CEE:3371 Principles of Hydraulics & Hydrology
Project #1: Pelton Turbine

Draft CTC Review Due: Monday 2 March
Final Report Due: Monday 7 March

Problem Statement

The *Pueblo Children's Museum* in Colorado has purchased a small Pelton turbine for its new display on renewable energy. The museum will divert water from the Fountain Creek to a nearby elevated storage pond; a pipe system connects the pond to the turbine in the museum display. A generator will convert the mechanical energy of the turbine into electricity (AC).

The system will be used in an exhibit that illustrates the conversion of hydraulic energy (the potential energy of water) into electricity. For educational purposes, the museum would like to operate the turbine and generate electricity to power various electronic devices in the exhibit (including, if possible, a computer and monitor for the exhibit). You have been hired by the museum as a consultant to evaluate the Pelton turbine's operation and advise them on what kind of devices it could power in an exhibit.

Project Objectives

Using laboratory experiments with the turbine-generator system, determine the power (W) that can be generated from the laboratory-scale Pelton turbine and its corresponding flow requirements, and the efficiency of the conversion of hydraulic energy into electricity. Recommend the types of devices that could be powered as part of an exhibit. Summarize information on the turbine's operation for use in the exhibit. Determine whether another generator (operating at a different rotational speed) could more efficiently convert mechanical energy into electricity.

Site Information

The pipe system to be used for the Pelton turbine is shown schematically below. Based on a preliminary hydraulic analysis of the pipe system at the museum, the effective head available for the turbine is ~70 feet; your experimental evaluation of the system should closely mimic this available energy head. Note that variations in the forebay water level will occur due to changes in pond storage; however, such variations are assumed to be minor for the turbine's operation at the museum.

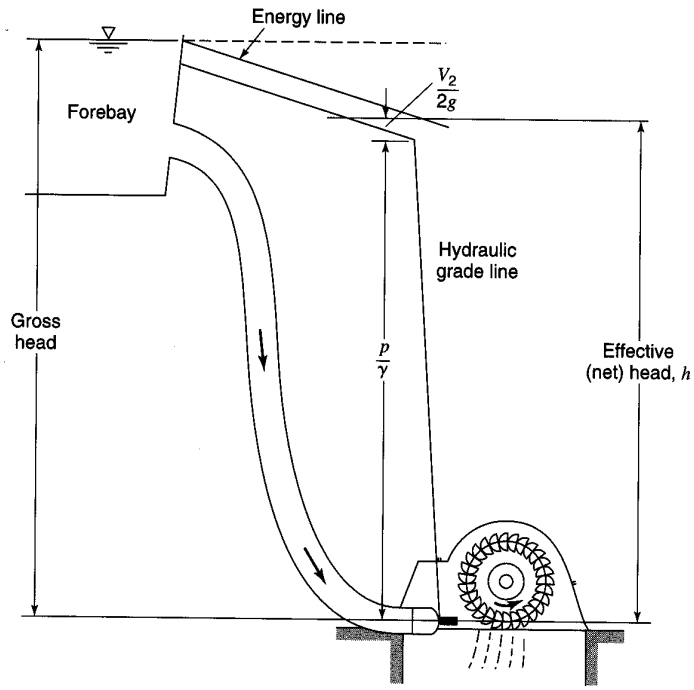

Figure 13.2.4 Definition sketch for impulse-turbine installation (from Linsley et al. (1992)).

Operational Information

The *Pueblo Children's Museum* is open 7 days a week. It intends to operate the Pelton turbine exhibit from 10 am to 3 pm each day.

The museum has secured rights to divert water from Fountain Creek. The maximum allotted diversion volume (in ft^3) each day depends on the creek's long-term *mean monthly discharge* (in cfs) for the month at a nearby site (USGS stream-gage 07106500). The maximum diversion allowed is:

Fountain Creek Mean Monthly Discharge Conditions	Maximum Daily Diversion
Less than 85 cfs	2500 ft^3
Between 85 and 150 cfs	5000 ft^3
Greater than 150 cfs	8500 ft^3

Monthly statistics for USGS stream-gages (surface water) are available through the National Water Information System (NWIS) at the USGS web site (go to http://waterdata.usgs.gov/nwis and first select *Colorado* from the NWIS pull-down menu. Then select *Surface Water* for the Data Category. Choose *Monthly* from the Statistics category and use the site number above to retrieve the appropriate data (use the Mean Monthly Discharge for the entire period of record to determine maximum daily diversions for each month).

Turbine Equipment

The Pelton turbine has been delivered to the fluid laboratory facilities for testing. Your project team will run tests to determine the energy conversion efficiency (hydraulic, electrical, and total) of the Pelton turbine under different power loads (for constant generator rotational speed that produces electricity at 60 Hz) and for different rotational speeds (without the generator). Details of the experimental methods to be used to test the turbine are available on ICON.

Project Report

Your project team must submit a draft and final project report to the museum's Board of Directors. The report should be concise and focused on answering the project objectives. Minimum required components:

1. Show the hydraulic power, the mechanical power, and the electrical power of the system for a range of flow rates to illustrate the conversion of hydraulic energy to electricity and the losses (inefficiencies) that are inherent (appropriate for inclusion in the exhibit).
2. Recommend operating conditions (e.g., flow rate and duration, turbine rotational speed, resulting power generation) for each month, based on an assessment of the available flow (imposed by diversion water rights) and the turbine's operational range.
3. Describe the number of types of devices that could be used in the exhibit; the devices are meant to illustrate to the Board what might be done at the exhibit.
4. Determine whether the turbine operates at peak hydraulic efficiency with the generator (which needs a fixed rotational speed to run at 60 Hz), or whether a new generator should be purchased (which operates at another rotational speed).

The report must contain information necessary to support your recommendations and conclusion; however, this information needs to be written at a level appropriate to the audience (i.e., the Board of Directors).

Consultation with College of Engineering *Hanson Center for Technical Communication* (CTC) is mandatory for this project. Schedule your consultation early — **all team members** must be present at the consultation.

Submit the final project report on ICON as a single document (in PDF or Word format). Submit the Contact Report you obtained from CTC (which indicates the date you were seen and the help you received) and your draft project report (the one reviewed by CTC) in class.