Jun 22nd, 4:15 PM - 4:30 PM

Session B3: Alden Fish-Friendly Hydropower Turbine: History and Development Status

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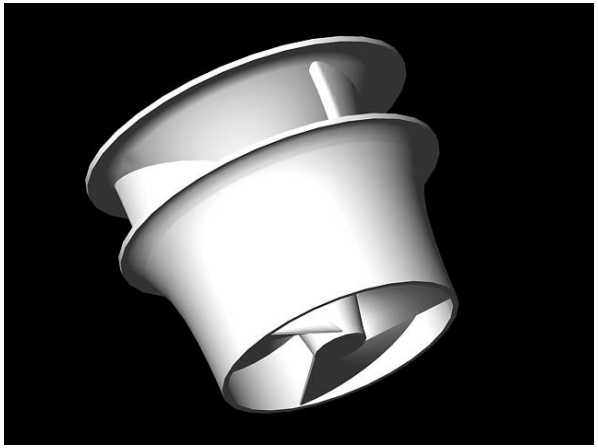
EPRI ELECTRIC POWER RESEARCH INSTITUTE

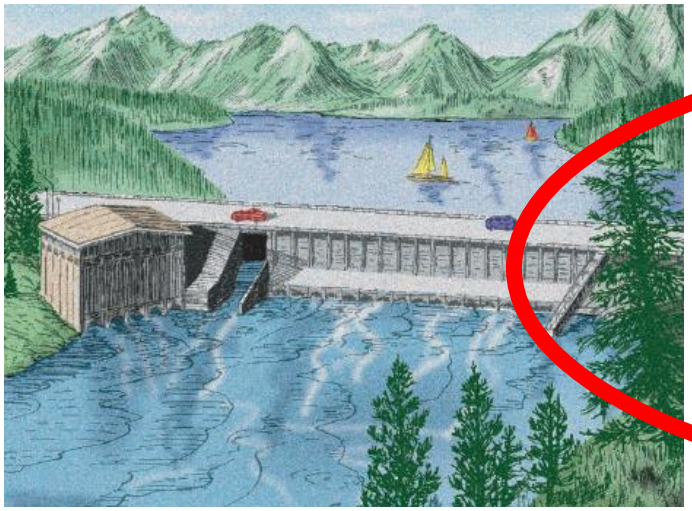
Alden Fish-Friendly Turbine History & Status

Douglas Dixon, PhD

Session B3: Environmentally-enhanced Hydropower Turbines for Fish Passage

Alden Turbine Status Summary





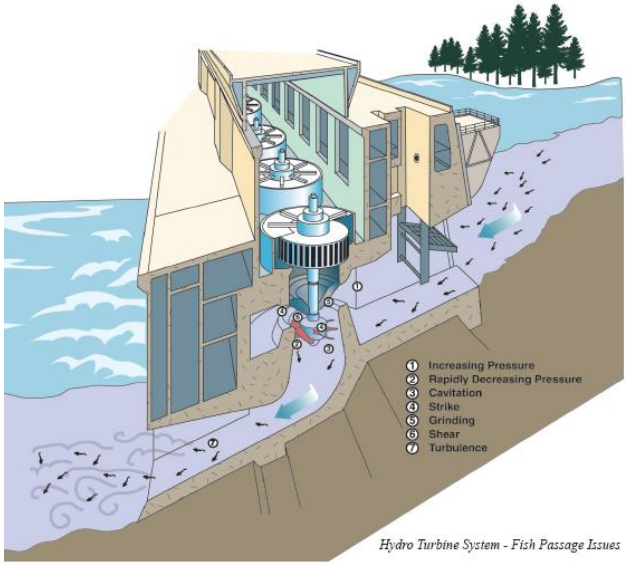
- EPRI, U.S. Department of Energy & Hydropower Industry funding:
  - Buildable turbine design from collaborative completed
  - Model test indicates favorable turbine performance
- Ready for purchase, deployment and field demonstration at a **new** hydropower site
- Retrofit design in development
- **Seeking U.S. or international site for 2016-18+ Demonstration Program**

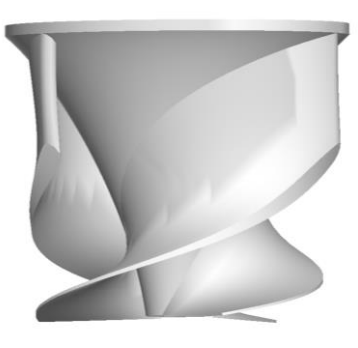
Overview of Presentation

- Brief history of the Alden turbine
- Recent EPRI efforts to complete engineering design
- EPRI efforts to find demonstration site
- **KEY QUESTIONS:**
  1. **How to engage resource agencies and NGOs to support deployment?**
  2. **How to engage investment and funding agencies and organizations to support deployment?**

Brief History of the Alden Turbine

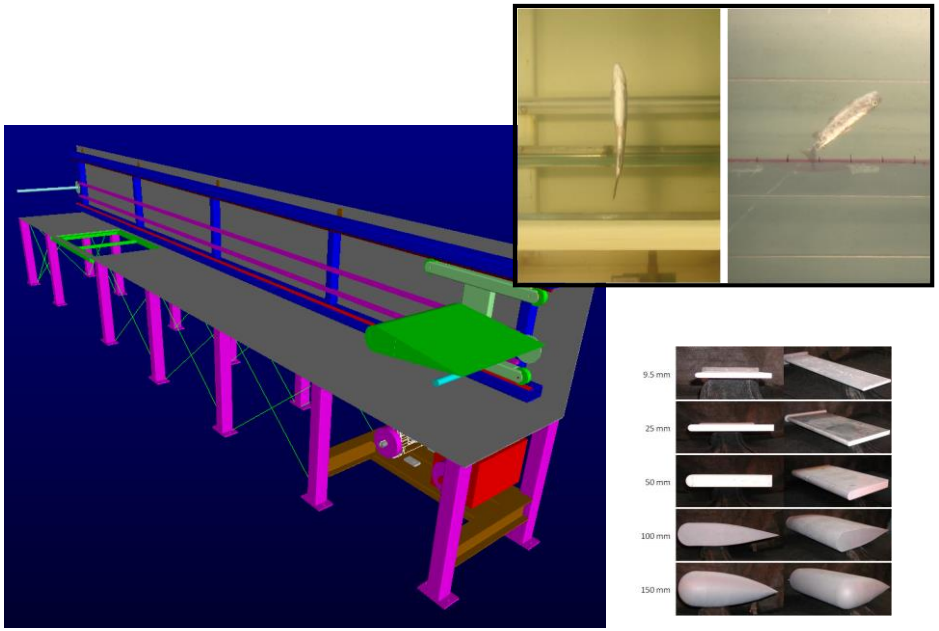
- 1995 EPRI-Industry-U.S. DOE Advanced turbine program
- Two turbine designs emerged: Minimum gap runner (MGR) and the **Alden Turbine**
  - MGR installed & “tested” in Pacific NW
  - Alden turbine only tested at pilot scale
- DOE Program canceled 2005
- EPRI took over Alden turbine’s continued development

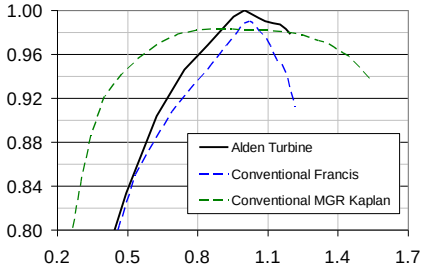




Brief History of the Alden Turbine (continued)

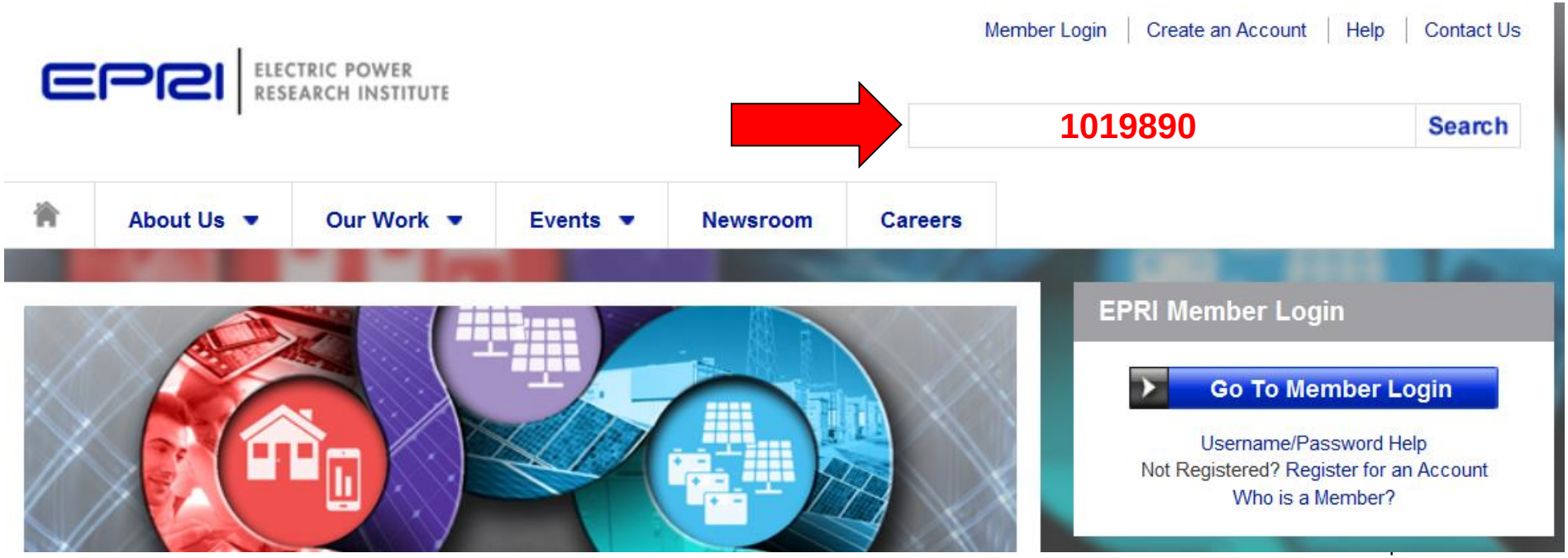
- 2006-2009: EPRI advanced turbine's conceptual design & scroll case (EPRI reports 1015600; 1014810)
- 2006-2011: EPRI turbine blade strike R&D (EPRI reports 1014937 and 1024684)
- 2009-2012: EPRI-DOE prototype & model test (EPRI report 1019890)
- 2011: EPRI-DOE turbine conference (EPRI report 1024609)
- **2012: DOE award for demonstration project…**





Accessing EPRI Reports

www.epri.com – enter report # in search box and download!



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Search Results

Your search for ***1019890*** resulted in the following:

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Product ID: 1019890 | **Published:** 07-Oct-2011 | **Type:** Technical Results | **Pages:** 280

Program: Renewable Generation

Research Results (1) | Research Support (0) | Meetings & Webcasts (0) | Web (0)

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"Fish Friendly" Hydropower Turbine Development and Deployment: Alden Turbine Preliminary Engineering and Model Testing

Product ID: 1019890 **Pages:** 280

Published: 07-Oct-2011 **Type:** Technical Results

Program: Renewable Generation (Search this Program Only)

Abstract: This report presents the results of a collaborative research project funded by the Electric Power Research Institute (EPRI), the U.S. Department of Energy (DOE), and hydropower industry partners with the objective of completing the remaining developmental engineering required for a "fish-friendly" hydropower turbine called the Alden turbine. Earlier engineering and research that was started in 1995 and completed in 2008 established a viable conceptual design. Additional engineering completed in 2009 and ...

“Fish Friendly” Turbine Development: Alden Design - What’s Different?

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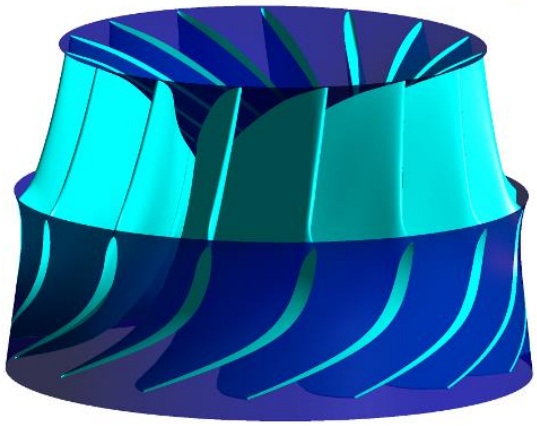
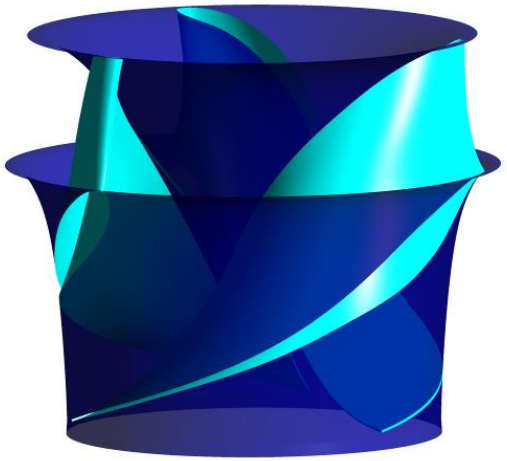
VOITH



Conventional Francis Turbine



Alden Turbine

What makes it “fish-friendly”? – larger diameter, slower rotation, reduced blades-vanes-gates, thickened leading edges on each, and eliminated damaging pressure and shear forces

Predicted Fish Survival

SPECIES TESTED


American eel


White sturgeon


Coho salmon


Rainbow trout


Smallmouth bass


Alewife

PREDICTED FULL-SCALE SURVIVAL

97 – 100 %

(based on pilot scale survival data)

Comparable Kaplan and Francis turbines < 85%

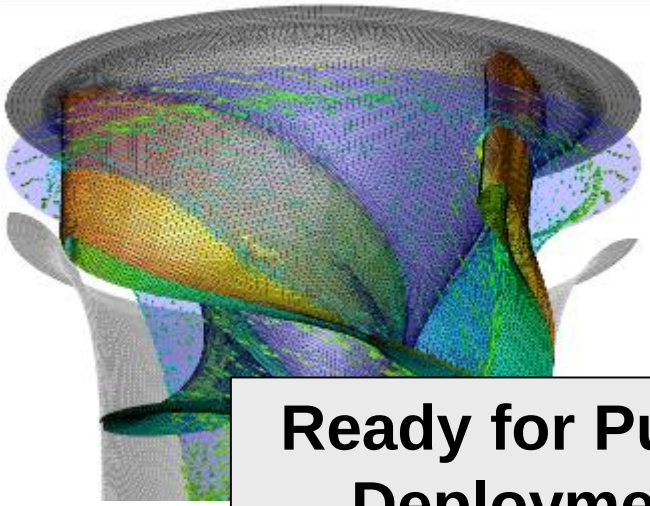
EPRI-DOE Advanced Turbine Research: Conceptual to Engineering Design (2009-12)

U.S. DEPARTMENT OF ENERGY

VOITH HYDRO POWER GENERATION

ALDEN Solving flow problems since 1894

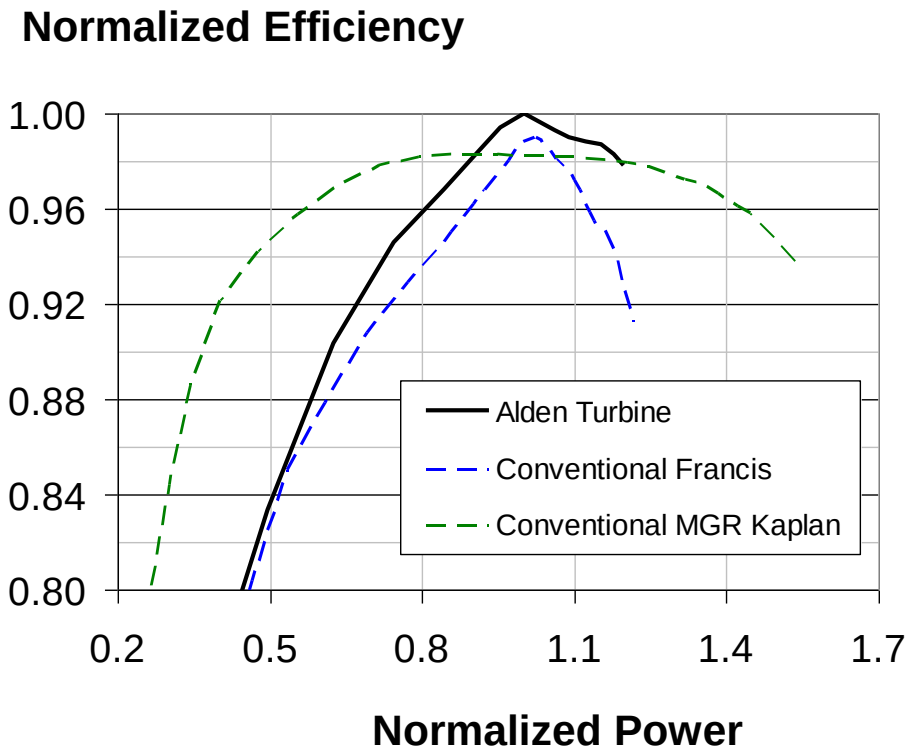
+ 8 Industry Co-sponsors

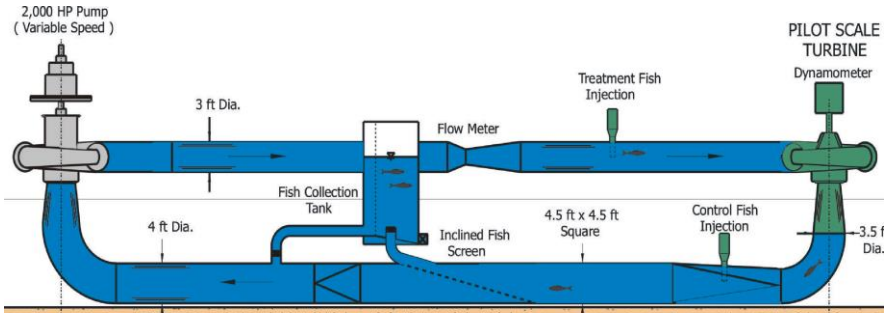


- Turbine runner refinement
- Stay ring and stay vanes
- Wicket gates
- Head cover
- Shafting, bearings, and seals
- Model construction and testing
- Supply schedule
- Cost for prototype site

Ready for Purchase, Fabrication, Deployment and Field Testing

Turbine Model Performance & Fish Survival





- Mechanical design review indicates it is readily implementable for a range of applications
- Performance exceeded expectations (94% at BEP)
- **Fish survival ~ 98%** for juvenile fish & eels compared to <85% for Kaplan and Francis designs
- EPRI Report 1019890; download at www.epri.com

Relative Turbine Costs

Cost Premium ~35%

<u>However</u>, there are offsetting benefits

- Less powerhouse excavation (higher turbine setting)
- Generating with bypass flow (previously wasted/spilled)
- Avoid O&M and capital costs for downstream fish bypass systems
- Potential permitting benefits

True/final costs comparison of project components may be less for a Alden unit than conventional units

Where Can This Turbine Be Used?

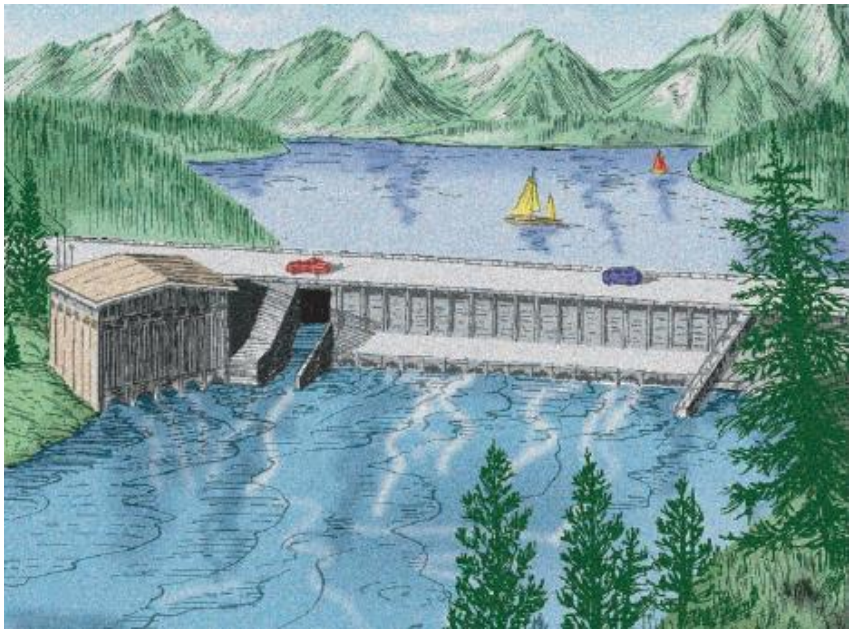
- New development
- Added capacity at existing dams
- Powering non-powered dams
- Minimum flow releases and other bypass systems

- **Have started developing a retrofit unit**

Why Demonstration?

Many to convince that this new technology is viable:

- Resource agencies
- NGOs (environmental groups)
- Industry (need better handle on cost & performance economics)



NEED Demos to reduce uncertainties in performance and cost and we need collaborative support to continue!

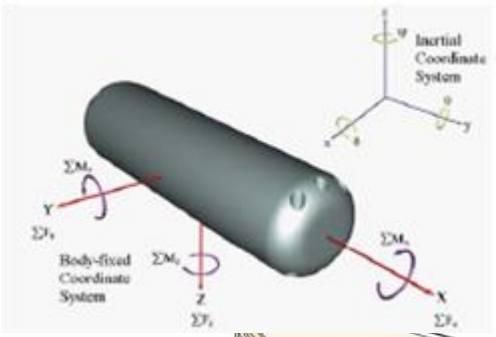
EPRI's Interest & Role in Supporting Demonstration

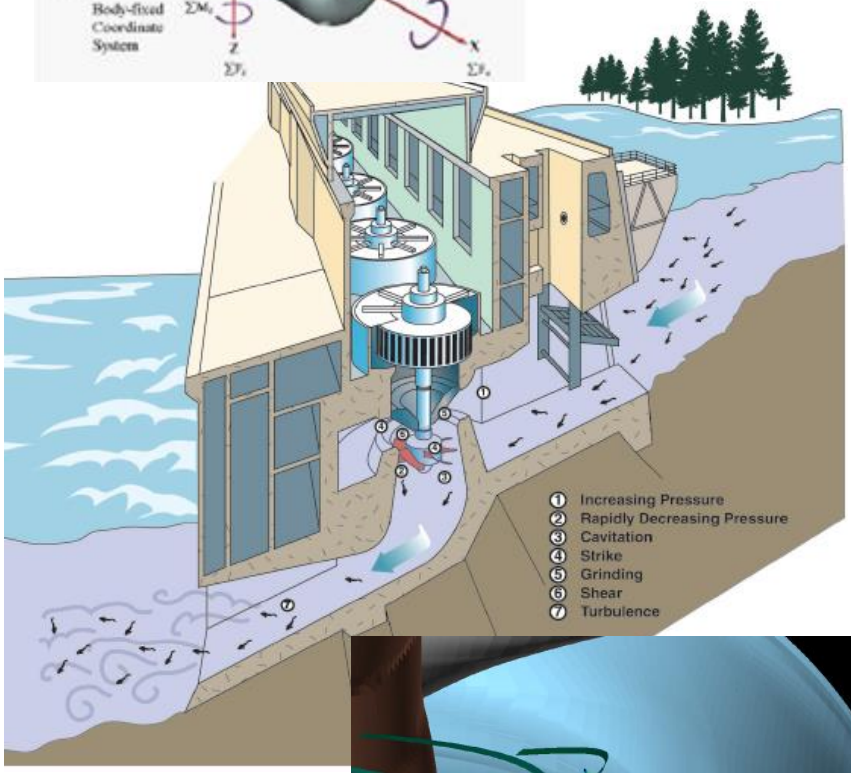
- **EPRI's Mission:** to conduct RD&D on key issues facing the electricity sector on behalf of our members, energy stakeholders, and society
- This demonstration advances an innovative electricity production option that is environmentally sustainable; low carbon and advances renewable energy options
- **EPRI will support developer to reduce investment risk**

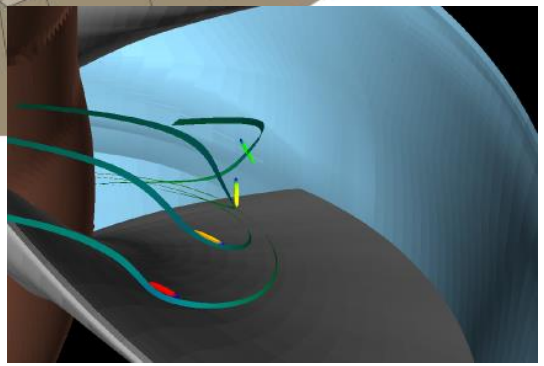
Preferred/Ideal Features of a Test Site

- **Head** = 75’ to 100’ (ideal), 30’ to 120’ (acceptable)
  - Low Head – Mortality due to blade strike is typically not a critical factor
  - High Head – Mortality may be due to other factors
- **Flow** = 1,000 cfs to 1,800 cfs (ideal), 600 cfs to 2,500 cfs (acceptable depending on head)
- **Fish Species** – juvenile anadromous salmon and/or herring, juvenile landlocked salmon, juvenile sturgeon, adult catadromous eels, juvenile and adult riverine/reservoir fish [need to validate pilot test predictions]

Future Testing





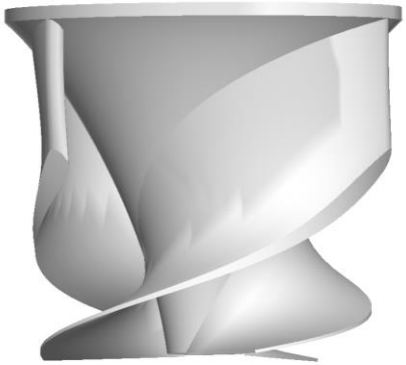


Summary

- Mechanical designs are ready for new development and will be ready for retrofit in near future
- Energy performance excellent
- There is a cost premium but offset by eliminating spillage and/or fish screening
- **NEED to engage government resource and regulatory agencies, NGOs, and investment banks**

EPRI, U.S. DOE and the Hydropower Industry

Together…Shaping the Future of Electricity



THANK YOU FOR YOUR ATTENTION!

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