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21ST CENTURY ADVANCED HYDROPOWER TURBINE SYSTEM

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Abstract

While hydropower turbine manufacturers have incrementally improved turbine technology to increase efficiency, the basic design concepts haven't changed for decades. These late 19th and early 20th century designs did not consider environmental effects, since little was known about environmental effects of hydropower at the time.

The U.S. Department of Energy (DOE) and the hydropower industry recognize that hydropower plants have an effect on the environment and there is a great need to bring turbine designs into the 21st century. DOE has issued a request for proposals (RFP) that requested proposers to discard conventional thinking, search out innovative solutions, and to visualize innovative turbines designed from a new perspective. This perspective would look at the "turbine system" (intake to tailrace) which will balance environmental, technical, and economic considerations. This paper describes the DOE Advanced Hydropower Turbine System Program.

Background

On February 18, 1993, DOE, Electric Power Research Institute (EPRI), and National Hydropower Association (NHA) representatives met to

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discuss possible joint activities. Out of this meeting came the concept of developing new, baseline "turbine" designs that give value to, and incorporate, environmental design parameters. Such an approach may require more trade offs than the conventional designs that balance only efficiency and cost. The design concepts could include, but are not limited to, the following:

- Variable speed and pitch turbines/generators to accommodate changing flow requirements (i.e., instream flow needs)
- Self-aeration turbines to maintain dissolved oxygen level requirements with minimal loss of energy production
- Durable, lightweight, cavitation-resistant materials
- Modularity, ease of maintenance
- Innovative, cost-effective fish passage strategies and technologies

Based on this February 1993 meeting, the reception of the concept presentation at the NHA Hydropower Conference in April 1993, and the expressed interest of various agencies and turbine manufacturers, DOE initiated the "Advanced Hydropower Turbine System Program." The purpose is to cost-share conceptual designs with industry to develop the next generation of hydropower turbines which will be incorporated environmentally friendly design concepts.

The NHA implemented an effort to obtain financial commitments from the industry. The initial goal of \$500,000 has been met and industry is prepared to contribute this amount in matching funds to cost share conceptual designs. NHA has created a non profit organization called the Hydropower Research Foundation, Inc. (HRFI), whose membership includes the following organizations which have donated \$50,000 each.

Electric Power Research Institute
Pacific Gas & Electric
Chelan County PUD
New England Power
Grant County PUD
Tennessee Valley Authority
Georgia Power Company
Washington Water Power Company

Idaho Power Company
Niagara Mohawk Power Corp.

PROGRAM SUMMARY

The first generation of new innovative, environmentally-friendly turbines is planned to be developed in phases as indicated below:

- | | |
|-----------|--|
| Phase I | Conceptual Designs |
| Phase II | Build and test fully engineered models of the most promising designs |
| Phase III | Build and test, to scale, prototypes of the most promising models in actual operating hydro plants |

The original estimated schedule and cost for developing the first generation of innovative, environmentally-friendly turbines is as follows:

Phase I	1 year	\$2,000,000	\$1,000,000 (actual)
Phase II	2 years	\$15,000,000	*
Phase III	2 years	\$30,000,000	*

* Currently not included DOE's FY 1996 or 1997 budget request.

Phase I

Work began on Phase I in February of 1994. DOE and NHA developed a structure for working together. This structure consists of two committees, a Steering Committee and a Technical Committee. The Steering Committee consists of DOE-HQ/DOE-ID and HRFI personnel, with both having equal representation. The purpose of the Steering Committee is to maintain focus on the program goals and objectives, establish the Technical Committee, approve technical committee members and advisors, and ensure the overall quality of the work from the Technical Committee.

The purpose of the Technical Committee is to draft the statement of work and evaluation criteria for request for proposal (RFP), review and evaluate proposals. The Technical Committee consisted of personnel from the firms represented by the HRFI, the Corps of Engineers, the Bureau of Reclamation, National Marine Fisheries Service, National Biological Survey, and the Nez Perce Department of Fisheries Management. The advisors consisted of personnel from the Idaho

National Engineering Laboratory (INEL), the Oak Ridge National Laboratory (ORNL), and other utilities. This is the first time in the history of the DOE Hydropower Program (and perhaps DOE), that major stakeholders were involved in the process of drafting a DOE solicitation.

A Notice of Intent was published in the Commerce Business Daily on April 7, 1994, to let potential proposers know that DOE would be developing a RFP for conceptual designs and put them on notice to begin formulating ideas and teams. Also, if they had suggestions for the RFP, they could submit them before May 15, 1994.

Twenty members of the Technical Committee met June 29 and 30, 1994 to develop the statement of work and evaluation criteria for the solicitation. On October 21, 1994, the Advanced Hydropower Turbine System RFP was issued, with the proposals due February 10, 1995.

Review Process

The DOE procurement procedures and regulations are not for the "weak of heart". In fact, these procedures and regulations are cumbersome, time consuming, and some defy common sense. The review process is rather boring. However, understanding the process is key to understanding the DOE procurement system.

Although the Steering and Technical Committees were established, they had no authority with regards to procurement. The Source Selection Official (SSO) is the only person who can select proposals for negotiations and subsequent award. The SSO established a Source Evaluation Panel (SEP). The purpose of SEP is to review and provide recommendations to the SSO. The SEP members consisted of five DOE-ID personnel. The Chair of the Source Evaluation Panel officially incorporated both the Steering and Technical Committees into the SEP as advisors. Figure 1 shows the organizational structure, and figure 2 shows the review process.

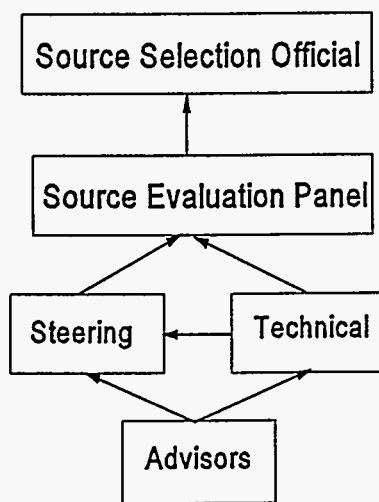


Figure 1 Organization Structure

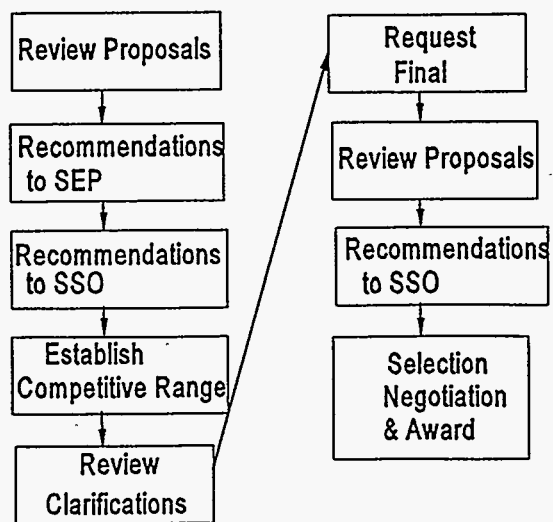


Figure 2 Review Process

Proposals are scored according to the Rating Plan. The strengths and weaknesses are noted along with any questions or items needing clarification. The Technical Committee comes to consensus on the raw scores. The SEP takes the Technical Committee's scores and recommendations into consideration while they evaluate the proposals. The weights, established by the Rating Plan, are applied to the consensus scores of the SEP. The SEP will recommend to the SSO whether to proceed ahead with selection, or to establish a competitive range. This recommendation is usually based on the need to clarify any items in a proposal in order to determine its merit. Only those proposals which have a chance to improve are considered in the competitive range. The loop of clarification and setting the competitive range can be repeated as often as needed before the best and final is requested.

DOE takes great care in maintaining the integrity of the review process. This assures that each proposal is treated equally and consistently.

And the Winners Are...

It is hoped that by the time this paper is presented at Waterpower the proposals selected for negotiations will be announced. Stay tuned!

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