Enhancing Hydro Power Through Environmental Technologies

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- **Introduction**

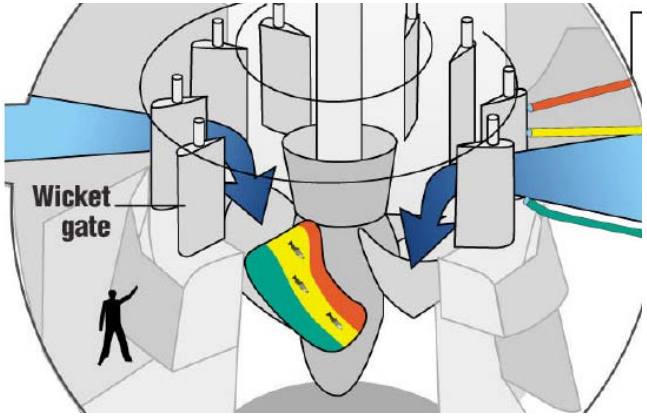
  Hydro Power Basics

- **“Fish Friendly” Turbine Development**

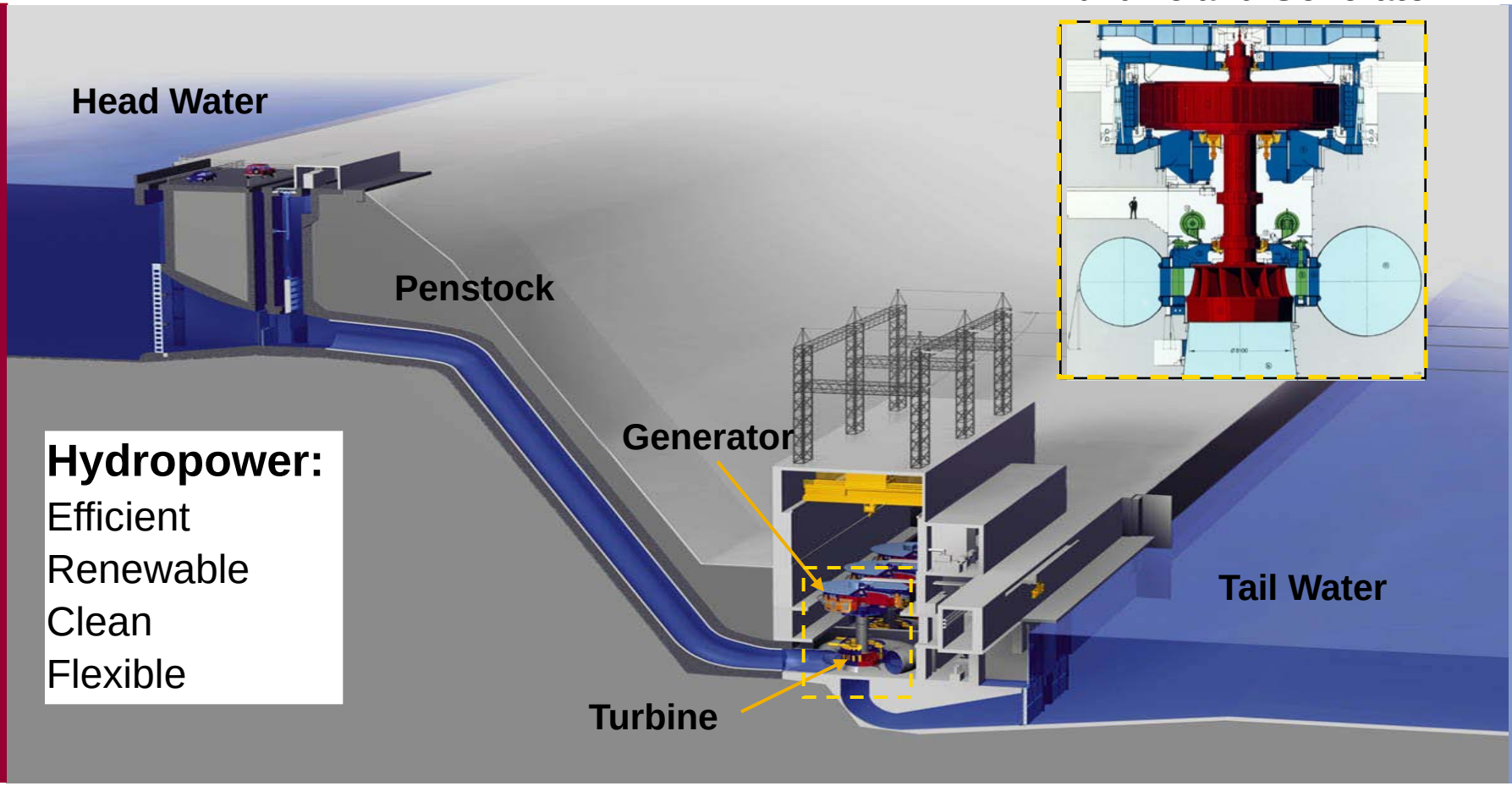
  Adjustable Blade Turbines

  Fixed Blade Turbines

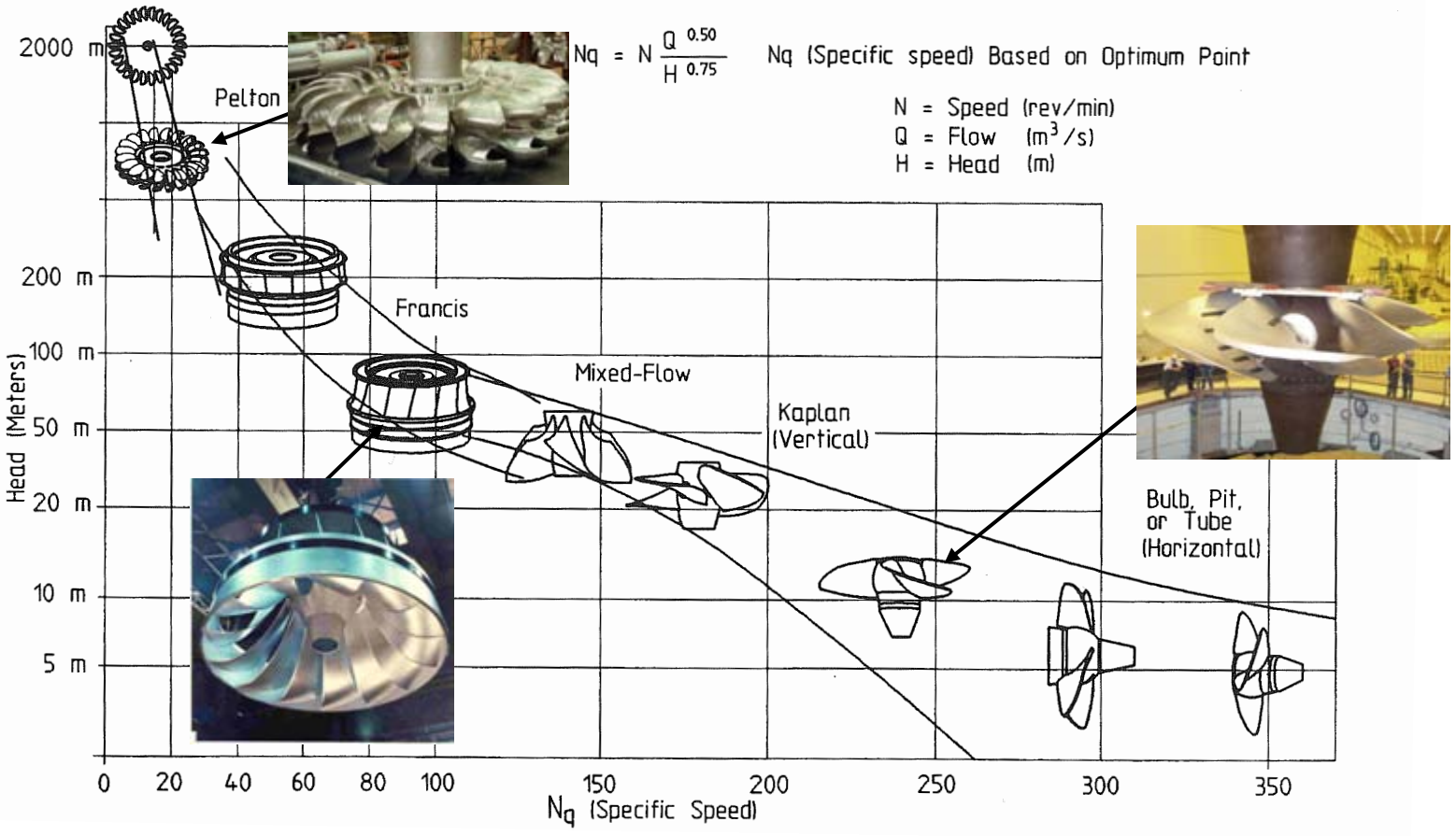
- **Future Development**



Hydro Power Basics



Hydro Power Basics: Turbine Types



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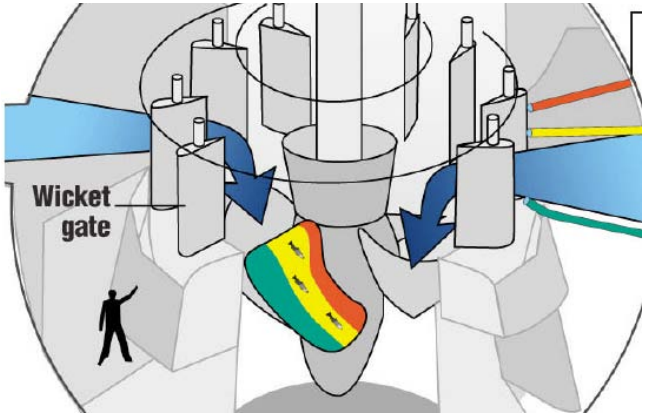


“Fish Friendly” Turbine Development

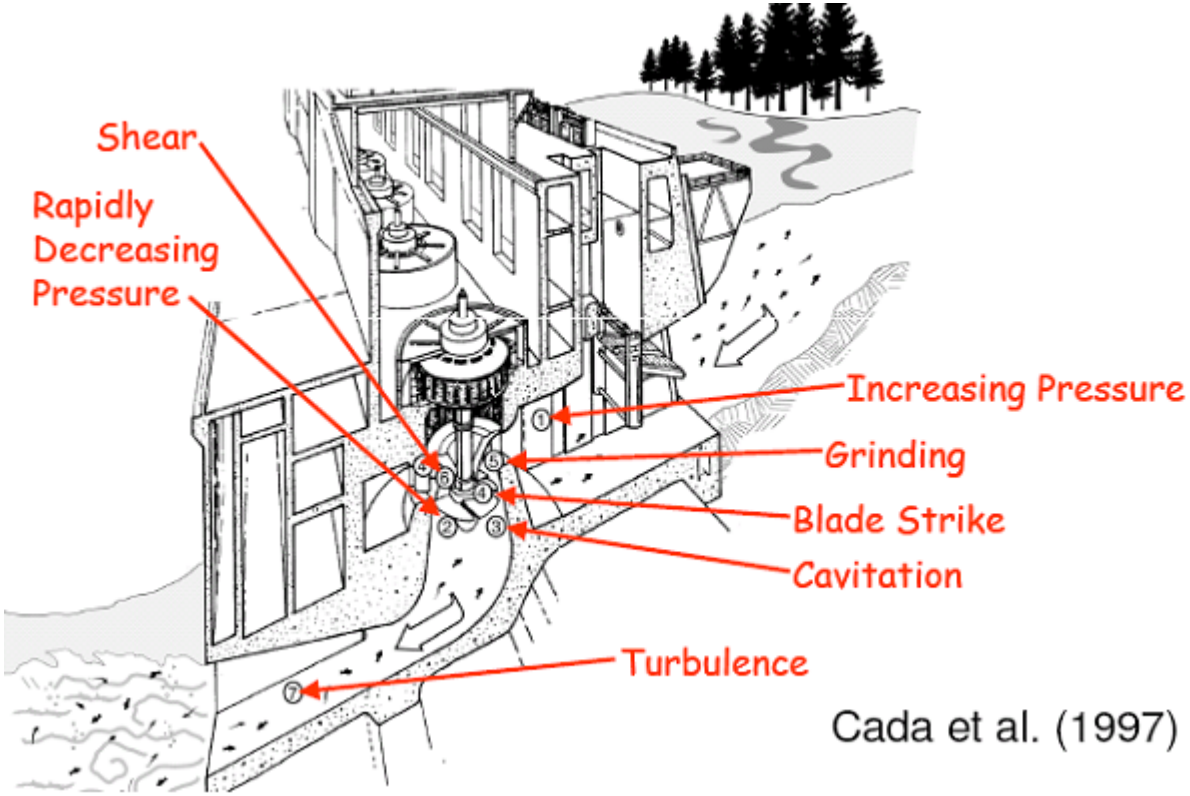
- Dams impede path of migrating fish (salmon, trout, eel, shad, etc.)

  - In the past, spilling has been utilized as well as surface water collection systems

  - In the 1990’s, the Department of Energy launched the Advanced Hydro Turbine Study

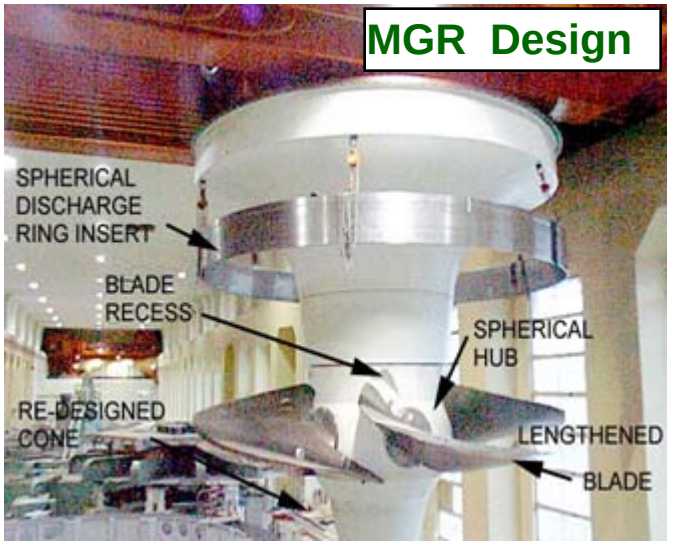
“Fish Friendly” Turbine Development

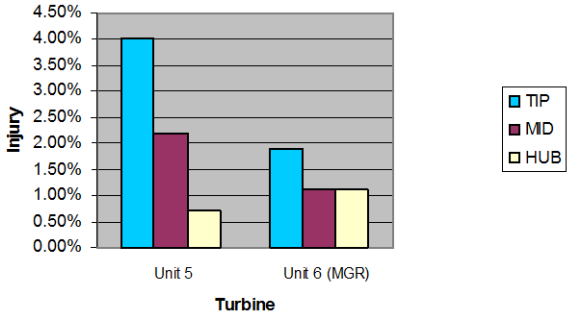
- Goal of AHTS was to reduce mechanism for fish injury through the turbine



“Fish Friendly” Turbine Development: Kaplan

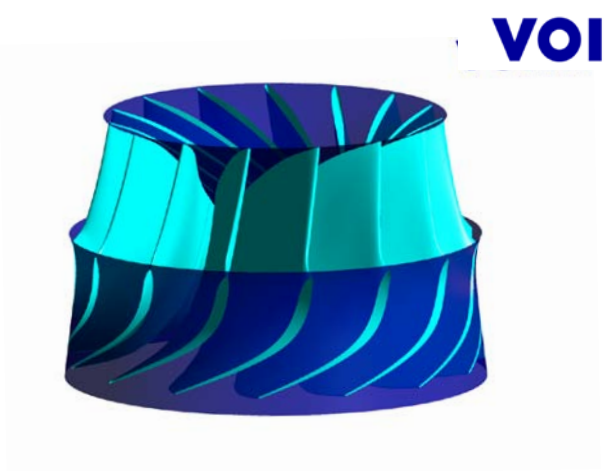
- Minimum Gap Runner



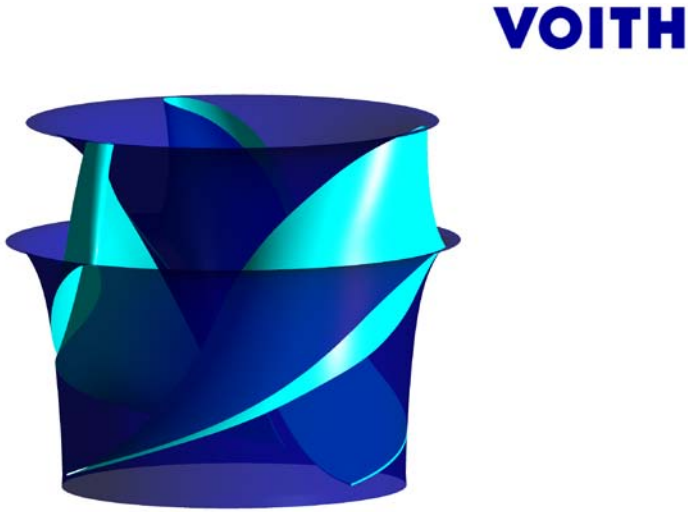


“Fish Friendly” Turbine Development: Alden Fixed Blade Design Concept

- Recently Voith has collaborated with Alden Research Labs to refine the concept of a “fish friendly” three bladed runner



Conventional Fixed Bladed Runner



Alden Fixed Bladed Runner

“Fish Friendly” Turbine Development: Alden Fixed Blade Design Concept

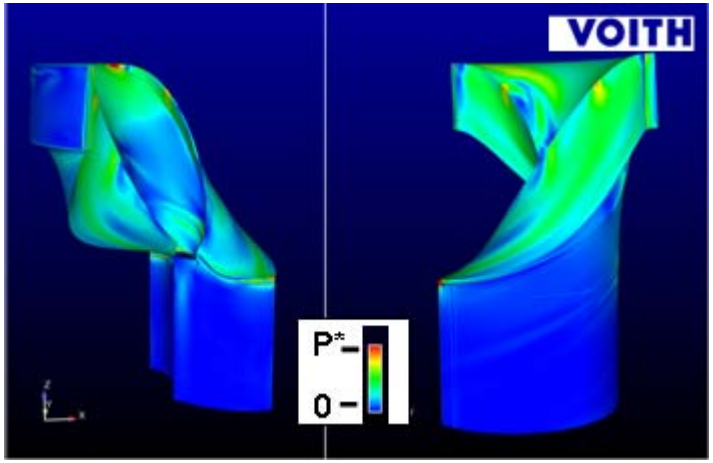
- Reduce fish mortality through improved:

  pressure levels through the turbine

  pressure change rates

  shear rates

  strike damage (blade shape)



Pressure Change Rate (P* is the pressure change rate threshold for fish passage)

strike occurrences (relative velocities, blade number, rotational speed)

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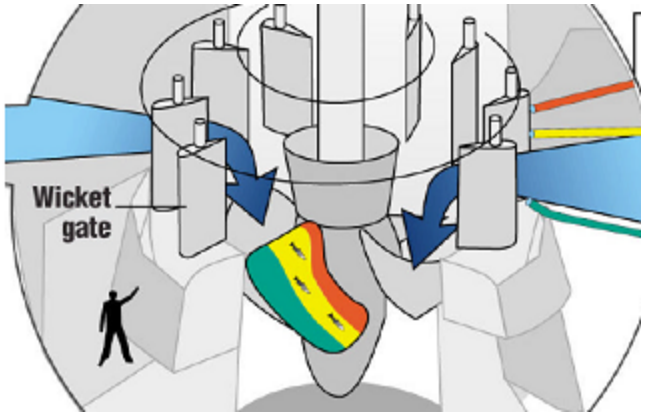


Future Work

- Further development of the Alden Turbine through DOE Grant ($1.2 million DOE matched by $1.4 million from EPRI)

Design and construction of a scale model (2009 – 2010)

Lab testing (Spring 2010)

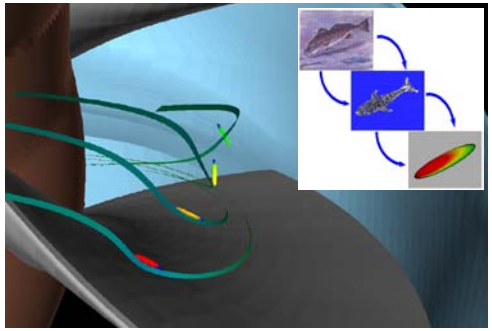
Final sizing of mechanical and BOP engineering systems (Summer – Fall 2010)

READY FOR DEPLOYMENT

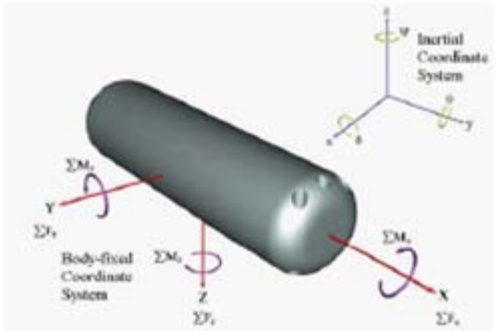
Possible pilot site includes Brookfield Power's School Street Station

Future Work

- Continue to develop and correlate state of the art computational design tools with field testing and biological data



"Virtual fish"



"Sensor fish"

"Real fish"

- Maintain high performance levels with diverse operation while further minimizing hydro's impact on the environment