SUSTAINABILITY INITIATIVES BY STUDENT ORGANIZATIONS FUNDING PROPOSAL

Part I - General Information

Name of Student Organization	Virginia Tech Facilities Engineering - Office of Energy Management
Contact/Responsible Person	Conor Doane
Contact Office Held/Title	Energy Analyst
Contact Email Address	conord99@vt.edu
Contact Telephone Number	(207) 400-2020

Part II - Project Cost Information

Estimate Cost of this Proposal	$30,000	See Part III.C
Estimated Savings –	$6,000/yr	See Part III.D
Net Cost of this Proposal	**$ 24,000 in year one**	

Part III - Supporting Information

A. Please describe your sustainability initiative and attach supporting documentation.

This sustainability initiative looks to decrease the amount of electricity the dual process cooling pump system at Latham Hall consumes to supply chilled water throughout the building. The existing pump system is overdesigned for the building and significant amounts of energy is wasted. A variable frequency drive (VFD) is a well-known and commonly used control mechanism for pump systems that balances out water flow in pipe networks. When a VFD is fully integrated into a process cooling pump system, the mechanism can be used to balance out pipe flow by controlling the motor speed of the pumps. The motor speed of the existing chilled water pumps in Latham Hall is excessive, and can be reduced to an optimal speed by installing two VFDs on the two pump system. This will reduce the electricity consumed by each motor over time and save energy that is currently being wasted. This sustainability initiative has the potential to improve the energy efficiency of Latham Hall, Virginia Tech's largest energy consuming building, and with the energy savings, this project is profitable in the long term.

The existing pump system at Latham Hall was inspected and photos of the pump system were taken (Figure 1). The Triple Duty Valve is a valve on pump systems used to monitor and control water flow (Figure 1C). The valve is always at some percent open between 0 and 100%. This value can be retrieved from reading the percent open label on the valve. For these chill water pumps at Latham Hall, antifreeze debris is covering the label values on this particular valve (Figure 1D). Another Triple Duty Valve in the building was inspected to show the label numbers clearly (Figure 2). Using the same scale on the visible label, it was determined that the Triple Duty Valves for the 2 pumps in the dual process cooling pump system were about 30% open. This percent open value was inputted into a valve performance curve specific to the type of Triple Duty Valve used in this system to find the head loss in feet (Attachment 1). A 25-ft head loss was determined and this was subtracted from the overdesigned total head value of 155-ft for the existing system. The pump system only needs to provide 130-ft of total head to provide the necessary flow of chilled water throughout the building. The value of 130-ft was inputted into the pump performance curve (Attachment 2). The drop in head allows for the motor speed to balance down to about 1400 rpm. This allows the pump motors to operate at 30 hp as opposed to 40 hp which they are currently designed to run at, creating a 10 hp savings. The savings in the motor speed and power lead to building energy and cost savings.

The VFD equipment is planned to be placed on a blank white wall next to the pump system in the mechanical room of Latham Hall (Figure 3A). The VFDs will be wired into the existing pump controller on the opposite side of the two pumps and this will allow the VFDs to monitor and alter the motor speed of both pumps (Figure 3B). An Excel workbook with the Latham Hall pump system notes and specifications is provided (Attachment 5).

(a) (b) (c) (d)

Figure 1 – (a) Dual Process Cooling Pump System (b) Two Pumps Bell and Gossett Series 1510 4GB 480 Volt 40 hp (c) Triple Duty Valve Bell and Gossett B-860B for Cooling Pump System (d) Triple Duty Valve % Open Label

(a) (b)

Figure 2 – (a) Triple Duty Valve Bell and Gossett B-860B Similar Pump System (b) Triple Duty Valve % Open Label

(a) (b)

Figure 3 – (a) VFD Wall Mounting Location (b) Pump Controller for VFDs to Wire Into

B. How does this initiative help to achieve the goals of the Virginia Tech Climate Action Committee Resolution and Sustainability Plan?

The Virginia Tech Climate Action Committee Resolution and Sustainability Plan aims to achieve fourteen major goals that will improve the university's impact on the local and global environment. This initiative will help Virginia Tech complete three of these goals.

1. Climate Action Goal 3: Establish a target for the reduction of campus greenhouse gas (GHG) emissions to 80% below the 1990 emission level of 188,000 tons by 2050, with interim targets for 2012 and 2025
2. Climate Action Goal 4: Work toward these emission reduction targets through improved energy efficiency and the reduction of energy waste
3. Climate Action Goal 1: Be a Leader in Campus Sustainability.

GHG emissions will need to be reduced significantly for Virginia Tech to meet Climate Action Goal 3. Latham Hall is the highest energy consuming building on campus and therefore is a hotspot of GHG emissions through the consumption of electricity generated by the burning of fossil fuels at local and regional power plants. The installation of VFDs for the dual process cooling pump system at Latham Hall will reduce the electricity demand of the building and reduce the net GHG emissions Latham Hall produces.

Installing VFDs also improves the overall energy efficiency of Latham Hall by reducing energy that is currently being wasted. The existing pump system is overdesigned and energy is lost, mainly at the 30% open Triple Duty Valve next to the two pumps. By controlling the motor speed with VFDs, the Triple Duty Valves can be opened and less head loss can occur in the system while energy consumption reduces and energy efficiency improves.

Being a leader in campus sustainability requires each building at Virginia Tech, but most importantly the major energy consuming buildings, to stay up to date with modern technology and systems that improve energy efficiency. VFDs allow for dynamic control of the energy the dual process cooling pumps at Latham Hall consume. This will help make Latham Hall more of a smart and sustainable building. This initiative is a simple, affordable, and critical step for Virginia Tech to take to become a leader in college campus sustainability nationwide.

C. What is the cost of your proposal? Please describe in adequate detail the basis for your cost estimate.

The estimated cost of this proposal is **$28,600** with outside consultants and **$23,500** with in-house engineering and project management. This estimate is a sum of five main components needed for a successful VFD installation. Vendors were contacted to provide accurate price estimates for the major components.

First, the two VFDs are estimated at $5,350 (Attachment 3). Second, the shaft bearings and grounding rings are estimated to be about $3000 based on previous project work. Third, the electrical labor and materials was quoted at $5,250 (Attachment 4). The fourth main component of the VFD installation is the motor work and testing and balancing (TAB) which was estimated at $5,300. The fifth component, the VFD start up, was estimated at $1,500 based on previous project work as well. This comes out to a total equipment and labor of $20,400, and a total of $23,500 when factoring in a 15% contingency.

The engineering and project management for this project will not cost anything upfront if the work is performed in-house, but if contracted out the engineering and project management is assumed to add about 25% to the total equipment and labor cost, totaling $28,600.

D. Will your proposal produce cost savings for the University? If so, how much? Please describe in adequate detail the basis for your savings estimate.

This proposal will reduce the electricity costs for Latham Hall by an estimated **$6000/yr**. The electricity cost savings is determined using the field data collected at Latham Hall, plugging it into the Triple Duty Valve curve and the Pump

Performance Curve (Attachment 1 and 2). From the field data the pump motor is rated at 40 hp. From the Pump Performance Curve, the 650 gpm flow rate shows that the motor only needs to run at about 32 hp. Factoring in the 25-ft head loss the Triple Duty Valve is creating to balance the system, the 130-ft head can be met with a motor running at about 1400 rpm and 30 hp. The net 10 hp in savings creates 65,000 kWh in energy savings per year using 0.746 kW/hp and an assumed 8700 hours per year of operation. With $0.10 per kWh, this amounts to roughly **$6000 per year** in cost savings for Latham Hall. The payback period for this project would be about **5 years**.

There will also be less motor and drive maintenance needed for the pumps throughout the years the pumps are in use, meaning lower overall maintenance costs for the system.[1] The motor lifespan will also be extended, extending the lifespan of the pump system as a whole because the motors are often the first components to need replacement.[1]

E. Is this funding request an Ongoing or One-Time change **(please check one)?**

× One-time ☐ **Ongoing**

F. Is funding available for this request from another source? If yes, describe the funding (source, amount, etc.)

NO

References

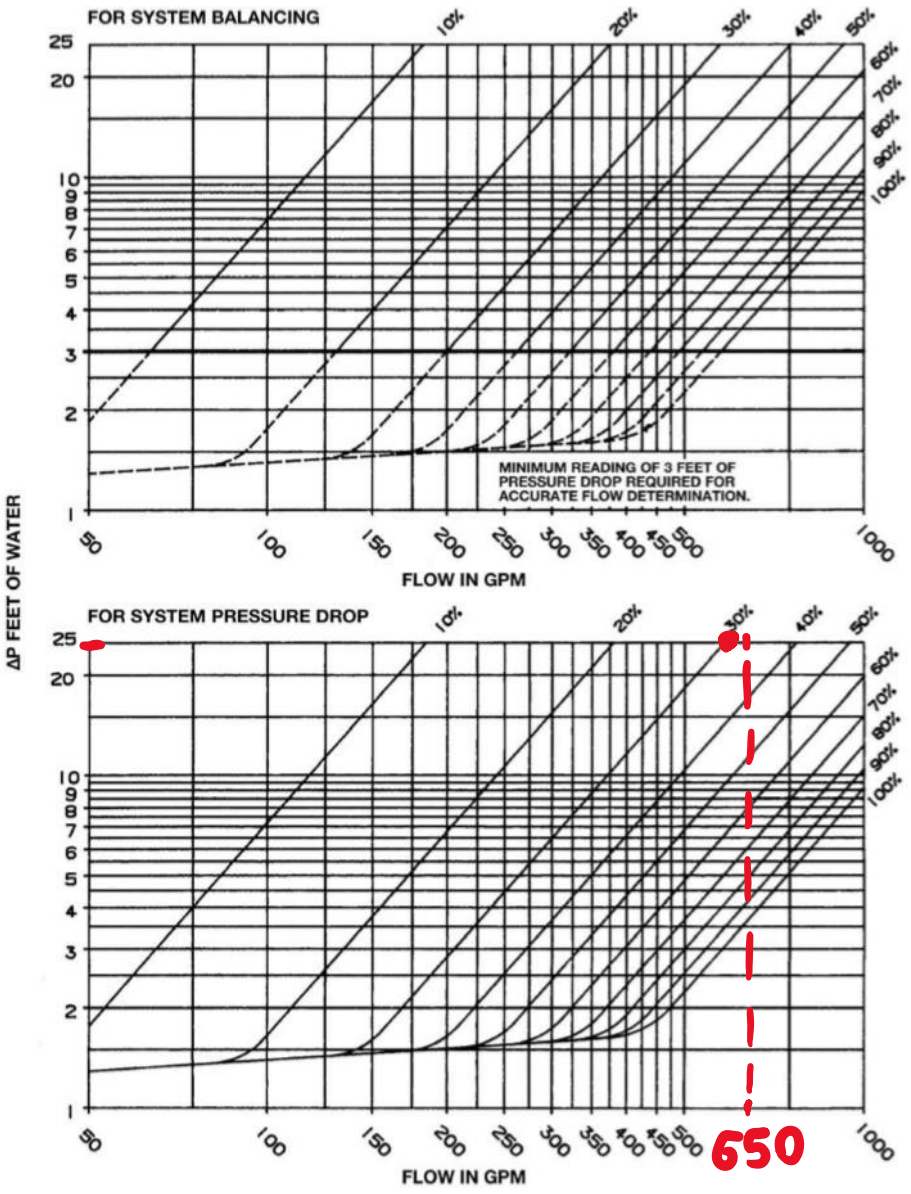
1) James Piper, P.E. “Variable-Frequency Drives Reduce Maintenance, Extend Motor Life”. FacilitiesNet. (2009) https://www.facilitiesnet.com/hvac/article/Variable-Frequency-Drives-Reduce-Maintenance-Extend-Motor-Life--10663#:~:text=VFDs%20control%20motor%20start%2Dup,windings%2C%20thereby%20extending%20motor%20life.

Attachment 1 – Triple Duty Valve Performance Curve

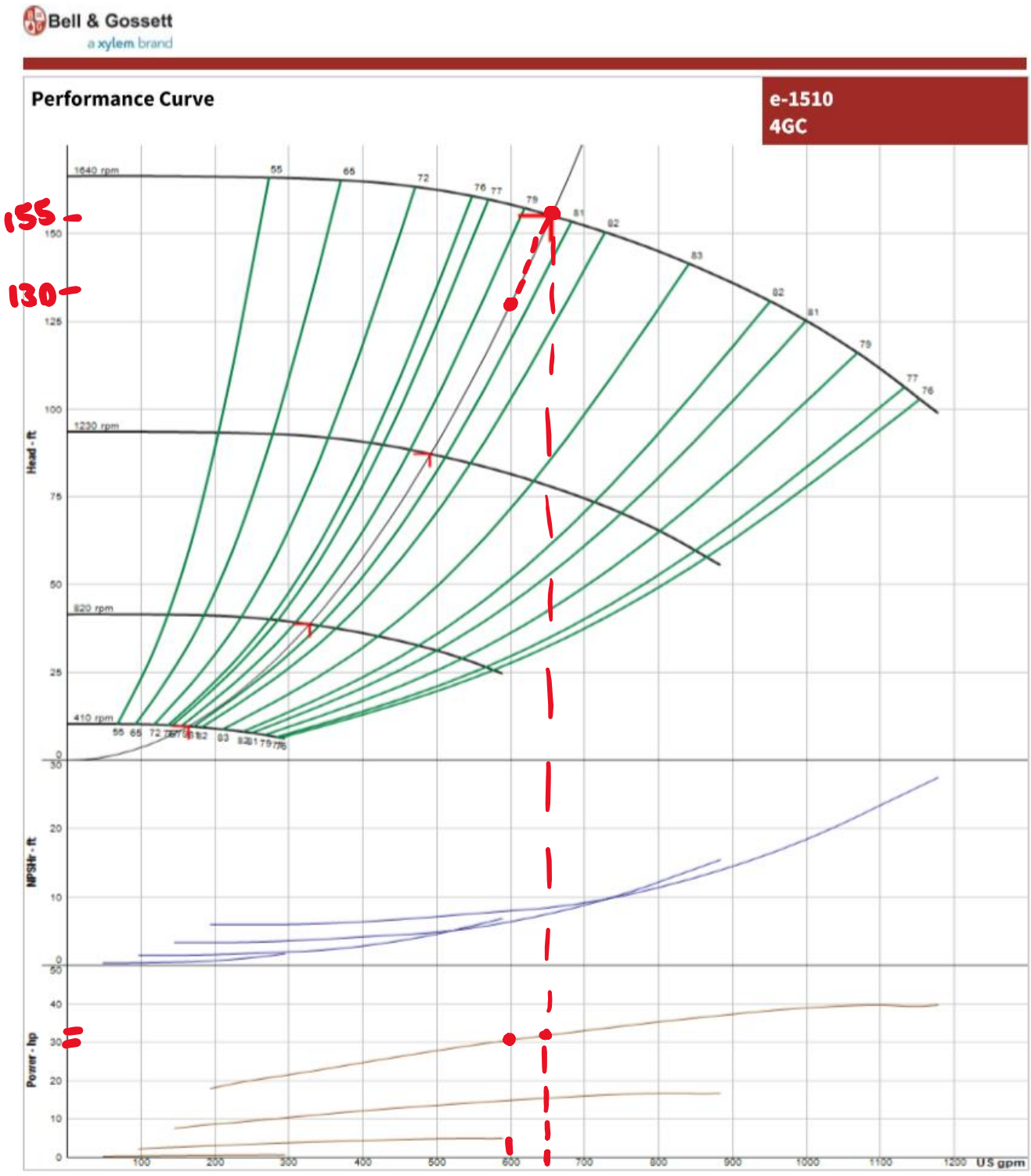
TRIPLE DUTY® VALVES

Triple Duty® Valve (Straight Pattern)
PERFORMANCE CHARACTERISTICS

Part No. 132125 Model No. 3DS-5S
Part No. 132154 Model No. 3DS-5G



Attachment 2 – Pump Performance Curve



Attachment 3 – Vendor VFD Quote

1125 SALEM AVE SW
ROANOKE VA 24016-2919
Phone: 540-510-3340
Fax: 540-343-4146

To: VIRGINIA TECH
North End Serives
300 TURNER ST. NW
BLACKSBURG VA 24061-0001
Attn: Conor Doane
Phone: 540-231-6000
Fax:
Email:

Date: 11/11/2020
Proj Name: VT LATHAM HALL VFDS
GB Quote #: 0236629424
Release Nbr:
Purchase Order Nbr:
Additional Ref#
Valid From: 11/09/2020
Valid To: 12/09/2020
Contact: ADAM ALBERT
Email: adam.albert@graybar.com

Proposal

We Appreciate Your Request and Take Pleasure in Responding As Follows

Item	Item/Type	Quantity	Supplier	Catalog Nbr	Description	Price	Unit	Ext.Price
100		1 EA	SQUARE D CO.	LOT SQUARE D DRIVES PER QUOTE# 2117449		$5,350.00	1	$5,350.00

Total in USD (Tax not included): $5,350.00

This equipment and associated installation charges may be financed for a low monthly payment through Graybar Financial Services (subject to credit approval). For more information call 1-800-241-7408 to speak with a leasing specialist.

To learn more about Graybar, visit our website at www.graybar.com **24-Hour Emergency Phone#: 1-800-GRAYBAR**

Subject to the standard terms and conditions set forth in this document. Unless otherwise noted,freight terms are F.O.B. shipping point prepaid and bill. Unless noted the estimated ship date will be determined at the time of order placement.

Attachment 4 – Vendor Electrical Labor and Materials Quote

ALVIS-LAING ELECTRIC Co.
Est. 1972
www.alviselectric.com
Christiansburg, VA
540-382-9351

Lowell Jessee
230 Sterrett Dr.
Blacksburg, Va
24061

November 11th, 2020

Attn: Lowell Jessee

Email: ljessee@vt.edu

Re: Latham Hall VFD install

Alvis-Laing Electric is pleased to provide a quotation for labor and materials required to install new VFDs for the cooling towers at Latham Hall. New EMT conduit to be installed inside the Mechanical room between mechanical panel and new VFD locations. Conduit for building controls to be installed from VFD location to building controller. Final connections at VFDs to be seal tight. Conduit routing and final location for drives to be verified with Va Techs L Jessee. All work to be done during normal workday hours and is priced at…

Five Thousand Two Hundred Fifty Dollars……..……..……..…….....$5,250.00

Respectfully submitted,

ALVIS-LAING ELECTRIC Co.

Malcolm Laing P.E.

Attachment 5 – Excel Table of Latham Hall Pump System Notes and Specifications

NOTES	
1.	2005 Project
2.	Fluid includes glycol for freeze protection so winter draining consideration is not recommended.
3.	System designed for continuous flow through both towers
4.	The closed circuit cooler sequence on drawings implies dampers, spray pumps, and then Fans
5.	The min temperature is 55 deg F
PUMP Information	
1.	Bell and Gossett Pump Info
a.	Model 1510 4GB
b.	12.875" Impeller
c.	650 gpm
d.	155 ft head
e.	40 hp
2.	Continuous Operation
3.	Initial Site Investigation
a.	The triple duty valve appears mostly shut
b.	The pump discharge gage read 100+ psi, 65 psi suction
4.	Electric Motor Info
a.	Marathon Inverty Duty
b.	DVB324TTDC4026AAS
c.	93%, 86% PF, Series E
5.	Per Drawings Triple Duty Valve is a B&G 3DS5S

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Part IV- Requestors/Reviewers

Conor Doane, Civil Engineering, Energy Analyst	11-29-20
Prepared By (Name of Contact for Student Organization)	Date
Lowell Jessee, Energy Engineer, VT Facilities Department of Energy Management	11-30-20
Reviewed By (Name of Appropriate University Official)	Date
Denny Cochrane	11/30/20
Reviewed By (Name of Office of Sustainability Representative)	Date