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The NAU Hydraulics Apparatus Testing Team: Hydraulics Testing Proposal

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1.0 Project Understanding

1.1 Project Purpose

The NAU Hydraulic Testing Apparatus Team will produce a hydraulic testing apparatus that can provide a variety of hydraulic heads, flow rates, and pressures. The apparatus will be designed to allow a diversity of interchangeable hydraulic parts to be tested. Once completely designed and built, many different Northern Arizona University stakeholders may use the apparatus for testing purposes.

The general goal of the Hydraulic Testing Apparatus is to produce an apparatus that can replace or be used for NAU's hydrology class projects and testing. The Apparatus will not only benefit faculty but also the students. Currently, the Water Resources courses must design and build a Guerilla Project in small groups. This project requires the students to build and test a small-scale hydraulic apparatus that demonstrates a hydraulic theory of their choosing. One major issue with this project is that the project is very small-scale that the students cannot get a clear understanding of the concepts that they are trying to test. A second major issue with the Guerilla Project is that some of the students use the stairs inside the Engineering Building for hydraulic head and sometimes spill water that ends up posing a safety hazard for other students. With the proposed Hydraulic Testing Apparatus, the Guerilla project can now be relocated outside and the students can test a much larger-scale model. The general goal of this project is to produce an apparatus that can replace or be used for NAU's hydrology class projects and testing.

1.2 Technical Considerations

The Hydraulic Testing Apparatus will come with a few technical issues that will need to be addressed:

- Identifying a source of water on the roof
- Locating an electrical source to power the pump
- Finding an adequate drainage at floor elevation.

An adequate water and electrical source will need to be accessible on the roof in order to fill the top tank and power the pump. A site evaluation on the roof will need to be scheduled and approved with facilities in order to assess what sources are currently available on the roof. A site evaluation will also be required for the floor elevation of the site to determine the drainage available.

1.3 Potential Challenges and Constraints

The potential challenges that are anticipated for this project are acquiring permission to access the roof and dealing with freezing outdoor temperatures. The Team must receive permission from Northern Arizona University Facilities and the Dean of the College of Engineering and Forestry to access the roof. A safety plan may be required from The Team to demonstrate safety precautions. Since Northern Arizona's temperature can get below freezing in the months of November through March, The Team must determine a way of addressing this challenge with the water inside the tanks and flowing through the pipes.

A potential constraint that will need to be addressed by The Team is the State budget limit of $1,000. The Team must stick within budget for all building and materials costs. Another measure may be looking for funding and donations within the local businesses of Flagstaff.

1.4 Stakeholders

The clients and main stakeholders for the hydraulic testing apparatus are the hydraulics classes taught at Northern Arizona University and the faculty looking to test different hydraulic technologies. Ideally, these stakeholders will use the model to teach the students about the principles of hydrology and other technologies like micro hydroelectric power generation or water supply systems.

2.0 Scope of Services

2.1 Task 1: Develop Required Parameters

Developing a hydraulic testing apparatus begins with communication with faculty, stakeholders, and advisors. Meetings with faculty and advisors will be scheduled to acquire ideas on the best way to test and analyze different components of the testing apparatus. The most applicable ideas will be selected by The Team in order to develop the parameters for functionality and specific components of the device. Communication with faculty who specifically teach the hydraulic classes will help direct the project to a design useful to the college.

2.2 Task 2: Design

An engineering schematic is developed to convey exact design ideas and help to refine the project into a final design. This task will include the development of a detailed set of engineering drawings that can be vetted by a senior engineer, and ensures the project transitions smoothly to the purchasing phase of the project. The design process will focus on interchangeability, ease of operation, and accessibility to encourage modification of system components. Careful consideration is given to securing loads at significant heights to ensure project safety. The type and location of instrumentation is also decided during this task for monitoring flow characteristics.

2.3 Task 3: Purchasing and Construction

Purchasing and construction details the tasks required to achieve a working hydraulic testing apparatus. Material selection and purchasing is completed based off the engineering design drawings developed in **Section 2.2**. This purchasing task also keeps the project's $1000 budget in mind. The components of the apparatus are selected to match the size of the project which includes 30 to 40 feet of head. Faculty members may purchase additional system components that they want tested.

2.4 Task 4: Testing and Analysis

Testing and analysis begins once construction of the hydraulic testing apparatus is complete. This includes monitoring flow characteristics with a data acquisition system and instrumentation. The experimental flow characteristic data will be compared to theoretical expected values to ensure the system works as intended. The Team would like to test the efficiency of a pump-as-turbine, as its efficiency is less than the normal operation of the pump and this data is not widely available. This test would provide valuable information and prove the functionality and legitimacy of the project.

2.5 Task 5: Management

A management task is necessary for this project to receive approval for construction and will likely extend through most of the semester. Since the project is to be built on the roof of the Engineering

Building, communication with building management and NAU facilities will ensure the project proceeds in a safe and permissible manner. This will require The Team to create a safety plan as well as understand and follow the rules of the building. A clear plan for accessing the rooftop is developed and a rooftop and ground assessment is completed for this task. The rooftop assessment helps to find the best place for installing the system as well as logistical items like water supply. A ground assessment sets a clear plan for the drainage of all the system's water. This task also includes scheduling regular meetings with the client to confirm that the project is meeting functionality guidelines.

3.0 Schedule

This Gantt chart details the project schedule and shows deadlines that need to be met in order to ensure all tasks are completed by next semester. The first task to this project is to start Developing Required Parameters. This ten-day task consists of getting ideas and information to construct the testing apparatus. Then the group plans on spending 21 days to design the system using the engineering building. Once design is completed, The Team will spend 25 days to purchase the material and construct the apparatus. Since all of the designing and constructing will be completed, The Team will perform tests and collect analysis using the apparatus. During the entire project, The Team must get permission to use the roof access and create a safe way to use the area. The final task will be to complete all the deliverables of the project. In the deliverables task, there is a 50% report that will take 40 days to produce, and a final report and presentation that will be created during the entire semester (80 days). This project will start on August 31, 2015 and will take 80 days to complete all of the tasks. The Team will complete the project for December 18, 2015.

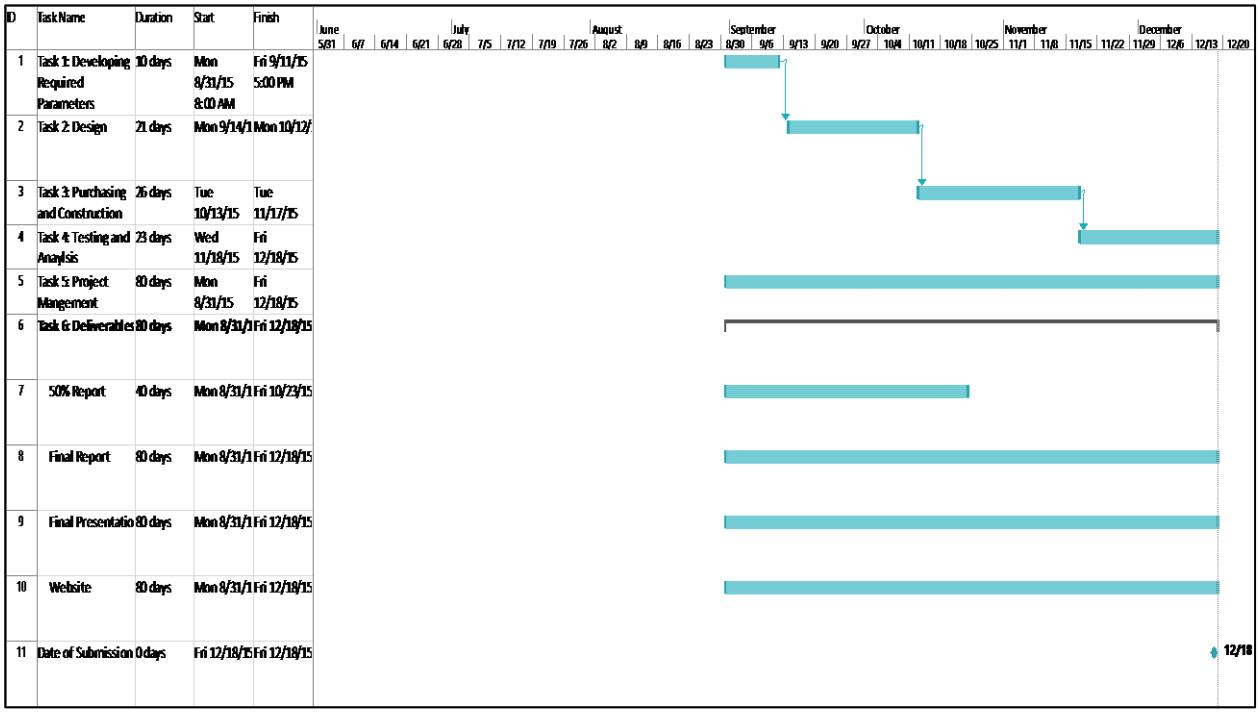

Figure 3.1: Gantt Chart

4.0 Staffing and Cost of Engineering Services

Table 4.1 shows the job title of each personnel employed for the project. A senior engineer is needed to approve designs and engineering schematics. Engineering hours are needed for design work and to ensure project safety requirements are met. An intern provides most of the manual labor required in the construction of the project, as well as collecting data for the testing and analysis of the finished system. The administrative assistant works with building and facilities management to ensure the project meets all building and NAU rules and regulations.

Table 4.1: Personnel Job Titles

Classification	Abbreviation
Senior Engineer	SENG
Engineer	ENG
Intern	INT
Administrative Assistant	AA

Table 4.2 details each personnel's rate of pay and hours required for the project. **Table 4.3** calculates the amount of money each personnel requires and lists a total for the entire project of $33,520.00. The senior engineer's hours are the lowest to keep the total staffing cost low. **Table 4.4** identifies the hours worked on each task by every individual personnel. The total amount of hours spend on this project will be 760 hours.

Table 4.2: Personnel Pay Rates

Classification	Base Pay Rate $/hr	Actual Pay $/hr	Billing Rate $/hr
SENG	80	104	114
ENG	33	53	58
INT	16	19	21
AA	18	34	38

Table 4.3: Staffing Cost

Personnel	Classification	Hours	Rate ($/hr)	Cost
	SENG	80	114	$ 9,120.00
	ENG	200	58	$ 11,600.00
	INT	320	21	$ 6,720.00
	AA	160	38	$ 6,080.00
Total		760		$ 33,520.00

*Overhead is included in staff salaries

Table 4.4: Personnel Hours per Task

	Personnel Hours			
Tasks	**SENG**	**ENG**	**INT**	**AA**
Task 1: Developing Required Parameters	5	0	0	0
Task 2: Design	5	75	25	0
Task 3: Purchasing and Construction	10	25	115	80
Task 4: Testing and Analysis	10	50	100	0
Task 5: Project Management	25	0	0	60
Task 6: Deliverables				
50% Report	4	10	10	0
Final Report	10	25	10	0
Final Presentation	10	15	10	0
Website	1	0	50	20
Total	80	200	320	160

Table 4.5 shows the material costs for the hydraulic testing apparatus. Preliminary dimensions and size of each component is listed for a projected material cost of $990.00. Once the project design is completed an accurate material list is finalized for purchasing. The materials budget for our project is $1000.00. Effort will be made to acquire donated materials from local Flagstaff businesses to ensure the project stays within budget restrictions.

Table 4.5: Project Material Cost

Materials	**Total Quantity**	**Quantity Description**	**Unit Cost**	**Total Cost**
Gallon tanks	2	Unit	$ 200.00	$ 400.00
Pump	1	Unit	$ 150.00	$ 150.00
Water Hose	1	Unit	$ 70.00	$ 70.00
PVC Pipe	100	LF	$ 0.85	$ 85.00
PVC Pipe Elbows	20	Unit	$ 0.50	$ 10.00
PVC Valves	5	Unit	$ 4.00	$ 20.00
CMP Pipe	50	LF	$ 1.00	$ 50.00
CMP Pipe Elbows	20	Unit	$ 1.00	$ 20.00
PRV Valve	1	Unit	$ 65.00	$ 65.00
Flow Sensors	6	Unit	$ 10.00	$ 60.00
Pressure Sensors	6	Unit	$ 10.00	$ 60.00
Total				$ 990.00