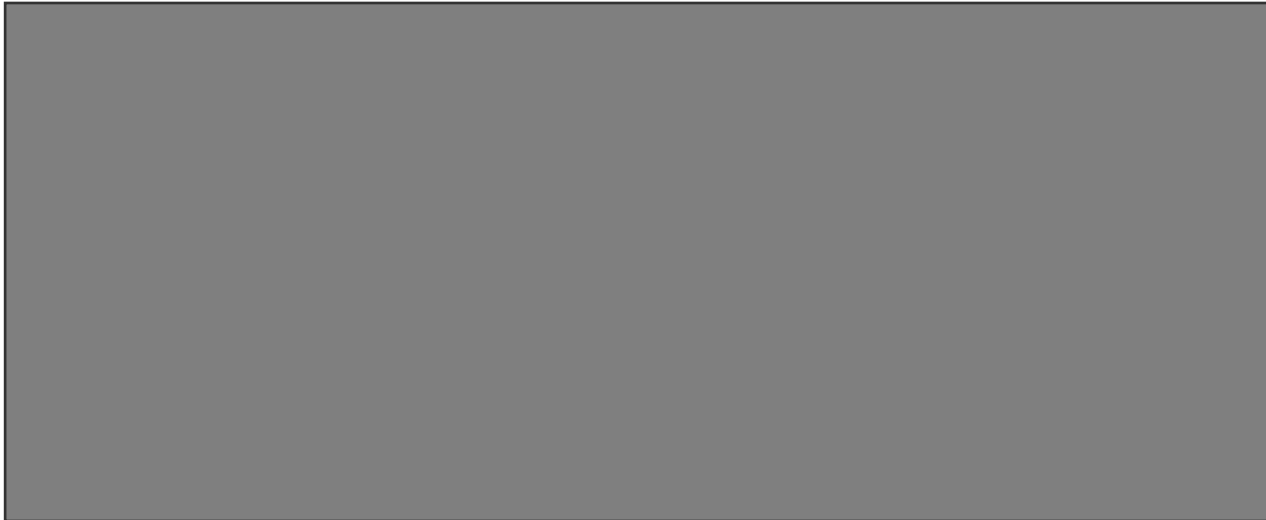


# PROJECT IDEA SUBMISSION

## SPONSOR'S INFORMATION



## PROJECT NAME

Multi-Mode Steam Pumping

## GENERAL PROJECT DESCRIPTION

*Design and test a water pump using steam as an energy source and apply water hammer phenomena. Expand on patent pending steam condensation water hammer pump : 20230258327 (uspto.gov) evaluating the highest discharge pressure of the other 6 types of water hammer against a check valve. There are 7 types of water hammer in Water Hammer Handbook for Nuclear Plant Engineers and Operators (epri.com). The student team is to select a different type (Not condensation induced water hammer) and design/build/test. For example, steam propelled water slug type of water hammer is a good candidate.*

## WHAT IS THE MECHANICAL ENGINEERING PROBLEM YOU ARE WANTING SOLVED?

*The team will focus on innovative water pumping efficiency by expanding the development of this revolutionary water pump driven by steam energy. This pump is the key new component used in Constellation's Patent Pending Freedom Cycle retrofit concept which is designed to directly reduce carbon waste footprint in an existing Rankine Cycle thermal power plant.*

**WHY IS THIS PROBLEM WORTH SOLVING?** (i.e. what is the value proposition?)

*The simple, but elegant pump's design can be replicated worldwide to immediately and effectively benefit the global climate. It will also be profitable and sustainable by power plant owners because of the significant fuel cost reductions while maintaining the same electrical production. The technology is important because if developed, it could provide significantly improved energy efficiency in the production of electricity for fossil fueled power plants, including Purdue's Walter W. Wade power plant. This technology also is applicable to existing fission nuclear power plants, new small modular reactors, other advanced reactors and even benefits future nuclear Fusion based reactors. This technology has potential to globally reduce CO2 emissions, reduce spent fuel waste, and reduce local environmental impact at power plants.*

**WHAT ARE THE MOST IMPORTANT FUNCTIONAL REQUIREMENTS AND CONSTRAINTS FOR THIS PROJECT?**

*Req 1: The pump water pressure delivered is well above the steam supply pressure*

*Req 2: The final working prototype to be delivered to Constellation in good working order (not broken, corroded, disassembled or unhooked)*

*Req 3: Final Design report include all data, and detailed parts list and vendor where acquired*

...

*Constraint 1: Maximize the water temperature being pumped*

*Constraint 2: Minimize the mass ratio of steam usage to water flow rate at maximum pressure*

*Constraint 3: Minimize the ratio of steam pressure usage to water pump discharge maximum pressure*

**WHAT IS YOUR BEST ESTIMATE OF THE COST OF THE MATERIALS REQUIRED TO BUILD THE PROPOSED PROTOTYPE?**

*\$1800*

**HOW MUCH TIME AND EFFORT WOULD YOU EXPECT TO SPEND ON THIS PROJECT IF YOU WERE DOING IT INTERNALLY?**

*Calendar Months: 1*

*Engineering man-hours: 160*

**DO YOU BELIEVE THE PROJECT CAN BE COMPLETED WITH EXISTING TECHNOLOGY? IF NOT, ELABORATE ON NEEDED DEVELOPMENTS?**

*Yes, the goal is to use off the shelf components commonly available. If needed, portions of previous ME463 designs for Constellation can be borrowed, expanded, improved. Also Constellation can provide guidance on component selection, set-up and operation.*

**LIST KEY CHALLENGES THAT MUST BE OVERCOME OR THE UNKNOWN/RISKS ASSOCIATED WITH THIS PROJECT.**

*Use of metal pipe obscures what the steam and water is doing inside. It will be challenging to visualize what is going on inside the pump, and therefore challenging to analyze it with simple engineering formulas. The pumping flow and pressure process is not steady with stochastic results within statistical limits. However, multiple ways can overcome this through available instrumentation and clever design of boundary condition tanks. The peak pressure for the pumping capacity is expected to be about 100 psig, but the exact number is not known. Copper pipes withstand 100 psig, there is a risk of a pipe leak or split if the students push the performance too high. I recommend eye protection and thermal gloves when operating. I recommend approaching design limits slowly, incrementally, and increasing strength of pipe design if needed, e.g. threaded steel pipes instead of copper if resulting measured pressure perform better than expected.*

**ATTACH ANY APPROPRIATE SKETCHES, DRAWINGS, DATA, PHOTOS, ETC. USEFUL IN JUDGING APPROPRIATENESS AND SCOPE OF PROPOSED PROJECT FOR ME SENIOR DESIGN.**

*These are Constellation Proprietary and will be shared after completion of the NDA and IP assignments.*

**ARE YOU WORKING WITH PURDUE ME SENIORS WHO YOU WOULD LIKE ON THIS PROPOSED PROJECT?**  YES  NO (If YES, provide what information you can.)

NAME	EMAIL

**ARE YOU WORKING WITH PURDUE ME FACULTY WHO YOU WOULD LIKE ENGAGED WITH THIS PROPOSED PROJECT?**  YES  NO (If YES, provide what information you can.)

NAME	EMAIL

To submit this document for consideration, please complete the survey using either the QR code or the link below.



[https://purdue.ca1.qualtrics.com/jfe/form/SV\\_73w7nFHWpto9iOG](https://purdue.ca1.qualtrics.com/jfe/form/SV_73w7nFHWpto9iOG)

If you have any questions concerning a proposed project or completing this form, please contact Professor Greg Jensen.

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