PRSRT STD
US POSTAGE PAID
BRUNSWICK ME
PERMIT 65

AQUACULTURE'S BUSINESS NEWSPAPER

Fish Farming News

VOLUME 11 • NOV/DEC • 2003 A COMPASS PUBLICATION

Quality standards key to system designs

Paul Hundley

SYSTEMS ENGINEERING

In part one of this two-part article, I presented the argument that safety, reliability, control, and cost-effectiveness must be the building blocks or "basis of design" for a good seawater system (see FFN July/Aug 2003).

The basis of design is the professional and technical essence of a consulting engineer's product and service. Because of the professional liability at stake, the basis of design for all projects should be expressed in writing and factored clearly into project design and construction documents.

Let's take a look at a number of specific design features that an aquacultural engineer should incorporate into the construction of a good seawater system. First, notice that I didn't use the term architect or coastal, civil, structural, or electrical engineer. Professionals in these disciplines must also apply their expertise and develop design and construction documents for their portion of the work.

Let's also take a look at the types of information that should be included in a written basis of design.

Owner direction

When we say owner, we mean the person or entity that owns or will own the constructed project. The owner has the need and vision for the project, as well as the capital to build it, and must be legally authorized to execute and be bound by written contracts.

The owner provides general and often specific direction with regards to design and construction. A written basis of design must reflect all aspects of an owner's direction.

The essence of numerous meetings and telephone calls with the owner must be organized and summarized in the basis of design and then reviewed and updated throughout the course of the design and construction process.

Performance criteria

The needs and vision of the owner must be qualified and quantified in order to be put into writing. The aquacultural engineer must perform certain calculations and make system and equipment selections to meet and satisfy the owner's needs and to establish the quality of the constructed project.

Further, the engineer must select and apply systems and equipment that control the aquacultural processes as intended in a safe, reliable, and cost-effective manner.

The basis of design must be sound and fully documented in published standards and project-specific analyses and evaluations.

The owner's needs and vision will be dictated by his budget. The engineer will often present alternative design solutions with respective construction and life-cycle cost estimates.

In the end, the owner and engineer need to agree on the chosen design solutions and document them in the basis of design with the appropriate calculations and comparative analyses.

Standards

Safety and reliability must be at the heart of all design and construction standards and must be applied during all phases of the project — design,

Photo courtesy of Paul Hundley

Above, seawater intake structure and pump house for the University of Massachusetts – School for Marine Science Technology, South Dartmouth, MA.

construction-document development, and actual construction.

Construction standards foster the means and methods to manufacture safe and reliable equipment and to construct safe and reliable systems and facilities.

A number of organizations and agencies require and/or administer these standards and are invaluable resources to aquacultural design planning.

They include:

- American Institute of Architects;
- American National Standards Institute (ANSI);
- American Society of Agricultural Engineers;
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers;
- American Society of Mechanical Engineers (ASME);
- American Society for Testing of Materials (ASTM);
- American Welding Society;
- Canadian Standards Association International;
- Expansion Joint Manufacturer's Association;
- Institute of Electrical and Electronic Engineers;
- Instrumentation, Systems, and Automation Society;
- International Organization for Standardization;
- Manufacturers Standardization Society of the Valve and Fittings Industry;
- National Electrical Manufacturers Association;
- National Fire Protection Association (NFPA);
- Occupational Safety and Health Administration; and
- Underwriter's Laboratories (UL).

A "Google" web search on these organizations and agencies at <www.google.com> will lead to full descriptions of their products and services and how to obtain them.

A comprehensive database of industry, government, and international standards may also be found at <www.nssn.org>.

Check lists

A basis of design should list the standards employed, recognizing that they have direct bearing on the quality and costs of systems and equipment.

Referencing these standards in the design and construction documents forms part of the legal basis for the contracted design or construction. Thus, the referenced standards must be specifically applicable and not just a general catch-all list of good intentions.

Here are examples of several project areas where design factors should be spelled out. For each design area, we will address three specific categories — owner direction, performance criteria, and standards.

At right is the seawater intake structure and pump house for the US Environmental Protection Agency, Atlantic Ecology Division, Wet Laboratory, Narragansett, RI.

Pump house

In the pump house, owner direction will likely include location and aesthetics.

Stated performance criteria should address:

- Appropriate size and arrangement of equipment that allows access for maintenance;
- Doors, openings, and pathways for moving equipment;
- Protection of equipment and personnel from extreme weather; and
- Optimized location with regards to shoreline, flood plain, intake length, and power feed.

Stated standards should comply with the NFPA "Life Safety Code."

Inlet screen

When it comes to design of the inlet screen, the owner may have little or no specific direction.

Stated performance criteria should address:

- Accessibility and/or removal for cleaning;
- Structural soundness with regard to storms, waves, removal, and mechanical cleaning;
- Very low inlet velocity and minimal pressure drop;
- Oversizing to make allowances for fouling;
- Corrosion-resistant materials such as fiber-reinforced plastic; and
- Consideration of a manufacturer with more than five years of experience.

Stated standards should include those specified by ASTM and ANSI.

Intake piping

For design of intake piping, the owner may offer little or no direction.

Stated performance criteria should address:

- Arrangement and redundancy for anaerobic or other cleaning schemes;
- Structural soundness with regard to storms and waves;
- Adequate hangers, anchors, and supports;
- Optimized flow velocity with regards to pump requirements, flow scour, and energy consumption; and
- Corrosion resistant materials.

Stated standards should include those specified by ASTM and ANSI.

Pumps, motors

When it comes to the selection of pumps and motors, owner direction will likely include manufacturer or supplier preference.

Stated performance criteria should address:

- Head and flow characteristics to match process requirements and piping head loss;

- Corrosion resistance;
- Redundancy;
- Heavy, continuous duty;
- Marine duty mechanical seals and sleeves;
- Power characteristics matched to available power source, three-phase if possible;
- Suitable motor protection;
- Housekeeping pad with inertia base or other vibration isolation;
- Local and remote instrumentation;
- Isolation and check valves;
- Aligned and independently supported suction and discharge piping;
- Flexible connections for noise and vibration control:
- Local power disconnect; and
- Onsite alignment and balance.

Stated standards should include those specified by ANSI, ASTM, ASME, and UL.

Supply piping

Owner direction regarding supply piping may include routing.

Stated performance criteria should address:

- Arrangement and redundancy for anaerobic or other cleaning schemes;
- Periodic cleanouts;
- High point vents;
- Slope for draining;
- Protection from storms and waves;
- Protection from UV oxidation;
- Protection from freezing;
- Proper trenching and backfilling;
- Adequate hangers, anchors, and supports;
- Optimized flow velocity with regards to flow scour and energy consumption; and
- Corrosion resistant materials.

Stated standards should include those specified by ASTM and ANSI.

Seawater storage

Owner direction regarding seawater storage and/or head tanks may include use and configuration preferences, locations, and aesthetics.

Stated performance criteria should address:

- Holdup volume to avoid excessive pump start-stop cycling;
- Storage for supply contingencies if practical;
- Cover for temperature and/or humidity control;
- Access for inspection, cleaning, and maintenance;
- Access to internals such as spray bars, float valves, standpipes, etc.;
- High point and atmospheric vents;
- Slope for draining;
- Foundations and supports for overfilled wet weights and high winds;
- Protection from freezing; and
- Corrosion resistant materials.

Stated standards should include those specified by ASTM and ANSI.

Final thoughts

Sometimes the best template for the formal documentation of a project is a "go-by" — a closely related version of a document used for a similar project.

The well disciplined engineer, however, typically will maintain a "master," which is an all-inclusive file of past projects that includes all known design and construction issues, performance criteria, standards, details, calculations, and other factors related to major engineered systems or subsystems.

It is also good practice to develop checklists that help assure standards for quality and help with design development, as well as take into account input from other members of your design team.

In this way, a well-written basis of design will improve the quality and streamline the effort for future designs. It also is invaluable in cases where your design intentions might be questioned or challenged.

Paul Hundley is president and principal engineer for Applied Aquatics Inc., a wholly owned subsidiary of RMF Engineering Inc., which has offices in: Albany, NY; Baltimore, MD; Charleston, SC; and Durham, NC.

Hundley has more than 30 years of experience in the design, construction, and operation of commercial, industrial, and institutional facilities and has been working in aquaculture since 1988.

He can be reached via: phone (843) 971-9639; fax (843) 971-9641; or e-mail <AAquatics@RMF.com>. Copies of this and other Systems Engineering articles are available on his web site at <www.RMF.com>.

Note: Some of the information contained in this article has been generated by independent sources. Such information is accurate to the best of the author's knowledge, but the author disclaims any liability for the accuracy or completeness of such information or the reliance by any party on such information. Reader comments and corrections are always welcomed.