: energy saved annually converting to the EEM units

$E_{savings\_annual} = 10074 \frac{kW\ hr}{yr}$

Contacted Mitch at Rogers' Machinery and he gave me a rough estimate for a Hankinson HES90 cycling compressor of ~$3,300/unit.

$dollar := 1$ input: assign "dollar" to SMath Studio

$Cost := 2 \cdot 3300 \cdot dollar$ input: cost estimate for one EEM

$Rate := 0.08848 \cdot \frac{dollar}{kW\ hr}$ input: assumed average energy sales rate based upon blended 3 tiers of residential

$C_{savings} := E_{savings\_annual} \cdot Rate$ calc: annual revenue from EEM

$C_{savings} = 891.3 \frac{dollar}{yr}$

$SPB := \frac{Cost \cdot Qty}{C_{savings}}$ calc: average energy simple payback

$\boxed{SPB = 14.8\ yr}$

Non-Energy Benefits (NEBs):
- Life (years of operation before failure) of the dryer(s) will be increased due to reduced hours of compressor operation. This is even more evident when the (2) units are operated in an N+1 redundancy configuration.

Energy Efficiency Improvements
Audit Report

Prepared for
Cabinet Gorge Hydro Electric Dam

Prepared by
Andy Paul, PE
Bryce Eschenbacher, PE
Levi Westra, PE
Energy Solutions Engineers

April 13, 2015

Overview

Facility: Cabinet Gorge Hydro Electric Dam
Audited by: Andy Paul PE, Bryce Eschenbacher PE
Onsite Staff: Alan Lackner
Facility Audited on: March 30th, 2015

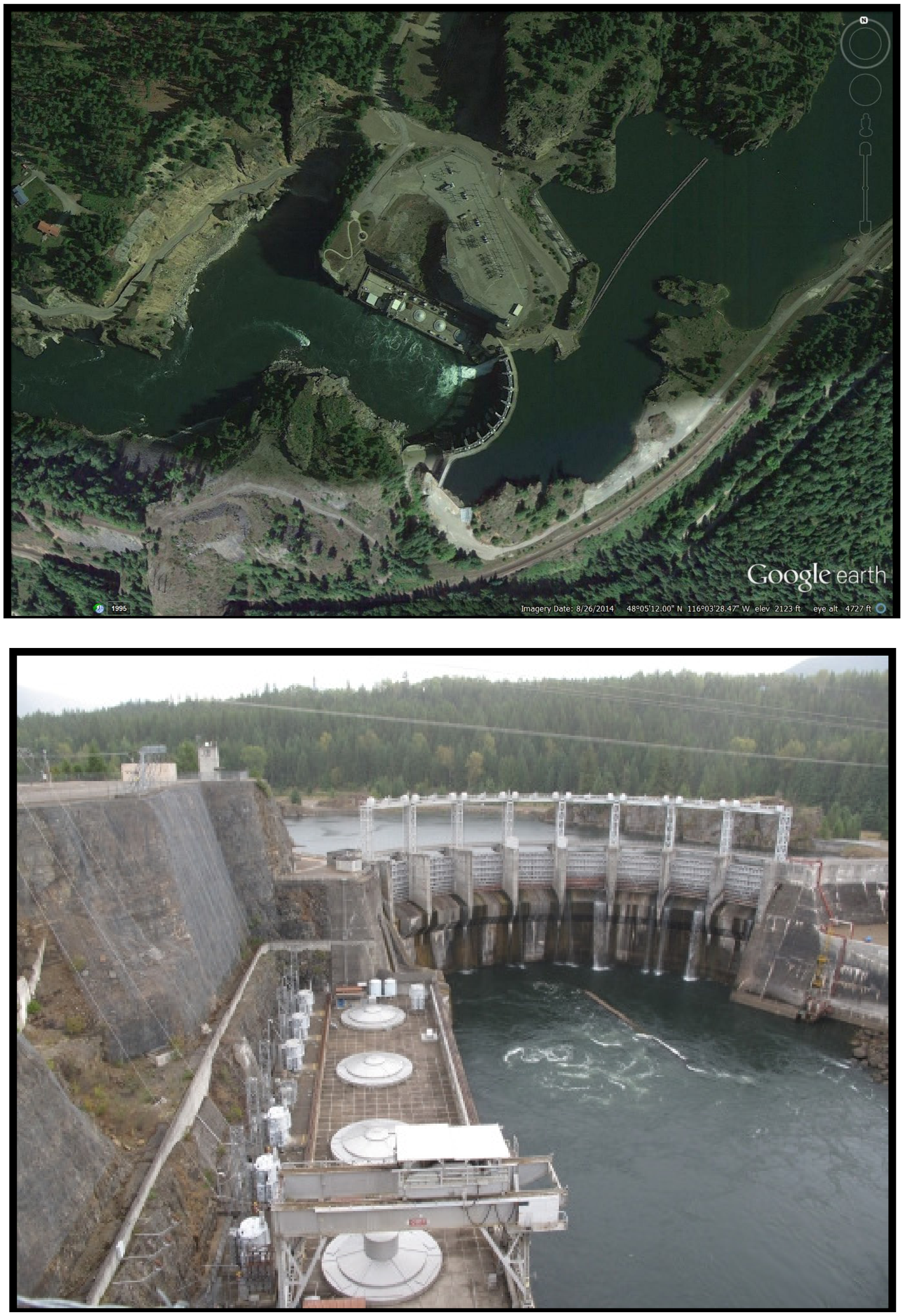


Figure 1 Google Images of the Cabinet Gorge Hydro Electric Dam

Avista's DSM Engineering staff visited the Cabinet Gorge Hydro Electric Dam to review their current building systems and discuss several concerns that the user's encountered during typical operation. Specifically, this audit was conducted to identify all possible energy efficiency improvements not related to the power generation process.

After completing a tour of the facility potential improvement measures were identified for consideration including capital projects as well as low-cost no-cost measures. This report is intended to provide a cursory review of possible energy savings. Each listed recommendation, and its estimated cost, is based upon historical experience and costing projections. Equipment life and performance will vary and a Statement of Work (SOW) for the capital project will determine the actual project costs and performance.

The facility consists of a control room, office space, break area and generation specific process areas including but not limited to generation floor and breaker floor.

Shell

Due to the design of the facility there are no real shell measures that can be undertaken that would benefit the facility or save energy.

Lighting

The lighting system is the largest inefficiency in the facility.

Cabinet Gorge is slated to have its lighting system completely replaced similarly to Noxon Rapids HED. The majority of the new system will be linear LED's with some screw in LED lamps where necessary. Based on the number of fixtures present in the facility it will reduce that plant electric load by a similar amount to Noxon Rapids load decrease, ~300,000 kWh.

HVAC

The facility is currently conditioned by several 480v electric unit heaters. These unit heaters have to run 24/7 in the winter to keep the temperature in the facility above 50ºF. In addition to the heaters there is a fresh air intake system, this system brings in outside air (OSA) and ducts it all around the facility. The OSA system will do a nightly flush of the facility during the warmer months in an attempt to keep the internal temperature low during the day. Currently there are no active heating and cooling elements in the system.

It is recommended that a water source heat pump system, similar to Noxon Rapids, be considered to condition the facility. The major costs of adding an HVAC system is the duct work and cooling/heating coils, the facility is already completely ducted and several cooling/heating coils are in place.

We recommend that the most efficient equipment that can be afforded be installed. This will be an expensive project to take on, but it will reduce the extreme temperature swings that happen inside the facility throughout the year and would provide protection for some of the sensitive equipment.

The relay tech room and the break room currently have window style AC units and small electric heaters to keep the space conditioned. It is recommended that stand alone ductless heat pump systems be installed to serve these spaces. Certain Mitsubishi and Daikin units can have multiple inside units, cassettes, paired with one condensing unit.

Compressed air

The facility's pneumatic systems consisted of several small (~25HP) reciprocating compressors along with two large oil-free rotary screw units. No recommendations will be made at this time with regards to the reciprocating units as they are near-perfect part-load machines. However, the two 250HP Kobelco compressors may represent an energy saving opportunity. The specifications for the machines are as follows:

TWO-STAGE, HEAVY-DUTY, OIL-FREE, WATER-COOLED, ROTARY SCREW AIR COMPRESSOR MOUNTED ON A FABRICATED STEEL BASE AND DRIVEN BY A 250 HP, 3/60/460 VOLT, PREMIUM EFFICIENCY, OPEN DRIPPROOF MOTOR.
.
SOLID-STATE (SOFT-START) MOTOR STARTER, 250 HP, 3/60/460 VOLT, IN NEMA 1 ENCLOSURE, MOUNTED, WIRED AND TESTED ON THE ASSEMBLY.
.
CUSTOM ENGINEERING AND FABRICATION.
SPECIAL ENGINEERING AND FACTORY FABRICATION TO DESIGN COMPRESSORS SO THEY CAN BE BROKEN DOWN AT THE JOBSITE, TRANSPORTED, AND REASSEMBLED IN THE COMPRESSOR ROOM.

The system is a serves a common header and the two units are controlled on a lead/lag fashion. Depending on the hours of operation and the actual cfm demand, a bolt-on variable frequency drive (VFD) on one of the units (the one providing the trim load) might be a good option. VFDs will modulate the compressor down so that the input power nearly matches the cfm demand with very little waste in the form of heat and blown off (unloaded) air. The system should be configured in such a way that the VFD-equipped machine responds to the base cfm demand below (100%) until it reaches near 100%. At that time the fixed-speed unit should cycle on to meet that full base load and the VFD unit trims. Again the cost-effectiveness depends on cfm demand and run-hours. We estimate the VFD cost for one compressor to be approximately $50,000 including installation and programming.

We hope that this report helps to identify some areas that the generating facility can gain some operational efficiency and reduce the parasitic load that these systems represent. If you decide to pursue any of these potential energy savings projects please let the Energy Solutions team know ahead of the start of the project.

Respectfully,

Andy Paul, Bryce Eschenbacher, and Levi Westra – April 13th, 2015

Energy Efficiency Improvements
Audit Report

Prepared for

Coyote Springs Thermal Generating Facility

Prepared by
Andy Paul, PE
Bryce Eschenbacher, PE
Levi Westra, PE
Energy Solutions Engineers

June 22, 2015

Overview

Facility: Coyote Springs Thermal Generation Facility
Audited by: Andy Paul PE, Bryce Eschenbacher PE and Levi Westra PE
Onsite Staff: Dan Turley, PGE
Facility Audited on: June 18th, 2015

Figure 1 Google Earth Images of the Coyote Springs Generation Facility

Avista's DSM Engineering staff visited the Coyote Springs generating facility to review their current building systems and discuss several concerns that the user's encountered during typical operation. Specifically, this audit was conducted to identify all possible energy efficiency improvements not related to the power generation process.

After completing a tour of the facility, potential improvement measures were identified for consideration including capital projects as well as low-cost no-cost measures. This report is intended to provide a cursory review of possible energy savings. Each listed recommendation and costing is based upon historical experience and costing projections. Equipment life and performance will vary and a Statement of Work (SOW) for the capital project will determine the actual project costs and performance.

The facility consists of an office, network room, and large high bay warehouse which houses two combine cycle steam turbines. Unit #2 belongs to Avista Utilities.

Shell

The majority of the facility houses the generating equipment, and associated process loads. The waste heat coming off of the equipment is the main source of heat during the winter months and the plant is not conditioned during the summer months. This reduces the amount of shell measure projects; insulation, weather sealing, windows, etc, that can be undertaken in this part of the facility. There are several areas; control room, MCC enclosures, switch gear, office areas, that may benefit from upgraded insulation and at the very least routine inspection and maintenance. Below are some suggestions for areas that should be checked.

1. Any man door leading to an area that is mechanically conditioned should have its weather stripping checked a couple of times a year and replaced as necessary.
2. If the roof insulation area above the office area is less than R19 additional insulation should be added. The office space has a drop ceiling throughout; un-faced batt insulation could easily be added above the ceiling panels.
3. The remainder of the facility is well insulated and does not have any weatherization or shell improvements required at this time. It is recommended that the roll up and man doors be checked periodically and maintenance be done as necessary.

While these measures will conserve energy, those savings will be negligible in comparison to the measures listed further in this report.

Lighting

The site employs T12 and T8 linear fluorescent lighting as well as 400 Watt high pressure sodium (HPS) high-bay and 250 Watt MH exterior lighting on dusk to dawn sensors. No parking lot lighting was observed.

Table 1 Capital Project Lighting Opportunity Summary

	Brief EEM* Description	EEM Cost	Measure Life	Electric kWh Savings
1	Control Room Lighting	**$5,194**	**20 yrs**	**6,368**
2	Generating Floor High Bays	**$44,646**	**20 yrs**	**85,778**
3	Roadway Lighting	**$225**	**20 yrs**	**1,085**

*EEM – Energy Efficiency Measure

1. Proposed Project #1: The facility currently has (x15) three lamp F32T8 fluorescent fixtures lighting the control room. The fixtures average 8,760 hrs of operation a year. The proposed project looks at replacing these fixtures with (x15) 40W linear LED fixtures. A simple lumen calculation shows that the overall lumens for the job were decreased by 34%.

    - The provided project is $5,194, this cost was calculated using fixture and install costs for these fixtures at Noxon Rapids HED.

2. Proposed Project #2: The facility currently has (x32) single lamp 400W High Pressure Sodium fixtures lighting the main generation facility. The fixtures average 8,760 hrs of operation a year. The proposed project looks at replacing these fixtures with (x32) 144W LED high bay fixtures (HEGRC4KN-SNG Dialight). A simple lumen calculation shows that the overall lumens for the job were increased by 50%.

    - The provided project is $44,646, this cost was calculated using fixture and install costs for a project at a local paper mill.

    During our conversation with facility staff it was mentioned that any fixture that would be installed on the generating floor would need to be able to operate in extreme temperatures. The ceiling on is upwards of 120 feet and the temperature can easily get over 120ºF. The proposed Dialight fixture has an operating temperature range of -40ºF to 149ºF. These fixtures should be able to handle the conditions at Coyote Springs. It is recommended that a couple of test fixtures be purchased and installed, this will allow the facility staff to see how the lights perform in the extreme temperatures present and evaluate how the like the quality of the light produced.

3. Proposed Project #3: The roadway is lit by single Lamp 250W metal halide cobra heads. This project would replace these with Cree 42W LED cobra heads. It is assumed that these fixtures have an average of 4,288 hrs/yr (dusk to dawn) annual operating hours. A simple lumen calculation shows that the overall lumens for the job were decreased by 71%. This analysis looks at the cost and energy savings for replacing one of these fixtures.

    - The provided project is $225, this cost was calculated using fixture and install costs for one of these fixtures at Noxon Rapids HED.

4. It should be noted that while the total system lumens decrease for projects 1 and 3, the actual lumens that reach the working space will more the likely increase. LED fixtures are very directional in the way they deliver lighting lumens. We recommend replacing a few light fixtures to make sure that they will meet your lighting needs. If you would like to see the fixtures in operation we recommend a trip to Noxon Rapids HED.

HVAC

1. The control room, office, restroom, break room, and the switch gear rooms are conditioned by two gas fired roof top units mounted on grade outside the building. One unit belongs to Avista and only serves Avista's switch gear; the other unit handles the control room, office, and PGE's switch gear. These units appear to have been recently replaced. The units have a cooling efficiency of 11.6 EER; energy code minimum efficiency is 11 EER. It is recommended that when these units come up for replacement in the future they are replaced with the most efficient piece of equipment that can be afforded.

    The supply and return ductwork for these units is un-insulated, it is recommended that insulation be added. There is a significant length of ductwork, 10 to 20 feet, exposed to the elements before turning into the building.

2. The generation floor has several 80% efficient natural gas fired unit heaters to provide supplemental heat in the winter. Currently Reznor makes a 90% efficient unit heater. While

replacing the existing heaters with a new higher efficiency unit would generate gas savings, the price of these units is high enough that the project would more than likely not make financial sense. In addition the staff stated that these units do not operate all that often. In the future when these units are at end of life we recommend purchasing and installing the most efficient units that can be afforded.

Process

Compressed Air System

The facility instrumentation and control air is provided by two Ingersol-Rand SSR-HP75 75kW rotary-screw load/unload compressors in an N+1 failsafe configuration. The compressors feed an Ingersoll-Rand TZ300 desiccant air-dryer and a large dry receiver. The air-dryer is a heatless unit and uses a timer to control regeneration cycles. There are several opportunities for reducing energy consumption of these devices, including adding VFDs to the compressors and upgrading the dryer to a heated/demand controlled unit.

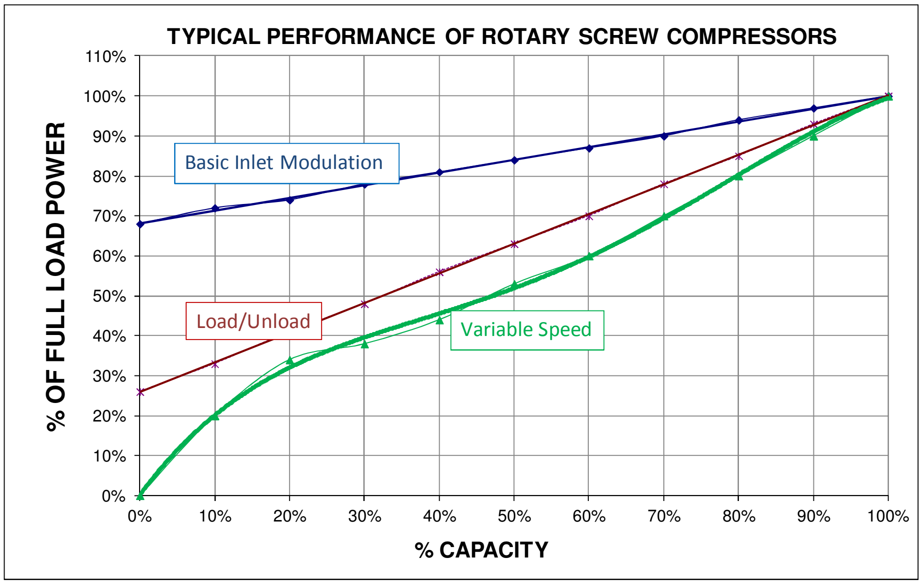


Figure 2 Comparison of rotary-screw air compressor controls (% load vs % flowrate)

A comparison of the existing load/unload controls to a VFD controlled air-compressor operating at 60% load 8760 hr/yr results in a 20% energy savings or around 130,000 kWh/yr. The 60% load is an assumption; this value may be higher or lower and will affect the annual energy savings. The $15,000 EEM cost assumes only one of the compressors is converted or replaced.

Table 2 Possible savings and roughly estimated costs for compressed air system EEMs.

	Brief EEM* Description	EEM Cost	Measure Life	Electric kWh Savings
1	Air-Compressor VFD	**$15,000**	**12 yrs**	**130,000**
2	Retrofit Air-Dryer with Dew-Point Controls	**$5,000**	**12 yrs**	**25,000**

The existing timer controlled compressed air-dryer operates on a 10 minute regeneration cycle regardless of the dew point of the treated air. The EEM would retrofit this unit with dew-point controls which would initiate a regeneration cycle only as required. The number of cycles will be reduced; they will become dependent on the amount of moisture in the ambient air and the amount of air being consumed by the facility. On average dew-point controls will reduce energy consumption about 40%, however, in central Oregon, where the average humidity levels are quite low, the savings will likely be greater. If the decision is made to replace the entire dryer, please consider replacing the unit with a heated unit for even more energy savings.

Boiler feed water pumps

The facility is presently equipped with two 2500HP boiler feedwater pumps, one with variable speed control (estimated installation, 2008). It is assumed that the pump operation is alternated with only one running at any given time. It is unclear as to why both pumps were not originally equipped with VFDs (budgetary concerns, no available changeover downtime, etc.?) unless the fixed-speed pump serves only as an installed backup. If they do in fact alternate duty, installing a bolt-on VFD to the remaining fixed speed pump should be a good option in terms of economics. Tremendous energy savings can be achieved by controlling flow rates by pump speed control as opposed to modulating the flow rates with control valves. Another option would be to control both feedwater pumps with only one VFD. The technology exists such that multiple motors can be controlled with one drive provided that the motor sizes are the same and that the speed reductions are the same, i.e. if one motor runs are 45Hz the other running motors must also run at 45Hz. This option might be worth looking into if both pumps are running at 30Hz (I assume that this is the minimum motor speed even though the Toshiba performance reports go down to 25% or 15Hz) and can deliver enough pressure to inject water into the high-pressure drum.

The above suggestion applies also to other process pumps such as the 700HP cooling tower pumps as well as other smaller process pumps. Pumps that; operate for a high percentage of time, have their flow rates varied via controls valves, and do not necessarily need to provide full flow/pressure to a process, are good candidates for variable frequency drives. Control valves (or any other fittings) represent an obstruction in the flow path. This obstruction creates a head loss and pressure drop that the pump/motor must overcome in order to meet pressure/flow requirements. As mentioned in the boiler feedwater paragraph above, removing (or adjusting control valve(s) to 100% open) these pipe components and controlling flow via motor speed, significant energy savings and process flexibility/longevity can be achieved.

We hope that this report helps to identify some areas that the generating facility can gain some operational efficiency and reduce the parasitic load that these systems represent. If you decide to pursue any of these potential energy savings projects please let the Energy Solutions team know ahead of the start of the project.

Respectfully,

Andy Paul, Bryce Eschenbacher, and Levi Westra – June 22nd 2015

Name: Coyote Springs Generating Facility - Control Room Lighting **Acct#**		
Existing Annual Consumption: (kilowatt hours)	11,169.00	
Lighting Energy Savings:(kilowatt hours)	5,913.00	
Lighting Demand Savings: (kilowatt demand)	0.54	
Cooling System Savings: (kilowatt hours)	455.30	
Cooling System Demand Savings: (kW demand)	0.04	
Lumen Comparison New/Existing	66.15%	
Total Energy Savings: (kilowatt hours)	6,368.30	
Total Demand Savings: (kilowatt demand)	**0.58**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**(51.44)**	
Maintenance Savings:	($373.22)	

Name: Coyote Springs Generating Facility - Generating Floor		
Acct#		
Existing Annual Consumption: (kilowatt hours)	126,144.00	
Lighting Energy Savings:(kilowatt hours)	85,777.92	
Lighting Demand Savings: (kilowatt demand)	7.83	
Cooling System Savings: (kilowatt hours)	0.00	
Cooling System Demand Savings: (kW demand)	0.00	
Lumen Comparison New/Existing	150.00%	
Total Energy Savings: (kilowatt hours)	85,777.92	
Total Demand Savings: (kilowatt demand)	**7.83**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	$518.36	

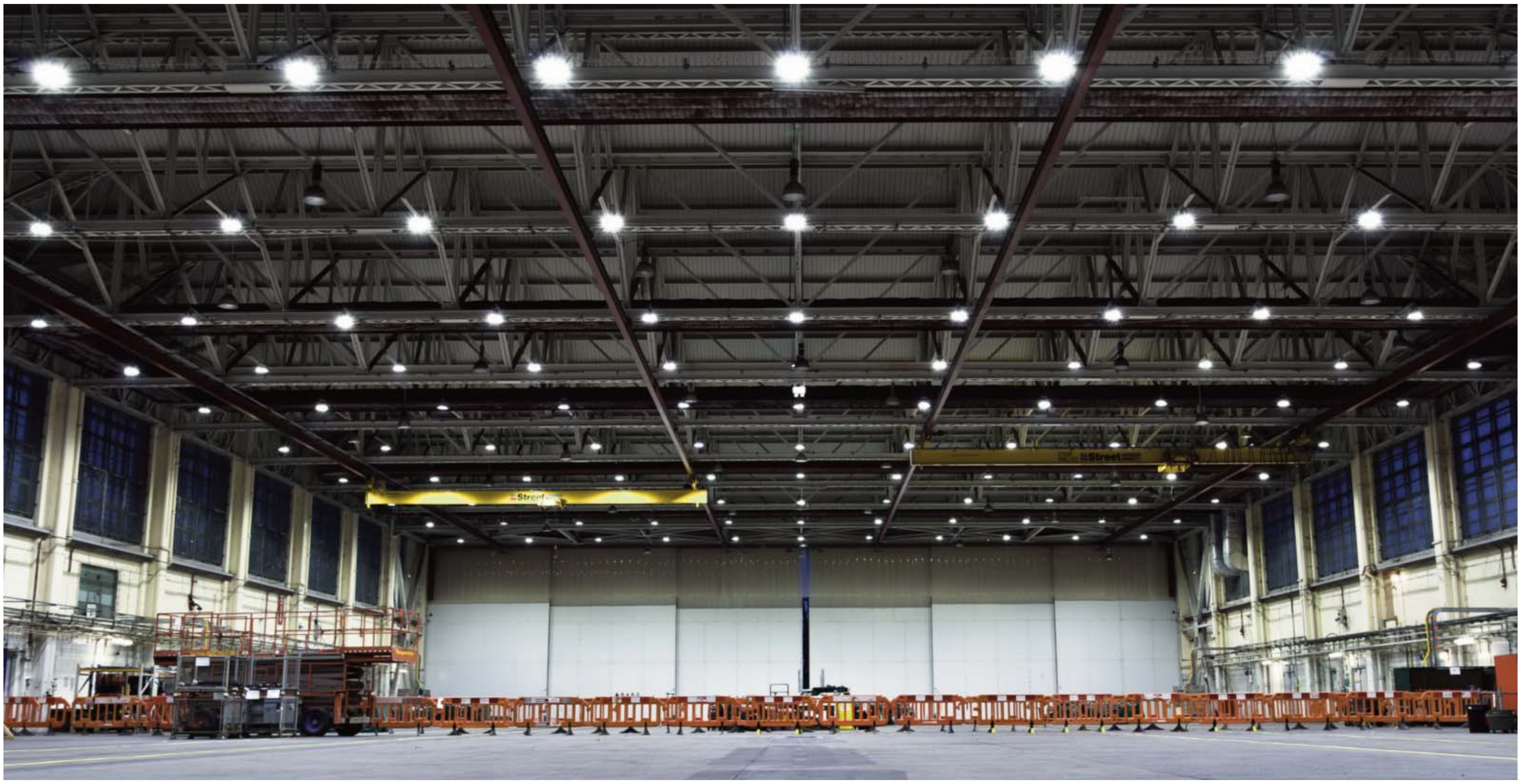
Name: Coyote Springs - Pole Lights **Acct#**		
Existing Annual Consumption: (kilowatt hours)	1,264.96	
Lighting Energy Savings:(kilowatt hours)	1,084.86	
Lighting Demand Savings: (kilowatt demand)	0.20	
Cooling System Savings: (kilowatt hours)	0.00	
Cooling System Demand Savings: (kW demand)	0.00	
Lumen Comparison New/Existing	18.59%	
Total Energy Savings: (kilowatt hours)	1,084.86	
Total Demand Savings: (kilowatt demand)	**0.20**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	$8.30	

Vigilant® LED High Bay

for Indoor and Outdoor Industrial Applications

Vigilant® LED High Bay

for Indoor and Outdoor Industrial Applications



About Dialight

Dialight (LSE: DIA.L) is leading the energy efficient LED lighting revolution around the world for industrial and hazardous areas as well as transportation and infrastructure applications. For 40 years it has been committed to the development of LED lighting solutions that enable organizations to vastly reduce energy use and maintenance needs, improve safety, ease disposal and reduce CO_2 emissions.

History at a Glance

1938 → Dialight founded in Brooklyn, NY
1971 → LED Circuit Board Indicator
1994 → LED Transit Vehicle Signals
1995 → LED Traffic Signals
2000 → FAA certified LED Obstruction Lights
2007 → LED Lighting for Hazardous Locations
2009 → LED High Bay Fixtures
2012 → Full performance 10-year warranty
2013 → Controls for LED Lighting
2014 → 125lm/W High Bay

Typical Applications

- Oil, Gas & Petrochemical
- Power Generation
- Mining
- Chemical
- Pharmaceutical
- Water & Sewage
- Food & Beverage
- Manufacturing
- Warehousing
- Cold Storage

View the full case studies at:

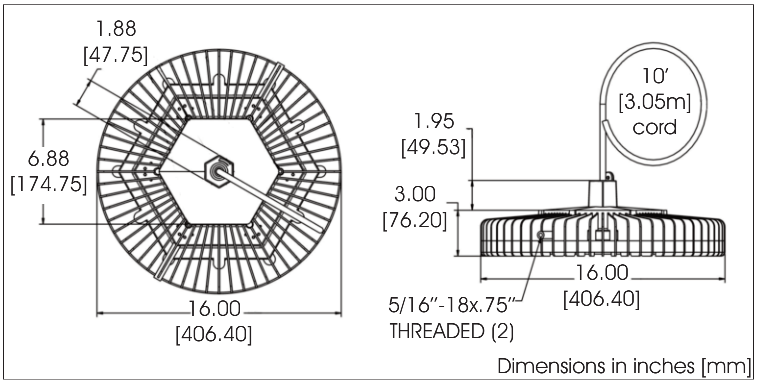
G.S. Dunn Limited - www.dialight.com/news/details/gsdunn_case_study
Rockline Industries - www.dialight.com/news/details/rockline_case_study
MedSafe - www.dialight.com/news/details/medsafe_case_study
Kuehne + Nagel - www.dialight.com/news/details/kuehne_nagel_case_study

Dialight also offers their products for Hazardous Locations

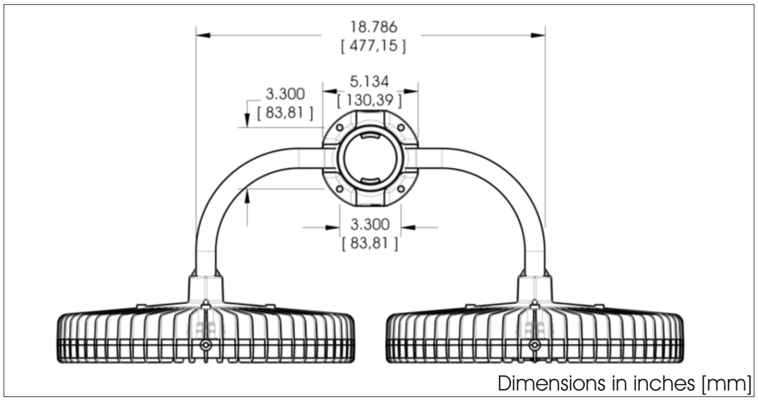
Complete your own Return on Investment calculation at: www.dialight.com/tcoCalculator/Vigilant_HighBay

Vigilant® LED High Bay

125 LPW



Dual Bracket



Certifications & Ratings

- UL 1598/A
- CSA 22 #250
- CE
- NEMA 4X
- IP 66
- Dark Sky Compliant

Features & Benefits

- L70 rated for >100,000 hours @ 25°C
- 10 year full performance warranty
- Up to 125 LPW
- Dual Mounting option available
- For 347-480V AC applications, consult factory
- Significantly reduced glare
- Instant on/off
- Maintenance free
- Mercury free
- No UV or IR
- Resistant to shock and vibration

Application:

At 125 lumens per Watt, Dialight's new ultra-efficient industrial LED High Bay revolutionizes the world of LED lighting and is by far the most innovative LED fixture available today. With a market-leading 10 year full performance warranty, the new 26,500 lumen high bay utilizes cutting-edge optical and electrical design to provide for significantly reduced glare and superior light distribution.

In its compact and lightweight structure, Dialight's new 125 lumen per Watt LED High Bay is designed to meet the most demanding specifications and is perfect for any industrial application where improved light levels are needed at minimum energy consumption for more than a decade.

Mechanical Information

Fixture weight:	18 lbs
Shipping weight:	24 lbs
Mounting:	(1) 3/4" NPT - top (2) 5/16"-18 x .75" UNC - side
Cabling:	10' (3.5m) STOOW Power Cord

Electrical Specifications

Operating Voltage:	
24,250-26,500lm:	110 - 277V AC
16,500-18,000lm:	100 – 277V AC (For 347 - 480V AC application, consult factory)
Total system power consumption:	See Table
Operating Temp:	-40°F to +149°F (-40°C to +65°C)
Harmonics:	IEC 61000-3-2
Noise requirement / EMC:	FCC Title 47, Subpart B, Section 15, class A device. RF Immunity; 10V/m, 80MHz-1GHz
Transient protection:	Protection devices capable of handling up to 6kV. Tested at independent laboratory for 6kV/2 ohm combination wave, as per IEEE C62.41, line-line and line-ground
Power Factor:	> 0.9

Construction:

Housing:	Copper free aluminum
Finish:	Polyester powder coated gray RAL 7040
Lens:	Tempered glass

Photometric Information

CRI:	75
CCT:	5,000K (cool white) 4,000K (neutral white)

All values typical unless otherwise stated
Lumen values are typical (tolerance +/- 10%)

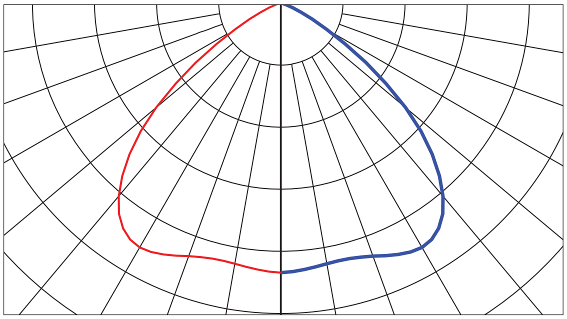
Vigilant® LED High Bay - Ordering Information

Part Number	Initial Fixture Lumens	Watt	Lumens Per Watt	CCT	UL-1598, IP-66, NEMA 4X CSA 22.2 #250, Marine Wet Locations	Safety Bracket	External Fuse	Lens	Optical Pattern	
									Circular	Wide
110 - 277V AC Models										
HEGMC4PN-SNG	26,500	212W	125	5,000K	•			Tempered Glass	•	
HEGRC4PN-SNG	26,500	212W	125	5,000K	•			Tempered Glass		•
HEGMN4PN-SNG	24,250	212W	114	4,000K	•			Tempered Glass	•	
HEGRN4PN-SNG	24,250	212W	114	4,000K	•			Tempered Glass		•
HEGMC4PN-SSG	26,500	212W	125	5,000K	•	•		Tempered Glass	•	
HEGRC4PN-SSG	26,500	212W	125	5,000K	•	•		Tempered Glass		•
HEGMN4PN-SSG	24,250	212W	114	4,000K	•	•		Tempered Glass	•	
HEGRN4PN-SSG	24,250	212W	114	4,000K	•	•		Tempered Glass		•
HEGMC4PN-SFG	26,500	212W	125	5,000K			•	Tempered Glass	•	
HEGRC4PN-SFG	26,500	212W	125	5,000K			•	Tempered Glass		•
HEGMN4PN-SFG	24,250	212W	114	4,000K			•	Tempered Glass	•	
HEGRN4PN-SFG	24,250	212W	114	4,000K			•	Tempered Glass		•
HEGMC4PN-SGG	26,500	212W	125	5,000K		•	•	Tempered Glass	•	
HEGRC4PN-SGG	26,500	212W	125	5,000K		•	•	Tempered Glass		•
HEGMN4PN-SGG	24,250	212W	114	4,000K		•	•	Tempered Glass	•	
HEGRN4PN-SGG	24,250	212W	114	4,000K		•	•	Tempered Glass		•
100 - 277V AC Models										
HEGMC4KN-SNG	18,000	144W	125	5,000K	•			Tempered Glass	•	
HEGRC4KN-SNG	18,000	144W	125	5,000K	•			Tempered Glass		•
HEGMN4KN-SNG	16,500	144W	114	4,000K	•			Tempered Glass	•	
HEGRN4KN-SNG	16,500	144W	114	4,000K	•			Tempered Glass		•
HEGMC4KN-SSG	18,000	144W	125	5,000K	•	•		Tempered Glass	•	
HEGRC4KN-SSG	18,000	144W	125	5,000K	•	•		Tempered Glass		•
HEGMN4KN-SSG	16,500	144W	114	4,000K	•	•		Tempered Glass	•	
HEGRN4KN-SSG	16,500	144W	114	4,000K	•	•		Tempered Glass		•
HEGMC4KN-SFG	18,000	144W	125	5,000K			•	Tempered Glass	•	
HEGRC4KN-SFG	18,000	144W	125	5,000K			•	Tempered Glass		•
HEGMN4KN-SFG	16,500	144W	114	4,000K			•	Tempered Glass	•	
HEGRN4KN-SFG	16,500	144W	114	4,000K			•	Tempered Glass		•
HEGMC4KN-SGG	18,000	144W	125	5,000K		•	•	Tempered Glass	•	
HEGRC4KN-SGG	18,000	144W	125	5,000K		•	•	Tempered Glass		•
HEGMN4KN-SGG	16,500	144W	114	4,000K		•	•	Tempered Glass	•	
HEGRN4KN-SGG	16,500	144W	114	4,000K		•	•	Tempered Glass		•

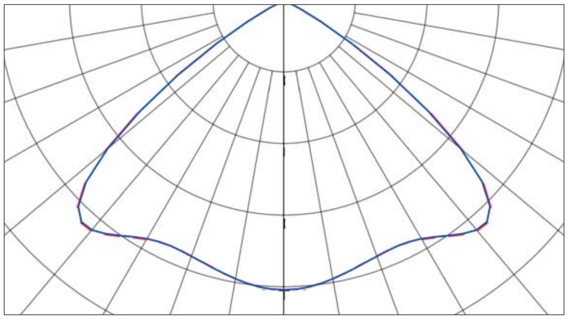
For 347 - 480V AC applications, consult factory

Optical Patterns

Circular Pattern



Wide Pattern



Vigilant® LED High Bay

Options and Accessories

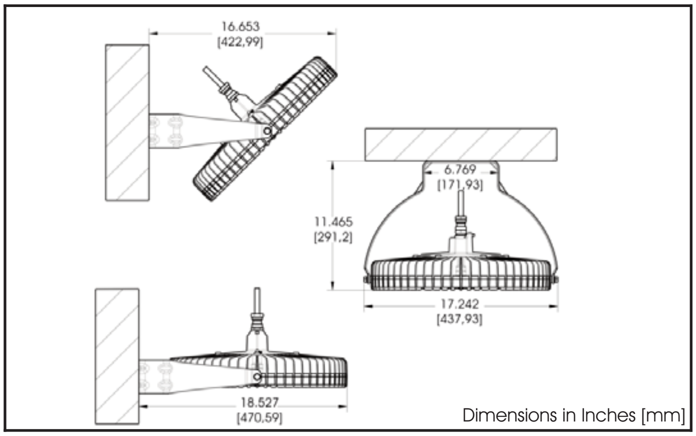
	Part Number	Description	Kit Includes
	HBXDUALBRCKT	Dual Bracket	Junction Box
	No Part Number	Pendant Mount (conduit supplied by installer)	Conduit supplied by installer
	HBXW2	Swivel Bracket and Cable Gland	Swivel Bracket Bracket to fixture hardware Cable Gland (1/2"), Reducer (3/4" to 1/2")
	HBXW3	Swivel Bracket	Swivel Bracket Bracket to Fixture Hardware
	HBXCU	Ceiling Mount	Swivel Hanger Cover 3" Conduit Nipple
	HBXCG	Cable Gland	Cable Gland (1/2") Reducer (3/4" to 1/2")
	HBXL	Loop (consult factory when using with occupancy sensor models)	Hanger Loop (GE LOOPM353)
	HBXH	Hook (consult factory when using with occupancy sensor models)	Hanger Hook (GE HOOKM353)
	HBXCAB48	48" Long Stainless Steel Safety Rope	5/32" Diameter Stainless rope with locking spring clip
	HBXTH347480[1]	Top hat with 347-480V isolated step down transformer (consult factory when using with hook or loop)	Top and bottom clam shell Conduit nipple 6' STOOW cable 347-480V step down transformer Fuse holder, 2 Fuses
	HBXLENGC	Tempered Glass	Lens, replacement clips, screws, gasket
	HBXREF22	22" Acrylic Reflector (must be ordered with High Bay, not a retrofit option)	Reflector, brackets, screws
	HBXDC	Dust Cover	Dust cover, clamp, spacer

[1] Top hat cannot be used with a mounting bracket

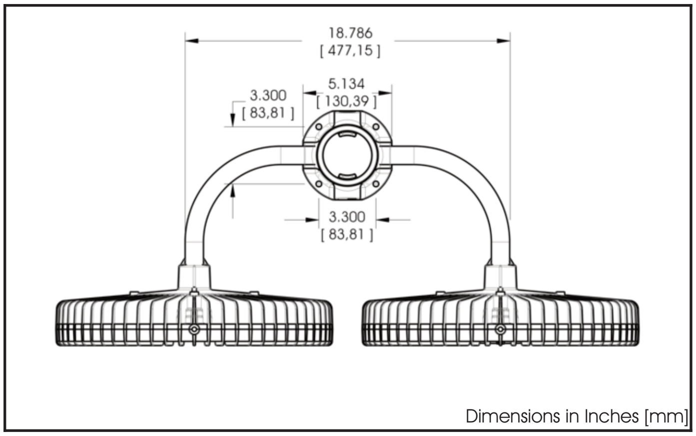
Vigilant® LED High Bay

Options and Accessories

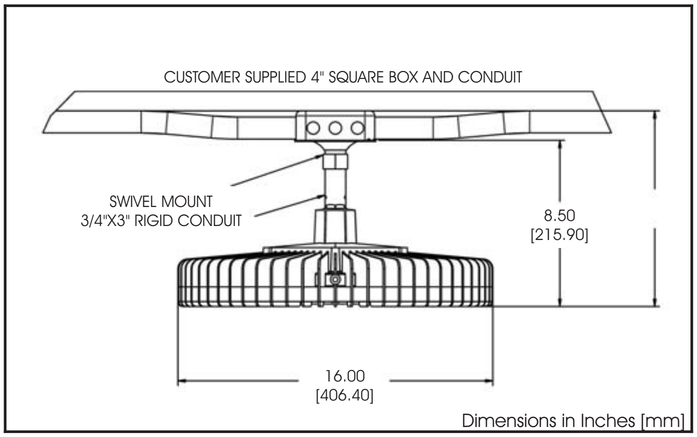
HBXW2 - Swivel Bracket and Cable Gland



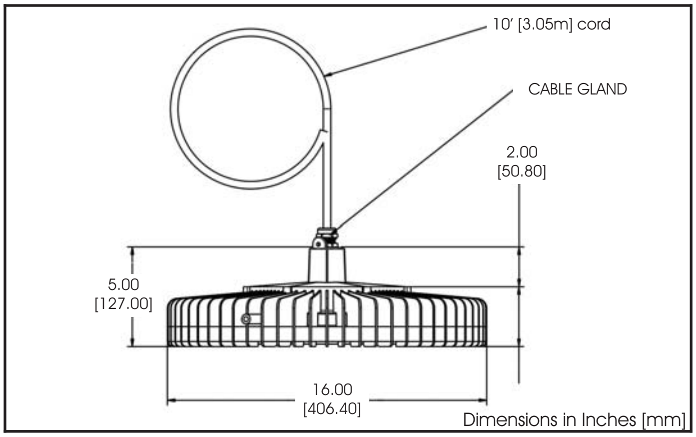
HBXDUALBRCKT - Dual Bracket



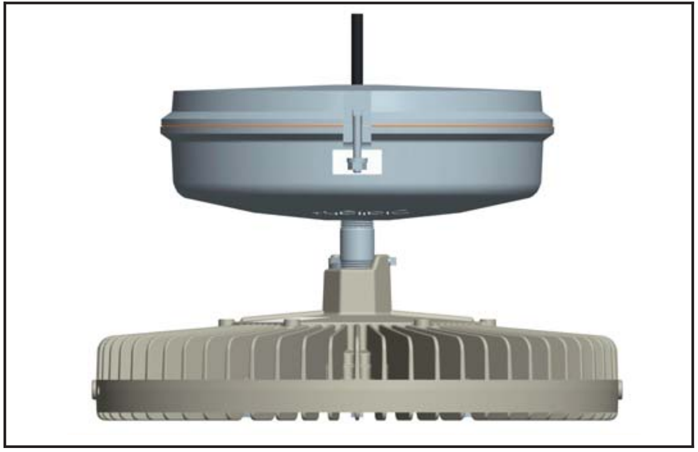
HBXCU - Ceiling Mount



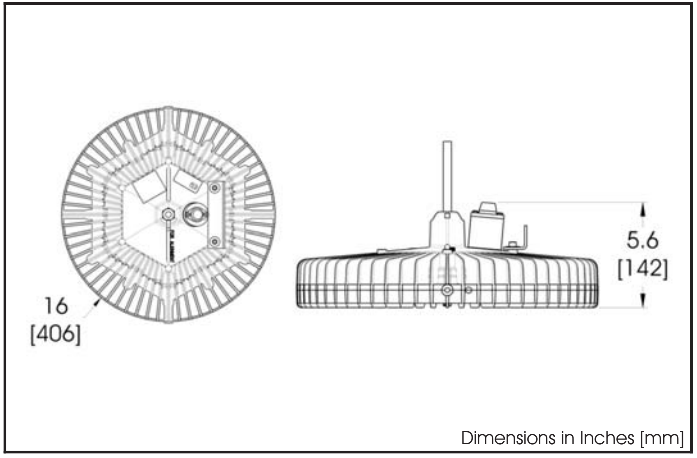
HBXCG - Cable Gland



HBXTH347480 - Top Hat (fixture sold separately)



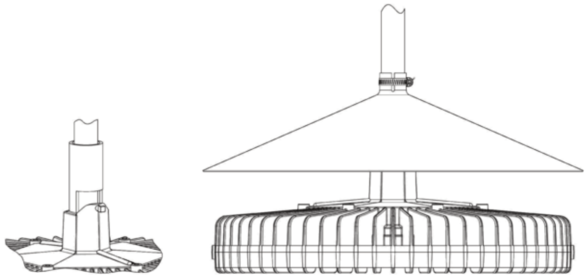
HEGMxxxx-SGG - Safety Bracket and Fuse Options



Vigilant® LED High Bay

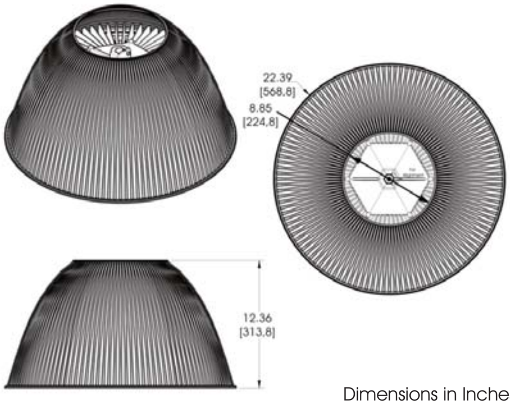
Options and Accessories

HBXDC - Dust Cover



Dimensions in Inches [mm]

HBXREF22 - 22" Acrylic Reflector



Dimensions in Inches [mm]

Energy Efficiency Improvements
Audit Report

Prepared for
Kettle Falls Generating Facility

Prepared by
Andy Paul, PE
Bryce Eschenbacher, PE
Levi Westra, PE
Energy Solutions Engineers

March 24, 2015

Overview

Facility: Kettle Falls Thermal Generation Facility
Audited by: Andy Paul PE, Bryce Eschenbacher PE and Levi Westra PE
Onsite Staff: Mike Floener and Greg Wiggins
Facility Audited on: March 5th, 2015

Figure 1 Google Earth Images of the Kettle Falls Generation Facility

Avista's DSM Engineering staff visited the Kettle Falls generating facility to review their current building systems and discuss several concerns that the user's encountered during typical operation. Specifically, this audit was conducted to identify all possible energy efficiency improvements not related to the power generation process.

After completing a tour of the facility potential improvement measures were identified for consideration including capital projects as well as low-cost no-cost measures. This report is intended to provide a cursory review of possible energy savings. Each listed recommendation and costing is based upon historical experience and costing projections. Equipment life and performance will vary and a Statement of Work (SOW) for the capital project will determine the actual project costs and performance.

The facility consists of office space, network room, shop areas, and 7 story high bay warehouse which contains the hog fuel boiler and steam turbine. In addition there are several outbuildings that house the water treatment facility, and other generating equipment.

Shell

There are several areas around the facility where additional weatherization work can be conducted.

1. The roll up doors could use new weather stripping along the outside edges of the doors and along the bottom. A noticeable draft can be felt when you stand next to the doors.

2. The man doors would also benefit from additional weather stripping.

These measures are applicable to the main plant area; this area is conditioned by waste heat off the boiler. The measures would apply to the support buildings, machine shop, and office space. While these measures will conserve energy, those savings will be negligible in comparison to the measure listed further in this report.

Lighting

The site employs T12 and T8 linear fluorescent lighting as well as 250 Watt High Pressure Sodium (HPS) high-bay, 70 Watt mercury vapor (MV) yard light and 1000W MV yard lights. The lights in the plant operate 24/7, yard lights operate dusk to dawn (4,288 hrs/yr), and it is assumed that the office lights operate 2,080 hrs/yr.

Table 1 Capital Project Lighting Opportunity Summary

	Brief EEM* Description	EEM Cost	Measure Life	Electric kWh Savings
1	Plant Lighting	**$56,515**	**20 yrs**	**150,190**
2	Plant Lighting Controls	**$66,515**	**20 yrs**	**183,058**
3	Yard Lighting	**$19,099**	**20 yrs**	**48,180**

*EEM – Energy Efficiency Measure

1. Proposed Project #1: The facility currently has (x127) single lamp 250W high pressure sodium fixtures in the main plant area. The main plant is seven floors; the lighting count includes each floor and the stairwell lighting. The fixtures operate 24/7, 8,760 hrs/yr. The proposed project looks at replacing these fixtures with (x127) single lamp 160W LED low bay fixtures, CREE CXB. A simple lumen calculation shows that the overall lumens for the job were decreased by 18.5%.

    - The provided project is $56,515, this cost was calculated using fixture costs, $370 per fixture, off the internet and estimated labor costs, $75 per fixture.

- It should be noted that the fixture count used for this analysis is as close as could be done while on site. If more fixtures are found the kWh savings and project cost will go up.

2. Proposed Project #2: This project looks at the additional savings that could be seen by installing occupancy sensors to the main generating facility. The controls proposed would leave 67 of the fixtures on 24/7 and the remaining 60 would only come on when someone is present in the space. This would reduce the operating hours for the 60 fixture by an estimated 35%.

    - The provided project is an additional $10,000 over the straight replacement project. This cost is purely an estimate and should be verified by a lighting professional. A high cost was estimated due to the complexity of the controls required for the space. Since the flooring in the plant is all metal grate there is a potential the lights on floor 6, for example, may come on when someone walks by on floor 5. To operate properly the sensors would need to be calibrated to only pick up on motion on the floor that they are located on.

3. Proposed Project #3: The facility currently has (x27) single lamp 70W mercury vapor fixtures and (x13) 1000W mercury vapor fixtures lighting up the yard. The fixtures operate dusk to dawn, 4,288 hrs/yr. The proposed project looks at replacing these fixtures with (x27) single lamp 52W RAB LED pole fixtures and (x13) single lamp 300W LED street lights, MaxLite Merek Series. A simple lumen calculation shows that the overall lumens for the job were decreased by 30%.

    - The provided project is $19,099, this cost was calculated using fixture costs, $499 per 300W fixture and $356 per 52W fixture, off the internet and estimated labor costs, $75 per fixture.

    - It should be noted that the fixture count used for this analysis is as close as could be done while on site. If more fixtures are found the kWh savings and project cost will go up.

4. It should be noted that while the total system lumens decrease for each of these projects, the actual lumens that reach the working space will more the likely increase. LED fixtures are very directional in the way they deliver lighting lumens. We recommend replacing a few light fixtures to make sure that they will meet your lighting needs. If you would like to see the fixtures in operation we recommend a trip to Noxon Rapids HED.

HVAC

1. The control room, restrooms, break room, and office space are conditioned by several gas fired roof top units. Some of these units have been replaced recently and the remaining units have been in service for a while. We were unable to determine the efficiency of the existing units. While there are newer units available that have efficiencies closer to SEER 19, the cost to purchase and install these units outweighs the potential energy savings. Our recommendation is to replace these units when they have reached their end of life. When you do replace these units purchase the most efficient units that can be afforded. It should also be noted the units use R-22 refrigerant, this refrigerant is no longer being manufactured. Should a unit need to be recharged you should consider replacing it with a high efficient unit at that point.

2. The generation floor has several natural gas unit heaters on each floor to provide supplemental heat. These units are only used during shutdowns. Due to the low annual usage it would not be a cost effective project to replace them. In the future when these units are at end of life we recommend purchasing and installing the most efficient units that can be afforded.

3. The machine shop has several natural gas radiant tubes to provide space heat. This type of heating in a shop area is an efficient option since it focuses on heating the occupants and not the surrounding area. It is important to have the thermostats set appropriately for this type of heat though. You want to set the temperature around 55º and have the thermostat closer to the ground than a typical installation. This will insure that the units are not heating the airspace to 55º and are instead only providing occupant comfort.

Boiler Forced Draft Blower System

The site employs a wood fired boiler to generate steam to drive a turbine. The boiler relies on a Forced Draft (FD) and Induced Draft (ID) fans driven by single-speed motors to provide combustion air. Currently combustion air flow-rates through the FD are regulated using inlet dampers which are open/closed depending on desired plant output and combustion performance. There is an opportunity to reduce average blower power draw and energy consumption using a Variable Frequency Drive (VFD).

	Brief EEM* Description	Roughly Estimated EEM Cost	Measure Life	Electric kWh Savings
1	FD Fan VSD	**$510,000**	**15 yrs**	**700,000**

1. Adjusting blower speed is the most efficient way to vary airflow rates. Based on SCADA, from a 2012 analysis, which documents plant gross output, FD fan current draw, and FD damper position, an estimated 700,000 kW*hr of energy could be “saved” using a VFD. A summary of the analysis, assumptions and results is appended to this document.

   Please note that during the 2015 site audit, the operations staff indicated that some processes and equipment had been changed since 2012 that reduced the average damper position from ~65% to ~50%. This has a noticeable impact on estimated energy savings. The value presented above is the average of the two configurations.

We hope that this report helps to identify some areas that the generating facility can gain some operational efficiency and reduce the parasitic load that these systems represent. If you decide to pursue any of these potential energy savings projects please let the Energy Solutions team know ahead of the start of the project.

Respectfully,

Andy Paul, Bryce Eschenbacher, and Levi Westra – March 24th, 2015

Name: Kettle Falls Generating Facility - Main Plant Lighting

Acct#

Existing Annual Consumption: (kilowatt hours)	328,193.40	
Lighting Energy Savings:(kilowatt hours)	150,190.20	
Lighting Demand Savings: (kilowatt demand)	13.72	
Cooling System Savings: (kilowatt hours)	0.00	
Cooling System Demand Savings: (kW demand)	0.00	
Lumen Comparison New/Existing	81.45%	
Total Energy Savings: (kilowatt hours)	150,190.20	
Total Demand Savings: (kilowatt demand)	**13.72**	
Estimated Project Cost: (Rough Estimate)	$73,152.00	
Customer Supplied Cost	$0.00	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	$549.75	

Costs updated on 1/0/1900

AE Jayson Hunnel ▼

Name: Kettle Falls Generating Facility - Main Plant Lightign w/ controls
Acct#

Existing Annual Consumption: (kilowatt hours)	328,193.40	
Lighting Energy Savings:(kilowatt hours)	183,057.72	
Lighting Demand Savings: (kilowatt demand)	13.72	
Cooling System Savings: (kilowatt hours)	0.00	
Cooling System Demand Savings: (kW demand)	0.00	
Lumen Comparison New/Existing	81.45%	
Total Energy Savings: (kilowatt hours)	183,057.72	
Total Demand Savings: (kilowatt demand)	**13.72**	
Estimated Project Cost: (Rough Estimate)	$83,152.00	
Customer Supplied Cost	$83,152.00	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	#DIV/0!	

Costs updated on 01-00-1900

AE Jayson Hunnel ▼

Name: Kettle Falls Generating Facility - Yard Lights

Acct#

Existing Annual Consumption: (kilowatt hours)	70,923.52	
Lighting Energy Savings:(kilowatt hours)	48,179.97	
Lighting Demand Savings: (kilowatt demand)	8.99	
Cooling System Savings: (kilowatt hours)	0.00	
Cooling System Demand Savings: (kW demand)	0.00	
Lumen Comparison New/Existing	69.68%	
Total Energy Savings: (kilowatt hours)	48,179.97	
Total Demand Savings: (kilowatt demand)	**8.99**	
Estimated Project Cost: (Rough Estimate)	$19,099.00	
Customer Supplied Cost	$0.00	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	$453.66	

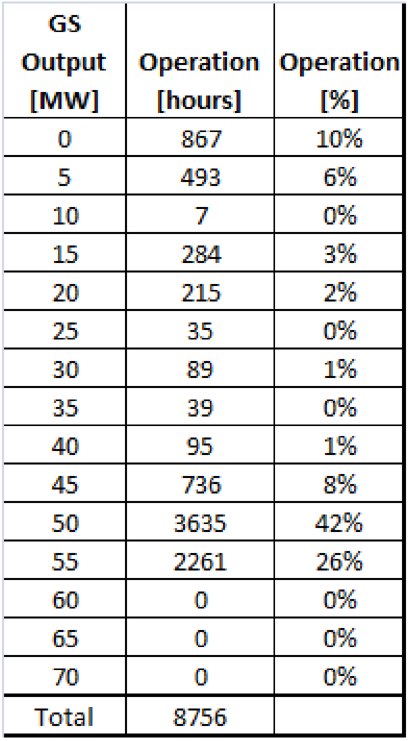
Costs updated on 1/0/1900

AE Jayson Hunnel ▼

Customer: Avista Generation; Kettle Falls Generation station ID/FD Fan VSD evaluation
Project State: EEM Evaluation
Date: 05/14/15
Analysis Description:
-Estimate the possible energy savings of converting the facility's ID/FD combustion blower to variable speed control.
-Assume that air-flow rates are proportional to generation rate.
-Assume the EEM will open the damper to 100%, combustion air flow-rate controlled via blower speed.
-Assume 4180 VAC nominal voltage and 0.7 power factor.

Inputs:

Table 1. Binned operational data from 2012 SCADA data. See excel worksheet "KF GS FD ID Fan VSD eval 101712.xlsm"



GS Output [MW]	Operation [hours]	Operation [%]
0	867	10%
5	493	6%
10	7	0%
15	284	3%
20	215	2%
25	35	0%
30	89	1%
35	39	0%
40	95	1%
45	736	8%
50	3635	42%
55	2261	26%
60	0	0%
65	0	0%
70	0	0%
Total	8756	

Figure A. Image of the FD damper actuator during 2015 audit. Note the position ~50%.

Figure 1. Graph of FD damper position versus averaged fan current draw. Sourced from SCADA data. Note the R2 value which indicates fan current is directly effected by damper position. Note the blower motor is 4180 volt.

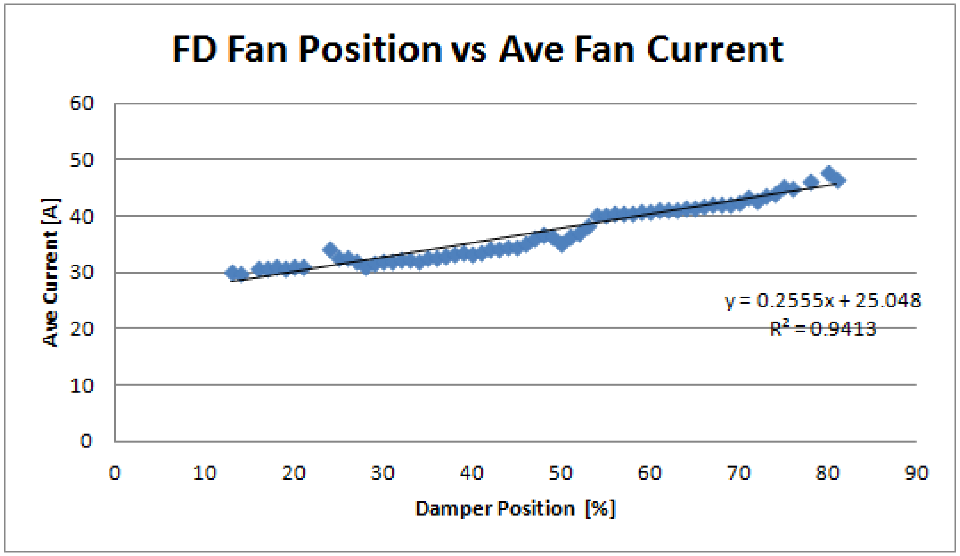


Figure 2. Graph of Station's power output vs damper positon. Note that the R2 value is somewhat low, this indicates that there are other variable effecting the output; likely fuel type, humidity, moisture content, air temperature.

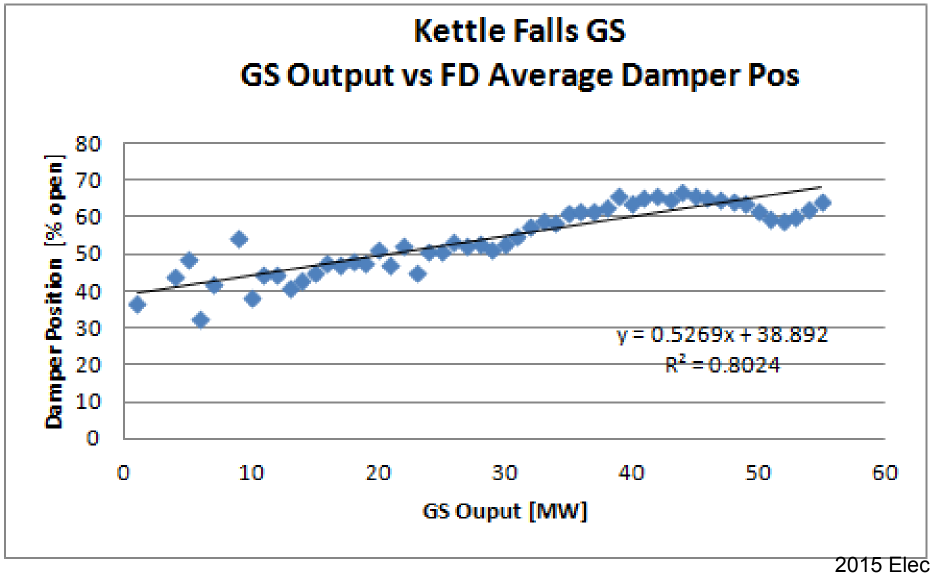
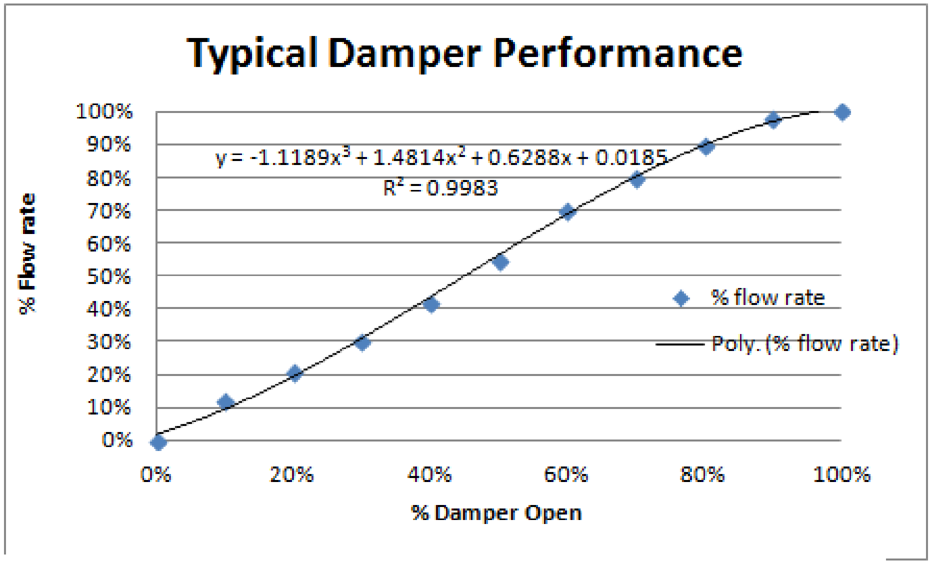


Figure 3. Typical damper performance from HVAC handbook. Assumes closed damper is ~25% of duct system total pressure drop



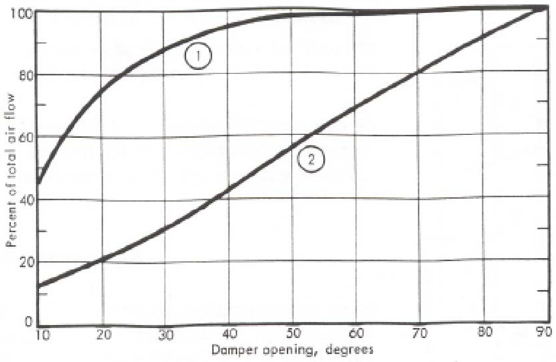
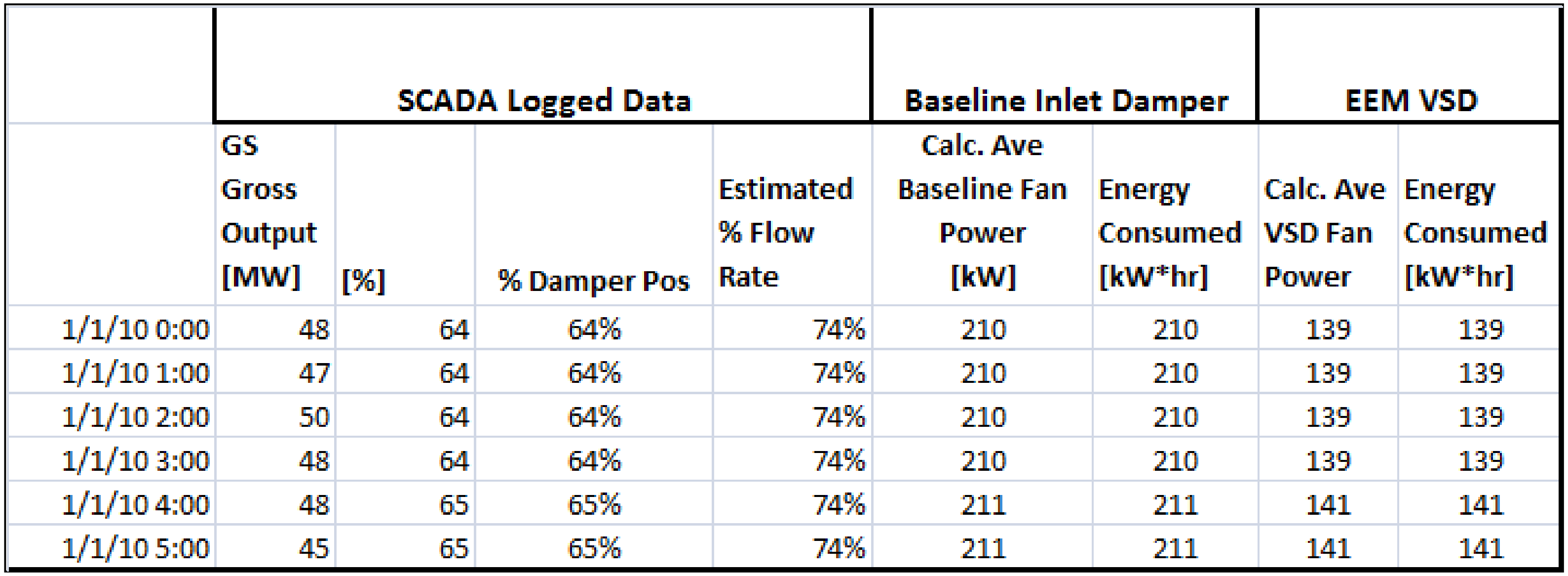


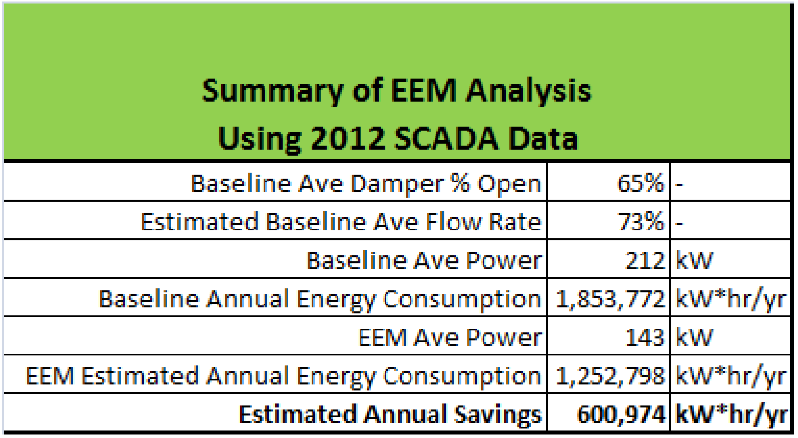
Figure 2. How well damper controls air flow depends on the ratio of damper's resistance (in wide open position) to that of the duct system. Parallel-leaf damper has characteristics of curve 1 when damper's resistance is 1 to 2 percent of total system loss. Preferred traits of curve 2 are obtained when damper represents 25 to 30 percent of total resistance. For opposed-leaf damper, best performance occurs when resistance is from 2 to 5 percent of total.

Table 2. Example of baseline and EEM FD fan analysis, based upon 2012 SCADA data and typical performance of dampered and VSD controlled blowers. See Excel worksheet "KF GS FD ID Fan VSD eval 101712.xlsm" for actual calculations.



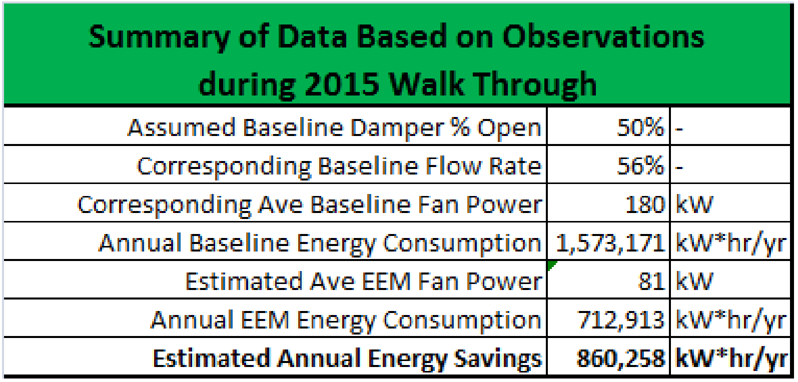
	SCADA Logged Data				Baseline Inlet Damper		EEM VSD	
	GS Gross Output [MW]	[%]	% Damper Pos	Estimated % Flow Rate	Calc. Ave Baseline Fan Power [kW]	Energy Consumed [kW*hr]	Calc. Ave VSD Fan Power	Energy Consumed [kW*hr]
1/1/10 0:00	48	64	64%	74%	210	210	139	139
1/1/10 1:00	47	64	64%	74%	210	210	139	139
1/1/10 2:00	50	64	64%	74%	210	210	139	139
1/1/10 3:00	48	64	64%	74%	210	210	139	139
1/1/10 4:00	48	65	65%	74%	211	211	141	141
1/1/10 5:00	45	65	65%	74%	211	211	141	141

Table 3. Summary of FD EEM performance based upon 2012 SCADA data.



Summary of EEM Analysis Using 2012 SCADA Data		
Baseline Ave Damper % Open	65%	-
Estimated Baseline Ave Flow Rate	73%	-
Baseline Ave Power	212	kW
Baseline Annual Energy Consumption	1,853,772	kW*hr/yr
EEM Ave Power	143	kW
EEM Estimated Annual Energy Consumption	1,252,798	kW*hr/yr
Estimated Annual Savings	**600,974**	**kW*hr/yr**

Table 4. Summary of FD EEM performance based on operator input that due to recent facility equipment changes that the FD blower has been operating with damper ~50% open.



Summary of Data Based on Observations during 2015 Walk Through		
Assumed Baseline Damper % Open	50%	-
Corresponding Baseline Flow Rate	56%	-
Corresponding Ave Baseline Fan Power	180	kW
Annual Baseline Energy Consumption	1,573,171	kW*hr/yr
Estimated Ave EEM Fan Power	81	kW
Annual EEM Energy Consumption	712,913	kW*hr/yr
Estimated Annual Energy Savings	**860,258**	**kW*hr/yr**

Simple Payback Analysis

$dollar := 1$

$rate_{ele} := 0.07 \cdot \frac{dollar}{kW\ hr}$ input: assumed average value of the energy commodity.

$$E_{savings} := \frac{\left(\frac{600000\ kW\ hr}{yr} + \frac{850000\ kW\ hr}{yr} \right)}{2}$$

$\boxed{E_{savings} = 725000 \frac{kW\ hr}{yr}}$

calc: estimated annual energy savings of the VFD.

$Sales := E_{savings} \cdot rate_{ele}$

$Sales = 50750 \frac{1}{yr}$

calc: estimated increase in energy sales.

$rate_{VFD\_MV} := 1000 \cdot \frac{dollar}{hp}$ input: estimate of typical medium voltage VFD installation cost.

$P_{VFD} := 300\ hp$ input: estimated VFD size.

$Cost_{project} := rate_{VFD\_MV} \cdot P_{VFD}$

$Cost_{project} = 300000\ dollar$

calc: rough estimate project cost.

$$SPB := \frac{Cost_{project}}{Sales}$$

calc: energy simple payback of the EEM.

$\boxed{SPB = 5.9\ yr}$

Energy Efficiency Improvements Audit Report

Prepared for

Little Falls Generating Facility

Prepared by
Andy Paul, PE
Bryce Eschenbacher, PE
Levi Westra, PE
Energy Solutions Engineers

February 13, 2015

Overview

Facility: Little Falls Hydro Electric Dam
Audited by: Andy Paul PE, Bryce Eschenbacher PE, and Levi Westra PE
Onsite Staff:
Facility Audited on: February 10th, 2015

Figure 1 Google Images of Little Falls Hydro Electric Dam

Avista's DSM Engineering staff visited the Little Falls Hydro Electric Dam to review their current building systems and discuss several concerns that the user's encountered during typical operation.

Specifically, this audit was conducted to identify all possible energy efficiency improvements not related to the power generation process.

After completing a tour of the facility potential improvement measures were identified for consideration including capital projects as well as low-cost no-cost measures. This report is intended to provide a cursory review of possible energy savings. Each listed recommendation and costing is based upon historical experience and costing projections. Equipment life and performance will vary and a Statement of Work (SOW) for the capital project will determine the actual project costs and performance.

It should be noted that this facility is currently undergoing a complete overhaul. Due to this there are very few projects that can be suggested that are not already going to be implemented.

The facility consists of a control room and generation specific process areas including but not limited to generation floor and breaker floor.

Shell

There are several areas around the facility where additional weatherization work can be conducted:

All exterior entry doors should have their weather stripping checked and replaced if necessary.

All windows that are not required to remain historically accurate should be replaced with energy efficient double pane windows.

Any portion of the plant that is going to have cooling installed; control room, battery room etc, should have the walls and ceiling insulated. The insulation will help thermally isolate it from the rest of the plant and reduce the amount of cooling required in the summer time.

There is currently little to no insulation above or below the roof deck in the plant. It is recommended that insulation, R-19 at the very least, be added below the deck. This insulation will aid in reducing the amount of time a unit has to be motored during the winter months to maintain space temperature.

Lighting

The facility currently employs T12 fluorescent lighting in the control room and surrounding areas and 400 Watt Metal Halide (MH) high-bay fixtures on the generating floor. The facility will have a brand new all LED lighting system installed during the overhaul. The DSM group at Avista made suggestions on what LED fixtures would be appropriate. Nathan Fletcher in the Generation Dept was in charge of the lighting design.

While there will be energy savings for this project, specifically with the generating floor lighting as well as the control room lighting, there will also be an additional lighting load installed. There are portions of the plant that were under lit and needed additional lighting fixtures installed. Regardless of the additional lighting fixtures, the new system will be as efficient as possible due to the installation of the LED fixtures in lieu of more traditional linear fluorescent and HID fixtures.

HVAC

The control room and few other areas in the plant will be getting new HVAC units installed to heat and cool the spaces. When selecting equipment considered installing the most efficient units that can be afforded. It is also recommended that heat pump units be installed instead of standard condensing units with electric resistive heat. New heat pumps are capable of working efficiently down to temperatures below zero. Since no natural gas is available at the Dam a heat pump is by far the most efficient way to provide space heat.

The main generating floor has no dedicated HVAC units. The heat from the generators keeps the space conditioned during the winter months. A generator will be motored to maintain heat if no generation is going on. It is recommended that dedicated HVAC units be installed to maintain the space temperature when the units are not running. This would reduce unnecessary wear and tear on the generating equipment as well as provide a known dedicated source of heat.

Installing two (possibly three) low speed/high volume destratification fans to help de-stratify the air within in the facility is recommended. With 40' ceilings the majority of buildings heated air will stack at the top, the fans would push that heated air back towards the floor and create a homogenous air temperature. This would reduce the amount of time that the space heat would need to run.

In addition these fans could be run in reverse during the summer months to help pull warm air off the floor and exhaust it out of the exhaust louvers located in the roof.

Process

	Brief EEM* Description	Rough EEM Cost Est.	Measure Life	Electric kWh Savings
1	Speed Controls Cooling/Exhaust Fans	**$10,000**	**16 yr**	**247,909**

The facility employs (4) exhaust fans, for ventilating the generator room, and (4) cooling fans for cooling the generation equipment. Currently the fans are controlled manually, turning fans on and off as needed; fans are operated independently, with units powered on as ventilation/cooling is required. There are some energy savings if the fans were each controlled automatically using Variable Frequency Drives (VFDs). The estimated savings is based upon switching from a manual control system to one that relies on indoor air temperature and equipment temperatures to power on and vary fan speeds to maintain temperatures. Reducing fan speeds reduces power requirements exponentially, resulting in the energy savings. A copy of the SMath Studio model and analysis is appended to the end of this document.

We hope that this report helps to identify some areas that the generating facility can gain some operational efficiency and reduce the parasitic load that these systems represent. If you decide to pursue any of these potential energy savings projects please let the Energy Solutions team know ahead of the start of the project.

Respectfully,

Andy Paul, Bryce Eschenbacher, Levi Westra, February 13th, 2015

Customer: Avista Generation; Little Falls Hydro Generation Station
Project State: Scoping Audit
Date: 03/04/15
Analysis Description: Evaluate the possible energy savings of retrofitting generation floor cooling and exhaust fans with variable speed drives.

Assumptions:

1. System is 3 ph 480VAC (nominal)
2. Units sized for 60% of their service
3. Baseline fan units operate 24/7/365
4. EEM operation is dependent on outside air temperature
5. Power factor nominal 0.80

Inputs:

$pct := \frac{1}{100}$ input- assign percentage

$V_{nom} := 480\,V$ input- assign nominal supplied voltage

$PF := 0.80$ input - assign assumed operational power factor

$Qty_{exhaust} := 4$ input - number of exhaust fans

$Qty_{cooling} := 4$ input - number of cooling fans

$A_{breaker\_exh} := 15\,A$ input - exhaust fan breaker/circuit size

$A_{breaker\_cooling} := 50\,A$ input - cooling fan breaker/circuit size

$F_{service} := 60 \cdot pct$ input - assumed sizing factor; percent power draw based on circuit size

$Duty_{cycle} := 69 \cdot pct$ input - assumed generator annual duty cycle; based on long lake VFD project notes.

$n := 2.5$ input - exponent for affinity law power calculations

Calculations:

$$P_{exhaust} := A_{breaker\_exh} \cdot V_{nom} \cdot F_{service} \cdot PF \cdot \sqrt{3}$$

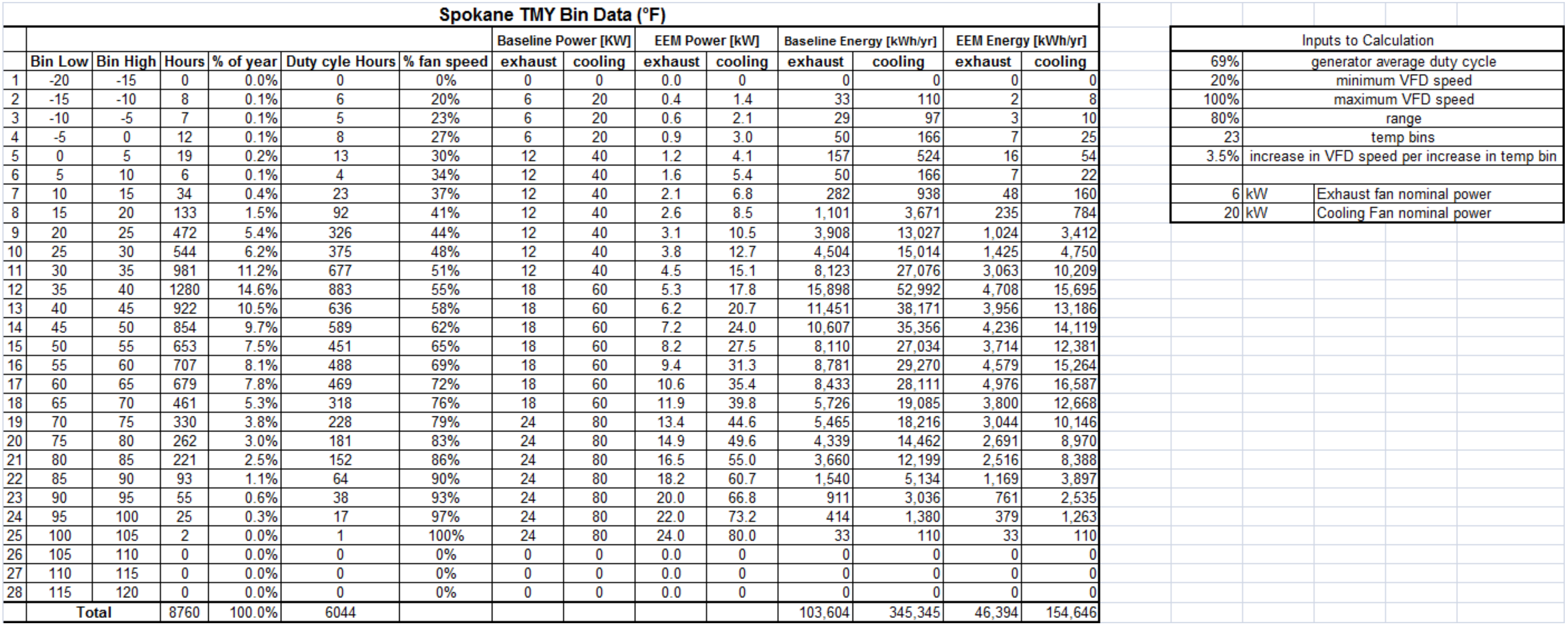
$$P_{exhaust} = 6\ kW$$

$$P_{cooling} := A_{breaker\_cooling} \cdot V_{nom} \cdot F_{service} \cdot PF \cdot \sqrt{3}$$

$$P_{cooling} = 20\ kW$$

Savings based on Spokane bin data

Table 1. Results from Excel Worksheet Bin analysis.



Spokane TMY Bin Data (°F)

							Baseline Power [KW]		EEM Power [kW]		Baseline Energy [kWh/yr]		EEM Energy [kWh/yr]	
	Bin Low	Bin High	Hours	% of year	Duty cyle Hours	% fan speed	exhaust	cooling	exhaust	cooling	exhaust	cooling	exhaust	cooling
1	-20	-15	0	0.0%	0	0%	0	0	0.0	0	0	0	0	0
2	-15	-10	8	0.1%	6	20%	6	20	0.4	1.4	33	110	2	8
3	-10	-5	7	0.1%	5	23%	6	20	0.6	2.1	29	97	3	10
4	-5	0	12	0.1%	8	27%	6	20	0.9	3.0	50	166	7	25
5	0	5	19	0.2%	13	30%	12	40	1.2	4.1	157	524	16	54
6	5	10	6	0.1%	4	34%	12	40	1.6	5.4	50	166	7	22
7	10	15	34	0.4%	23	37%	12	40	2.1	6.8	282	938	48	160
8	15	20	133	1.5%	92	41%	12	40	2.6	8.5	1,101	3,671	235	784
9	20	25	472	5.4%	326	44%	12	40	3.1	10.5	3,908	13,027	1,024	3,412
10	25	30	544	6.2%	375	48%	12	40	3.8	12.7	4,504	15,014	1,425	4,750
11	30	35	981	11.2%	677	51%	12	40	4.5	15.1	8,123	27,076	3,063	10,209
12	35	40	1280	14.6%	883	55%	18	60	5.3	17.8	15,898	52,992	4,708	15,695
13	40	45	922	10.5%	636	58%	18	60	6.2	20.7	11,451	38,171	3,956	13,186
14	45	50	854	9.7%	589	62%	18	60	7.2	24.0	10,607	35,356	4,236	14,119
15	50	55	653	7.5%	451	65%	18	60	8.2	27.5	8,110	27,034	3,714	12,381
16	55	60	707	8.1%	488	69%	18	60	9.4	31.3	8,781	29,270	4,579	15,264
17	60	65	679	7.8%	469	72%	18	60	10.6	35.4	8,433	28,111	4,976	16,587
18	65	70	461	5.3%	318	76%	18	60	11.9	39.8	5,726	19,085	3,800	12,668
19	70	75	330	3.8%	228	79%	24	80	13.4	44.6	5,465	18,216	3,044	10,146
20	75	80	262	3.0%	181	83%	24	80	14.9	49.6	4,339	14,462	2,691	8,970
21	80	85	221	2.5%	152	86%	24	80	16.5	55.0	3,660	12,199	2,516	8,388
22	85	90	93	1.1%	64	90%	24	80	18.2	60.7	1,540	5,134	1,169	3,897
23	90	95	55	0.6%	38	93%	24	80	20.0	66.8	911	3,036	761	2,535
24	95	100	25	0.3%	17	97%	24	80	22.0	73.2	414	1,380	379	1,263
25	100	105	2	0.0%	1	100%	24	80	24.0	80.0	33	110	33	110
26	105	110	0	0.0%	0	0%	0	0	0.0	0	0	0	0	0
27	110	115	0	0.0%	0	0%	0	0	0.0	0	0	0	0	0
28	115	120	0	0.0%	0	0%	0	0	0.0	0	0	0	0	0
	Total		8760	100.0%	6044						103,604	345,345	46,394	154,646

Inputs to Calculation		
69%	generator average duty cycle	
20%	minimum VFD speed	
100%	maximum VFD speed	
80%	range	
23	temp bins	
3.5%	increase in VFD speed per increase in temp bin	
6	kW	Exhaust fan nominal power
20	kW	Cooling Fan nominal power

$E_{baseline} := 103604 \, kW \, hr + 345345 \, kW \, hr$

calc - total annual baseline nergy consumption of the exhaust and cooling fans; assumes 69% duty cycle, 60% sizing factor and linear reduction in # of fans operated based on binned outside temperature data for Spokane area. Reference Excel worsheet "Little Falls DAm_EEM Eval_Exhaust Cooling Fan_030415.xls" for details. A copy of the worksheets results is above in table 1.

$E_{EEM} := 46394 \, kW \, hr + 154646 \, kW \, hr$

calc - total annual EEM energy consumption of the exhaust and cooling fans; assumes 69% duty cycle, 60% sizing factor and linear reduction in fan speeds based on binned outside temperature data for Spokane area. see excel worksheet "Little Falls DAm_EEM Eval_Exhaust Cooling Fan_030415.xls" for details.

$E_{savings} := E_{baseline} - E_{EEM}$

$$\boxed{E_{savings} = 247909 \, kW \, hr}$$

⊞ Double check of above model

Energy Efficiency Improvements Audit Report

Prepared for

Long Lake Hydro Electric Dam

Prepared by

Andy Paul, PE
Bryce Eschenbacher, PE
Levi Westra, PE
Energy Solutions Engineers

February 13, 2015

Overview

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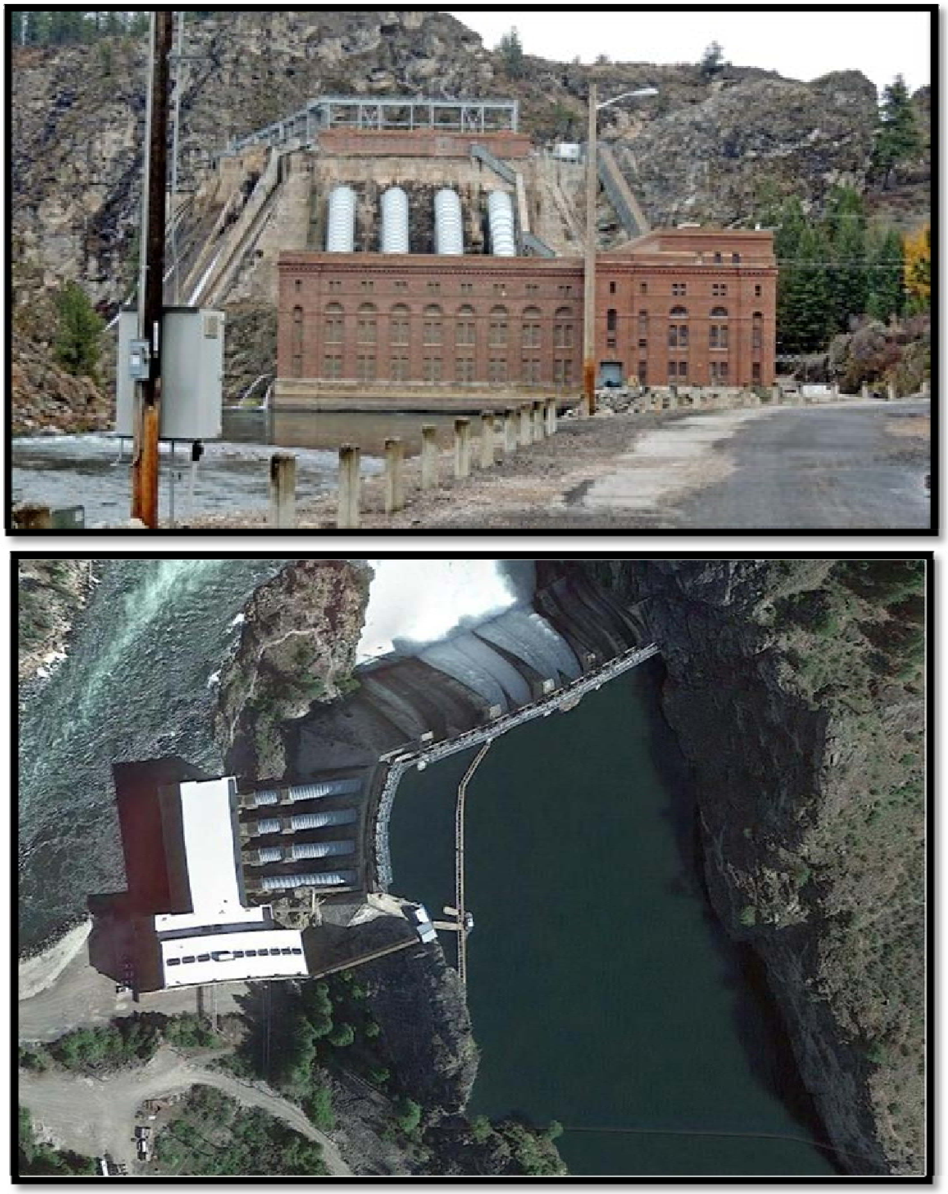
Audited by: Andy Paul PE, Bryce Eschenbacher PE, and Levi Westra PE
Onsite Staff:
Facility Audited on: February 10th, 2015



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The facility consists of a control room, office space, break area and generation specific process areas including but not limited to generation floor and breaker floor.

Shell

There are several areas around the facility where additional weatherization work can be conducted.

1. All exterior entry doors should have their weather stripping checked and replaced if necessary.

2. All windows that are not required to remain historically accurate should be replaced with energy efficient double pane windows.

3. Any portion of the plant that currently has heating or cooling installed should have the walls and ceiling insulated. The insulation will help thermally isolate it from the rest of the plant and reduce the amount of cooling required in the summer time.

4. There is currently little to no insulation above or below the roof deck in the plant. It is recommended that insulation, R-19 at the very least, be added below the deck. This insulation will aid in reducing the amount of time a unit has to be motored during the winter months to maintain space temperature.

Lighting

The site employs T12, T8 and T5 linear fluorescent lighting as well as 400 Watt Metal Halide (MH) high-bay and 250 Watt MH exterior lighting on dusk to dawn sensors. No parking lot lighting was observed.

Table 1 Capital Project Lighting Opportunity Summary

	Brief EEM* Description	EEM Cost	Measure Life	Electric kWh Savings
1	Generating Floor High Bays	**$18,252**	**20 yr**	**17,441**
2	Exterior Wall Packs	**$1,339**	**20 yr**	**2,084**

*EEM – Energy Efficiency Measure

1. Proposed Project #1: The facility currently has (x11) single lamp 400W Metal Halide fixtures and (x8) single lamp 1000W incandescent fixtures lighting the main generation facility. It is assumed that the lights are on for an average 3,600 hrs a year. The proposed project looks at replacing these fixtures with (x30) 200W linear LED high bay fixtures. A simple lumen calculation shows that the overall lumens for the job were decreased by 43%.
    - The provided project is $18,252, this cost was calculated using fixture and install costs for these fixtures at Noxon Rapids HED.

2. Proposed Project #2: The facility currently has (x2) single lamp 250W high pressure sodium cobra head fixtures outside the main entry door. The fixtures average 4,288 hrs (dusk to dawn) of

operation a year. The proposed project looks at replacing these fixtures with (x2) 52W LED wall packs. A simple lumen calculation shows that the overall lumens for the job were decreased by 73%.

  - The provided project cost is $1,336, this cost was calculated using fixture and install costs for these fixtures at Noxon Rapids HED.

3. It should be noted that while the total system lumens decrease for each of these projects, the actual lumens that reach the working space will more the likely increase. LED fixtures are very directional in the way they deliver lighting lumens. We recommend replacing a few light fixtures to make sure that they will meet your lighting needs. If you would like to see the fixtures in operation we recommend a trip to Noxon Rapids HED.

4. In addition to the projects listed above there are several other areas that would benefit from installing new lighting fixtures.

    - The control room and machine shop both have 2L T12 fluorescent fixtures that should be replaced with the new LED fixtures or at the very least 2L T8 fluorescent fixtures.

    - The breaker floor is severely under lit and would greatly benefit from additional lighting fixtures being installed. There is no chance of energy savings in this case since there are only 5 light fixtures in the entire area. The greater benefit would be the increased worker safety and having more light to perform work.

    - The generator floor entry hallway is lit by 100W incandescent fixtures. It is recommended that these be replace with a comparable 20W LED screw in lamp or at the very least a 23W compact fluorescent lamp.

HVAC

1. During the walk through it was mentioned that the control room has a dedicated cooling system but no heating, the generators provide heat for the facility. It is recommended that some type of supplemental electric heat be installed to heat the control room.
2. The main generating floor has no dedicated HVAC units. The heat from the generators keeps the space conditioned during the winter months. A generator will be motored to maintain heat if no generating is going on. It is recommended that dedicated HVAC units be installed to maintain the space temperature when the units are not running. This would reduce unnecessary wear and tear on the generating equipment as well as provide a known dedicated source of heat.
3. Installing two (possibly three) low speed/high volume destratification fans to help de-stratify the air within in the facility is recommended. With 40’ ceilings the majority of buildings heated air will stack at the top, the fans would push that heated air back towards the floor and create a homogenous air temperature. This would reduce the amount of time that the space heat would need to run.

   In addition these fans could be run in reverse during the summer months to help pull warm air off the floor and exhaust it out of the exhaust louvers located in the roof.

Process

Brief EEM Description	Annual Electric kWh Savings
Variable Speed Stator Cooling Blowers	135,000

- Generator cooling fan controls- The (4) hydro-turbine power generators require cooling to operate reliably. Currently the operators operate (4) 100 hp blowers to circulate air from a plenum located below the generators. The blowers operate at a fixed speed forcing outside air to maintain stator temperatures. In the winter the outside air temperature is too low, louvers/baffles are manually opened to re-circulate pre-heated air from within the generator room to keep stator temps from dropping. The EEM would automatically adjust blower speed to reduce flow of the colder outside air across the stators instead of re-circulating pre-heated air eliminating the baffle/louver operation. Because blowers are variable torque devices power consumption is exponentially related to blower speed. The above estimated savings is the annual estimated energy savings based on average yearly temperatures, one time measured power draw, stator temperature goals, and affinity laws for four stators. A copy of the analysis is appended to this document.

Figure 2 Long Lake generator.

Figure 3 Long Lake dam generator passage for cooling air.

Figure 4 Long Lake stator cooling blower (left) and motor (right).

We hope that this report helps to identify some areas that the generating facility can gain some operational efficiency and reduce the parasitic load that these systems represent. If you decide to pursue any of these potential energy savings projects please let the Energy Solutions team know ahead of the start of the project.

Respectfully,

Andy Paul, Bryce Eschenbacher, and Levi Westra – February 13th, 2015

Customer: Long Lake Dam;
Project: Cooling Fan VFD Drive Evaluation
Date: 01/07/10

Define the Situation:

Randy Gnaedinger contacted Tom about having the team evaluate the possible benefits of installing VFD drives on the (4) ~100hp generator cooling fans at the Long Lake Dam. Tom, Andy and I visited the site on 12/30/09. We met with Bill Maltby, the facility's chief operator. He gave us a tour. We took air temperature, air speed, air flow rate, plenum, and power measurements of the (4) operating fan units.

Goals:

1. Determine fan speeds required maintain stator temperature at 60°C (ideal operational temp)
2. Evaluate power draw of fans at required fan speeds
3. Compare power draw with EEM to power draw without EEM

Assumptions:

-system is steady state, no accounting for stator/generator mass
-air temperature measured supplying fan #5 was 74°F, while air temp supplying fan #1 was 53°F. It is assumed that this is attributed to the team leaving the access door open to the plenum during the tour. For this analysis I will use 53°F as the baseline for all of the fans.
-this analysis does not account for the effect VFDs will have on the air temperature within the generator room.
-assume that the louvers in the room will no longer be used to control fan supply air temp. fans will draw only outside air, temperature will be purely ambient.
-assume the dry bulb temperaure equals the wet bulb temperature of air coming out of air washers which will assume is equal to the dew point temp pluse 2°F (conservative); unless the water temperature exceeds the dew point, at which point employ the water temperature.
-assume the dry bulb temp is equal to the ambient temperature when the air washer is not being used (winter months).
-apply infinity fan laws to estimate fan speed and power based on air flow needs
-assumed that the air washers would be employed shortly after the last freezing potential in the spring, and discontinued once freezing temperatures were encountered in the fall. Reviewed 1987 data, and it appears assuming air washers come on line begining in May and taken offline begining in October is appropriate. Currently there is no schedule for air washers. The

electrician enables the system sometime in the spring when it seems like it won't freeze, and disables the system in the fall when it starts to get cold. The operators start washing the air once they are unable to maintain stator temps at or below the 60°C optimal temperature.
-applied a website generated excel equation to calculate wet bulb temp based on dry bulb and releative humidity:
http://www.the-snowman.com/wetbulb2.html

I verified the relative accuracy of the calculation using the pychrometric chart located in the MERM appendix 38.C
-assumed that a VFD turndown ratio at a minimum of 20% did not hinder or cause problems for fan operation
-assumed all four fans are delivering the same air flow to each generator

Inputs:	**Supporting Results/Comments:**
$temp_{air\_exit\_stator} := 76\,°F = 297.6\,K$	measured 74°F air coming through the access door to the plenum, for a conservative estimate I added a fudge factor.
$temp_{stator} := 60\,°C = 333.1\,K$	this is the target stator temperature. facilities team adjusts internal louvers and air washer operation in order to maintain this temperature at 60°C
$temp_{fan1\_air} := 60\,°F = 288.7\,K$	measured temperature of air supplied to fan #1 during visit on 12/30/09
$air\_speed_{fan1} := 1900\,\frac{ft}{min}$	measured average air speed using the kestrel
$air\_speed_{fan5} := 2500\,\frac{ft}{min}$	measured average air speed using the kestrel
$Xarea_{plenum\_fan5} := 39in \cdot 81in = 21.9 \cdot ft^2$	measured plenum cross-secitonal area, note plenum 5 does not share the same dimensions with 1-4.
$Xarea_{plenum\_fan1to4} := 48in \cdot 96in = 32 \cdot ft^2$	measured plenum cross-sectional area, note fans 1-4 all share the same plenum size
$air\_flow_{fan5} := 44000\,\frac{ft^3}{min}$	measured air flow rate using kestrel hand held meter using plenum dimensions inputted into unit.

$power_{fan1} := 75kW$ measured power draw by fan #1 during tour

$power_{fan2} := 7kW$

$power_{fan4} := 19kW$

$power_{fan5} := 36kW$

$average\_duty := 69\%$ typical duty cycle of each of the (4) generators per year.

$\eta_{sat\_air\_washer} := 90\%$

$air\_flow\_calc_{fan5} := air\_speed_{fan5} \cdot Xarea_{plenum\_fan5} = 54843.7 \cdot \frac{ft^3}{min}$ sanity check on kestrel air flow measurement

$\eta_{VFD} := 98\%$

$Cp_{air\_290K} := 1.0048 \cdot 10^3 \frac{J}{kg \cdot K}$ specific heat of air at a mixing cup temperature of 290K ref. MERM ap.35.D

$\rho_{air\_290K} := 1.246 \frac{kg}{m^3} = 0.1 \cdot \frac{lbm}{ft^3}$ density of air at a mixing cup temp of 290K ref MERM ap.35.D

Calculations:

Goal #1

▼ Estimating Power rejected by Gen 1 as heat

$$temp_{air\_mixing\_cup} := \frac{temp_{air\_exit\_stator} + temp_{fan1\_air}}{2} = 293.1\,K$$

$$\frac{1000kW}{20 \cdot 10^{6} W} = 5\,\%$$

$$air\_flow\_calc_{fan1} := air\_speed_{fan1} \cdot Xarea_{plenum\_fan1to4} = 60800 \cdot \frac{ft^{3}}{min}$$

$$m_{dot\_fan1} := air\_flow\_calc_{fan1} \cdot \rho_{air\_290K} = 4729.3 \cdot \frac{lbm}{min}$$

$$\boxed{heat\_transfer_{stator} := m_{dot\_fan1} \cdot Cp_{air\_290K} \cdot \left(temp_{air\_exit\_stator} - temp_{fan1\_air}\right) = 319.3 \cdot kW}$$

estimated amount of heat being rejected to air by generator #1

$$heat\_transfer_{stator} := 1MW$$

after a discussion with Randy, to be better represent actual generator efficiency (~95%) I assigned 1 MW to be rejected via forced convection. Overroad my heat calculation and forced 1MW rejection into model

▲ Estimating Power rejected by Gen 1 as heat

▼ Generator 1 - Final Analysis with weather and gen schedule data

Data Imports from GEG Bin data 1987

$Temp_{drybulb\_hourly} :=$

$Temp_{est\_wetbulb\_hourly} :=$

$schedule_{generator\_1} :=$

factor of safety to approximate some building air recirculation back into the plenum to maintain building air temp above 50F

$$temp_{drybulb\_out\_airwasher} := \left[\left(Temp_{drybulb\_hourly} + temp_{FS}\right) - \eta_{sat\_air\_washer} \cdot \left(Temp_{drybulb\_hourly} - Temp_{est\_wetbulb\_hourly}\right)\right] {}^{\circ}F$$

calculation of predicted dry bulb air temp leaving the air washers,
calculation referenced from MERM eq 38.34 assumed air washer saturation efficiency of 90% (conservative value)

$Temp_{est\_wetbulb\_hourly} =$

	0
98	30
99	28.9
100	28.9
101	28.9
102	28
103	28.9
104	...

$schedule_{generator\_1} =$

	0
0	0
1	0
2	0
3	0
4	...

$temp_{drybulb\_out\_airwasher} =$

	0
0	30
1	30
2	30
3	30
4	...

$\cdot °F$

results of calculating dry bulb temperature; includes air washer scheduled operation

$temp_{air\_\_EEM\_exit\_stator} := 92\,°F$

assigned a value to the exit air temperature from the stator; based on best estimate of ideal exit temperature to maintain stator temperature

$heat\_transfer_{stator} = 1000\,kW$

$$m_{dot\_generator\_1} := \frac{heat\_transfer_{stator}}{Cp_{air\_290K} \cdot \left(temp_{air\_\_EEM\_exit\_stator} - temp_{drybulb\_out\_airwasher}\right)}$$

$n := 8759$

$i := 0 .. n$

$m_{dot\_generator\_1} =$

	0
0	28.9
1	28.9
2	28.9
3	...

$\frac{kg}{s}$

$m_{dot\_schedule\_generator1_i} := m_{dot\_generator\_1_i} \cdot schedule_{generator\_1_i}$

adjusting air requirements for when generator is operating. Based on data obtained from Rodney Picket for hourly generator operation for 2009

$m_{dot\_schedule\_generator1} =$

	0
0	0
1	0
2	...

$\frac{kg}{s}$

$$air\_flow_{generator\_1} := \frac{m_{dot\_schedule\_generator1}}{\rho_{air\_290K}}$$

$air\_flow_{generator\_1} =$

	0
5	49150.7
6	49150.7
7	49874.9
8	50772.7
9	...

$\cdot \frac{ft^3}{min}$

$$air\_flow\_calc_{fan1} = 60800 \cdot \frac{ft^3}{min}$$

$$\max\left(air\_flow_{generator\_1}\right) = 189450.2 \cdot \frac{ft^3}{min}$$

$$fan\_speed\_percentage_{EEM\_generator\_1} := \frac{air\_flow_{generator\_1}}{air\_flow\_calc_{fan1}}$$

$fan\_speed\_percentage_{EEM\_generator\_1} =$

	0
2029	122.4
2030	122.4
2031	119.3
2032	119.3
2033	...

$\cdot \%$

need an adjusted fan speed. when fan speed requirements exceed 100% the fan can only deliver that 100%

$$\text{adjusted\_fan\_speed}(\text{fan\_speed}) := \text{if}(\text{fan\_speed} > 1, 1, \text{fan\_speed})$$

$$\text{adjusted\_fan\_speed}_{\text{gen1}_i} := \text{adjusted\_fan\_speed}\left(\text{fan\_speed\_percentage}_{\text{EEM\_generator\_1}_i}\right)$$

$\text{adjusted\_fan\_speed}_{\text{gen1}} =$

	0
0	0
1	0
2	0
3	0
4	0.8
5	0.8
6	0.8
7	0.8
8	0.8
9	0.9
10	0.9
11	0.9
12	0.9
13	0.9
14	0.9
15	...

$$\max\left(\text{adjusted\_fan\_speed}_{\text{gen1}}\right) = 100 \cdot \%$$

note from Randy: every year, for approximately 1 week, the sytem's needs exceed flow rate needs

$$power_{EEM\_generator\_1} := \frac{power_{fan1}}{\eta_{VFD}} \cdot \left(adjusted\_fan\_speed_{gen1}\right)^{3}$$

$$power_{EEM\_generator\_1} = \begin{array}{|c|r|}\hline & 0 \\ \hline 0 & 0 \\ \hline 1 & 0 \\ \hline 2 & 0 \\ \hline 3 & \ldots \\ \hline \end{array} \cdot kW$$

$$power_{generator\_1} := schedule_{generator\_1} \cdot power_{fan1}$$

$$power_{generator\_1} = \begin{array}{|c|r|}\hline & 0 \\ \hline 0 & 0 \\ \hline 1 & 0 \\ \hline 2 & \ldots \\ \hline \end{array} \cdot kW$$

$$\boxed{annual\_fan\_energy_{EEM\_generator\_1} := \sum power_{EEM\_generator\_1} \cdot hr = 380508.9 \cdot kW \cdot hr}$$

estimated power used by generator 1's cooling fan if a VFD were installed during 2009 operating year

$$\boxed{annual\_fan\_energy_{generator\_1} := \sum power_{generator\_1} \cdot hr = 452925 \cdot kW \cdot hr}$$

estimated power used by generator 1's cooling fan during 2009 operating year

▲ Generator 1 - Final Analysis with weather and gen schedule data

Generator 2 - Final Analysis with weather and gen schedule data

$schedule_{generator\_2} :=$

$$m_{dot\_generator\_2} := \frac{heat\_transfer_{stator}}{Cp_{air\_290K} \cdot \left(temp_{air\_\_EEM\_exit\_stator} - temp_{drybulb\_out\_airwasher}\right)}$$

$m_{dot\_generator\_2} =$ $\frac{kg}{s}$

	0
0	28.9
1	28.9
2	28.9
3	...

$$m_{dot\_schedule\_generator2_i} := m_{dot\_generator\_2_i} \cdot schedule_{generator\_2_i}$$

adjusting air requirements for when generator is operating. Based on data obtained from Rodney Picket for hourly generator operation for 2009

$m_{dot\_schedule\_generator2} =$ $\frac{kg}{s}$

	0
0	0
1	0
2	0
3	...

$$air\_flow\_calc_{fan2} := air\_flow\_calc_{fan1}$$

$$air\_flow_{generator\_2} := \frac{m_{dot\_schedule\_generator2}}{}$$

$air\_flow_{generator\_2} =$ $\cdot \frac{ft^3}{min}$

	0
0	0
1	0
2	0
3	...

$air\_flow_{generator\_2} =$ $\cdot \frac{ft^3}{min}$

	0
0	0
1	0
2	...

$$\max\left(air\_flow_{generator\_2}\right) = 189450.2 \cdot \frac{ft^3}{min}$$

$$fan\_speed\_percentage_{EEM\_generator\_2} := \frac{air\_flow_{generator\_2}}{air\_flow\_calc_{fan2}}$$

$fan\_speed\_percentage_{EEM\_generator\_2} =$ ·%

	0
0	0
1	0
2	0
3	...

$$adjusted\_fan\_speed_{gen2_i} := adjusted\_fan\_speed\left(fan\_speed\_percentage_{EEM\_generator\_2_i}\right)$$

$adjusted\_fan\_speed_{gen2} =$ %

	0
0	0
1	0
2	0
3	0
4	80.8
5	80.8
6	80.8
7	...

$$\max\left(adjusted\_fan\_speed_{gen2}\right) = 100 \cdot \%$$

$$power_{EEM\_generator\_2} := \frac{power_{fan2}}{\eta_{VFD}} \cdot \left(adjusted\_fan\_speed_{gen2}\right)^{3}$$

$power_{EEM\_generator\_2} =$ ·kW

	0
4	3.8
5	3.8
6	...

$$power_{generator\_2} := schedule_{generator\_2} \cdot power_{fan2}$$

$power_{generator\_2} =$ ·kW

	0
0	0
1	0

2	...

$annual\_fan\_energy_{EEM\_generator\_2} := \sum power_{EEM\_generator\_2} \cdot hr = 35196 \cdot kW \cdot hr$

estimated power used by generator 1's cooling fan if a VFD were installed during 2009 operating year

$annual\_fan\_energy_{generator\_2} := \sum power_{generator\_2} \cdot hr = 42490 \cdot kW \cdot hr$

estimated power used by generator 1's cooling fan during 2009 operating year

▲ Generator 2 - Final Analysis with weather and gen schedule data

▼ Generator 3 - Final Analysis with weather and gen schedule data

$schedule_{generator\_3} :=$

$schedule_{generator\_3} =$

	0
0	1
1	1
2	1
3	...

$$m_{dot\_generator\_3} := \frac{heat\_transfer_{stator}}{Cp_{air\_290K} \cdot \left(temp_{air\_\_EEM\_exit\_stator} - temp_{drybulb\_out\_airwasher}\right)}$$

$m_{dot\_generator\_3} =$ $\frac{kg}{s}$

	0
0	28.9
1	28.9
2	...

$m_{dot\_schedule\_generator3_i} := m_{dot\_generator\_3_i} \cdot schedule_{generator\_3_i}$

$m_{dot\_schedule\_generator3} =$

	0
0	28.9
1	28.9
2	28.9
3	...

$\frac{kg}{s}$

adjusting air requirements for when generator is operating. Based on data obtained from Rodney Picket for hourly generator operation for 2009

$air\_flow\_calc_{fan3} := air\_flow\_calc_{fan1}$

$air\_flow_{generator\_3} := \frac{m_{dot\_schedule\_generator3}}{\rho_{air\_290K}}$

$air\_flow_{generator\_3} =$

	0
0	49150.7
1	49150.7
2	...

$\cdot \frac{ft^3}{min}$

$air\_flow_{generator\_3} =$

	0
0	49150.7
1	49150.7
2	...

$\cdot \frac{ft^3}{min}$

$\max\left(air\_flow_{generator\_2}\right) = 189450.2 \cdot \frac{ft^3}{min}$

$fan\_speed\_percentage_{EEM\_generator\_3} := \frac{air\_flow_{generator\_3}}{air\_flow\_calc_{fan3}}$

$fan\_speed\_percentage_{EEM\_generator\_3} =$

	0
0	80.8
1	80.8
2	80.8
3	...

$\cdot \%$

$adjusted\_fan\_speed_{gen3_i} := adjusted\_fan\_speed\left(fan\_speed\_percentage_{EEM\_generator\_3_i}\right)$

$adjusted\_fan\_speed_{gen3} =$

	0
0	80.8
1	80.8
2	80.8
3	80.8
4	...

%

$$\max\left(adjusted\_fan\_speed_{gen3}\right) = 100 \cdot \%$$

*Note: Fan #3 is used as a backup; I assumed fan #4 is supplying ~100% of the flow to gen 3

$$power_{EEM\_generator\_3} := \frac{power_{fan4}}{\eta_{VFD}} \cdot \left(adjusted\_fan\_speed_{gen3}\right)^{3}$$

$$power_{generator\_3} := schedule_{generator\_3} \cdot power_{fan4}$$

$power_{EEM\_generator\_3} =$

	0
0	10.2
1	10.2
2	...

$\cdot kW$

$power_{generator\_3} =$

	0
0	19
1	19
2	...

$\cdot kW$

$$\text{annual\_fan\_energy}_{\text{EEM\_generator\_3}} := \sum \text{power}_{\text{EEM\_generator\_3}} \cdot \text{hr} = 95546.3 \cdot \text{kW} \cdot \text{hr}$$

estimated power used by generator 1's cooling fan if a VFD were installed during 2009 operating year

$$\text{annual\_fan\_energy}_{\text{generator\_3}} := \sum \text{power}_{\text{generator\_3}} \cdot \text{hr} = 114019 \cdot \text{kW} \cdot \text{hr}$$

estimated power used by generator 1's cooling fan during 2009 operating year

▲ Generator 3 - Final Analysis with weather and gen schedule data

▼ Generator 4 - Final Analysis with weather and gen schedule data

$$\text{schedule}_{\text{generator\_4}} :=$$

$$\text{schedule}_{\text{generator\_4}} =$$

	0
0	1
1	...

$$m_{\text{dot\_generator\_4}} := \frac{\text{heat\_transfer}_{\text{stator}}}{\text{Cp}_{\text{air\_290K}} \cdot \left(\text{temp}_{\text{air\_\_EEM\_exit\_stator}} - \text{temp}_{\text{drybulb\_out\_airwasher}}\right)}$$

$$m_{\text{dot\_generator\_4}} = \frac{\text{kg}}{\text{s}}$$

	0
0	28.9
1	28.9
2	...

$$m_{\text{dot\_schedule\_generator4}_i} := m_{\text{dot\_generator\_4}_i} \cdot \text{schedule}_{\text{generator\_4}_i}$$

$m_{\text{dot\_schedule\_generator4}} =$

	0
0	28.9
1	28.9
2	...

$\frac{kg}{s}$

adjusting air requirements for when generator is operating. Based on data obtained from Rodney Picket for hourly generator operation for 2009

$$\text{air\_flow\_calc}_{\text{fan4}} := \text{air\_flow\_calc}_{\text{fan1}}$$

$$\text{air\_flow}_{\text{generator\_4}} := \frac{m_{\text{dot\_schedule\_generator4}}}{\rho_{\text{air\_290K}}}$$

$\text{air\_flow}_{\text{generator\_4}} =$

	0
0	49150.7
1	49150.7
2	...

$\cdot \frac{ft^3}{min}$

$\text{air\_flow}_{\text{generator\_4}} =$

	0
0	49150.7
1	49150.7
2	...

$\cdot \frac{ft^3}{min}$

$$\max\left(\text{air\_flow}_{\text{generator\_2}}\right) = 189450.2 \cdot \frac{ft^3}{min}$$

$$\text{fan\_speed\_percentage}_{\text{EEM\_generator\_4}} := \frac{\text{air\_flow}_{\text{generator\_4}}}{\text{air\_flow\_calc}_{\text{fan4}}}$$

$\text{fan\_speed\_percentage}_{\text{EEM\_generator\_4}} =$

	0
0	80.8
1	...

$\cdot\%$

$$\text{adjusted\_fan\_speed}_{\text{gen4}_i} := \text{adjusted\_fan\_speed}\left(\text{fan\_speed\_percentage}_{\text{EEM\_generator\_4}_i}\right)$$

$\text{adjusted\_fan\_speed}_{\text{gen4}} =$

	0
0	80.8
1	80.8
2	80.8
3	...

%

$$\max\left(\text{adjusted\_fan\_speed}_{\text{gen4}}\right) = 100\cdot\%$$

*Note: Fan #3 is used as a backup; I assumed fan #5 is supplying ~100% of the flow to gen 4

$$\text{power}_{\text{EEM\_generator\_4}} := \frac{\text{power}_{\text{fan5}}}{\eta_{\text{VFD}}}\cdot\left(\text{adjusted\_fan\_speed}_{\text{gen4}}\right)^3$$

$\text{power}_{\text{EEM\_generator\_4}} =$

	0
0	19.4
1	19.4
2	19.4
3	19.4
4	...

$\cdot\text{kW}$

$$\text{power}_{\text{generator\_4}} := \text{schedule}_{\text{generator\_4}}\cdot\text{power}_{\text{fan5}}$$

$\text{power}_{\text{generator\_4}} =$

	0
0	36
1	36
2	...

$\cdot\text{kW}$

$$\boxed{\text{annual\_fan\_energy}_{\text{EEM\_generator\_4}} := \sum \text{power}_{\text{EEM\_generator\_4}}\cdot\text{hr} = 176804.6\cdot\text{kW}\cdot\text{hr}}$$

estimated power used by generator 1's cooling fan if a VFD were installed during 2009 operating year

$$\boxed{\text{annual\_fan\_energy}_{\text{generator\_4}} := \sum \text{power}_{\text{generator\_4}} \cdot \text{hr} = 214380 \cdot \text{kW} \cdot \text{hr}}$$

estimated power used by generator 1's cooling fan during 2009 operating year

▲ Generator 4 - Final Analysis with weather and gen schedule data

Summary of Results:

$$\text{total\_energy\_annual}_{\text{no\_VFD}} := \text{annual\_fan\_energy}_{\text{generator\_1}} + \text{annual\_fan\_energy}_{\text{generator\_2}} + \text{annual\_fan\_energy}_{\text{generator\_3}} \cdots + \text{annual\_fan\_energy}_{\text{generator\_4}}$$

$$\boxed{\text{total\_energy\_annual}_{\text{no\_VFD}} = 823814 \cdot \text{kW} \cdot \text{hr}}$$

$$\frac{\text{total\_energy\_annual}_{\text{no\_VFD}}}{365\text{day}} = 2257\,\text{kW} \cdot \frac{\text{hr}}{\text{day}}$$

typically the dam personel see ~4-6 aMW*hr/day

$$\text{total\_energy\_annual}_{\text{VFD}} := \text{annual\_fan\_energy}_{\text{EEM\_generator\_1}} + \text{annual\_fan\_energy}_{\text{EEM\_generator\_2}} \cdots + \text{annual\_fan\_energy}_{\text{EEM\_generator\_3}} + \text{annual\_fan\_energy}_{\text{EEM\_generator\_4}}$$

$$\boxed{\text{total\_energy\_annual}_{\text{VFD}} = 688055.8 \cdot \text{kW} \cdot \text{hr}}$$

$$\boxed{\text{energy\_savings} := \text{total\_energy\_annual}_{\text{no\_VFD}} - \text{total\_energy\_annual}_{\text{VFD}} = 135758.2 \cdot \text{kW} \cdot \text{hr}}$$

$$\text{energy\_rate} := \frac{100\$}{1\text{MW} \cdot \text{hr}}$$

$$\boxed{\text{savings} := \text{energy\_savings} \cdot \text{energy\_rate} = 13575.8\,\$}$$

$$\boxed{\frac{\text{savings}}{12\%} = 113131.9\,\$}$$

Energy Efficiency Improvements
Audit Report

Prepared for
Nine Mile Hydro Electric Dam

Prepared by
Andy Paul, PE
Bryce Eschenbacher, PE
Levi Westra, PE
Energy Solutions Engineers

February 13, 2015

Overview

Facility: Nine Mile Hydro Electric Dam
Audited by: Andy Paul PE, Bryce Eschenbacher PE, and Levi Westra PE
Onsite Staff:
Facility Audited on: February 10th, 2015

Figure 1 Google Images of Nine Mile Hydro Electric Dam

Avista's DSM Engineering staff visited the Nine Mile Hydro Electric Dam to review their current building systems and discuss several concerns that the user's encountered during typical operation.

Specifically, this audit was conducted to identify all possible energy efficiency improvements not related to the power generation process.

After completing a tour of the facility potential improvement measures were identified for consideration including capital projects as well as low-cost no-cost measures. This report is intended to provide a cursory review of possible energy savings. Each listed recommendation and costing is based upon historical experience and costing projections. Equipment life and performance will vary and a Statement of Work (SOW) for the capital project will determine the actual project costs and performance.

It should be noted that this facility is currently undergoing a complete overhaul. Due to this there are very few projects that can be suggested that are not already going to be implemented.

The facility consists of a control room and generation specific process areas including but not limited to generation floor and breaker floor.

Shell

There are several areas around the facility where additional weatherization work can be conducted.

1. All exterior entry doors should have their weather stripping checked and replaced if necessary.

2. All windows that are not required to remain historically accurate should be replaced with energy efficient double pane windows.

3. Any portion of the plant that is going to have cooling installed; control room, battery room etc, should have the walls and ceiling insulated. The insulation will help thermally isolate it from the rest of the plant and reduce the amount of cooling required in the summer time.

4. There is currently little to no insulation above or below the roof deck in the plant. It is recommended that insulation, R-19 at the very least, be added below the deck. This insulation will aid in reducing the amount of time a unit has to be motored during the winter months to maintain space temperature.

Lighting

The facility currently employs T12 fluorescent lighting in the control room and surrounding areas and 400 Watt Metal Halide (MH) high-bay fixtures on the generating floor. The facility will have a brand new all LED lighting system installed during the overhaul. The DSM group at Avista made suggestions on what LED fixtures would be appropriate. Quinton Snead in the Generation Dept was in charge of the lighting design.

While there will be energy savings for this project, specifically with the generating floor lighting as well as the control room lighting, there will also be an additional lighting load installed. There are portions of the plant that were under lit and needed additional lighting fixtures installed. Regardless of the additional lighting fixtures, the new system will be as efficient as possible due to the installation of the LED fixtures in lieu of more traditional linear fluorescent and HID fixtures.

HVAC

1. The control room and few other areas in the plant will be getting new HVAC units installed to heat and cool the spaces. When selecting equipment considered installing the most efficient units that can be afforded. It is also recommended that heat pump units be installed instead of standard condensing units with electric resistive heat. New heat pumps are capable of working efficient down to temperatures below zero. Since no natural gas is available at the Dam a heat pump is by far the most efficient way to provide space heat.

2. The main generating floor has no dedicated HVAC units. The heat from the generators keeps the space conditioned during the winter months. A generator will be motored to maintain heat if no generating is going on. It is recommended that dedicated HVAC units be installed to maintain the space temperature when the units are not running. This would reduce unnecessary wear and tear on the generating equipment as well as provide a known dedicated source of heat.
3. Installing two (possibly three) low speed/high volume destratification fans to help de-stratify the air within in the facility is recommended. With 40' ceilings the majority of buildings heated air will stack at the top, the fans would push that heated air back towards the floor and create a homogenous air temperature. This would reduce the amount of time that the space heat would need to run.

   In addition these fans could be run in reverse during the summer months to help pull warm air off the floor and exhaust it out of the exhaust louvers located in the roof.

We hope that this report helps to identify some areas that the generating facility can gain some operational efficiency and reduce the parasitic load that these systems represent. If you decide to pursue any of these potential energy savings projects please let the Energy Solutions team know ahead of the start of the project.

Respectfully,

Andy Paul, Bryce Eschenbacher, and Levi Westra – February 13th, 2015

Energy Efficiency Improvements Audit Report

Prepared for

North East Combustion Turbine
Thermal Facility

Prepared by

Bryce Eschenbacher, PE
Energy Solutions Engineer

June 19, 2015

Overview

Facility: North East Combustion Turbine
Audited by: Bryce Eschenbacher PE
Onsite Staff: Dwayne Wright
Facility Audited on: June 16th, 2015

Figure 1 Google Image of the North East Combustion Turbine Thermal Facility

Avista's DSM Engineering staff visited the North East CT to review their current building systems and discuss several concerns that the user's encountered during typical operation. Specifically, this audit was conducted to identify all possible energy efficiency improvements not related to the power generation process.

After completing a tour of the facility potential improvement measures were identified for consideration including capital projects as well as low-cost no-cost measures. This report is intended to provide a cursory review of possible energy savings. Each listed recommendation and costing is based upon historical experience and costing projections. Equipment life and performance will vary and a Statement of Work (SOW) for the capital project will determine the actual project costs and performance.

Shell

The main warehouse at the facility was completed recently and is well insulated with good exterior doors. No improvements need to be made at this point in time. Below are some recommendations of the few other buildings that may benefit from insulation or weatherization:

1. The MCC building has a through wall AC unit and small electric heater. The weather stripping for the exterior door should be checked and replaced if it's found to be faulty. This will aid in reducing the AC load in the summer and the heating load in the winter.
2. The pump house and tool crib are similar to the MCC and should have their exterior door weather stripping checked.

Lighting

The new warehouse employs T8 linear fluorescent fixtures; the remainder of the facility is a mix of T12 linear fluorescents and screw in incandescent fixtures. The yard lights are quartz halogen fixtures. The majority of these fixtures only operate a couple of hours a day and would not generate enough energy savings to justify their replacement on those grounds. The increase in efficiency and longevity of the fixtures on the other hand should be consider and replacement based on this planned. Below is a list of potential lighting projects to consider.

Table 1 Capital Project Lighting Opportunity Summary

	Brief EEM* Description	EEM Cost	Measure Life	Electric kWh Savings
1	Halogen Pole Lights	**$1,350**	**20 yr**	**5,145.6**

*EEM – Energy Efficiency Measure

1. Proposed Project #1: There are currently (x6) quartz halogen yard lights. For this analysis it is assumed that they are 250W lamps. These lights only operate when work is being down at the facility. It was stated that the lights should be on dusk to dawn to provide some security lighting as well. This analysis looks at the potential savings that would be seen if the existing lights were on dusk to dawn. The proposed project looks at replacing these fixtures with 50W LED spot lights. A simple lumen calculation shows that the overall lumens for the job were increased by 43%.
    - The provided project cost is $3,600; this cost was calculated using fixture cost found online and an estimated $75 per fixture for install.
2. The two lamp F48T12 linear fluorescent fixtures in the MCC room, tool crib, pump house, and generator room, should be replaced with new linear LED fixtures. The 50W linear fixtures that were used at Noxon Rapids are recommended for these areas. The cost to purchase and install these fixtures is $347.50 (based on invoiced costs from Noxon).

HVAC

1. The main warehouse is conditioned by a gas fired unit hearer in the work area and a Mitsubishi ductless heat pump serves the office area. The unit heater should be replaced with a 90%+ unit when the current unit has reached its end of life. The ductless heat pump is a compact and efficient means of condition the office space.
2. There are several small through the wall air conditioning units at some of the smaller outbuildings. It is recommended that these be replaced with the most efficient units available when the existing units fail.
3. The engine compartments are conditioned by two 1.5 ton York roof top unit mounted on grade outside of the units. These units keep the engine compartment above freezing in the winter and cool it down when maintenance needs to be done in the summer. The existing units are aged and use R-22 refrigerant, which is no longer manufactured. At some point it will be necessary to replace these units as parts and refrigerant become scarce. It is recommended that they be replaced with the most efficient units that can be afforded.

We hope that this report helps to identify some areas that the generating facility can gain some operational efficiency and reduce the parasitic load that these systems represent. If you decide to pursue any of these potential energy savings projects please let the Energy Solutions team know ahead of the start of the project.

Respectfully,

Bryce Eschenbacher – June 19, 2015

Name: North East CT - Halogen to LED **Acct#**		
Existing Annual Consumption: (kilowatt hours)	6,432.00	
Lighting Energy Savings:(kilowatt hours)	5,145.60	
Lighting Demand Savings: (kilowatt demand)	0.96	
Cooling System Savings: (kilowatt hours)	0.00	
Cooling System Demand Savings: (kW demand)	0.00	
Lumen Comparison New/Existing	142.86%	
Total Energy Savings: (kilowatt hours)	5,145.60	
Total Demand Savings: (kilowatt demand)	**0.96**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	$50.76	

Energy Efficiency Improvements
Audit Report

Prepared for

Noxon Rapids Hydro Electric Dam

Prepared by
Andy Paul, PE
Bryce Eschenbacher, PE
Levi Westra, PE
Energy Solutions Engineers

February 10, 2015

Overview

Facility: Noxon Rapids Hydro Electric Dam
Audited by: Andy Paul PE, Bryce Eschenbacher PE
Onsite Staff:
Facility Audited on: January 15th, 2015

Figure 1 Google Images of the Noxon Rapids Hydro Electric Dam

Avista’s DSM Engineering staff visited the Noxon Rapids Hydro Electric Dam to review their current building systems and discuss several concerns that the user’s encountered during typical operation. Specifically, this audit was conducted to identify all possible energy efficiency improvements not related to the power generation process.

After completing a tour of the facility potential improvement measures were identified for consideration including capital projects as well as low-cost no-cost measures. This report is intended to provide a cursory review of possible energy savings. Each listed recommendation and costing is based upon historical experience and costing projections. Equipment life and performance will vary and a Statement of Work (SOW) for the capital project will determine the actual project costs and performance.

The facility consists of a control room, office space, break area and generation specific process areas including but not limited to generation floor and breaker floor.

Shell

Due to the design of the facility there are no real shell measures that can be undertaken that would benefit the facility or save energy.

Lighting

The site recently completed a full lighting system replacement. The old system was made up of old two lamp 48W T12 fluorescent fixtures, incandescent screw in lamps of varying wattages, and metal halide fixtures. The system is entirely made up of LED fixtures. The Majority being linear LED fixtures with some screw in lamps throughout. This lighting project reduced the annual lighting load by 382,115 kWh. The lighting system was the largest inefficiency in this facility.

In addition to the new lighting fixtures the entire lighting system was re-wired. New lighting panels were installed as well.

HVAC

1. The facility employs a water source heat pump, along with a couple of air handlers and several unit heaters, to condition the generating floor and all rooms on that same level. The access and observation galleries are unconditioned.

   During the audit we were not able to determine the size or efficiency of the unit because the name plate was in-accessible. Based on the equipments vintage, and a statement from facility staff that the equipment needs regular maintenance, we recommend that this equipment be replace with a modern efficient water source heat pump. It is recommended that the most efficient equipment that can be afforded be installed.

We hope that this report helps to identify some areas that the generating facility can gain some operational efficiency and reduce the parasitic load that these systems represent. If you decide to pursue any of these potential energy savings projects please let the Energy Solutions team know ahead of the start of the project.

Respectfully,

Andy Paul, Bryce Eschenbacher – February 10th, 2015

Energy Efficiency Improvements
Audit Report

Prepared for

Post Falls Hydro Electric Dam

Prepared by
Andy Paul, PE
Bryce Eschenbacher, PE
Levi Westra, PE
Energy Solutions Engineers

May 28, 2015

Overview

Facility: Post Falls Hydro Electric Dam
Audited by: Andy Paul PE, Bryce Eschenbacher PE, and Levi Westra PE
Onsite Staff: Laroy Dowd
Facility Audited on: May 20th, 2015

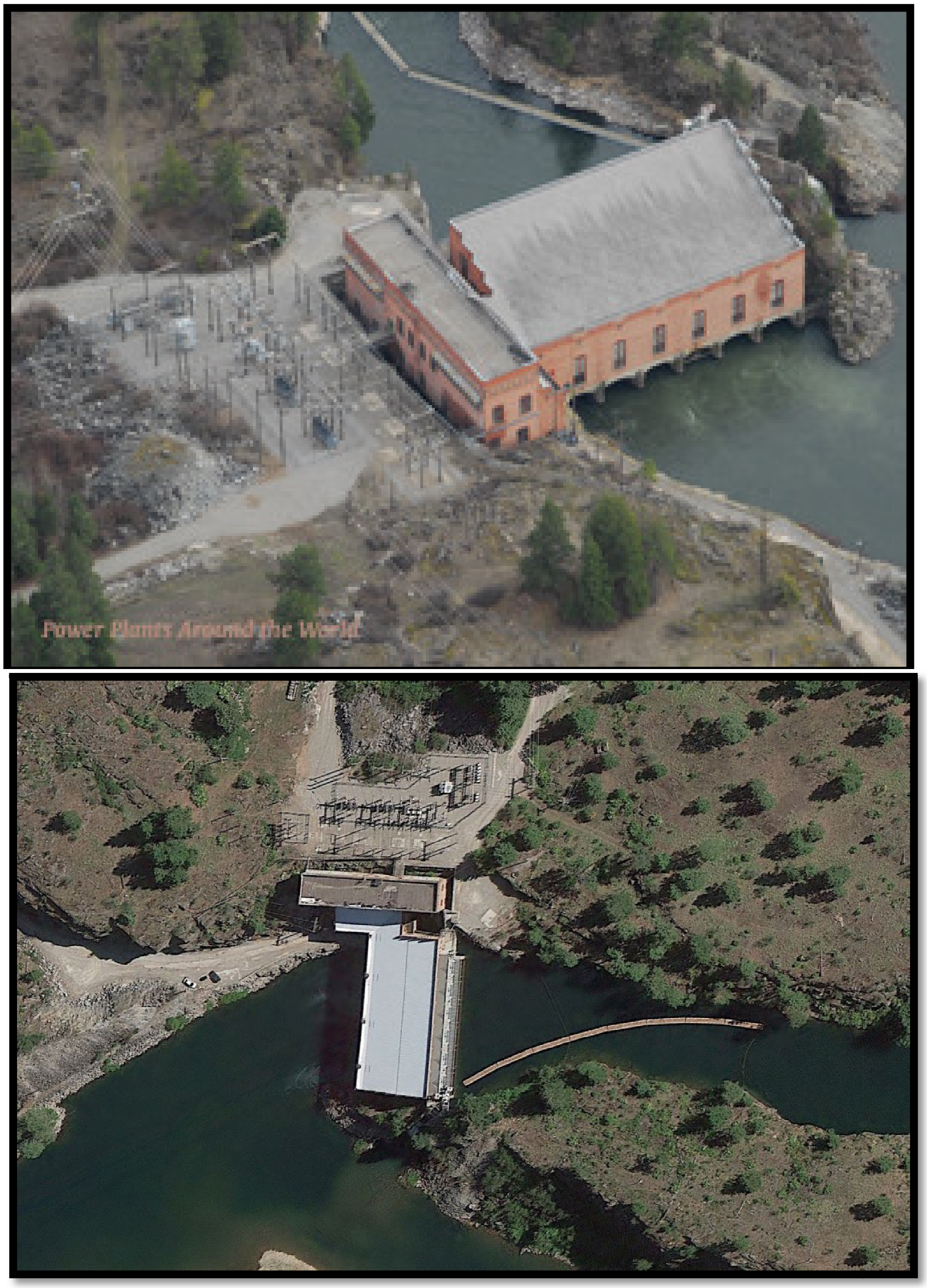

Figure 1 Google Images of the Post Falls Hydro Electric Dam

Avista's DSM Engineering staff visited the Post Falls Hydro Electric Dam to review their current building systems and discuss several concerns that the user's encountered during typical operation. Specifically, this audit was conducted to identify all possible energy efficiency improvements not related to the power generation process.

After completing a tour of the facility potential improvement measures were identified for consideration including capital projects as well as low-cost no-cost measures. This report is intended to provide a cursory review of possible energy savings. Each listed recommendation and costing is based upon historical experience and costing projections. Equipment life and performance will vary and a Statement of Work (SOW) for the capital project will determine the actual project costs and performance.

The facility consists of a control room, office space, break area and generation specific process areas including but not limited to generation floor and breaker floor.

Shell

There are several areas around the facility where additional weatherization work can be conducted. It should be noted that this facility has no dedicated heating source due to an almost constant operation of at least one unit, which provides enough heat for generating floor and control room. The control room area has a couple of window style air conditioning units for the summer months. The recommendations made below should only be acted on if there are future plans to provide this facility with a dedicated heating and cooling source. As the facility operates now, these measures are not necessary and will not reduce the electric load.

1. All exterior entry doors should have their weather stripping checked and replaced if necessary.
2. All windows that are not required to remain historically accurate should be replaced with energy efficient double pane windows.
3. Any portion of the plant that currently has heating or cooling installed should have the walls and ceiling insulated. The insulation will help thermally isolate it from the rest of the plant and reduce the amount of cooling required in the summer time.
4. There is currently little to no insulation above or below the roof deck in the plant. It is recommended that insulation, R-19 at the very least, be added below the deck.

Lighting

The site employs T12 and T8 linear fluorescent lighting, linear LED fixtures, as well as 150 Watt High Pressure sodium high-bay fixtures. No parking lot lighting was observed.

Table 1 Capital Project Lighting Opportunity Summary

	Brief EEM* Description	EEM Cost	Measure Life	Electric kWh Savings
1	Control Room T12s	**$3,462.50**	**20 yr**	**1,776**
2	Generating Floor HPS	**$2,423.75**	**20 yr**	**3,312**

*EEM – Energy Efficiency Measure

1. Proposed Project #1: The control room currently has (x4) Two lamp F48T12 and (x3) Two lamp F96T12 fluorescent fixtures serving the break room and storage areas. The proposed project

looks at replacing these fixtures with (x10) 40W linear LED fixtures. A simple lumen calculation shows that the overall lumens for the job were decreased by 11%.

   - The provided project is $3,462.50, this cost was calculated using fixture and install costs for these fixtures at Noxon Rapids HED.

2. Proposed Project #2: The facility currently has (x7) single lamp 150W high pressure sodium fixtures located above the units on the generating floor. It is assumed that the fixtures average 3,600 hrs of operation a year. The proposed project looks at replacing these fixtures with 40W linear LED fixtures. A simple lumen calculation shows that the overall lumens for the job were increased by 28%.

   - The provided project cost is $2,423.75; this cost was calculated using fixture and install costs for these fixtures at Noxon Rapids HED.

3. It should be noted that while the total system lumens decrease for project #1, the actual lumens that reach the working space will more the likely increase. LED fixtures are very directional in the way they deliver lighting lumens. We recommend replacing a few light fixtures to make sure that they will meet your lighting needs. If you would like to see the fixtures in operation we recommend a trip to Noxon Rapids HED.

HVAC

1. The main generating floor has no dedicated HVAC units. The heat from the generators keeps the space conditioned during the winter months. A generator will be motored to maintain heat if no generating is going on, which is rare at this plant. During the summer months the heat from the generators is exhausted from the space via several exhausts fans mounted in the upper windows of the power house. These exhaust fans are controlled manually are on 24/7 during the warmer months. It is recommended that thermostats be installed to control these exhaust fans. The thermostats will reduce the run time of the fans during spring and fall when the fans are more than likely left on when they may not be necessary.
2. It is recommended that the control room have a dedicated HVAC unit installed. The space is currently heated by residual heat from the generators and controls cabinets, and is cooled by a couple of window style air conditioners. A dedicated system would provide a more comfortable environment for the operators as well as the controls equipment present in the space. If this is a project that is going to be implemented, moving forward with shell recommendation number 3 is advised.

We hope that this report helps to identify some areas that the generating facility can gain some operational efficiency and reduce the parasitic load that these systems represent. If you decide to pursue any of these potential energy savings projects please let the Energy Solutions team know ahead of the start of the project.

Respectfully,

Andy Paul, Bryce Eschenbacher, and Levi Westra – May 28, 2015

Name: Post Falls Hydro Electric Dam - T12 to LED **Acct#**		
Existing Annual Consumption: (kilowatt hours)	3,088.80	
Lighting Energy Savings:(kilowatt hours)	1,648.80	
Lighting Demand Savings: (kilowatt demand)	0.37	
Cooling System Savings: (kilowatt hours)	126.96	
Cooling System Demand Savings: (kW demand)	0.03	
Lumen Comparison New/Existing	88.53%	
Total Energy Savings: (kilowatt hours)	1,775.76	
Total Demand Savings: (kilowatt demand)	**0.39**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	($30.72)	

Name: Post Falls Hydro Electric Dam - Generating Floor

Acct#

Existing Annual Consumption: (kilowatt hours)	5,472.00	
Lighting Energy Savings:(kilowatt hours)	3,312.00	
Lighting Demand Savings: (kilowatt demand)	0.74	
Cooling System Savings: (kilowatt hours)	0.00	
Cooling System Demand Savings: (kW demand)	0.00	
Lumen Comparison New/Existing	128.04%	
Total Energy Savings: (kilowatt hours)	3,312.00	
Total Demand Savings: (kilowatt demand)	**0.74**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	($311.14)	

Energy Efficiency Improvements
Audit Report

Prepared for

Post Street Hydro Electric Facility
Upper Falls Hydro Electric Facility

Prepared by

Andy Paul, PE
Bryce Eschenbacher, PE
Levi Westra, PE
Energy Solutions Engineers

June 19th, 2015

Overview

Facility: Post Street Hydro Electric Facility/Upper Falls Hydro Electric Facility
Audited by: Andy Paul PE, Bryce Eschenbacher PE, and Levi Westra PE
Onsite Staff: Josh Stringfellow
Facility Audited on: June 10th, 2015

Figure 1 Google Images of the Post St/Monroe Hydro Electric Dam

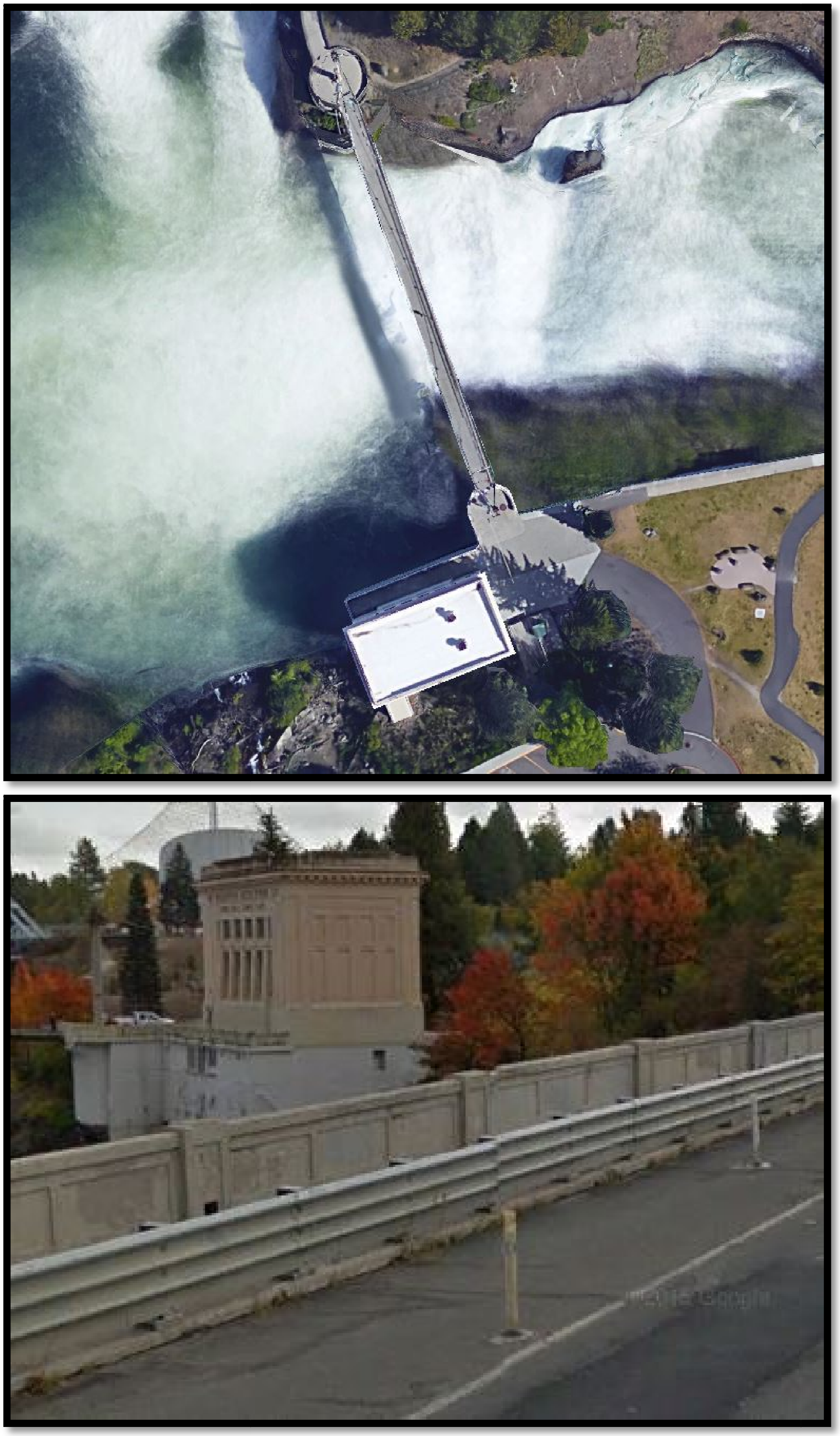

Figure 2 Google Images of the Upper Falls Hydro Electric Project

Avista’s DSM Engineering staff visited the Post St. / Monroe St. Hydro Electric facility to review their current building systems and discuss several concerns that the user’s encountered during typical operation. We were unable to visit the Upper falls facility due a time constraint and limited access due to their being no operator on site currently. We did discuss the systems at Upper Falls and have recommendations for improvements listed below. Specifically, this audit was conducted to identify all possible energy efficiency improvements not related to the power generation process.

After completing a tour of the facility potential improvement measures were identified for consideration including capital projects as well as low-cost no-cost measures. This report is intended to provide a cursory review of possible energy savings. Each listed recommendation and costing is based upon historical experience and costing projections. Equipment life and performance will vary and a Statement of Work (SOW) for the capital project will determine the actual project costs and performance.

The facility consists of a control room, office space, break area and generation specific process areas including but not limited to generation floor and breaker floor.

Shell

There are several areas around the facility where additional weatherization work can be conducted.

1. All exterior entry doors should have their weather stripping checked and replaced if necessary.

2. The control room should have insulation installed above the ceiling and in the walls if possible. The insulation will help thermally isolate it from the rest of the plant, which is only maintained at above freezing in the winter and is unconditioned otherwise.

3. There is currently little to no insulation above or below the roof deck above the substation. During the winter four Reznor natural gas unit heaters keep the space above freezing. It is recommended that insulation, R-19 at the very least, be added below the deck. This insulation will aid in reducing the amount of time the unit heaters have to run to maintain the space temperature.

Lighting

The site employs T12, induction fluorescent high bays as well as various wattages of incandescent and compact fluorescent screw in lamps.

Table 1 Capital Project Lighting Opportunity Summary

	Brief EEM* Description	EEM Cost	Measure Life	Electric kWh Savings
1	Utility men break room	**$1,498**	**20 yr**	**2,151**
2	Control room	**$3,745**	**20 yr**	**4,340**
3	Network Feeder tunnel	**$5,718**	**20 yr**	**8,344**

*EEM – Energy Efficiency Measure

1. Proposed Project #1: The Utility Men break room currently has (x4) four lamp F48T12 fluorescent fixtures that operate 2,080 hrs a year (40hrs/wk). The proposed project looks at replacing these

fixtures with (x4) 50W linear LED fixtures. A simple lumen calculation shows that the overall lumens for the job were decreased by 60%.

- The provided project is $1,498, this cost was calculated using fixture and install costs for these fixtures at Noxon Rapids HED.

2. Proposed Project #2: The facility currently has (x10) two lamp fluorescent fixtures that operate 8,760 hrs a year (40hrs/wk). The proposed project looks at replacing these fixtures with (x10) 50W linear LED fixtures. A simple lumen calculation shows that the overall lumens for the job were decreased by 20%.

    - The provided project cost is $3,745, this cost was calculated using fixture and install costs for these fixtures at Noxon Rapids HED.

3. Proposed Project #3: The facility currently has (x15) two lamp fluorescent fixtures that operate 8,760 hrs a year (40hrs/wk). The proposed project looks at replacing these fixtures with (x15) 50W linear LED fixtures. A simple lumen calculation shows that the overall lumens for the job were decreased by 20%. In addition to switching out the lights it is proposed that an occupancy sensor be installed to control these lights. This is an area of the facility that is only checked once or twice a day, unless maintenance is being performed. A properly located occupancy sensor will be able to turn the lights on before an operator reaches the space and will keep the lights on during the time that they are present. Otherwise they will go off.

    - The provided project cost is $5,717.50; this cost was calculated using fixture and install costs for these fixtures at Noxon Rapids HED. An additional $100 was added for the occupancy sensor.

4. It should be noted that while the total system lumens decrease for each of these projects, the actual lumens that reach the working space will more the likely increase. LED fixtures are very directional in the way they deliver lighting lumens. We recommend replacing a few light fixtures to make sure that they will meet your lighting needs. If you would like to see the fixtures in operation we recommend a trip to Noxon Rapids HED.

5. In addition to the projects listed above there are several other areas that would benefit from installing new lighting fixtures.

    - Most of the lower levels are lit with incandescent screw in lamps which remain on 24/7. It is recommended that these lamps be switch out for comparable LED screw in lamps and that the fixtures are placed on occupancy sensors. The sensors for these lights would need to be placed in the stairwells coming down to the space. This would ensure that the lights are on when the operator enters the space. In addition a redundant sensor (or two) should be placed in the space to provide the control necessary to keep the lights on when they are working in the space. It is highly recommend that a lighting design professional be brought in to properly design this system.

    - There are (x22) screw in compact fluorescent lamps located along the crane rail. It is recommended that these are replaced with comparable LED screw in lamps.

6. The lighting in the Monroe St. Turbine pit is all T8 linear fluorescent fixtures. A simple upgrade would be to change out the existing 32W T8 lamps with 25W T8 lamps. This would also require the ballasts to be changed. These fixtures could also be converted to linear LED tubes. We recommend that the lighting in the Post St. Building be upgraded before replacing the lighting at Monroe St.

7. The lighting at the Upper Falls facility was stated to be high pressure sodium fixtures. It is assumed that these are 400W lamps. It is recommended that these fixtures be upgraded to high

bay LED fixtures. Little Falls Dam is upgrading all of the high pressure sodium fixtures these to LED, Nathan Fletcher was in charge of that design.

HVAC

1. The control room is conditioned by an electric forced air furnace paired with a condensing unit for cooling. The condensing unit was recently replaced and is fairly efficient. It is recommended that that the furnace be replaced with a 90%+ efficient gas unit. On average a gas furnace will use ½ of the energy that an electric furnace will to provide the amount of heat. Gas is located nearby for the Reznor unit heaters.
2. The substation floor is conditioned by (x4) Reznor unit heaters. These heaters are used to keep the space above freezing during the winter. The units are 80% efficient and appear to be in good working order. When the time comes to replace them it is recommended that 90%+ unit heaters be purchased.
3. Installing two (possibly three) low speed/high volume destratification fans to help de-stratify the air within in the facility is recommended. With 40' ceilings the majority of buildings heated air will stack at the top, the fans would push that heated air back towards the floor and create a homogenous air temperature. This would reduce the amount of time that the space heat would need to run.

We hope that this report helps to identify some areas that the generating facility can gain some operational efficiency and reduce the parasitic load that these systems represent. If you decide to pursue any of these potential energy savings projects please let the Energy Solutions team know ahead of the start of the project.

Respectfully,

Andy Paul, Bryce Eschenbacher, and Levi Westra – June 19th 2015

Name:Post St. Hydro Electric Dam - Utility Men Break Room

Acct#

Existing Annual Consumption: (kilowatt hours)	2,412.80	
Lighting Energy Savings:(kilowatt hours)	1,996.80	
Lighting Demand Savings: (kilowatt demand)	0.77	
Cooling System Savings: (kilowatt hours)	153.75	
Cooling System Demand Savings: (kW demand)	0.06	
Lumen Comparison New/Existing	39.79%	
Total Energy Savings: (kilowatt hours)	2,150.55	
Total Demand Savings: (kilowatt demand)	**0.83**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**(17.37)**	
Maintenance Savings:	$25.63	

Name: Post St. Hydro Electric Dam - Control Room **Acct#**		
Existing Annual Consumption: (kilowatt hours)	8,409.60	
Lighting Energy Savings:(kilowatt hours)	4,029.60	
Lighting Demand Savings: (kilowatt demand)	0.37	
Cooling System Savings: (kilowatt hours)	310.28	
Cooling System Demand Savings: (kW demand)	0.03	
Lumen Comparison New/Existing	79.58%	
Total Energy Savings: (kilowatt hours)	4,339.88	
Total Demand Savings: (kilowatt demand)	**0.40**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**(35.06)**	
Maintenance Savings:	($0.23)	

Name: Post St. Hydro Electric Dam - Network Feeder Lighting		
Acct#		
Existing Annual Consumption: (kilowatt hours)	12,614.40	
Lighting Energy Savings:(kilowatt hours)	8,343.90	
Lighting Demand Savings: (kilowatt demand)	0.55	
Cooling System Savings: (kilowatt hours)	0.00	
Cooling System Demand Savings: (kW demand)	0.00	
Lumen Comparison New/Existing	79.58%	
Total Energy Savings: (kilowatt hours)	8,343.90	
Total Demand Savings: (kilowatt demand)	**0.55**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	$106.38	

Energy Efficiency Improvements
Audit Report

Prepared for

Rathdrum Combustion Turbine
Thermal Facility

Prepared by
Andy Paul, PE
Bryce Eschenbacher, PE
Levi Westra, PE
Energy Solutions Engineers

May 28, 2015

Overview

Facility: Rathdrum Combustion Turbine
Audited by: Andy Paul PE, Bryce Eschenbacher PE, and Levi Westra PE
Onsite Staff: N/A
Facility Audited on: May 20th, 2015

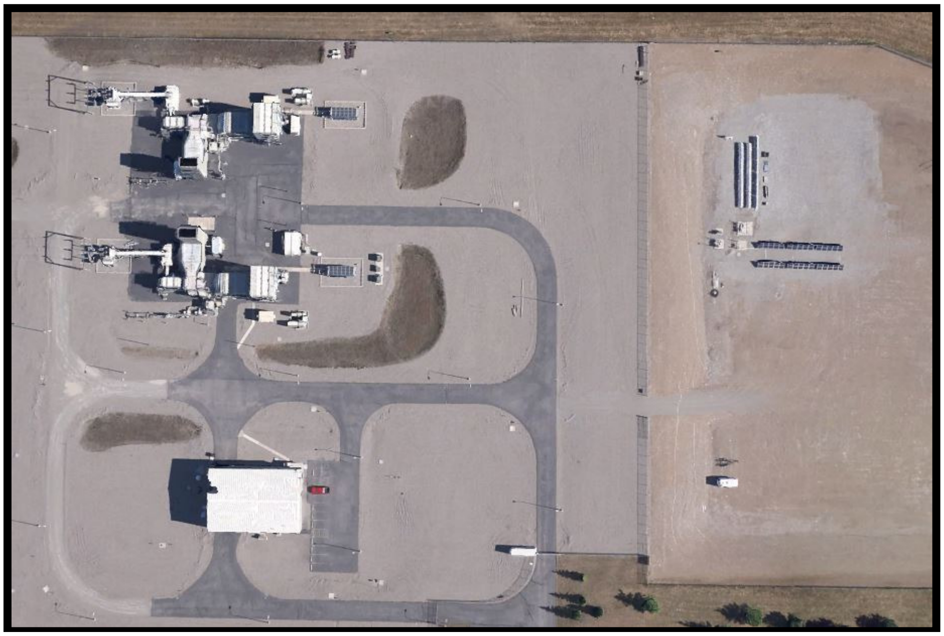

Figure 1 Google Image of the Rathdrum Combustion Turbine Thermal Facility

Avista's DSM Engineering staff visited the Rathdrum CT to review their current building systems and discuss several concerns that the user's encountered during typical operation. Specifically, this audit was conducted to identify all possible energy efficiency improvements not related to the power generation process.

After completing a tour of the facility potential improvement measures were identified for consideration including capital projects as well as low-cost no-cost measures. This report is intended to provide a cursory review of possible energy savings. Each listed recommendation and costing is based upon historical experience and costing projections. Equipment life and performance will vary and a Statement of Work (SOW) for the capital project will determine the actual project costs and performance.

Shell

There are a couple of areas around the facility where additional weatherization work can be conducted. It should be noted that this facility is rarely staffed and is generally operated remotely when it is needed. That being said, it is assumed that shop building is maintained at 55º in the winter (freeze protection) and below 78º in the summer. We were unable to verify the actual HVAC set point. Even with minimal HVAC the weatherization recommendations below will save energy.

1. All exterior entry doors should have their weather stripping checked and replaced if necessary. This includes the 5 man door and 2 roll up doors.
2. There are a couple of exhaust louvers on the backside of the shop building. If these louvers are not equipped with motorized dampers with proper blade seals, it is recommended that they are installed. When the louvers are not needed a large amount of outside air may be making its way back into the building, which would increase the HVAC load.

Lighting

The site employs metal halide road way light and halogen pole lights around the equipment. We were not able to get inside of the shop building to inspect the lights present. Based on the age of the facility

Table 1 Capital Project Lighting Opportunity Summary

	Brief EEM* Description	EEM Cost	Measure Life	Electric kWh Savings
1	Roadway lighting	**$10,020**	**20 yr**	**16,273**
2	Halogen Pole Lights	**$3,600**	**20 yr**	**3,200**

*EEM – Energy Efficiency Measure

1. Proposed Project #1: The roadway is lit by (x15) Single Lamp 250W Metal halide cobra heads. This project would replace these with (x15) Cree 42W LED cobra heads. It is assumed that these fixtures have an average of 4,288 hrs/yr (dusk to dawn) annual operating hours. A simple lumen calculation shows that the overall lumens for the job were decreased by 81%.
    - The provided project is $10,020, this cost was calculated using fixture and install costs for these fixtures at Noxon Rapids HED.
2. Proposed Project #2: The facility currently has (x16) single lamp halogen pole mounted lights. Wattage could not be confirmed for these lamps. For this analysis it is assumed that they are 250W lamps. It is also assumed that the fixtures average 1,000 hrs of operation a year and are only used for spot lighting when work is being done. The proposed project looks at replacing these fixtures with 50W LED spot lights. A simple lumen calculation shows that the overall lumens for the job were increased by 43%.
    - The provided project cost is $3,600; this cost was calculated using fixture cost found online and an estimated $75 per fixture for install.
3. It should be noted that while the total system lumens decrease for project #1, the actual lumens that reach the working space will more the likely increase. LED fixtures are very directional in the way they deliver lighting lumens. In addition the existing high pressure sodium fixtures produce a yellow light which is not conducive to good visibility while working. We recommend replacing a few light fixtures to make sure that they will meet your lighting needs. If you would like to see the fixtures in operation we recommend a trip to Noxon Rapids HED.

HVAC

1. The main facility shop building's office area is conditioned by a 5 ton air conditioner paired with a natural gas furnace. Based on the age of the building is assumed that the furnace is around 80% efficient. Since this facility is rarely manned the payback for installing a new HVAC system is too long to consider on a financial basis. But when the existing equipment fails it is recommended that the most efficient equipment be purchased to replace it.
2. There are several small through the wall air conditioning units at some of the smaller outbuildings. It is recommended that these be replaced with the most efficient units available when the existing units fail.

We hope that this report helps to identify some areas that the generating facility can gain some operational efficiency and reduce the parasitic load that these systems represent. If you decide to pursue any of these potential energy savings projects please let the Energy Solutions team know ahead of the start of the project.

Respectfully,

Andy Paul, Bryce Eschenbacher, and Levi Westra – May 28, 2015

Name: Rathdrum CT - Pole Lights		
Acct#		
Existing Annual Consumption: (kilowatt hours)	18,974.40	
Lighting Energy Savings:(kilowatt hours)	16,272.96	
Lighting Demand Savings: (kilowatt demand)	3.04	
Cooling System Savings: (kilowatt hours)	0.00	
Cooling System Demand Savings: (kW demand)	0.00	
Lumen Comparison New/Existing	18.59%	
Total Energy Savings: (kilowatt hours)	16,272.96	
Total Demand Savings: (kilowatt demand)	**3.04**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	$124.47	

Name: Rathdrum CT - Halogen to LED **Acct#**		
Existing Annual Consumption: (kilowatt hours)	4,000.00	
Lighting Energy Savings:(kilowatt hours)	3,200.00	
Lighting Demand Savings: (kilowatt demand)	2.56	
Cooling System Savings: (kilowatt hours)	0.00	
Cooling System Demand Savings: (kW demand)	0.00	
Lumen Comparison New/Existing	142.86%	
Total Energy Savings: (kilowatt hours)	3,200.00	
Total Demand Savings: (kilowatt demand)	**2.56**	
Estimated Project Cost: (Rough Estimate)	See Report	
Heating System Penalty: (therms)	**0.00**	
Maintenance Savings:	$63.43	