

MEMORANDUM

To: Rose Engineer
From: Rose Client
Date: 5 February 2003
Subject: Performance Testing of the Terry GLT-360 Steam Turbine

It has come to our attention that Rose-Hulman Institute of Technology has a Terry GLT-360 steam turbine that they may be disposing of in the next couple of years. We are very interested in this machine; however, we are unsure about the amount of power that can be generated by this turbine. We believe that we can duplicate the Rose-Hulman installation using waste process steam.

Please perform a "performance test" of the turbine in its current installation for at least one operating point. Write a one-page memo that reports your results and document your measurements and calculations in the attachments. Your memo should report the following information for at least one operating point:

- Data Sheet with original measurements.
- Property Calculation Sheets (blank forms attached to this memo).
- Calculate and report
 - the shaft power produced by the turbine, in Btu/s and in hp.
 - the shaft torque produced by the turbine, in ft-lbf.
 - the heat transfer rate from the turbine (Process 3 → 4 → 5 on the system schematic), in Btu/s and in hp. Would it be reasonable so assume that the turbine operates adiabatically?
 - the overall efficiency for the turbine:

$$\eta_{overall} = \frac{\dot{W}_{shaft,out}}{\dot{W}_{shaft,out,ideal}} = \frac{\dot{W}_{shaft,out}}{\dot{m}_{cond}(h_4 - h_{5s})}$$

- the Rankine cycle thermal efficiency for the power plant:

$$\eta_{thermal} = \frac{\dot{W}_{net,out}}{\dot{Q}_{boiler,in}} = \frac{\dot{W}_{turbine,out} - \dot{W}_{pump,in}}{\dot{Q}_{boiler,in}}$$

where the boiler heat transfer occurs between State 2 and State 3.

- Plot the Process 3 → 4 → 5 on an h-s (Mollier) diagram for steam.
- Finally determine how many years it would take to pay off the steam turbine if we bought it from Rose-Hulman for \$10,000, used it to drive an ac electric generator, and sold the electricity for \$0.08/kW-h. Assume that the generator has an efficiency of 80%.

As always you should clearly reference lengthy calculations in the appendices of your memo and summarize the important information in the memo.